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# Nantahala and Pisgah National Forests



## Final Environmental Impact Statement

for the  
Land Management Plan

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**Final Environmental Impact Statement  
for the Land Management Plan  
Nantahala and Pisgah National Forests  
*National Forests in North Carolina***

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**Abstract:** This Environmental Impact statement (EIS) documents the analysis of six alternatives (A through E Modified) developed by the Forest Service to revise the land and resource management plan, as amended, for the Nantahala and Pisgah National Forests (NFs). The revised forest plan would provide for the programmatic management of approximately one million acres administered by the U.S. Forest Service in Western North Carolina (WNC). The Bureau of Land Management (BLM) is a cooperating agency, because the BLM has legal jurisdiction over the federal mineral estate underlying the Nantahala and Pisgah NFs. The EIS analyzes the anticipated progress toward desired conditions as well as potential environmental and social consequences of implementing each alternative. Alternative A is the no-action alternative and would keep in place the management direction from the current forest plan, as amended. Alternative B responds to those who desire more flexibility for managing vegetation patterns, wildlife habitats, recreation, and access. Alternative C is intended to be responsive to those who desire more certainty defined in the forest plan and less project level flexibility for managing vegetation patterns, wildlife habitats, recreation, and access. Alternative D is an intermediate approach between Alternatives B and C in terms of plan restrictions versus project flexibility for vegetation management, recreation, and access. Alternative E was added between the draft and final EIS to be responsive to public comments. Alternative E Modified incorporates instructions from the plan revision objection process and incorporates corrections of errors that were identified as needed following the issuance of the January 2022 plan and EIS. The notice of intent (NOI) to prepare an EIS was published in the Federal Register on March 12, 2014. The notice of availability (NOA) for the DEIS was published in the Federal Register on February 14, 2020, and extended an additional 45 days to close on June 29, 2020. Public input was also used to update the Revised Forest Plan and its associated Final Environmental Impact Statement. The response to those comments can be seen in FEIS Appendix A. The Forests prepared a final EIS and draft ROD, and initiated the objection filing period on January 21, 2022. The objection filing period closed on Tuesday, March 22, 2022. Changes that resulted from this objection review, including, instructions, clarifications and voluntary modifications have been made in the Plan, EIS, appendices, Record of Decision, and the project record.



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## Executive Summary

This Final Environmental Impact Statement (FEIS), prepared by the U.S. Forest Service, describes and analyzes in detail alternatives for managing the land and resources of the Nantahala and Pisgah National Forests. It describes the affected environment and discloses environmental effects of the alternatives.

### Proposed Action & Scope of the Decision

The Forest Service proposes to revise the amended Land and Resource Management Plan (forest plan or plan) for the Nantahala and Pisgah National Forests (1994) in compliance with the National Forest System (NFS) land management planning rule (36 CFR § 219), hereinafter referred to as the “2012 Planning Rule.” In this document, the terms “proposed plan,” “revised plan,” or “draft plan” are synonymous with “proposed action.”

The proposed action is needed to address significant changes that have occurred in ecological, economic, and social conditions in the area since the 1994 Amendment as well as changes in resource demands, availability of new scientific information, and promulgation of new policy, including the 2012 Planning Rule. This revised forest plan addresses the Need for Change identified at the initiation of the forest plan revision process.

The proposed action updates the goals and desired conditions, objectives, standards and guidelines, and monitoring requirements of the plan. In addition, the proposal recommends areas for inclusion in the National Wilderness Preservation System, identifies rivers that are eligible as Wild and Scenic Rivers, designates Special Interest Areas, and identifies priority watersheds.

The Forest Service has prepared the proposed plan and environmental impact statement (EIS) in accordance with Title 36 Code of Federal Regulations, Part 219 – National Forest System Land Management Planning (2012 Planning Rule), the National Forest Management Act of 1976 (NFMA), the National Environmental Policy Act (NEPA) of 1969, and other relevant federal and state laws and regulations. This EIS discloses the direct, indirect, and cumulative environmental impacts that would result from the proposed action and alternatives. The February 2020 proposed plan and associated set of maps represent the action Alternatives B, C, or D. The plan direction for Alternative E is the final plan and map set that accompanies this FEIS. The revised plan includes desired conditions, objectives, standards, and guidelines for the Forests, including a new management area (MA) framework and goals for 12 geographic areas. The preferred alternative is Alternative E Modified.

Additional documentation, including detailed analyses of project area resources, public involvement information, and various documents used in developing alternatives and as background information for the resource specialists’ analyses, may be found in the planning record located at the National Forests in North Carolina Supervisor’s Office.

Analysis in this EIS is limited to the needs for change and to significant issues (discussed below). Many issues raised during the scoping process are beyond the scope of this plan revision process and are not considered in the EIS. For example, issues associated with site-specific activities that are addressed by project-level decisions are not addressed. Project-level environmental analysis will still be completed for specific proposals to implement the forest plan’s direction.

The area affected by the proposal includes 18 counties of Western North Carolina with National Forest System Lands managed by the National Forests in North Carolina.



## Public Engagement and the Planning Process

A land management plan (Plan) that is reflective of diverse interests and communities can only be successfully implemented through sustained public involvement in an environment that is welcoming and inclusive. The final Plan and final Environmental Impact Statement (EIS) was built on an unprecedented degree of public and government involvement for the Nantahala and Pisgah NFs. The high level of collaboration and input provides a foundation for equitable benefits from the Forests and an increased understanding of the values of the diverse communities and individuals that care about the planning area. The Plan's strong emphasis on public involvement has provided a platform for diverse interests to work together to create a more inclusive and collaborative Plan.

Throughout this planning process, forest leadership and the plan revision team invested in outreach, dialogue, and relationships with partners, community stakeholders, and non-traditional audiences to engage them early and often throughout the planning process. In building the Plan, EIS alternatives, and the analysis, the Forest Service engaged with local citizens, resource professionals, state agencies, local governments, other federal agencies, federally recognized Tribes, non-government organizations, researchers, the academic community, and youth. Additionally, there have been three active collaborative groups involved with the Nantahala and Pisgah NFs plan revision process, representing diverse interests.

Public and government involvement is not just part of plan development – it will be an integral part of plan implementation, monitoring, and adaptive management. One of four plan themes is Partnering with Others, outlining how forest managers will work with other federal, state and local governments, Tribes, and partners across boundaries to achieve shared objectives as we implement the Plan. Working collaboratively allows the Forest Service to accomplish more work on the ground than any one entity could accomplish alone. The first section of plan direction outlines desired conditions for working with others, stating that public involvement will lead to better outcomes for forest resources. During implementation, public and local government involvement will allow for continued learning and understanding between the Forest Service and others and will promote a common understanding of resource opportunities and challenges. The Plan intends that proactive efforts reach both traditional and non-traditional users and lead to a greater citizen understanding, appreciation, advocacy, and participation in forest stewardship and conservation.

Input from public and government engagement has been used to:

- Document the current condition and trend of forest resources;
- Identify how the planning area is valued, how it can benefit local communities and how it can preserve traditional cultures;
- Identify the need for change;
- Draft plan direction by resource topic;
- Develop a management area structure;
- Create a geographic area chapter;
- Create alternatives;
- Inform the analysis of effects;
- Inform the final plan and environmental analysis.
- Key stages of public input included meetings prior to formal plan initiation, the plan assessment, identifying the Need for Change, the wilderness inventory and evaluation process, and development of plan content. The Notice of Intent (NOI) to Prepare an EIS was published in the *Federal Register* on

March 12, 2014. Thousands of submitted comments reflect the strong values people have for the Nantahala and Pisgah NFs as well as the commitment that individuals have for ensuring appropriate management into the future. A 135-day public comment period on the draft Forest Plan and associated DEIS was initiated on February 14, 2020. Comments received during the comment period can be viewed in the Comment Analysis and Response Application (CARA) reading room at <https://cara.ecosystem-management.org/Public//ReadingRoom?Project=43545>. Response to these public comments can be found in appendix A.

More detail on public involvement milestones and the individuals, organizations and local governments involved in forest plan development is outlined in EIS Appendix H.

## **Themes**

In working together with partners and the public, four themes emerged: connecting people to the land, sustaining healthy ecosystems, providing clean and abundant water, and partnering with others. These themes guide FS work, providing strategic focus while identifying that through shared stewardship the American public gains immense benefits from national forests beyond individual values and interests. The themes are consistent across all alternatives and were integral in shaping the forest plan desired conditions as well as the geographic area descriptions and goals.

## **Issues Addressed**

Issues raised during the plan development process help determine the scope of the analysis and shape the alternatives. The issues below are summarized from thousands of written public comments and hundreds of hours of conversations with concerned citizens and partners. While they are described as discrete issues below, they are interrelated and should be considered in the broader context of multiple-use management. For example, the amount of forest allocated to special designations has an impact on the amount of forest available for timber harvest and potentially the contributions to local economies. Access and recreation are closely related in terms of the type of recreation experiences and activities that the public is pursuing and their options for accessing the Forests.

### **Issue: Vegetation patterns and wildlife habitats**

This issue refers to the desired amount of young forest, old growth forest, and interior or core forest on NFS lands. Generally, the supply of very young forests and very old forests is limited in the plan area and there is support for providing more, although there is disagreement about the best tools for forest management and the appropriate locations for these seral stages. Regarding management tools, public interests range from favoring mechanical enhancement of young forest through silvicultural management (including timber harvest and prescribed fire) to favoring natural disturbance processes without human intervention. There are locations on the Forests where some individuals desire natural disturbances, while others see opportunities for active management to create young forest habitat.

There are differences of opinion about the use of scheduled regeneration treatments to meet desired conditions. Some believe that harvesting trees to create young forest is a necessary method for sustaining resilient forest conditions. Others would prefer that regeneration is only used to improve species composition, rather than being used to regenerate young forest of the same forest type. As a result, there are differences of opinion about the acceptable management activities that can occur on lands suitable for timber production and what types of management activities can occur on lands not suitable for timber production.

There are differences of opinion about the best way to provide old growth forest conditions, including whether the forests should be allowed to age naturally or be manipulated to expediate the development of old growth characteristics, and how much forest should be managed as old growth.

There are also differences of opinion about the best way to manage areas that have rare and unique ecological communities and values and whether these areas should be allocated to special interest areas with specific management area direction.

Vegetation patterns are inextricably linked to plant and animal species found in forest habitats, therefore management of young, old, open and closed forests leads to disagreements about the best way to manage for species diversity and abundance. There are differences of opinion about how much young forest is needed to support healthy wildlife and about what guidance is needed to protect or manage rare and unique species.

### **Issue: Special designations**

This issue addresses the number, type, and extent of special designations and recommended designations in the plan area and the impact of these designations on the other issues described here. Public interests range from support for fewer acres in special designations to support for tens or hundreds of thousands of acres of additional area designations across the Forests. General disagreement regarding special designations revolves around the allowable activities within special designations, the duration for which these designations apply, and the ability of future forest planning efforts to respond to changing conditions after designations are recommended or established. Some members of the public are concerned that additional designations would limit management flexibility, while others value the long-term protections provided by designations.

More specifically, there is a difference of opinion about the places and total acres that should be recommended to Congress for designation as wilderness. Some value that recommending an area for wilderness would set the area aside from timber management and that the area would be managed to maintain wilderness characteristics until Congress takes action to either designate the area or release it for other management. Wilderness supporters value that wilderness provides passive restoration of native ecosystems, opportunities for a remote recreation experience, and an emphasis on core interior forests that are unfragmented by roads and development. Others have concerns that recommended wilderness would limit active management, including restoration opportunities, as well as limit motorized access to the Forests, limit future opportunities for mountain biking, and limit activities that require commercial permits, such as commercial plant collection and outfitters and guides. Those who are not in favor of additional wilderness have concerns about providing management restrictions that would be long-term, citing that if Congress chooses to designate wilderness, there would be no ability to change the management emphasis in future planning efforts. Many members of the public believe that some amount of recommended wilderness is appropriate on the Nantahala and Pisgah NFs but disagree on the extent and location of recommended areas.

Some individuals desire to see more areas administratively recognized for their unique features, such as by creating a National Recreation Area for heavily used recreation areas of the Forests or creating more Special Interest Areas identified for their unique resource values. Others question whether these special designations are needed to sustain their unique characteristics and believe that highlighting unique values might increase visitation to a degree that compromises the area's characteristics or fear that special designation might preclude support for multiple-use management.

### **Issue: Access**

The access issue is related to the extent of the road and trail systems that provide access to Nantahala and Pisgah NFs. System roads are the primary means of motorized access to the national forests; however, they are also a source of concern regarding the environmental effects on water quality, wildlife habitat, and the social impacts on remote settings. The current road system has a backlog of maintenance needs. One perspective desires to reduce system road mileage by eliminating closed roads

or other roads that are determined to be “not needed” and limiting new road construction. Another perspective is to open roads that are currently closed for motorized use by the public, particularly during hunting seasons for big game and to allow access to an aging population.

There is disagreement about the use of road building to access unroaded parts of the Forests. Some forest plan objectives would require additional road building to accomplish the objectives, and opinions differ about where road building should be allowed.

There is disagreement about how and when new trails should be added to the designated system and how many trail miles are needed to provide ample access and opportunity to different recreation interests (linked to recreation issue below as well). Trail users generally wish to retain and increase trail miles for some uses, while the current trail system is financially unsustainable.

### **Issue: Recreation**

Many forest users have an activity they want perpetuated or enhanced and many have a preferred setting in which to enjoy that activity. Forest visitors seeking developed recreation generally desire different forest settings than hunters and anglers. Trail uses can be incompatible, such as horse-riding, hiking, or mountain biking, and some users prefer separate locations to emphasize different types of experiences. Some recreation experiences on the Forests exclude others – for example, mountain biking is prohibited in recommended wilderness, leading to tension when deciding where to emphasize wilderness characteristics versus future mountain biking opportunities. Another multiple use tension arises from the issue that some recreationists do not desire to see or experience multiple-use management of the Forests, such as timber management, while they are recreating.

Recreation demands on the Forests are increasing, and this must be balanced with the reality that recreation has varying degrees of impact on forest resources and maintaining recreation infrastructure requires funding. In order to be sustainable, recreation use must be ecologically sound, socially supported, and economically feasible to maintain by the Forests and partners. There are different views of how to improve recreation sustainability and how future recreation projects should be planned.

### **Issue: Economic contributions of the Forests**

Many residents of WNC depend on the Forests for their way of life, for food from hunting and gathering, and sometimes for their professional livelihoods. The importance of economic and social contributions of the Forests to the surrounding communities is an issue that has been raised by many commenters and local governments. While some outputs from management can be easily valued, such as timber receipts, firewood permits, and recreation fees, contributions of other goods and services are more difficult to measure, such as wildlife habitat and diversity, scenic landscapes, recreational tourism, clean water, and clean air. There are diverse perspectives about the best mix of management techniques to provide benefits for recreation and tourism, outfitter and guides, forest product industries, and quality of life in the surrounding communities.

### **Issues not addressed in the revised forest plan**

Two issues of note that are not addressed in the revised forest plan are 1) an availability decision regarding oil and gas leasing on the Nantahala and Pisgah NFs and 2) management of the Chattooga Wild and Scenic River. Due to the geology, there is low potential for commercial development of oil and gas deposit and the oil and gas availability decision was not included in this forest plan revision process. If technologies change and there is interest in commercial interest in developing those resources, the oil and gas availability will be re-evaluated at that time. The Chattooga Wild and Scenic River is managed in coordination with the Sumter NF and the Chattahoochee-Oconee NF. Ongoing monitoring is necessary to determine if a change in visitor use management on the Chattooga River is needed. Additional

explanation regarding the Chattooga River is included in FEIS Chapter 2, Alternatives Considered but Eliminated from Detailed Study.

## Alternatives

Since Fall 2014, plan direction and maps have been shared and refined to be responsive to public comments, collaborative input, and agency review. As a result, plan direction and management area allocations have been iteratively adjusted during the planning process.

In summary, developing action alternatives began with an analysis of the Need for Change in 2014, which reviewed the existing plan and identified what should be carried forward unchanged and what needed to change in the revised forest plan. The Need for Change helped to inform and build a proposed plan that was responsive to the needs of the Forests and responsive to public concerns regarding future management. Preliminary plan content was shared with the public during late 2014. The forestwide direction was adjusted and shared again in 2016. An updated management area construct and management area and geographic area direction was shared in 2017 for most general management areas (management area direction for special designations was not available at that time).

The Forest Service is acutely aware that the development of alternatives has the potential to polarize interests, harming the collaborative strides we have all made to seek mutually beneficial solutions. Therefore, our alternative development took care to ensure that the themes of the alternatives did not polarize interests, but, instead, built upon shared values. For example, while it would have been much simpler for this analysis to set up one alternative that maximized land in passive management such as Recommended Wilderness and another to contrast it with most active management and fewest acres recommended for wilderness, care was taken to avoid such polarizing stances. In this EIS, the alternative with the most Recommended Wilderness is also the alternative with the most land of the Forests in active timber management, as both can be accomplished on the same Forest.

The following alternatives are analyzed in detail, including the no action (Alternative A) and Action Alternatives (B, C, D, E and E Modified):

The plan direction for Alternative A is reflected in the current forest plan as amended. The plan direction for Alternatives B, C, and D is reflected in the proposed plan that accompanied the DEIS. Differences between plan direction for Alternatives B, C and D (for plan components ECO-S-28, REC-S-14, REC-O-07) are explained within the proposed plan itself on the appropriate page for each plan component. The plan direction for Alternative E is the plan that accompanied the January 2022 FEIS and draft record of decision. The plan direction for Alternative E Modified is the final plan that accompanies this FEIS, reflecting changed plan direction resulting from instructions, voluntary modifications, and clarifications identified during the Plan revision objection process.

Differences in proposed land allocations can be seen by reviewing the accompanying set of maps. Forestwide maps that can be used to coarsely compare alternatives are available in Appendix I, although the more detailed set of maps should be reviewed to compare specific locations, as the small maps in this chapter do not capture the full degree of detail.

Together, the changes in plan direction and management area allocation respond to the Need for Change and the significant issues that are described in Chapter 1 of the FEIS.

While all five alternatives provide for a wide range of multiple uses, goods, and services, each addresses the issues in different ways, reflecting the range of opinions expressed in public comments.

- **Alternative A, the No Action:** This alternative is the current forest plan, as amended. The current forest plan would continue to guide management of the Nantahala and Pisgah NFs under this alternative.

- **Alternative B** responds to those who desire more flexibility for managing vegetation patterns, wildlife habitats, recreation, and access. This alternative:
  - Provides the largest land base for creating young forest structure through mechanical treatment in the Matrix management area.
  - Designates the smallest old growth network in the forest plan but allows for the most project level flexibility for making old growth network adjustments during plan implementation.
  - Provides the most flexibility for adding new trails to the trail system.
  - Includes the largest amount of the forest where road access is prioritized, including the most opportunities for opening seasonally closed roads in Interface and Matrix for hunting and other uses, with the most acres available for new road building.
  - Recommends the most acreage for future designation as wilderness by Congress; this is consistent with the theme of retaining flexibility for locating young forest habitat and access, because areas recommended for wilderness are generally not areas that would otherwise be managed for young forest habitat or motorized access.
- **Alternative C** is intended to be responsive to those who desire more certainty defined in the forest plan and less project level flexibility for managing vegetation patterns, wildlife habitats, recreation and access. This alternative:
  - Allocates a greater amount of the Forests to Backcountry and responds to the issue of designating places with rare and unique ecological values into the Ecological Interest Areas management areas. This would provide more limitations on the timber management activities that can occur in these locations.
  - Establishes a larger old growth network than Alternatives A, B, and D and sets the footprint of the network for the life of the forest plan.
  - Responds to the need for more sustainable recreation by being the most restrictive when adding new trails to the system, allowing the least flexibility for adding trails during plan implementation.
  - Includes the fewest opportunities for opening seasonally closed roads in Interface and Matrix for hunting and other uses.; includes and a greater emphasis on decommissioning unneeded roads in Backcountry, with the fewest acres available for new road building.
  - Recommends the fewest acres for wilderness, instead providing the greatest acreage of backcountry that provides a semi-primitive non-motorized recreation experience, some of which may be suitable for future mountain biking opportunities.

**Alternative D** is an intermediate approach between Alternatives B and C in terms of plan restrictions versus project flexibility in managing for vegetation patterns, wildlife habitat, recreation, and access. This alternative:

- Responds to the issue of designating places with rare and unique ecological values into the Ecological Interest Area MA, it also maintains much of the Forests in the Matrix MA, allowing for flexibility of active management to meet young forest habitat needs and respond to emerging forest health issues.



- Establishes an old growth network that is larger than Alternative B and smaller than Alternative C and E and allows for project level additions where old-growth conditions are under-represented.
- Provides moderate restrictions on new trail building and establishes a new tool, a trail bank, which can be used across the Forests to build sustainable trail miles.
- Provides motorized access opportunities between the amounts in Alternatives B and C for opening seasonally closed roads in Interface and Matrix for hunting and other uses, decommissioning unneeded roads in Backcountry, and the percent of the forest open to new road building.
- This alternative recommends only those areas with the highest quality wilderness characteristics for wilderness designation, more than Alternative C but less than Alternative B.

**Alternative E** incorporates public comments between the draft and final plan. This alternative:

- Increases emphasis on prescribed fire, using fire and mechanical harvest to restore open forest conditions, and nonnative invasive species treatments in tiered objectives.
- Establishes an old growth network that is larger than any of the other alternatives and sets the footprint of the network for the life of the forest plan.
- Addresses the challenge of trail management by collaborating with partners to focus on supply and demand issues on some geographic areas of the forest and ensuring that new trail miles are socially, ecologically and fiscally sustainable, and in good locations for future soil and water needs.
- Provides motorized access opportunities comparable to Alternative D, focusing on opening seasonally closed roads in Interface and Matrix for hunting and other uses, and decommissioning unneeded roads in Backcountry.
- Recommends more acres and areas for wilderness than Alternatives A and C, but less than B and D, recommending areas with the strongest wilderness characteristics in combination with public comments and management needs for other multiple uses.

**Alternative E Modified** incorporates remedies, voluntary modifications, and clarifications identified during the Plan revision objection process and incorporates corrections of errors that were identified as needed following the issuance of the January 2022 plan and EIS.

- A list of changes to the plan is shown in Chapter 2. All modifications are within the range of effects considered by the other action alternatives and are responsive to issues identified in previous comment periods and during objections.
- The sub-bullets above for Alternative E also apply to Alternative E Modified.
- Except where Alternative E Modified is specifically noted in the discussion of effects, it can be assumed that the effects of Alternative E discussed in Chapter 3 are the same as the effects of Alternative E Modified.

Additional alternatives were considered but eliminated from detailed study.

## **Summary of Effects Analysis**

### **Alternative features by comparison**

The following tables compare alternatives by summarizing management area allocations and the ability to achieve desired conditions, focusing on selected indicators for the issues used for alternative development.

There are instances where total forest acreage numbers of management areas may not be considerably different between alternatives, however the location of where those acres are identified across the landscape may be very different. The detail of how different places are proposed to be managed must be examined at a fine scale to appreciate the effects of those designations. Comparison of aggregate acres of management areas between alternatives at the broad landscape scale does not reveal the meaningful differences between alternatives. Therefore, a simple chart comparing acres should not be relied on for alternative comparison as much as reviewing management area maps.

**Table i. Alternative Features Comparison, Organized by Issue**

<b>Plan Decision</b>	<b>Alt. A</b>	<b>Alt. B</b>	<b>Alt. C</b>	<b>Alt. D</b>	<b>Alt. E</b>	<b>Alt. E Modified (preferred)</b>
<b>Issue 1: Vegetation Patterns and Wildlife Habitats</b>						
<i>Young forest creation (annual acres)</i>	650 acres <sup>1</sup>	Tier 1: 650-1200 acres Tier 2: 1200 to 3200 acres				
<i>Intermediate thinning treatments (annual acres)</i>	150 acres <sup>2</sup>	Tier 1: 150-400 acres Tier 2: 400- 600 acres				
<i>Thin and burn for open forest woodland (annual acres)</i>	N/A	N/A	N/A/	N/A	Tier 1: 300 to 600 acres Tier 2: 600 to 900 acres	
<i>Land operable for timber management, all conditions (estimated acres)</i>	206,000-430,000 acres	240,000-594,000 acres	238,000-488,000 acres	243,000-535,000 acres	233,000-505,000 acres	
<i>Land operable for timber management, commercially viable currently (estimated acres)</i>	98,000-216,000 acres	113,000-265,000 acres	111,000-235,000 acres	113,000-260,000 acres	108,000-245,000 acres	
<i>Plan level designated old growth network (acres)</i>	211,118 acres	202,524 acres	255,968 acres	226,015 acres	265,441 acres	
<i>Adjustments to the old growth network expected at the project level</i>	Project level adjustments may be made	Project level adjustments may be made	Network set at plan level; no project level adjustments	Project level adjustments must meet identified conditions	Network set at plan level; no project level adjustments	
<i>Prescribed fire (annual acres)</i>	8,500 acres	Tier 1: 6,500 to 10,000 acres Tier 2: 10,000 to 20,000 acres				Tier 1: 10,000 to 20,000 acres Tier 2: 20,000 to 45,000 acres
<i>Ecological Interest Area MA (acres)</i>	N/A	0	79,550 acres	26,000 acres	22,195 acres	

<sup>1</sup> Young forest and intermediate thinning acreage from Alt A represents the activity levels as implemented in the last 10 years, not as planned in the 1994 plan, which was much higher. See EIS Ch. 3 for more.

<sup>2</sup> Young forest and intermediate thinning acreage from Alt A represents the activity levels as implemented in the last 10 years, not as planned in the 1994 plan, which was much higher. See EIS Ch. 3 for more.

Plan Decision	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E Modified (preferred)
Issue 2: Special Area Designations						
Special Interest Areas	50,519 acres	102,650 acres			118,810 acres	119,462 acres
Wilderness - Designated	6 areas; 66,400 acres					
Wilderness Study Areas	5 areas; 26,816 acres					
Recommended Wilderness	3 areas (3 WSAs); 15,226 acres	23 areas (5 WSAs); 126,333 acres	2 areas (2 WSAs); 11,193 acres	16 areas (4 WSAs); 74,173 acres	14 areas (4 WSAs); 49,098 acres	
Wild and Scenic Rivers - Designated	3 rivers					
Wild and Scenic Rivers - Eligible	10 rivers	19 rivers			18 rivers	19 rivers
Appalachian National Scenic Trail corridor <sup>3</sup>	16,100 acres	45,290 acres	51,660 acres	49,900 acres	48,152 acres	48,533 acres
Heritage Corridors	NA	8,370 acres	8,760 acres	8,530 acres	6,512 <sup>4</sup> acres	
Scenic Corridors	NA	23,310 acres	20,940 acres	23,770 acres	21,851 acres	
Issue 3: Access						
Percent of the forest in management areas where road access is prioritized	51%	60%	48%	59%	58%	

<sup>3</sup> The Appalachian Trail National Scenic Trail corridor will be managed comparably under all alternatives. Under alternative A, a smaller area was mapped in the forest plan than the area that is regularly considered in project design. The proposed plan in the action alternatives has been updated to incorporate the potential foreground acreage that is reviewed at the project level. Corridor acreage differs among action alternatives because of variations in recommended wilderness.

<sup>4</sup> Between the release of the proposed plan and final plan, the location of the Trail of Tears National Historic Trail was updated based on new information, resulting in an adjustment to this management area location. More information is available in the Tribal Resources section of Chapter 3.

<b>Plan Decision</b>	<b>Alt. A</b>	<b>Alt. B</b>	<b>Alt. C</b>	<b>Alt. D</b>	<b>Alt. E</b>	<b>Alt. E Modified (preferred)</b>
<i>Percent of the forest in management areas where road building is not allowed</i>	11%	23%	14%	19%	17%	
<b>Issue 4: Recreation</b>						
<i>Approach to adding trail miles to the system</i>	N/A	Least restrictive	Most restrictive	Moderately restrictive, with a trail bank	Moderately restrictive without a trail bank	
<i>Acres managed for semi-primitive non-motorized recreation (Estimated Acres)</i>	146,000 acres	177,000 acres	313,000 acres	206,000 acres	208,000 acres	
<i>Acres managed for primitive recreation (Estimated Acres)</i>	65,000 acres	194,000 acres	96,000 acres	145,000 acres	121,000 acres	
<i>Recreation focused management area</i>	N/A	67,150 acres	55,200 acres	66,980 acres	65,890 acres	66,305 acres
<b>Issue 5: Economic Contributions of the Forests</b>						
<i>Jobs Generated<sup>5</sup></i>	3,280	Tier 1: 3,421 Tier 2: 3,809	Tier 1: 3,417 Tier 2: 3,821	Tier 1: 3,420 Tier 2: 3,804	Tier 1: 3,425 Tier 2: 3,808	
<i>Labor Income</i>	\$109,110,000	Tier 1: \$116,702,000 Tier 2: \$134,394,000	Tier 1: \$116,484,000 Tier 2: \$134,923,000	Tier 1: \$116,653,000 Tier 2: \$134,207,000	Tier 1: \$116,862,000 Tier 2: \$134,141,000	
<i>Projected Wood Sale Quantity (PWSQ)</i>	3.8 MMCF	Tier 1: 6.1 MMCF Tier 2: 11.8 MMCF	Tier 1: 6.2 MMCF Tier 2: 12.3 MMCF	Tier 1: 6.1 MMCF Tier 2: 11.6 MMCF	Tier 1: 5.0 MMCF Tier 2: 11.1 MMCF	

<sup>5</sup> The estimated differences in job and labor income between alternatives are not meaningful given fluctuations in local and global market conditions and actual resource use. The meaningful difference is shown between Tier 1 and Tier 2 activity levels, not between alternatives themselves.

Plan Decision	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E Modified (preferred)
<i>Projected Timber Sale Quantity (PTSQ)</i>	2.1 MMCF	Tier 1: 4.4 MMCF  Tier 2: 10.1 MMCF	Tier 1: 4.5 MMCF  Tier 2: 10.6 MMCF	Tier 1: 4.4 MMCF  Tier 2: 9.9 MMCF	Tier 1: 3.3 MMCF  Tier 2: 9.4 MMCF	
<i>Acres Suited for Timber Production</i>	361,176	405,657	321,670	409,337	459,175	458,027

### Comparison of how alternatives move toward long-term desired conditions

Below is a summary of the effects of implementing each alternative. Information in the table is focused on activities and effects where different levels of effects can be distinguished quantitatively or qualitatively among alternatives.

**Table ii. Summary of the Ability of Each Alternative to Achieve Management Needs and Key Desired Condition Concepts as Analyzed and Disclosed in Chapter 3**

#### Key

++ = very effective at achieving desired conditions

+ = effective at achieving desired conditions

o = neutral contribution toward achieving desired conditions

- = ineffective at achieving desired conditions

-- = very ineffective at achieving desired conditions

Long Term Desired Condition	Ability to Move Toward Desired Conditions					
	Alternative A*	Alternative B*	Alternative C*	Alternative D*	Alternative E*	Alternative E Modified*
Plan theme: Sustaining Healthy Ecosystems						
<i>Increasing pace and scale of ecological restoration</i>	O	+	+	+	+	+
<i>Increasing open forest habitat in short supply</i>	O	+	+	+	++	++



Long Term Desired Condition	Ability to Move Toward Desired Conditions					
	Alternative A*	Alternative B*	Alternative C*	Alternative D*	Alternative E*	Alternative E Modified*
<i>Increasing young forest habitats in short supply</i>	-	++	++	++	++	++
<i>Increasing old growth habitat in short supply</i>	++	++	++	++	++	++
<i>Provide a representative network of designated old growth</i>	+	-	++	+	++	++
<i>Protecting and restoring unique habitats</i>	+	++	++	++	++	++
<i>Providing for the persistence of rare species including Species of Conservation Concern</i>	++	++	++	++	++	++
<i>Improving fire regimes for ecosystem health</i>	-	+	+	++	++	++
<i>Reducing risk to communities from wildfire</i>	+	+	+	++	++	++
<i>Addressing emerging forest health threats</i>	-	+	+	+	+	+
Plan theme: Providing Clean and Abundant Water						
<i>Maintaining healthy watersheds – priority watersheds</i>	+	++	++	++	++	++

Long Term Desired Condition	Ability to Move Toward Desired Conditions					
	Alternative A*	Alternative B*	Alternative C*	Alternative D*	Alternative E*	Alternative E Modified*
<i>Improving aquatic organism passage</i>	+	+	+	+	+	+
<i>Reducing unneeded and unauthorized roads</i>	O	+	++	+	+	+
Plan theme: Connecting people to the land						
<i>Recognizing places and uses that are important to visitors</i>	O	++	++	++	++	++
<i>Recognizing cultural and Tribal values of the Forest</i>	O	++	++	++	++	++
<i>Improving seasonal access to closed roads</i>	O	++	+	+	+	+
<i>Providing opportunities for solitude and unconfined recreation</i>	O	++	O	+	+	+
<i>Improving recreation sustainability</i>	-	O	+	++	++	++
<i>Contributing to local economies</i>	+	++	++	++	++	++
<i>Providing timber forest products</i>	+	++	++	++	++	++
Plan theme: Partnering with Others						

Long Term Desired Condition	Ability to Move Toward Desired Conditions					
	Alternative A*	Alternative B*	Alternative C*	Alternative D*	Alternative E*	Alternative E Modified*
<i>Leveraging resources to achieve shared goals</i>	O	++	++	++	++	++
<i>Incorporating public involvement in project design</i>	+	++	++	++	++	++
<i>Recognizing opportunities to work across the Forest boundary</i>	O	++	++	++	++	++

\*In this table, Alternative A is analyzed as currently implemented. Alternatives B-E are analyzed as planned.

The above information is considered an executive summary and greater detail can be found within the full Environmental Impact Statement.



## Chapter 1: Purpose and Need

### 1.1 Proposed Action

The Forest Service proposes to revise the amended Land and Resource Management Plan (forest plan or plan) for the Nantahala and Pisgah National Forests (1994) in compliance with the National Forest System (NFS) land management planning rule (36 CFR § 219), hereinafter referred to as the “2012 Planning Rule.”

The proposed action is needed to address significant changes that have occurred in ecological, economic, and social conditions in the area since the 1994 Amendment as well as changes in resource demands, availability of new scientific information, and promulgation of new policy, including the 2012 Planning Rule. This revised forest plan addresses the Need for Change identified at the initiation of the forest plan revision process.

The Forest Service has prepared the proposed plan and environmental impact statement (EIS) in accordance with Title 36 Code of Federal Regulations, Part 219 – National Forest System Land Management Planning (2012 Planning Rule), the National Forest Management Act of 1976 (NFMA), the National Environmental Policy Act (NEPA) of 1969, and other relevant federal and state laws and regulations. This EIS discloses the direct, indirect, and cumulative environmental impacts that would result from the proposed action and alternatives. The plan direction for Alternative A is reflected in the current (1994) forest plan as amended. The February 2020 proposed plan and associated set of maps represent the action Alternatives B, C, or D. The plan direction for Alternative E is the plan and map set that accompanied the January 2022 FEIS and draft record of decision. The plan direction for Alternative E Modified is the final plan that accompanies this FEIS, reflecting changed plan direction resulting from instructions, voluntary modifications, and clarifications identified during the Plan revision objection process. The revised plan includes desired conditions, objectives, standards, and guidelines for the Forests, including a new management area (MA) framework and goals for 12 geographic areas. The preferred alternative is Alternative E Modified.

Additional documentation, including detailed analyses of project area resources, public involvement information, and various documents used in developing alternatives and as background information for the resource specialists’ analyses, may be found in the planning record located at the National Forests in North Carolina Supervisor’s Office.

Analysis in this EIS is limited to the needs for change and to significant issues (discussed below). Many issues raised during the scoping process are beyond the scope of this plan revision process and are not considered in the EIS. For example, issues associated with site-specific activities that are addressed by project-level decisions are not addressed. Project-level environmental analysis will still be completed for specific proposals to implement the forest plan’s direction.

### 1.2 Document Structure

This Environmental Impact Statement (EIS) is organized into four chapters:

- *Chapter 1. Purpose and Need for Action:* This chapter includes information on the history of the forest plan, the purpose and need for the forest plan revision, and the Forest Service’s proposal for achieving that purpose and need. This section also details how the Forest Service informed the public of the plan development and how the public responded.
- *Chapter 2. The Proposed Action and Alternatives:* The chapter provides a more detailed description of the Forest Service’s proposed plan as well as alternative methods for achieving the

stated purpose. For this forest plan revision, the proposed plan serves as the proposed action. The proposed plan and accompanying maps identify where plan direction differs by alternative. These alternatives were developed based on significant issues raised by the public and other agencies, which are described. Finally, this section provides a summary table of the environmental consequences associated with each alternative.

- *Chapter 3. Affected Environment and Environmental Consequences:* The chapter describes the environmental effects of implementing the draft plan and other alternatives. The analysis is organized by resource area.
- *Chapter 4. List of Preparers and Consultation and Coordination:* The chapter provides a list of preparers and agencies consulted during the development of the EIS.
- *Literature Cited*
- *Appendices:* The appendices provide more detailed information to support the analyses presented in the EIS.
  - *Appendix A. Response to Comments*
  - *Appendix B. Description of the Analysis Process*
  - *Appendix C. Ecological Sustainability Analysis*
  - *Appendix D. Vegetation Modeling Methods*
  - *Appendix E. Wilderness Evaluation Process*
  - *Appendix F. Wild and Scenic River Evaluation Process*
  - *Appendix G. Coordination with other Public Planning Efforts*
  - *Appendix H. Public and Government Involvement*
  - *Appendix I. Maps*
- *Accompanying document:* Nantahala and Pisgah National Forests Land Management Plan
- *Additional resource:* Final Response to Objection Issues and Instructions

## 1.3 Background

The Nantahala and Pisgah National Forests (NFs) are located in 18 counties in Western North Carolina (WNC). Pisgah National Forest (NF) was established in 1916 and Nantahala NF in 1920. The two National Forests together now total approximately 1,043,000 acres in size (USDA Forest Service 2013c) and are managed under one Land Management Plan (forest plan). The total land area of the 18-county assessment area is approximately 4,795,098 acres, with over 77 percent forest land. The National Forests are within a much larger matrix of forest land, predominantly privately owned forest land. Figure 1 displays the Nantahala and Pisgah NFs across the 18-county area in WNC. For ease of discussion throughout this document, the Nantahala and Pisgah NFs will be referred to as “the Forests” when referencing the single administrative unit, the staff that administers the unit, or the NFS lands within the unit.



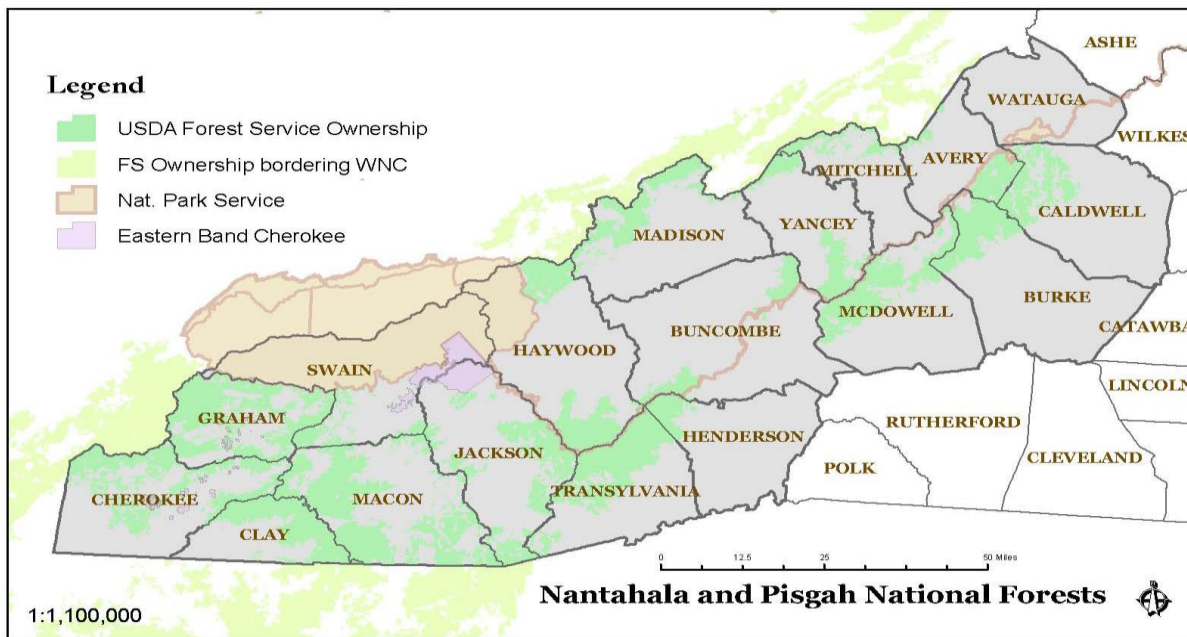


Figure 1. Nantahala and Pisgah National Forests

Management of the Nantahala and Pisgah NFs is organized into six ranger districts.

Nantahala NF:

- Cheoah District based in Robbinsville, NC
- Tusquitee District based in Murphy, NC
- Nantahala District based in Franklin, NC

Pisgah NF:

- Pisgah District based in Pisgah Forest, NC
- Appalachian District based in Mars Hill, NC
- Grandfather District based in Nebo, NC

## The Nantahala and Pisgah National Forests

The Nantahala and Pisgah NFs lie within a geological area known as the Blue Ridge province of the Appalachian Mountains. These mountains form a southwest to northeast range through WNC and contain many peaks over one mile in elevation. The Nantahala and Pisgah NFs are home to a rich diversity of plant and animal species, provide an abundance of clean air and water, and attract visitors from across the country because of their scenic beauty, wildlife habitats, and recreational opportunities.

The 18-county plan area is home to many third- and fourth-generation residents, many of Scots-Irish descent. In addition, many retirees and second-home owners have moved into the area over the years, both groups citing the natural beauty and cultural opportunities of the area as major reasons for their move. The town of Cherokee, NC, located within the Qualla Boundary in the far western part of the state, is the cultural center of the Eastern Band of Cherokee Indians. Approximately 8,000 of the 13,000 enrolled members of the Tribe live within the Qualla Boundary. Other Cherokee lands in North Carolina include the 2,255-acre parcel in Graham County, home to the Snowbird community, and 5,320 acres scattered throughout Cherokee County.

The WNC region is favored with abundant supplies of water and many localities depend at least in part on water coming from the NFS lands. Nantahala and Pisgah NFs supply timber to the local mills, including an element of high-quality hardwoods that may not be as available from private timberlands. Firewood, plus a wide variety of medicinal, edible, and horticultural and craft plants, is available from these National Forests by permit, whereas other public lands may not provide those benefits. The Forests contain areas of importance to members of several Native American tribes, ensuring that opportunities for traditional practices and access to sacred sites are preserved.

The Forests play an important role in sustaining the diversity of plant and animal communities present in the plan area. For example, they contain a greater proportion of high elevation forests and other high elevation ecosystems including high elevation red oak, northern hardwood, spruce-fir, and beech gap/boulder field forests and Southern Appalachian balds, than are available in the surrounding landscape. These forest communities provide habitat for many rare or uncommon species of plants and animals such as Gray's lily, spruce-fir moss spider, and Carolina northern flying squirrel. Many of the plants and animals that comprise the highly diverse Southern Appalachian ecosystems may have opportunity to thrive across the broader landscape, but those that are rare or that require special conditions may be better protected or find refuge on parts of the landscape more common within the National Forest System lands and the rare habitats found there. Additionally, as reflected by the multitude of high elevation areas, there are hundreds of miles of coldwater streams that support aquatic species of high ecological and public value, such as native brook trout.

Most of the forested land in WNC is privately owned; therefore, many residents and visitors do not have access for recreation, hunting and fishing, or forest product gathering. The Forests provide visitors and residents with that opportunity, providing access to both developed recreation areas and remote backcountry locations. The Nantahala and Pisgah NFs are among the most visited forests in the country and provide visitors with unique opportunities for a wide range of recreational activities and experiences that also provide economic support to surrounding communities. Many visitors to the forests are local; however, many also visit from neighboring states including Alabama, Georgia, Tennessee, Virginia, and West Virginia (National Visitor Use Monitoring, 2013). The largest cities within an hour and a half driving radius include Atlanta, Knoxville, Chattanooga, Charlotte, and Winston-Salem. In addition, Asheville, NC, the Blue Ridge Parkway, and Great Smoky Mountains National Park draw national and international audiences.

A wide range of developed and dispersed recreational opportunities are offered in the Nantahala and Pisgah NFs. The majority of gamelands open for hunting in WNC are located in the Nantahala and Pisgah National Forests. Likewise, whitewater rafting and the economic benefits derived from outfitter guides are for the most part provided by rivers that run at least in part through NFS lands. Additionally, the preponderance of public land at the high elevations that allows for passage of the Appalachian National Scenic Trail and unobstructed views from the Blue Ridge Parkway are additional economic drivers to the local economies. These one-of-a-kind scenic attractions that are available on the Forests add to the sense of place for residents and draw tourists that contribute to local economies.

## **The Forest Plan**

The original forest plan for the Nantahala and Pisgah NFs was signed in 1987 and was updated with a significant forest plan amendment in 1994. There have been 26 amendments to the forest plan addressing new land acquisitions, management of Wild and Scenic Rivers, and updated plan direction based on best available scientific information.

The revised plan will guide management of NFS lands so that they are ecologically sustainable and contribute to social and economic sustainability; consist of ecosystems and watersheds with ecological integrity and diverse plant and animal communities; and have the capacity to provide people and

communities with ecosystem services and multiple uses that provide a range of social, economic, and ecological benefits for the present and into the future. These benefits include clean air and water; habitat for fish, wildlife, and plant communities; and opportunities for recreational, spiritual, educational, and cultural benefits (36 CFR 219.1(c)). The purpose of this land management plan is to guide future projects, practices and uses, to assure sustainable multiple-use management on the Nantahala and Pisgah NFs over the next 15 years..

## **1.4 Purpose and Need for Action**

The National Forest Management Act (NFMA) requires that forest plans be revised every 10 to 15 years or when conditions on the planning unit have changed substantially. The existing forest plan for the Nantahala and Pisgah NFs is over twenty years old, and since the amended plan was approved in 1994, there have been changes in economic, social, and ecological conditions, as well as changes in resource demands, availability of new information based on monitoring and scientific research, and promulgation of new policy, including the 2012 Planning Rule. Additionally, extensive public and employee involvement, along with science-based evaluations, have helped to further identify the areas of the existing forest plan that need to be changed. Below is a summary of the Need for Change that was identified through public involvement early in the plan revision process. A more fully developed description of the Need for Change is available in the planning record.

The 2014 Need for Change identified that there is a need to achieve the following in the revised plan:

### **Across All Forest Resources**

- Address how forest management in all resource areas should be prioritized given varying budget and personnel levels likely to be available over the course of the planning cycle;
- Review the overall management area framework used in the 1987 Plan and consider modifications to reduce complexity and increase flexibility for restoration and creation of wildlife habitat;
- Update objectives to reflect realistic expectations regarding the amount of work that can be achieved within a planning cycle;
- Recognize and include plan components to guide and potentially enhance the role of the Nantahala and Pisgah NFs contribution to social and economic sustainability by supporting local cultures and economies through commodity production, including timber and other multiple-use products, and the service-based economy that includes recreation and tourism;
- Include plan direction regarding potential climate change impacts such as increases in storm events, flooding, wildfires, and other extreme weather;
- Incorporate opportunities for working across boundaries to manage landscapes with adjacent land managers, such as state and federal partners, tribes, and other land management entities;
- Update direction to be consistent with the 2012 Planning Rule and other recent laws and policies.

### **Ecosystems, Rare Habitats, and Rare Species**

- Restore habitat components such as tree species composition and canopy structure in a variety of ecosystems, including young and old growth forest;
- Manage, maintain, or restore ecosystems, watersheds and rare habitats to better control non-native invasive species and to reconsider riparian area management;

- Address current and future forest health impacts including insect pests, diseases, and pathogens;
- Manage prescribed fire by incorporating direction with an integrated resource approach to prescribed fire activities and flexibility for restoration and maintenance of ecosystems;
- Identify priority watersheds for restoration;
- Clarify plan direction for the designated old growth network.

## **Wildlife and Fish Habitat**

- Restore declining aquatic and terrestrial wildlife habitat and consider species in decline, including game and non-game species appreciated by wildlife enthusiasts such as hunters, anglers, birders, etc.;
- Increase the amount of young forest across the landscape;
- Improving aquatic passage in streams.

## **Recreation and Scenery**

- Transition recreational facilities to accommodate a sustainable level of use;
- Respond to changing trends in services, activities, and types of facilities desired by the public, while balancing those trends with fiscal reality;
- Address the sustainability of the trail systems considering changing trends in use, conditions, and maintenance capacity, including volunteer groups;
- Integrate scenery management as a part of ecosystem management for the National Forests.

## **Designated Areas**

- Clarify and update plan direction regarding designated areas including Special Interest Areas, Roan Mountain, the Appalachian Trail, and Experimental Forests;
- Conduct inventory and evaluation of potential additions to Wilderness and identify the eligibility of rivers for inclusion in the National Wild and Scenic Rivers System. Reconsider previous recommendations for Wilderness and update plan direction regarding management of Wilderness and Wilderness Study Areas (WSA), and other designated areas;
- Clarify management direction for the congressionally designated Cradle of Forestry in America;
- Clarify management for continued recreation at Bent Creek Experimental Forest while ensuring research objectives are met.

## **Roads**

- Manage roads given the reality of limited maintenance funds combined with the public's desire for motorized access to the Forests;
- Manage a sustainable road system that includes road construction and reconstruction as well as direction for closing out unneeded roads, including temporary roads and roads in environmentally or geologically hazardous locations;
- Address the public's desire to access the National Forests.

## **Cultural and Tribal Resources**

- Recognize and manage traditional cultural properties and sacred sites, such as the Trail of Tears;

- Consider landscapes of cultural value in management area direction, including Cherokee town sites, historic trail corridors, and high elevation balds.

## Special Uses

- Update plan language regarding special use permitting.

Using the above Need for Change that was defined in 2014, and extensive additional public involvement, the Forest Service established parameters for the development of the forest plan in 2016, such that all alternatives would do the following:

- Provide for multiple uses that include a balanced level of timber harvest, recreation, wildlife, water, and wilderness in compliance with the Multiple Use Sustained Yield Act and NFMA.
- Improve forest health and resiliency by increasing the pace and scale of restoration above current levels; maintaining and improving the diversity of forest vegetation, especially young forest, open forest, and old growth conditions; and control invasive species.
- Improve wildlife habitat. The plan maintains or improves habitat conditions for the wildlife species that depend on the forest, including federally listed species and species of conservation concern, rare and unique habitats, as well as resident and migrant game species, pollinators, birds, bats, fish, and more. This includes direction to provide young forests in strategic locations that benefit those species dependent on these habitats which are in short supply.
- Contribute to clean and abundant water. The plan contributes to sustainable surface water and ground water flow, protects water quality through national forest lands, maintains fish and wildlife habitat, controls erosion, restores streams and streamside zones, and continues to provide a source of drinking water to communities in WNC.
- Improve the Forests' world class recreation opportunities for year-round outdoor play and exercise. The plan provides for both developed and dispersed recreation on land and water, from an outdoor multiple use trail system to indoor facilities, ensuring opportunities and sites are sustainable for the future.
- Enable forest access for visitors, including hunting and fishing and gathering of forest products, as well as providing for the needs of federally recognized tribes.
- Contribute to local economies by collaboratively providing resources, improvements to infrastructure, sustainable levels of renewable forest commodities, and contributing to local businesses, tourism, and sustainable community growth.
- Contribute to the economy from timber receipts, outfitter and guide permits, recreation, and tourism. All plan alternatives will sustain the Forests' scenic beauty and cultural resources, enabling the Forests to remain a destination for spiritual renewal and connecting to our shared history.
- Manage existing administrative and congressionally designated areas which will not be changed during revision. These areas include:
  - The Cradle of Forestry Historic Site
  - Wild and Scenic Rivers
  - Inventoried Roadless Areas
  - Research Natural Areas
  - Experimental Forests
  - National Scenic and Historic Trails such as the Appalachian Trail and the Trail of Tears

- Wilderness
  - Wilderness Study Areas
- Recognize the value of partners in shaping our shared future. The plan demonstrates how other agencies, government and non-government partners, volunteers, and visitors contribute to sustaining these National Forests and will identify and help facilitate additional opportunities to work together for shared goals.
- Build around input from the public, governments, federally recognized tribes and best available science.
- Provide geographic area direction for the Forests' distinct landscapes, recognizing opportunities for restoration and sustainable recreation opportunities, connections to nearby communities, and opportunities for partnerships with the public, other organizations, and governments in each part of the Forests.

## 1.5 Decision Framework

The forest supervisor of the National Forests in North Carolina is the responsible official for this project and will make the final decision on the selected alternative for the revised plan. The forest supervisor will review the proposed plan alternatives and their environmental consequences, while considering the identified needs for change and issues raised during the scoping process, the requirements of the NFMA (P.L. 94-588) and the Multiple Use-Sustained Yield Act (P.L. 86-517) of 1960, and the diverse needs of forest users and sustainable resource management. Based on the analysis in this EIS and public comments, the responsible official will identify a selected alternative in a draft record of decision that will be subject to an objection process guided by direction in 36 CFR Subpart B (219.50 to 219.62).

After reviewing the results of the analysis evaluated in the final EIS, the responsible official will issue a draft record of decision, in accordance with agency decision making procedures (40 CFR 1502.2) that will:

- Disclose the decision (identifying the selected alternative) and reasons for the decision,
- Discuss how public comments and issues were considered in the decision, and
- Discuss how all alternatives were considered in reaching the decision, specifying which one is the environmentally preferable alternative (defined in 36 CFR 220.3).

A final record of decision and accompanying forest plan will create a framework and set a course of action for managing the Nantahala and Pisgah NFs for the next 10 to 15 years. Approval of the forest plan will identify management areas and will include recommendations for areas that can only be designated by statute, such as wilderness.

Forest plans are strategic in nature and do not compel the agency to undertake any site-specific projects. Rather, plans establish overall desired conditions and objectives that the individual national forest strives to meet. Forest plans also establish limitations on what actions would be authorized and what conditions would be met during project level decision-making. Project-level environmental analysis will still need to be completed for specific proposals to implement the direction in the forest plan.

The identification of species of conservation concern will be made by the regional forester in coordination with the forest supervisor.

The Bureau of Land Management (BLM) is a cooperating agency in the Nantahala and Pisgah NF plan revision, because the agency has legal jurisdiction over the federal mineral estate underlying the Nantahala and Pisgah NFs.

**The decision elements of a forest plan include the following:**

**1. Plan components that together form a framework designed to provide for multiple use management that maintains or restores ecological sustainability and plant and animal diversity and contributes to social and economic sustainability.**

**Desired Conditions** - A narrative description of the characteristics of the plan area toward which management should be directed (36 CFR 219.7(e)(1)(i)); FSH 1909.12, chapter 20, section 22.11). Desired conditions are in the long term and may not be immediately achieved.

**Objectives** - Measurable, time-specific statements of the desired rate of progress toward a desired condition or conditions. (36 CFR 219.7(e)(1)(ii)), FSH 1909.12, chapter 20, section 22.12).

**Standards and Guidelines** - Constraints on project and activity decision making (36 CFR 219.7(e)(1)(iii) and (iv)), FSH 1909.12, chapter 20, section 22.13 and 22.14).

**Determinations of the Suitability of Lands for Various Uses** - Mandatory identifications of lands that are “suitable” and “not suitable” for timber production and identifications of lands that are “suitable” or “not suitable” for various other uses (36 CFR 219.7(e)(1)(v)) and 36 CFR 219.11, FSH 1909.12, chapter 20, section 22.15).

**Goals** - Broad statements of intent other than desired conditions (36 CFR 219.7 (e)(2), FSH 1909.12, chapter 20, section 22.16).

**2. Management areas and geographic areas and their applicable plan components** (36 CFR 219.7 (d); FSH 1909.12, chapter 20, section 22.2).

**3. A monitoring program** (36 CFR 219.7 (f)(i)(iii); 36 CFR 219.12.3; FSH 1909.12, chapter 30).

**4. Identification of watersheds that are a priority for maintenance or restoration** (36 CFR 219.7 (f)(i); FSH 1909.12, chapter 20, section 22.31).

**5. Identification of riparian management zones** (36 CFR 219.8 (a)(3)(ii); FSH 1909.12, chapter 20, section 23.11e).

**6. Identification of the eligibility of rivers in the plan area for Wild & Scenic River designation** (36 CFR 219.7 (c)(2)(vi); FSH 1909.12, chapter 80).

**7. Recommendations, if any, for wilderness designation of lands in the plan area** (36 CFR 219.7 (c)(2)(v); FSH 1909.12, chapter 70).

**8. Recommendations for establishment of designated areas or establishment of such areas** (36 CFR 219.7 (c)(2); FSH 1909.12, chapter 20, section 24).

Together these desired conditions, objectives, suitability of lands, standards, guidelines, management areas, and geographic areas will provide a management framework for the Nantahala and Pisgah NFs until amended or revised.

## **1.6 Public Engagement and the Planning Process**

A forest plan that is reflective of diverse public interests can only be successfully implemented through sustained public involvement in an environment that is welcoming and inclusive. Forest leadership and the plan revision Interdisciplinary Team (IDT) invested in dialogue and relationships with partners and community stakeholders and engaged them early and often throughout the planning process. A detailed review of the public engagement process is included as Appendix H of this document; the following section is an overview.

The proposed action and analysis were built on an unprecedented degree of public input. Since the planning process began, the Forest Service has engaged with interested citizens, resource professionals, non-government organizations, researchers, the academic community, and youth. To gather input for the assessment, plan, and analysis, the agency hosted 49 face-to-face plan revision meetings around the Forests. Forest Service staff have been invited to participate in or present at dozens of meetings with organizations that have interests in the National Forests, have attended monthly meetings of active coalitions, and have engaged directly with individual citizens who have attended meetings or submitted comments.

Government input has also been integral to the development of the proposed action and analysis. In addition to ongoing district ranger interaction with the local governments, the forest supervisor and district rangers reached out to all 18 counties in the plan area and had in-person meetings with elected officials in 15 counties and the three NC Councils of Government to address the forest plan revision process. Forest Service staff engaged with 12 federally recognized tribes that have connections to forest lands. The Forest Service has also sought input from multiple state and federal agencies on many resource topics.

The plan's strong emphasis on public involvement has provided a platform for diverse interests to work together to create a more collaborative plan. New groups representing multiple interests formed during the plan development process and provided comments to the Forest Service as coalitions. Two were very active, meeting almost monthly from the assessment stage throughout plan development and providing input at each stage of plan development: the Nantahala-Pisgah Forest Partnership and the Fish and Wildlife Conservation Council.

To better understand zones of agreement around critical plan issues, the Forest Service sought the assistance of the National Forest Foundation (NFF), a congressionally chartered non-profit partner. NFF supported a formal collaborative process known as the Stakeholders Forum for the Nantahala and Pisgah Forests plan revision which brought diverse interests together regularly during the plan development phase.

The design of public participation was dynamic, allowing opportunities to both inform the public and accept feedback on the overall approach to the planning process as well as specific elements of the plan. Public participants had opportunities to engage in the planning process through public meetings, workshops, open houses, email, and postal mail. Meetings and workshops, offered in locations around the Forests, provided the public with opportunities to learn about forest resources, provide input on plan components, and review and refine plan content.

Key stages of public input included meetings prior to formal initiation, the plan assessment, identifying the Need for Change, the wilderness inventory and evaluation process, and development of plan content. The Notice of Intent (NOI) to Prepare an EIS was published in the *Federal Register* on March 12, 2014. Thousands of submitted comments reflect the strong values people have for the Nantahala and Pisgah NFs as well as the commitment that individuals have for ensuring appropriate management into the future. A 135-day public comment period on the draft Forest Plan and associated DEIS was initiated on February 14, 2020. Comments received during the comment period can be viewed in the Comment Analysis and Response Application (CARA) reading room at <https://cara.ecosystem-management.org/Public//ReadingRoom?Project=43545>. Response to these public comments can be found in appendix A.

In working together with partners and the public, four themes emerged: connecting people to the land, sustaining healthy ecosystems, providing clean and abundant water, and partnering with others. These themes are described below and apply forestwide across all resource areas. These themes are described below and apply forestwide across all resource areas. These themes guide FS work, providing strategic focus while identifying that through shared stewardship the American public gains immense benefits



from national forests beyond individual values and interests. The themes are consistent across all alternatives and were integral in shaping the forest plan desired conditions as well as the geographic area descriptions and goals.

### **Theme: Connecting People to the Land**

From the very beginning, the forests of Western North Carolina have been recognized for their importance to people. The rich cultural mosaic of people who have called this region their home depend on the forest for scenic beauty, year-round outdoor play and exercise, spiritual renewal, traditional uses like hunting, fishing, and gathering, and economic opportunity.

Under this theme, the plan recognizes the contribution of the Pisgah and Nantahala NFs to communities and quality of life in the broader region, and the cultural traditions and economies that depend on the forest. Objectives address management of sustainable recreation, volunteerism, nature-based education, forest products, protection of cultural resources, and relationships with federally recognized tribes and improving inclusivity and diversity in connecting people to the land.

### **Theme: Sustaining Healthy Ecosystems**

The Nantahala and Pisgah NFs support a diversity of forest communities from southern pine to northern hardwood forests. When compared to the southern Appalachian Region, the forests contain a proportionally greater amount of high-elevation forests and southern Appalachian balds, rare plant and animal communities, and headwater streams than the area as a whole.

Under this theme, the plan focuses on improving the ability of forests to remain healthy and resilient, despite stresses and disturbances. Objectives under this theme address maintaining and improving the diversity of forest structure (age classes or seral stages), composition (species) and function; managing the use of silvicultural and fire tools; managing for wildlife habitat and rare species and communities; and controlling noxious weed and invasive plants.

### **Theme: Providing Clean and Abundant Water**

Water is a life-sustaining resource for the Nantahala and Pisgah NFs and the natural and social communities that depend on it. Beyond the ecological communities, forest waters also support municipal water supplies, tribal lands, agriculture and industry.

Under this theme, plan components focus on how management will contribute to sustainable surface water and groundwater flow, maintain natural hydrology and fish and wildlife habitat, control erosion, and stabilize streambanks and apply best management practices for water quality. Objectives under this theme address watershed improvement projects, maintaining water quality, road maintenance, stream restoration, habitat management, and mitigate effects of acid rain on NFS lands.

### **Theme: Partnering With Others**

The U.S. Forest Service collaborates with partners to enhance its mission to sustain the National Forests in North Carolina. Forest managers work with other federal, state and local governments, Tribes, and partners across boundaries to achieve shared objectives. Working collaboratively allows us to accomplish more work on the ground than any one agency could do alone.

Plan direction under this theme prepares the Nantahala and Pisgah National Forests to be a model for partnerships. A section on public involvement describes how citizens and groups can engage in project development early in the process; tiered objectives that were requested by the public and partners reflect additional outcomes that may be possible with added capacity of partners and partner resources; and geographic area goals identify opportunities to accomplish cross boundary needs that serve the American public. The plan also emphasizes expanding the diversity of forest visitors, volunteers, and partners, and increasing public land employment pathways across all demographics.

## 1.7 Identifying the Issues

Citizens, organizations and governments submitted comments in response to the Notice of Intent during the 30-day comment period in 2013 and at numerous public meetings and engagements between 2013 and 2017. All public engagement documentation is located in the project record. All comments were reviewed to identify issues and frame their associated cause and effect relationships. Issues were separated into significant and non-significant issues. Non-significant issues are identified as those: 1) outside the scope of the proposed action; 2) already addressed by law, regulation, the proposed revised plan, or other higher level decision; 3) irrelevant to the decision to be made; or 4) conjectural and not supported by scientific or factual evidence. Significant issues are defined as those directly or indirectly caused by implementing the proposed action. For details on how these issues were used to formulate alternatives, see the “Alternatives Considered in Detail” section of chapter 2.

The issues below are summarized from thousands of written public comments and hundreds of hours of conversations with concerned citizens and partners. While they are described as discrete issues below, they are interrelated and should be considered in the broader context of multiple-use management. For example, the amount of forest allocated to special designations has an impact on the amount of forest available for timber harvest and potentially the contributions to local economies. Access and recreation are closely related in terms of the type of recreation experiences and activities that the public is pursuing and their options for accessing the Forests.

### **Issue: Vegetation Patterns and Wildlife Habitats**

This issue refers to the desired amount of young forest, old growth forest, and interior or core forest on NFS lands. Generally, the supply of very young forests and very old forests is limited in the plan area and there is support for providing more, although there is disagreement about the best tools for forest management and the appropriate locations for these seral stages. Regarding management tools, public interests range from favoring mechanical enhancement of young forest through silvicultural management (including timber harvest and prescribed fire) to favoring natural disturbance processes without human intervention. There are locations on the Forests where some individuals desire natural disturbances, while others see opportunities in the same locations for active management to create young forest habitat.

There are differences of opinion about the use of scheduled regeneration treatments to meet desired conditions. Some believe that harvesting trees to create young forest is a necessary method for sustaining resilient forest conditions. Others would prefer that regeneration is only used to improve species composition, rather than being used to regenerate young forest of the same forest type. As a result, there are differences of opinion about the acceptable management activities that can occur on lands “suitable for timber production” and what types of management activities can occur on lands “not suitable for timber production.”

There are differences of opinion about the best way to provide old growth forest conditions, including whether the forests should be allowed to age naturally or be manipulated to expediate the development of old growth characteristics, and how much forest should be managed as old growth.

There are also differences of opinion about the best way to manage areas that have rare and unique ecological communities and values and whether these areas should have different management area direction.

Vegetation patterns are inextricably linked to plant and animal species found in forest habitats, therefore, management of young, old, open and closed forests leads to disagreements about the best way to manage for species diversity and abundance. There are differences of opinion about how much

young forest is needed to support healthy wildlife and about what guidance is needed to protect or manage rare and unique species.

### **Issue: Special Designations**

This issue addresses the number, type, and extent of special designations and recommended special designations in the plan area and the impact of these designations on the other issues described here. Public interests range from support for fewer acres in special designations to support for tens or hundreds of thousands of acres of additional area designations across the Forests. General disagreement regarding special designations revolves around the allowable activities within special designations, the duration for which these designations apply, and the ability of future forest planning efforts to respond to changing conditions after designations are recommended or established. Some members of the public are concerned that additional designations would limit management flexibility, while others value the protections provided by designations.

More specifically, there is a difference of opinion about the places and total acres that should be recommended to Congress for designation as wilderness, the most restrictive type of FS management. Some value that recommending an area for wilderness would set the area aside from timber management and that the area would be managed to maintain wilderness characteristics until Congress takes an action to either designate the area or release it for other management. Wilderness supporters value that wilderness provides passive restoration of native ecosystems, opportunities for a remote recreation experience, and an emphasis on core interior forests that are unfragmented by roads and development. Others have concerns that Recommended Wilderness would limit active management, including restoration opportunities, as well as limit motorized access to the Forests, limit future opportunities for mountain biking, and limit activities that require commercial permits, such as commercial plant collection. Those who are not in favor of additional wilderness have concerns about providing management restrictions that would be long-term, citing that if Congress chooses to designate wilderness, there would be no ability to change the management emphasis in future planning efforts. Many members of the public believe that some amount of Recommended Wilderness is appropriate on the Nantahala and Pisgah NFs but disagree on the extent and location of recommended areas.

Some individuals desire to see more areas administratively recognized for their unique features, such as by creating a National Recreation Area for heavily used recreation areas of the Forests or creating more Special Interest Areas identified for their unique resource values. Others question whether these special designations are needed to sustain their unique characteristics and believe that highlighting unique values might increase visitation to a degree that compromises their characteristics or fear that special designation might preclude support for multiple-use management.

### **Issue: Access**

The access issue is related to the extent of the road and trail systems that provide access to Pisgah and Nantahala NFs. System roads are the primary means of motorized access to the national forest; however, they are also a source of concern regarding the environmental effects on water quality, wildlife habitat, and the social effects on remote settings. The current road system has a backlog of maintenance needs. One perspective desires to reduce system road mileage by eliminating closed roads or other roads that are determined to be “not needed” and limiting new road construction. Another perspective is to open roads that are currently closed for motorized use by the public, particularly during hunting seasons for big game.

There is disagreement about the use of road building to access unroaded parts of the Forests. Some forest plan objectives would require additional road building to accomplish the objectives, and opinions differ about where road building should be allowed.

There is disagreement about how and when new trails should be added to the designated system and how many trail miles are needed to provide ample access and opportunity to different recreation interests (linked to recreation issue below as well). Trail users generally wish to retain and increase trail miles for some uses, while the current trail system is financially unsustainable.

### **Issue: Recreation**

Many forest users have an activity they want perpetuated or enhanced and many have a preferred setting in which to enjoy that activity. Forest visitors seeking developed recreation generally desire different forest settings than hunters and anglers. Trail uses can be incompatible, such as horse-riding, hiking, or mountain biking, and some users prefer separate locations to emphasize different types of experiences. Some recreation experiences on the Forests exclude others – for example, mountain biking is prohibited in recommended wilderness, leading to tension when deciding where to emphasize wilderness characteristics versus future mountain biking opportunities. Another multiple use tension arises from the issue that some recreationists do not desire to see or experience multiple-use management of the Forests, such as timber management, while they are recreating.

Recreation demands on the Forests are increasing, and this must be balanced with the reality that recreation has varying degrees of impact on forest resources and maintaining recreation infrastructure requires funding. In order to be sustainable, recreation use must be ecologically sound, socially supported, and economically feasible to maintain by the Forests and partners. There are different views of how to improve recreation sustainability and how future recreation projects should be planned.

### **Issue: Economic Contributions of the Forests**

Many residents of WNC depend on the Forests for their way of life, for food from hunting and gathering, and, sometimes, their professional livelihoods. The importance of economic and social contributions of the National Forests to the surrounding communities is an issue that has been raised by many commenters and local governments. While some outputs from management can be easily valued, such as timber receipts, firewood permits, and recreation fees, contributions of other goods and services are more difficult to measure, such as wildlife habitat and diversity, scenic landscapes, recreational tourism, clean water, and clean air. There are diverse perspectives about the best mix of management techniques to provide benefits for recreation and tourism, outfitter and guides, forest product industries, and quality of life in the surrounding communities.

### **Issues Not Addressed in the Revised Forest Plan**

Two issues of note that are not addressed in the revised forest plan are 1) an availability decision regarding oil and gas leasing on the Nantahala and Pisgah NFs and 2) management of the Chattooga Wild and Scenic River. Due to the geology, there is low potential for commercial development of oil and gas deposit and the oil and gas availability decision was not included in this forest plan revision process. If technologies change and there is interest in commercial interest in developing those resources, the oil and gas availability will be re-evaluated at that time. The Chattooga Wild and Scenic River is managed in coordination with the Sumter NF and the Chattahoochee-Oconee NF. Ongoing monitoring is necessary to determine if a need to change visitor use management on the Chattooga River is needed. Additional explanation regarding the Chattooga River is included in Chapter 2, Alternatives Considered but Eliminated from Detailed Study.

## **1.8 Best Available Scientific Information**

The 2012 planning rule requires the responsible official to use the best available scientific information to inform the development of a forest plan. Resource specialists considered what is most accurate, reliable, and relevant in their use of the best available scientific information. The best available scientific

information includes the publications and other sources listed in the Literature Cited section of this Draft Environmental Impact Statement. Best available science also includes information obtained from other sources, such as participation and attendance at scientific conferences, scientific knowledge from local experts, findings from ongoing research projects, workshops and collaborations, professional knowledge and experience, and information received during public participation periods.

## 1.9 Other Related Efforts

Previously approved and ongoing projects and activities are not required to meet the direction of the revised forest plan and will remain consistent with the direction in the 1986 forest plan, as amended.

Revised forest plan direction will apply to all projects and/or activities that have a decision made on or after the effective date of the final record of decision. A project or activity approval document will describe how the project or activity is consistent with the applicable plan components.

When a proposed project or activity would not be consistent with the applicable plan components, the responsible official shall take one of the following steps, subject to valid existing rights (36 CFR 219.15(c)):

- Modify the proposed project or activity to make it consistent with the applicable plan components,
- Reject the proposal or terminate the project activity,
- Amend the plan so that the project or activity will be consistent with the plan, as amended, or
- Amend the plan contemporaneously with the approval of the project or activity so that the project or activity will be consistent with the plan, as amended. This amendment may be limited to apply only to the project or activity.

The forest supervisor or district ranger is the responsible official for project-level planning. In order for prohibitions or activities to take place on the ground, project decisions will need to be made following site-specific analysis in compliance with NEPA.



## **Chapter 2: Alternatives**

This chapter describes and compares the alternatives considered for the forest plan revision for the Nantahala and Pisgah NFs. It includes a description of each alternative considered and presents the alternatives in comparative form, clearly defining the differences between each alternative and providing a clear basis for choice among options by the decision maker.

In addition to the no action alternative, this analysis considers five action alternatives, further described below. Alternative E Modified is the preferred alternative.

### **2.1 Alternative Development**

#### **2.1.1 Summary of Alternative Development Milestones**

Since Fall 2014, plan direction and maps have been shared and refined to be responsive to public comments, collaborative input, and agency review. As a result, plan direction and management area allocations have been iteratively adjusted during the planning process.

In summary, developing action alternatives began with an analysis of the Need for Change in 2014, which reviewed the existing plan and identified what should be carried forward unchanged and what needed to change in the revised forest plan. The Need for Change helped to inform and build a proposed plan that was responsive to the needs of the Forests and responsive to public concerns regarding future management. Preliminary plan content was shared with the public during late 2014. The forestwide direction was adjusted and shared again in 2016. An updated management area construct and management area and geographic area direction was shared in 2017 for most general management areas (management area direction for special designations was not available at that time). The draft EIS and proposed plan were published in February 2020 and public comments helped inform the development of Alternative E, as presented in the final EIS. Alternative E Modified incorporates remedies, voluntary modifications, and clarifications identified during the Plan revision objection process and incorporates corrections of errors that were identified as needed following the issuance of the January 2022 plan and EIS.

More detail on iterative adjustments made to alternatives is available in the project record.

#### **2.1.2 How Public Involvement Influenced Alternative Development**

As described more thoroughly in Chapter 1 and Appendix H, the proposed action and analysis have been built on an unprecedented degree of public input. We appreciate the collaborative spirit that this planning process has instilled. Collaborative capacity – the notion that we can do more for the Forests if we do it together – is a core value within the plan.

The Forest Service is acutely aware that the development of alternatives has the potential to polarize interests, harming the collaborative strides we have all made to seek mutually beneficial solutions. Therefore, our alternative development took care to ensure that the themes of the alternatives did not polarize interests, but instead, built upon shared values. For example, while it would have been much simpler for this analysis to set up one alternative that maximized land in passive management such as Recommended Wilderness and another to contrast it with most active management and fewest acres recommended for wilderness, care was taken to avoid such polarizing stances. In this EIS, the alternative with the most Recommended Wilderness is also the alternative with the most land of the Forests in active timber management, as both can be accomplished on the same Forest.

In building alternatives that advance forest goals while meeting multiple interests, the following concepts were incorporated into alternative development in direct response to public request:

**Plan direction is kept consistent between alternatives on topics where there is widespread support.** Where there is broad agreement among diverse interests, the plan direction is the same for all action alternatives. As a result of broad agreement on many resource management topics, only three plan components differed among Alternatives B, C, and D in the draft plan, including two standards and one objective (more on these differences is explained below). The remaining plan desired conditions, objectives, standards, and guidelines are consistent across Alternatives B, C and D. Many plan components were updated in Alternative E between draft and final in response to comments.

**Alternatives examine different ways that management can be sensitive to place-based values.** The Forest Service recognized primary differences of perspective about forest management are based on where management activities will occur, which led to the modification of management area assignments across alternatives. Using this place-based context, the FS also designed alternatives to consider how progress on multiple goals could be made simultaneously.

**Alternatives that do not benefit multiple interests were not considered in detail.** The Forest Service ensured that alternatives designed to benefit a single interest at the expense of other multiple uses were eliminated from detailed study (see Alternatives Considered but Eliminated from Detailed Study).

**Alternatives recognize that the Forest Service can do more with the help of partners and analyze the possibility of greater capacity as part of the range of each alternative.** All alternatives include a two-tiered approach to objectives which further expands the range of alternatives. The action alternatives each consider a base tier of what we can accomplish under current Forest Service capacity (Tier 1) and a broader stretch objective of what could be accomplished with additional resources, personnel, partner, or volunteer support beyond current contributions (Tier 2). This approach was suggested by partners during the development of the draft plan. Because Tier 1 and Tier 2 objectives are captured in all action alternatives, each action alternative itself provides a range of management activities that responds to public input.

Incorporating the above principles impacted the range of alternatives shared in the draft Environmental Impact Statement. Alternatives developed with these principles are more similar when compared than they might have been in a traditional alternative development process. Previous plan development processes would have shown a greater range of effects by separating interests into different alternatives. Instead, the current process advances multiple interests by ensuring diverse interest groups can see some of their needs met in each alternative. Ensuring that all interests can be on the same landscape via different spatial configurations creates results where the analysis differences between each action alternative are not dramatic.

Overall, the extensive public engagement and collaboration, the use of tiered objectives in all alternatives, and the intent to depolarize alternatives so that many interests are met in each alternative, has a result of narrowing the range of alternatives and associated effects. Through this approach, each alternative should better enable increased support during implementation.

Alternative E, an additional alternative analyzed in detail, was added between the draft and final EIS. Alternative E made iterative adjustments to the proposed plan and Alternatives B, C and D, because it was influenced by public comments received on the draft. Alternative E contained edited plan components (desired conditions, objectives, standards, guidelines), management area maps, and other plan content (management approaches, background). A summary of changes between Alternative E and



the other action alternatives is discussed in this chapter and in Chapter 3. Edited changes were shown in grey highlights in the January 2022 plan so the public could focus on the changed content.

Following the plan revision objection process, Alternative E Modified incorporates remedies, voluntary modifications, and clarifications, and incorporates corrections of errors that were identified as needed following the issuance of the January 2022 plan and EIS. A list of changes to the plan is shown in EIS Chapter 2. All modifications are within the range of effects considered by the other action alternatives and are responsive to issues identified in previous comment periods and during objections. Except where Alternative E Modified is specifically noted in the discussion of effects, it can be assumed that the effects of Alternative E Modified discussed in Chapter 3 are the same as the effects of Alternative E. Additionally, some comments during the plan revision process resulted in alternatives considered but not analyzed in detail.

## 2.2 Summary of Alternatives Analyzed in Detail

The following alternatives are analyzed in detail, including the no action (Alternative A) and Action Alternatives (B, C, D, E and E Modified):

The **plan direction** for Alternative A is reflected in the current forest plan as amended. The plan direction for Alternatives B, C, and D is reflected in the proposed plan that accompanied the DEIS. Differences between plan direction for Alternatives B, C and D (for plan components ECO-S-28, REC-S-14, REC-O-07) are explained within the proposed plan itself on the appropriate page for each plan component. The plan direction for Alternative E is the plan that accompanied the January 2022 FEIS and draft record of decision. The plan direction for Alternative E Modified is the final plan that accompanies this FEIS, reflecting changed plan direction resulting from instructions, voluntary modifications, and clarifications identified during the Plan revision objection process.

Differences in proposed land allocations can be seen by reviewing the accompanying **set of maps**. Forestwide maps that can be used to coarsely compare alternatives are available at the end of this chapter, although the more detailed set of maps should be reviewed to compare specific locations, as the small maps in this chapter do not capture the full degree of detail.

Together, the changes in plan direction and management area allocation respond to the Need for Change and the significant issues that are described in chapter 1.

While all six alternatives provide for a wide range of multiple uses, goods, and services, each addresses the issues in different ways, reflecting the range of opinions expressed in public comments.

- **Alternative A, the No Action:** This alternative is the current forest plan, as amended. The current forest plan would continue to guide management of the Nantahala and Pisgah NFs under this alternative.
- **Alternative B** responds to those who desire more flexibility for managing vegetation patterns, wildlife habitats, recreation, and access. This alternative:
  - Provides the largest land base for creating young forest structure through mechanical treatment in the Matrix management area.
  - Designates the smallest old growth network in the forest plan but allows for the most project level flexibility for making old growth network adjustments during plan implementation.
  - Provides the most flexibility for adding new trails to the trail system.

- Includes the largest amount of the forest where road access is prioritized, including the most opportunities for opening seasonally closed roads in Interface and Matrix for hunting and other uses, with the most acres available for new road building.
  - Recommends the most acreage for future designation as wilderness by Congress; this is consistent with the theme of retaining flexibility for locating young forest habitat and access, because areas recommended for wilderness are generally not areas that would otherwise be managed for young forest habitat or motorized access.
- **Alternative C** is intended to be responsive to those who desire more certainty defined in the forest plan and less project level flexibility for managing vegetation patterns, wildlife habitats, recreation and access. This alternative:
  - Allocates a greater amount of the Forests to Backcountry and responds to the issue of designating places with rare and unique ecological values into the Ecological Interest Areas management areas. This would provide more limitations on the timber management activities that can occur in these locations.
  - Establishes a larger old growth network than Alternatives A, B, and D and sets the footprint of the network for the life of the forest plan.
  - Responds to the need for more sustainable recreation by being the most restrictive when adding new trails to the system, allowing the least flexibility for adding trails during plan implementation.
  - Includes the fewest opportunities for opening seasonally closed roads in Interface and Matrix for hunting and other uses.; includes and a greater emphasis on decommissioning unneeded roads in Backcountry, with the fewest acres available for new road building.
  - Recommends the fewest acres for wilderness, instead providing the greatest acreage of backcountry that provides a semi-primitive non-motorized recreation experience, some of which may be suitable for future mountain biking opportunities.

**Alternative D** is an intermediate approach between Alternatives B and C in terms of plan restrictions versus project flexibility in managing for vegetation patterns, wildlife habitat, recreation, and access. This alternative:

- Responds to the issue of designating places with rare and unique ecological values into the Ecological Interest Area MA, it also maintains much of the Forests in the Matrix MA, allowing for flexibility of active management to meet young forest habitat needs and respond to emerging forest health issues.
- Establishes an old growth network that is larger than Alternative B and smaller than Alternative C and E and allows for project level additions where old-growth conditions are under-represented.
- Provides moderate restrictions on new trail building and establishes a new tool, a trail bank, which can be used across the Forests to build sustainable trail miles.
- Provides motorized access opportunities between the amounts in Alternatives B and C for opening seasonally closed roads in Interface and Matrix for hunting and other uses, decommissioning unneeded roads in Backcountry, and the percent of the forest open to new road building.

- This alternative recommends only those areas with the highest quality wilderness characteristics for wilderness designation, more than Alternative C but less than Alternative B.

**Alternative E** incorporates public comments between the draft and final plan. This alternative:

- Increases emphasis on prescribed fire, using fire and mechanical harvest to restore open forest conditions, and nonnative invasive species treatments in tiered objectives.
- Establishes an old growth network that is larger than any of the other alternatives and sets the footprint of the network for the life of the forest plan.
- Addresses the challenge of trail management by collaborating with partners to focus on supply and demand issues on some geographic areas of the forest and ensuring that new trail miles are socially, ecologically and fiscally sustainable, and in good locations for future soil and water needs.
- Provides motorized access opportunities comparable to Alternative D, focusing on opening seasonally closed roads in Interface and Matrix for hunting and other uses, and decommissioning unneeded roads in Backcountry.
- Recommends more acres and areas for wilderness than Alternatives A and C, but less than B and D, recommending areas with the strongest wilderness characteristics in combination with public comments and management needs for other multiple uses.

**Alternative E Modified** incorporates remedies, voluntary modifications, and clarifications identified during the Plan revision objection process, and incorporates corrections of errors that were identified as needed following the issuance of the January 2022 plan and EIS.

- A list of changes to the plan is shown in Section 2.4. All modifications are within the range of effects considered by the other action alternatives and are responsive to issues identified in previous comment periods and during objections.
- The sub-bullets above for Alternative E also apply to Alternative E Modified.
- Except where Alternative E Modified is specifically noted in the discussion of effects, it can be assumed that the effects of Alternative E discussed in Chapter 3 are the same as the effects of Alternative E Modified.

## 2.3 Features that Are Common to the Action Alternatives

### 2.3.1 Plan Direction

Action alternatives were specifically designed to meet the purpose and need (see chapter 1) and be responsive to the issues.

All action alternatives emphasize **ecosystem restoration and maintenance** to achieve healthy systems. Ecosystem **restoration** will not return ecosystems to a past historic state, because contemporary constraints and conditions have caused ecosystems to develop altered trajectories. Instead, restoration focuses on re-establishing key characteristics such as the composition, structure, pattern, and ecological function necessary to make ecosystems sustainable, adaptive, resilient, and productive under current and future conditions. Ecosystem **maintenance** occurs when a currently healthy system or a restored system are sustained in that resilient state. The plan is built on the assumption that ecosystems are most resilient when they have high ecological integrity, which is characterized by having composition,

structure, function, and species' population and community dynamics that occur within an appropriate range of variability. This framework assumes that the past **range of variability** serves as a reference for functional and sustainable systems that are complex and adaptive in the context of global change.

All action alternatives identify **priority watersheds** for restoration where emphasis will be placed on maintaining or improving the watershed condition class.

Under all action alternatives, the plan provides an increased emphasis on **social values**. The forestwide plan direction includes a section on Community Connections, which outlines desired conditions and objectives for providing benefits to **local communities**, and a section on **public involvement** and collaboration, making a commitment to continue involving members of the public in developing projects on the ground. For example, all action alternatives include an objective to meet with local governments every other year to understand their interests in developing projects:

- COM-O-01** Every other year host a discussion with interested WNC local governments or their economic development offices to foster shared actions that support local jobs, attract tourism, and encourage coordination on public health and safety issues.

This new guideline is included in the public involvement section:

- PI-G-01** In order to encourage meaningful public participation during preparation of integrated landscape projects, the Forest Service should facilitate collaboration among state and local governments and Indian tribes and participation of interested persons, except where emergency situations warrant an expedited time frame.

This shift in plan direction compared to Alternative A will ensure that projects and program management at the forest level are continually considering public interests through early public involvement.

Additionally, Alternatives B, C, D, E and E Modified include a chapter on **geographic areas**, in which each area of the Forest is recognized for the values it provides to the public in the context of the WNC landscape. The places and uses that are important to people are highlighted. Each geographic area has a section that identifies the cultural history of the area, ecological values, ways people connect to the land, water and watershed connections to the region, places to be managed in recognition of their unique features, and ways to work together across the Forests' boundary to further shared goals. This chapter was composed using public information about the places and uses that people value on the Forests, and it provides a vision for how the Forests will be managed in recognition of those interests. Geographic areas provide direction that is consistently applied across the Forests, reflecting where there are some differences based on the unique sense of place (Andereck and Knopf 2007; Parker and Green 2016). As a result of using this information to shape projects and activities, the action alternatives are more effective at addressing social values than Alternative A.

Geographic areas show the Forests in an all-lands context, recognizing partnerships between the Forests and neighboring communities and identifying opportunities that cross the FS boundary. For example, there is a new objective to work with communities on economic development opportunities. Alternatives B, C, D, E and E Modified give a clearer focus on the economic role of the Forests in the broader Western North Carolina landscape.

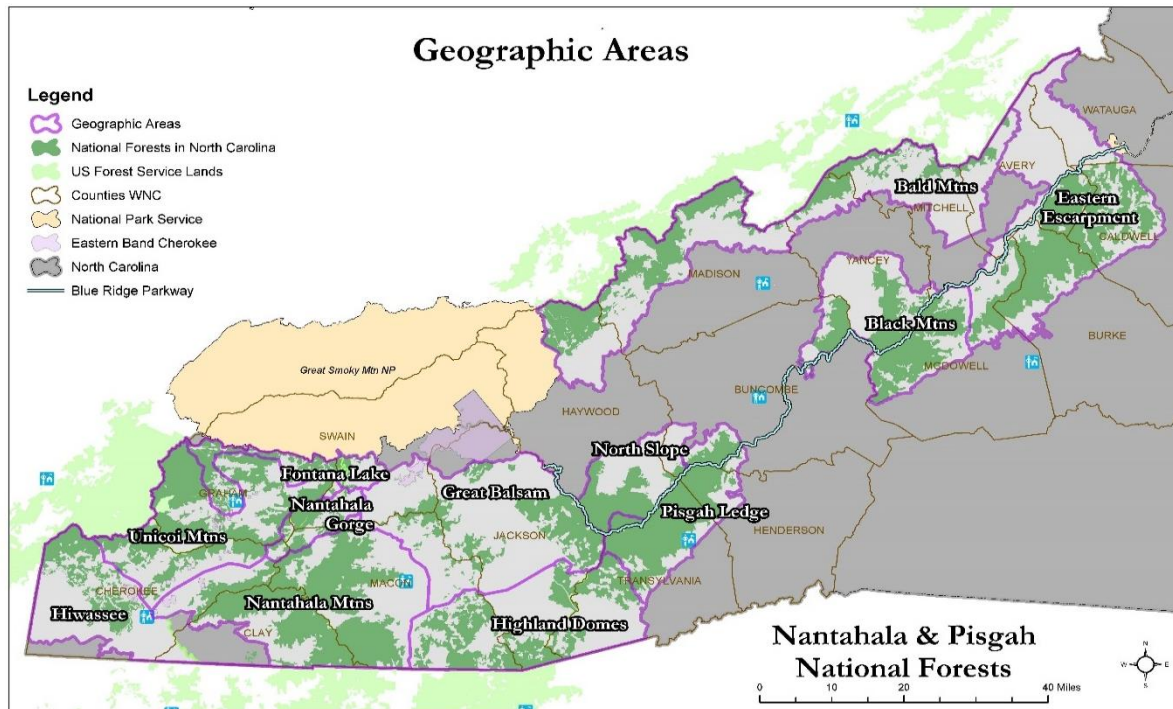


Figure 2. Geographic areas of the Nantahala and Pisgah National Forests.

### 2.3.2 Management Area Allocation

In Alternatives B, C, D, E and E Modified, the Interface Management Area (MA) was designed around the places where people have heaviest use of the Forests, reflecting locations of key **access** that will be sustained. This management area includes both highly **developed areas** and **national trails** that are not covered by stand-alone management areas (the Appalachian Trail and Heritage Corridors such as the Trail of Tears and Unicoi Turnpike are identified as their own management areas). For those who want to see recreation highlighted as a key aspect of management on the National Forests, the Interface MA reflects a management intent to sustain recreation and visitor use as a priority in these locations.

Alternatives B, C, D, E and E Modified all provide greater **economic contributions** to the local economy, in terms of jobs and income, than Alternative A. However, the differences across action alternatives are small, and variation in actual impacts make Alternatives B, C, D, E and E Modified somewhat equivalent.

Alternatives B, C, D, E and E Modified provide a greater awareness and protection of **tribal and cultural values**.

The following management area allocations are generally consistent across alternatives:

- Research Natural Areas,
- Appalachian National Scenic Trail Corridor,
- National Scenic Byways, Heritage Corridors,
- Designated Wild and Scenic Rivers,
- Congressionally Designated Wilderness,
- Congressionally Designated Wilderness Study Areas,

- Roan Mountain,
- Cradle of Forestry in America.

Exceptions to consistency occur when more restrictive management is specified in an alternative, such as when a Research Natural Area is recommended for Wilderness. In those cases, the more restrictive management area is shown on the map. Additionally, some errors were found in the draft maps that were corrected in the final map set.

The Experimental Forest Management Area includes Bent Creek, Coweeta and Blue Valley Experimental Forests. National datasets serve as the area identified in Alternatives B, C and D, and about 23 acres of land are added to the Blue Valley Experimental Forest in Alternative E and E Modified to eliminate a sliver between the Experimental Forest and the Congressionally Designated Wilderness Study Area.

In all action alternatives, **Inventoried Roadless Areas** are built into the Backcountry MA or more restrictive management areas, and they do not vary by alternative.

All action alternatives recognize **newly eligible Wild and Scenic Rivers** and their outstandingly remarkable values, with one error corrected in the final, resulting in one fewer river being advanced in Alternative E (see Appendix F). An additional eligible Wild and Scenic River was added to Alternative E Modified (see below).

Further described in Section 2.1.2, all alternatives contain numerous objectives with two levels of proposed activity, identified as Tier 1 and Tier 2 objectives. Tier 1 objectives are based on a continuation of recent Forest Service budgets and capacity, while Tier 2 objectives reflect additional outcomes that may be possible with added capacity of partners and partner resources.

## 2.4 Features that Vary Between Action Alternatives

### 2.4.1 Management Area Allocation Differences in Alternatives B, C and D

Much of the public input the FS received from collaborative groups, organizations and individuals was related to where management occurs on the Forests, therefore, the primary difference between alternatives B, C and D is the **allocation of management areas**. Management area allocations were designed to be consistent with the theme of the alternatives.

More specifically, the size and configuration of **Matrix**, **Ecological Interest Area** and **Backcountry** varied between action alternatives. Some commenters value the flexibility of the Matrix management area to address multiple uses and active management needs that may emerge over the life of the plan while others expressed concern, primarily over timber harvest treatments in this management area and requested a new management area which had more restrictions on timber activities, Ecological Interest Areas. Other comments requested that areas be recognized in Backcountry for their semi-primitive non-motorized character. Generally,

- In Alternative B, lands that were not otherwise identified in Interface for their recreation values, Backcountry for their semi-primitive character or in a designated management area such as Wilderness, Appalachian Trail Corridor, Special Interest Areas, etc., were generally included in the Matrix MA. As a result, Alternative B has the most Matrix MA of all alternatives. This alternative does not contain Ecological Interest Areas, and most closely matches maps that were available during the public involvement leading up to the development of the proposed plan.
- In Alternative C, large areas of the forest in semi-primitive non-motorized conditions were generally allocated to Backcountry Management Area. If the areas did not have large semi-primitive non-motorized core areas, but had few roads and contained North Carolina Natural

Heritage Natural Areas or were identified by partners as having old growth characteristics, the lands were generally allocated to the Ecological Interest Area Management Area where timber harvest is more restricted than in Matrix. As a result, the Backcountry MA and Ecological Interest Areas MA are largest, and the Matrix is the smallest in Alternative C.

- In Alternative D, areas that had active management opportunities for timber were included in Matrix MA; areas were generally allocated to Ecological Interest Area MA if they contained existing high quality old growth forest, or high ranking state natural heritage areas; areas were allocated to Backcountry MA if they contained more than 2,500 acres in semi-primitive non-motorized character with surrounding lands and did not have active timber management needs that would require road construction in the next 10 to 15 years. As a result, the Matrix, Ecological Interest Area, and Backcountry MAs in this alternative are more evenly balanced compared to Alternatives B and C.

**Recommended Wilderness** (lands recommended for inclusion in the National Wilderness Preservation System) varies by alternative, responding to those who seek different amounts of land in this type of management.

- Alternative B is responsive to those individuals and groups who support the largest amount of NFS lands to be preserved as designated wilderness and thus recommends the largest total acreage.
- Alternative C is responsive to those who are generally opposed to additional designated wilderness and thus recommends the least total acreage.
- Alternative D is intended to strike a balance between the public desire to actively manage and restore the forest for resiliency and biological diversity, to provide for semi-primitive non-motorized recreation settings without many of the restrictions of wilderness designation, and to preserve as recommended wilderness areas those which possess the highest degree of undeveloped and natural characteristics, opportunities for solitude or primitive and unconfined recreation, or other features of value. As a result, it contains an amount of recommended wilderness between Alternatives B and C.
- More information on differences between alternatives is contained in the wilderness evaluation (Appendix E).

Generally, the **Interface** management area that includes concentrated use areas, National Recreation Trails, and primary access routes to recreation sites does not differ among alternatives except for where it is overlaid by more restrictive management areas.

While this describes the general approach to management area allocation, decisions and occasional deviations to this approach were made in individual locations, consistent with the theme of each alternative, using input from Forest Service employees and information contained in public comments. The maps in Appendix I should be used to compare differences between alternatives. Geographic Information System shapefiles are available for download at [www.fs.usda.gov/goto/nfsc/nprevision](http://www.fs.usda.gov/goto/nfsc/nprevision). Details about the spatial sources used for mapping each management area can be found in EIS Appendix B.

As a result of the above approach, there are cases where total forest acreage numbers of management areas may not be considerably different between alternatives, however the **location** of where those acres are identified across the landscape may be very different. The detail of how different places are proposed to be managed must be examined at a fine scale to appreciate the effects of those designations. Comparison of aggregate acres of management areas between alternatives at the broad landscape scale does not reveal the meaningful differences between alternatives. Therefore, reviewing

management area maps is more helpful for alternative comparison than relying on a simple comparison of total acres.

Although the objectives for management are largely the same between alternatives, as a result of different management area allocations, the landscape where management activities can occur differs by alternative. This results in different effects to the long-term trend of forest resources.

The following issues from Chapter 1 are addressed by varying the allocation of management areas:

- **Vegetation Patterns:** The opportunity for creating **young forest** is least restricted where Matrix is the largest. Where Ecological Interest Areas or Backcountry are larger, there are more restrictions on the types of projects and treatments that can be used to establish young forest.
- **Vegetation Patterns and Wildlife Habitat:** In response to those who desire a finer degree of recognition for areas with unique ecological values, three action alternatives include a new management area called Ecological Interest Areas. This management area was designed to emphasize **compositional restoration** as a primary driver of management activities. The size of this management area differs between Alternatives C, D, and E. This management area has zero acres in Alternative B.
- **Special Designations:** the areas and amount of land managed as **Recommended Wilderness** (which is recommended for inclusion in the National Wilderness Preservation System) varies by alternative, responding to those who seek different amounts of land in this type of management.
- **Recreation:** The management area allocations of backcountry and Recommended Wilderness differ by alternatives in a way that could impact future **mechanized or motorized forms** of recreation, such as mountain biking.
- **Access:** The opportunity for **seasonally open roads** in Interface and Matrix and **decommissioned roads** in Backcountry varies as the size of these areas varies by alternative. Where Matrix is larger, there is more land available for increasing roaded access; where Backcountry is larger, there are more acres where decommissioning unneeded roads is prioritized and permanent **road building** is restricted. The different management area allocations of Interface, Ecological Interest Areas and Recommended Wilderness by alternative would also have an impact on road building.
- **Economic contributions:** Different management area allocations and Recommended Wilderness allocations by alternative will enable different configurations of the land that result in different areas that emphasize timber management, special product collection, and recreational tourism.

## 2.4.2 Plan Direction Differences in Alternatives B, C and D

Beyond changes in the management area allocation, Action Alternatives B, C and D contained three plan components that varied between alternatives. The following paragraphs summarize these changes, and more information about the details of these plan language differences and their effects is found in chapter 3.

- 1) In response to the issue of vegetation patterns and wildlife habitat, management of the **old growth network** varies by alternative. The land identified as the designated old growth network varies by alternative (see maps later in this chapter). Also, a standard for modifying the old growth network at the project level, ECO-S-27, varies by alternative:
  - ECO-S-27: A standard that identifies how project-level information can be used to adjust the designated potential old growth network that differs in each Alternative A, B, C and D.



See the designated old growth network section for more information.

- 2) In response to the issues of recreation and access, management strategy for **new trail construction** for non-motorized uses varies by alternative. The requirements that must be met to add new trails to the system vary by alternative, including REC-S-14 and REC-O-7:
- REC-S-14: A standard for when new trail construction for non-motorized uses can occur that differs between Alternatives B, C, and D.
  - REC-O-7: An objective on establishing a trail bank that can be used to add new sustainable trail miles to the non-motorized trail system that is only present in Alternative D and not considered in Alternatives A, B, or C.

See the recreation section for more information.

### 2.4.3 How Alternative E Differs from Alternatives B, C and D

When Alternative E was drafted following the public comment period, plan direction on the old growth network and new trail construction was developed for the new alternative. Additionally, several other plan component changes were made in response to public comments and are summarized below. New and edited material can quickly be seen by focusing on the grey highlights in the final plan. A detailed spreadsheet of all the changes between the proposed plan released with Action Alternatives B, C, and D, and the final plan released with Alternative E is available in the project record.

#### Management area allocation

In Alternative E, areas identified in public comments were re-evaluated. Adjustments were made to the mapping of Matrix, Ecological Interest Area, Interface, and Backcountry based on map changes in the allocation of Special Interest Areas, and areas recommended or not recommended for Wilderness and updated information about the Trail of Tears National Historic Trail. Additionally, these spatial adjustments were made:

- Updates to the designated old growth network.
- Adjustments to the forest Special Interest Areas MA.
- A different allocation of areas for recommended wilderness.
- The Heritage Corridor Management Area was updated to reflect more recent information about the Trail of Tears National Historic Trail. (See Appendix B)
- Updated mapping of Matrix, Ecological Interest Area, Interface, and Backcountry, and Appalachian National Scenic Trail based on changes related to MA allocations described above.
- Assignment of new Forest Service land acquisitions to management areas.
- A minor adjustment to the boundary for the Blue Valley Experimental Forest, increasing the overall acreage from 1,401 acres to 1,424 acres, in coordination with the Regional Forester and Southern Research Station Director.
- Minor corrections to management area lines.

#### Plan direction

Below is a summary of plan direction that was updated in Alternative E, based on public comments and FS input between the draft and final EIS. Edited changes for Alternative E were shown in grey highlights in the January 2022 plan so the public could focus on the changed content. A detailed spreadsheet of all

the changes between the proposed plan released with Action Alternatives B, C, and D, and the January 2022 plan released with Alternative E is available in the project record.

Following the summary of all topics, more detail is provided on the two topics where plan direction varied between alternatives in the draft plan: old growth management and sustainable trails.

Alternative E changes:

- Climate change: Updated management approaches for adapting to climate change.
- Streamside zones: Increased the distance of the streamside zone around intermittent streams to 50 feet to match the distance in which NC forest practice water quality guidelines apply, and language was added to recognize the role of ephemeral streams.
- Terrestrial Ecosystems:
  - Reorganized plan content with a clearer delineation of subsections for Ecozones, Wildlife Habitat, Designated Old Growth Network, Forest Health and Timber.
  - Objectives for young forest, open forest woodlands, and stand and community improvement were reframed in terms of annual acres rather than decadal.
  - An objective was added for thin and burn activities to improve woodland and open forest conditions.
  - The prescribed fire objective was increased to better reflect current capacity (Tier 1) and to enable greater activity level if additional resources become available (Tier 2).
  - A second tier objective was added for community and stand improvement activities.
  - Reorganized other objectives in the Designated Old Growth Network, Forest Health and Watershed sections.
  - Anticipated techniques and priorities were expanded in management approaches.
- Plant and Animal Diversity:
  - Clarified how the FS will partner with the US Fish and Wildlife Service, North Carolina Wildlife Resources Commission and North Carolina Heritage Program in working to maintain, enhance and restore plant and animal diversity.
  - Clarified how the USFS will coordinate with the NC Natural Heritage Program when designing projects in North Carolina Natural Heritage Areas.
  - Added an objective and standard associated with managing and restoring *Hudsonia montana* and *Liatris helleri* populations.
- Forest Health: The nonnative invasive species treatment objective was increased to better reflect current capacity (Tier 1) and to enable greater activity level if additional resources become available (Tier 2).
- Timber: Clarified restocking levels and size of openings.
- Transportation and Analysis: Clarified how many miles of road and trail miles will be restored to natural contours.
- Recreation Settings: Updated recreation opportunity settings and classes for each management area.
- Dispersed Recreation - sustainable trails:

- Added an objective and corresponding Geographic Area goals to address collaborative trail planning to address equestrian or bicycle supply and demand issues;
  - Modified new trail construction direction to ensure that new trails meet the latest design standards, while incentivizing relocation of unsustainable system trails, construction of short connectors to form loops, closure of unauthorized routes, collaborative planning and strengthening partnerships;
  - Clarified how relocation of unsustainable system trails will be addressed;
  - Updated guidance on managing climbing routes through unique habitats and cultural resource sites.
- Scenery: Linked scenic character descriptions to the Geographic Area descriptions.
- Tribal Resources:
  - Incorporated the development of traditional ecological knowledge from Federally Recognized Tribes early in project design.
  - Added an objective to work with Tribes and the Southern Research Station on studies of sustainable plant harvest.
  - Identified additional opportunities to work with Tribes.
- Minerals and Energy:
  - Clarified the relationship between the USFS and the Bureau of Land Management in managing the federal mineral estate.
  - Recognized the role of critical minerals for renewable energy technology.
  - Clarified that an oil and gas availability decision is not being made at this time due to the lack of industry interest and the low potential for oil and gas resources on the Forests.
- Community Involvement, Public Involvement, Conservation Education:
  - Emphasized partnering with others to expand capacity and continued collaboration with communities, Tribes, partners, volunteers, and other governments through the addition of management approaches and geographic area goals.
  - Clarified the intent that these initiatives are culturally inclusive, engaging diverse audiences.
- Separated Ecological Interest Areas and Special Interest Areas into two separate management areas with unique plan direction.
- Updated the names and acres of Special Interest Areas by Geographic Area, informed by additional field visits and coordination with the NCHP, and FS staff between draft and final.

The action Alternatives B, C, and D included in the DEIS had largely the same plan direction. The two topics which varied by alternative were: management of the old growth network and new trail construction. This section summarizes how Alternative E addressed these two topics.

## Topics where draft plan direction differed between action alternatives

The action Alternatives B, C, and D included in the DEIS had largely the same plan direction. The two topics which varied by alternative were: management of the old growth network and new trail construction. This section summarizes how Alternative E addressed these two topics.

### Old growth management

The revised plan identifies mature and old growth forests<sup>6</sup> as a desired habitat type needed throughout the landscape (LMP Plan, Table 3). Old growth forests are currently rare in the Southern Appalachians. The 1994 plan, as amended, identifies “the desired future condition for old growth across the forest is to have a network of small, medium and large sized old growth areas, representative of sites, elevation gradients, and landscapes found in the Southern Appalachians and on the Forests, that are well dispersed and interconnected by forested lands.” While these patches do not always contain existing old growth forest, all are designated to allow old growth characteristics to develop over the long term. The designated old growth network is established to ensure old growth conditions develop and persist into the future. It does not account for all the pockets of old forest that may exist on the Nantahala and Pisgah NFs. To address project level challenges around old growth management, proposed alternatives differed in the size and configuration of the designated Old Growth network, and each had a different standard about how adjustments would be made to the designated Old Growth network during the next 20 years based on project level information.

Comments received on the draft forest plan varied in terms of whether the old growth network should be set at the plan level versus adjusted in project level decisions. Some commenters favored identifying old growth forest at the plan level to provide certainty about the old growth’s defined spatial role. Supporters of setting the network at the plan level stated that identifying the designated network in the plan reduces the analysis during project level planning, improves project efficiencies, and ensures consistency in approach across ranger districts and through changes in leadership. Others favored project level adaptability, stating that old growth forest is not static on the landscape, it is not well inventoried, and that the best land allocation for the designated OG network may shift over the next 10 to 20 years. Other commenters advocated for a cap-and-trade style designated OG network where the overall size of the network is established (capped) in the plan, but the individual patches are added or dropped (traded) during projects based on field assessment. Conceptually, a cap-and-trade approach would allow for high quality existing old forest to be added to the network when it is found at the project level, while patches with lower quality old growth potential that are in the network could be removed from the network and allocated to other types of multi-use management. However, commenters and the best available science differ on the initial acreage for that network, and the criteria for adjusting patches. Some individuals advocated for adding to the network based on local site conditions, and others suggested it should be based on the management area assignment. Overall, there are strong disagreements on the size of the network and what and how to adjust the network over time. A cap-and-trade approach is primarily untested, not clearly defined, would require additional level of project survey for old growth characteristics, and would likely be regularly challenged.

After considering public comments and the DEIS findings, Alternative E changed the size and configuration of the designated OG network to strategically enhance the network’s resiliency and ecological diversity. Alternative E’s more than 54,000 acres of additions to the designated OG network

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<sup>6</sup> For the purposes of this document, the term “old growth” references forests with old growth characteristics, which differs from old forest. Old forest has met the minimum age threshold to be considered an old growth state, but may or may not be functional old growth, having other important characteristics of old growth.

include areas where creation of young forest is unlikely to be prioritized, including designated wilderness, wilderness study areas, recommended wilderness, research natural areas, and the corridors of designated wild and scenic rivers that are classified as wild. Beyond these management areas, additional patches were included in the network with consideration of the full range of biodiversity representation, using ecozone representation, moisture and elevation gradient diversity, as well as spatial distribution and redundancy. The adjustments focused on increasing overall patch size for resiliency (White, Tuttle, and Collins 2018), overall network diversity (McGee and Kimmerer 2002, McGee 2018, Wyatt and Silman 2010, CCEA 1992, Margules and Pressey 2000, Noss and Copperrider 1994), and contribution to an efficient network (Kukkala and Moilanen 2013, Margules and Pressey 2000). The adjusted network size and configuration incorporates landscape planning concepts from scientific literature, academic input, as well as local information provided by commenters and the NC Natural Heritage Program regarding inventoried locations of existing old growth forest patches. The adjusted designated Old Growth network:

- Defines a spatial role for the development of old growth characteristics in the plan;
- Includes all ecozones, moisture conditions, and elevation gradients.
- Includes lands that will be managed passively to allow the forest to age naturally – such as designated and recommended wilderness.
- Emphasizes large old growth patches, thereby increasing the network's overall resiliency and connectivity across the forests.
- Considers information from collaborators and the North Carolina Natural Heritage program about existing old growth forest.

The resulting network includes 291 separate patches totaling 265,385 acres that represent approximately 25% of the Nantahala and Pisgah NFs. Under this new configuration, Alternative E would provide the largest network of any alternative and would increase the amount of large patches by 25% more than the existing network, increasing overall resiliency and connectivity. Also, in Alternative E, the size and configuration of the network is defined at the plan level, and projects will not be able to add, subtract or adjust the footprint of the designated OG network. Just as in the other alternatives, Alternative E provides direction to enhance old growth characteristics within the designated old growth network, such as managing for forest health treatments.

Setting the network at the plan level addresses the landscape scale appropriate for a forest plan. We recognize that some individuals and groups want to preserve every patch of old forest and we recognize the inherent value of exceptionally old trees. This approach provides the local line officer discretion about what to do when additional high-quality old forest is found during this planning cycle. The district ranger, or the forest supervisor for multi-district projects, will retain the option of how to manage old trees, old stands, or old growth forest patches in the project itself, depending on the management area direction, site-specific conditions, and ecological needs in the area. If an area is identified as best managed for old growth characteristics, then the project can manage for those conditions, but the area will not be added to the forestwide Designated OG Network.

### **Sustainable Trails**

There were many public comments received on the draft plan regarding sustainable trail management and the conditions for new trail construction proposed in Alternatives B, C, and D. While there was general support for sustainable trail construction, there was concern about requiring an offset of decommissioned miles that would essentially cap the miles of system trails (Alternative C), and about the logistics associated with administering a trail bank of miles (Alternative D). Commenters also voiced

concern regarding the requirement for bicyclists and equestrian users to stay on system trails, and how effective the current system trails would be in accommodating increasing use in some locations.

The Forest Service recognizes that the current designated trail network does not meet the need for equestrian and bicycle trails in all geographic areas across the Forests, which is partially why there is an abundance of user-created trails on the Forests.

The final plan provides a framework for collaborative trail planning within geographic areas to develop a sustainable trail network that provides quality recreation opportunities while also addressing and decommissioning user-created trails. Specifically, of the following adjustments were made to plan language in Alternative E:

- Alternative E provides guidance on sustainable trails that limits new construction and adoption of authorized routes to those developed collaboratively, using modern design principles and where one of the following applies:
  - There is a commitment to long-term maintenance by a volunteer or partner agreement, or
  - The route resolves a critical health and safety need, or
  - The route resolves a supply-demand issue identified in geographic area goals, or
  - The route is offset by trail decommissioning or unauthorized route closure.
- A goal was added in four geographic areas (Bald Mountains, Black Mountains, Eastern Escarpment and Highland Domes) to address known supply and demand issues for equestrian and/or bicycle trail opportunities through collaborative trail planning.
- Objective REC-O-07 was modified and separated into two components. Part (a) says collaborative trail planning to address equestrian and/or bicycle trail supply/demand issues in specified geographic areas needs to begin within 5 years. Part (b) says that collaborative trail planning should occur forestwide every 5-7 years, building on the existing Nantahala and Pisgah National Forest Trail Strategy.
- Language was added to standard REC-S-11 that collaborative trail planning to address equestrian and bicycle trail demand will be underway prior to issuing a forest supervisor order allowing equestrian (horse, stock, pack and saddle) and bicycle use only on open or gated system roads, or system trails designated for those uses.
- A management approach recommending strategies that can be used to accomplish objective REC-O-07(b) was also added. This management approach identifies specific issues that could be addressed in the collaborative trail planning process and clarifies that this planning could take multiple forms.

Comprehensively, these adjusted plan components require implementation of contemporary trail design principles, minimal resource impacts or user conflicts, and full consideration of the three aspects of sustainable recreation (ecological, social, and economic).

Unlike other alternatives, Alternative E does not quantitatively restrict the total miles of trails that can be developed, nor does it establish a trail bank, but it will result in a heightened emphasis on ensuring that new trail developments are economically, ecologically, and socially supported for the long term.

#### **2.4.4 Alternative E Modified**

The Forests prepared a final EIS and draft ROD, and initiated the objection filing period on January 21, 2022. The objection filing period closed on Tuesday, March 22, 2022. Changes that resulted from this objection review, including, instructions, clarifications and voluntary modifications have been made in the Plan, EIS, appendices, Record of Decision, and the project record. Alternative E Modified

incorporates these instructions from the plan revision objection process and incorporates corrections of errors that were identified as needed following the issuance of the January 2022 plan and EIS. All modifications are within the range of effects considered by the other action alternatives and are responsive to issues identified in previous comment periods and during objections. Additional information about final Plan changes made for Alternative E Modified can be found in the Nantahala and Pisgah National Forest Plan Revision Objection Response and final Record of Decision.

## Management area allocation

In Alternative E Modified, the following management area allocation changes were made:

- The Special Interest Area management allocation around the Big Ivy/Craggy Mountain Area increased by about 700 acres.
  - Changed 474 acres from Matrix management area to Special Interest Area on Snowball Mountain, and added it to the Big Ivy/Craggy Mountain Forest Scenic Area.
  - Changed 234 acres from Interface management area to Special Interest Area for management of botanical resources in a NC Natural Heritage Natural Area, on Paynes Knob and Rock Knob in the Shope Creek area.
- Slivers and mapping inaccuracies were corrected resulting in minor corrections to management area lines.

## Plan changes

In Alternative E Modified, the following plan direction and plan content changes were made:

- Chapter 1: Described the purpose of management approaches as optional plan content used to establish priority and focus as well as to describe possible implementation techniques.
- Chapter 2, Soils: Added missing footnotes to the Superscripts 6 and 7 in SLS-S-02. Added a management approach to describe methods that can be used to reduce erosion potential.
- Chapter 2, Terrestrial Ecosystems: Modified desired conditions to explicitly mention the intent to both reduce departure from potential natural vegetation composition by ecozone, and reduce the structural departure from the natural range of variation. Clarified that the patches in ECO-DC-04 are isolated ones.
- Chapter 2, Plant and Animal Diversity:
  - Added a plan standard (final PAD-S-02) similar to one that had been in the draft plan that clarified how the plan provides for the persistence of Species of Conservation Concern and the recovery of federally listed species. Note that the addition of this standard resulted in changed numbering for the standards in this section that follow.
  - Modified PAD-S-06 to refocus the standard on managing human activities in the vicinity of active peregrine falcon nests rather than identifying specific recreation uses.
  - Added a management approach for collaborating with the climbing and recreational community on peregrine falcon monitoring and seasonal closures.
- Chapter 2, Timber: Defined “stacking” roads via a footnote.
- Chapter 2, Lands and Special Uses: Clarified LSU-S-03 related to public health and safety.

- Chapter 2, Recreation:
  - Added management approaches related to equestrian campgrounds regarding minimizing user conflict and providing educational information to non-equestrian campers.
  - Clarified that REC-S-11 will be implemented forestwide through a Forest Supervisor order after collaborative trail planning identified in Objective REC-O-07(a) has been achieved and associated Geographic Area Goals have been completed.
  - Updated the goals for addressing supply/demand at equestrian and/or bicycled opportunities in the affected geographic areas, clarifying that metrics for achieving the goals for each geographic area are determined through the collaborative process. Refined REC-O-07 to reference associated goals.
- Chapter 3, Geographic Areas:
  - Added introduction explanation that Goals for Sustaining Healthy Ecosystems considered each geographic area's departure from the Natural Range of Variation, as well as information from local employees and the public.
  - Updated maps and descriptions to ensure all features were accurate and improve map resolution.
- Chapter 4, Special Interest Area Management Area: Increased the size of the Big Ivy/Craggy Mountain Forest Scenic Area by about 700 acres, shifting acreage from Interface and Matrix to Special Interest Area (see Management Area Allocation section just above).
- Chapter 4, Wild and Scenic Rivers: Added 3.2 miles of the North Fork of the French Broad River to the list of newly eligible Wild and Scenic Rivers, with a recreational classification.
- Chapter 4, Congressionally Designated Wilderness and Recommended Wilderness:
  - Revamped management approach related to naturalize campsites.
  - Renamed Southern Nantahala Wilderness recommended extensions to "West," "Central," and "East" to avoid potentially offensive names. The FS anticipates revised names following plan finalization.
- Chapter 5, Monitoring: Clarified that the separate monitoring guide document, rather than the monitoring program identified in this chapter, will outline the methodology for monitoring questions.
- Appendix B: Updated timber suitability to reflect final Alternative E Modified allocation changes, and ad an error found during the objection process.
- Appendix B: Updated Projected Wood Sale Quantity (PWSQ) and Projected Timber Sale Quantity (PTSQ) calculations using a comparable methodology as was used in the EIS to calculate forest product output analysis.
- Multiple sections: Updated references to the best management practices (BMPs) being used, such as Forest Service BMPs, North Carolina BMPs, or others as appropriate.
- Multiple sections: Replaced the potentially offensive name "gypsy moth" with "spongy moth."
- Updated scattered clerical errors throughout the document.



## 2.5 How Action Alternatives Respond to Issues

### 2.5.1 Alternative A - No Action

**Summary:** Alternative A, the No Action alternative, is the current forest plan, as amended in 1994. The current forest plan would continue to guide management of the Nantahala and Pisgah NFs under this alternative. A map of this alternative is available in Appendix I.

This alternative provides the baseline for the effects analysis. Management area direction would remain the same, and current recommendations for wilderness would remain in place. Where annual accomplishments have varied from forest plan assumptions, or where recent budgets have resulted in different activities than the levels planned for in 1994, the actual accomplishments are noted. The 1987 forest plan, as amended, is available electronically and may be viewed or downloaded from the National Forests in North Carolina website at: <https://www.fs.usda.gov/nfsnc/>.

Since the time the amended plan was signed in 1994, approximately 13,000 acres of land have been acquired by the National Forests in North Carolina, many which have not had management area direction assigned. Additionally, the 2001 Roadless Rule designated 152,488 acres as Inventoried Roadless Areas (IRAs), approximately 13 percent which were in management areas that were previously suitable for timber production. The allocation of lands to IRAs increased the amount of lands managed for backcountry experiences and limited road building and timber harvest on approximately 14 percent of the Nantahala and Pisgah NFs.

The 1994 amendment to the forest plan responded to issues regarding uneven aged versus even aged management, economic contributions of the forests, and diversity of forest age structure and wildlife species. The issues raised in the current forest plan revision are similar to some of the issues previously raised in the amendment of the 1987 Forest Plan.

#### How the Current Plan relates to Issue 1 - Vegetation Patterns and Wildlife Habitats

- The 1987 Plan, as amended in 1994, includes plan direction for managing for old growth in large, medium, and small patches distributed across the landscape. Early successional habitat is well distributed across the Forests with a recognition that habitat is provided at three geographic scales: the landscape (watershed) level, the management area level, and the compartment level. This alternative identifies high quality forest interior bird habitats that are distributed throughout the Forests.

#### Response to Issue 2 - Special Designations

- Alternative A includes the designation of Special Interest Areas across the Forests that are managed to protect, and, where appropriate, foster public use and enjoyment of unique scenic, geological, botanical, or zoological attributes. Six areas (approximately 66,000 acres) are Designated Wildernesses, and five areas are congressionally designated Wilderness Study Areas (26,816 acres) and managed to maintain their wilderness characteristics. Three of the five Wilderness Study Areas are recommended for Wilderness designation: Craggy Mountain WSA, Harper Creek WSA, and Lost Cove WSA.
- This alternative provides protection of areas of scenic interest (approximately 320,000 acres identified as visually sensitive), including scenery from the Appalachian Trail and the Blue Ridge Parkway. Most of the lands in the Semi-Primitive Non-Motorized recreation inventory are allocated to management areas that do not include commercial timber harvesting.

### **Response to Issue 3 - Access**

- With the 1994 Amendment to the Forest Plan, the amount of management areas that feature open road recreation decreased by almost 40,000 acres to favor wildlife conditions.
- Alternative A would continue to provide both motorized and non-motorized access to the Forests. This alternative projects constructing and reconstructing about 31 miles of road per year, with about 66 percent of road construction occurring on slopes less than 40 percent.

### **Response to Issue 4 - Recreation**

- A diversity of recreation settings are provided across the Forests, ranging from Semi-Primitive Non-Motorized to Roaded Natural.
- Alternative A includes an emphasis on semi-primitive, backcountry recreation with approximately 117,000 acres of land allocated to Backcountry MA and an additional 68,100 acres in other management areas that limit road construction and timber harvest.

### **Response to Issue 5 - Economic Contributions of the Forests**

- Alternative A delivers a sustainable timber supply with an average annual allowable sale quantity of 34 million board feet. Approximately 3,300 acres per year could be regenerated. 528,000 acres, or about half of the Forests, is in management areas where timber production may occur. Of those acres, approximately 276,000 acres, or 27 percent of the Forests, is available for harvest, which is limited at the project level by the following factors: rock outcrops, steep slopes, inaccessible tracts, threatened and endangered species habitat, archeological sites, riparian zones, economics, the age and condition of the trees, and the need to disperse harvests across the landscape.
- The tourism industry of Western North Carolina is supported through the protection of recreational opportunities and scenic forest landscapes as identified in management area allocations.

## **2.5.2 Alternative B**

**Summary:** Alternative B responds to those who desire more flexibility at the project level for managing vegetation patterns, wildlife habitats, recreation, and access. This alternative provides the largest land base for creating young forest structure through mechanical treatment due to the largest allocation of Matrix management area. This alternative provides the smallest plan level designated old growth network, coupled with the most project level flexibility for making old growth network adjustments. This alternative provides the most plan level flexibility for adding new trails to the trail system in the future. This alternative also recommends the most acreage for wilderness; this is consistent with the theme of retaining flexibility for locating young forest habitat, because areas recommended for wilderness are generally unroaded and are not areas that would otherwise be managed for young forest habitat. A map of this alternative is available in Appendix I.

### **Response to Issue 1 - Vegetation Patterns and Wildlife Habitats**

- Alternative B includes the greatest amount of forest acres allocated to the Matrix MA which allows for the greatest amount of flexibility to regenerate young forest.
- Establishes at the plan level a network of designated old growth comprised of large, medium, and small patches. Additional small patches of old growth forest may be added to the designated network at project level analysis. The plan level old growth network in this alternative is smaller than the old growth network in Alternatives C, D and E.

- Provides direction for managing rare and unique communities, as well as NC Natural Heritage Program Natural Areas, wherever they occur on the landscape, but does not include any acres in an Ecological Interest Area MA, except those that are recognized as Special Interest Areas (see below).

### **Response to Issue 2 – Special Area Designations**

- Recommends twelve extensions to existing wildernesses and eleven stand-alone Recommended Wilderness areas (five of which are WSAs). These areas are largely unroaded, have some wilderness characteristics either throughout or within a portion of the area, and have been advocated for by groups that support recommended wilderness.

### **Response to Issue 3 – Access**

- Provides the greatest opportunities for motorized public access on open forest roads and the greatest opportunity for increasing seasonal access on open roads, because it allocates the greatest amount of land to Interface and Matrix MAs of all alternatives.

### **Response to Issue 4 – Recreation**

- This alternative provides a considerable opportunity for a primitive or semi-primitive non-motorized recreation experience which is associated with the large amount of wilderness recommendations.
- Provides the greatest opportunity among action alternatives for new trail construction for non-motorized uses with the fewest restrictions on when new trail construction could occur.
- Commercial collection of non-timber forest products would be limited compared to the other alternatives because of the greater amount of wilderness recommendations.

### **Response to Issue 5 - Economic Contributions of the Forests**

- Generates contributions to the local economy through revenues from timber receipts and wilderness recreation and tourism.
- Provides least acres of land available for permitted collection of non-timber forest products across much of the Forests, because this alternative recommends the most acres for wilderness.

## **2.5.3 Alternative C**

**Summary:** Alternative C is intended to be responsive to those who desire more certainty at the plan level and less project level flexibility for managing vegetation patterns, wildlife habitats, recreation and access. This alternative allocates a greater amount of the Forests to Backcountry and Ecological Interest Areas management areas compared to the other alternatives, which would provide more limitations on the timber management activities that can occur in these locations. This alternative establishes the largest old growth network at the plan level and then prevents future project level adjustments. This alternative is the most restrictive when adding new trails to the system, allowing less project level flexibility. This alternative recommends the fewest acres of wilderness of the alternatives, instead offering the greatest acreage of backcountry that allows for a semi-primitive non-motorized recreation experience that will provide the most opportunity for future mountain biking. A map of this alternative is available in Appendix I.

### **Response to Issue 1 - Vegetation Patterns and Wildlife Habitats**

- Alternative C emphasizes passive management over a greater portion of the land compared to the other alternatives and provides more land where management activities focus on restoration of species composition over structural composition.

- Concentrates creation of young forest habitat on a smaller area of the Forests because less of the forest is in the Matrix MA compared to other alternatives.
- Includes an Ecological Interest Management Area which emphasizes activities that focus on enhancing or maintaining high quality ecological communities and their local attributes. This is accomplished by restricting timber harvest, except where it contributes to desired species composition.
- Designates the largest old growth network at the forest plan level with no new small patches added to the network during project level planning. The existing old growth forest that is found outside the designated old growth network will be managed consistent with the MA in which it is found.

### **Response to Issue 2 – Special Area Designations**

- Recommends two areas for wilderness, both of which are congressionally designated Wilderness Study Areas. The remaining three Wilderness Study Areas will continue to be managed to preserve wilderness characteristics.

### **Response to Issue 3 – Access**

- Provides the least opportunity for increasing seasonal access on open roads, because more of the Forests is allocated to the Backcountry MA in this alternative.

### **Response to Issue 4 – Recreation**

- With more of the Forests allocated to the Backcountry MA, there is a greater emphasis on semi-primitive non-motorized settings and opportunities.
- New trail construction requires public involvement via collaborative planning processes to identify needs. This alternative includes the most restrictive provisions for new trail construction for non-motorized uses in that a new trail must be needed to mitigate resource damage, safety issues, and users' conflicts, and the old trail will be decommissioned, or new trail mileage will be offset by a comparable length of decommissioned trail in another location.

### **Response to Issue 5 - Economic Contributions of the Forests**

- Provides availability of permits for collection of non-timber forest products across much of the Forests, because little of the Forests is recommended for wilderness.
- Generates contributions to the local economy that are focused more on revenues from recreation, outfitters, and guides as opposed to timber receipts.
- Commercial timber management generates fewer dollars compared to other alternatives.

## **2.5.4 Alternative D**

**Summary:** Alternative D aims to strike a balance between Alternatives B and C in terms of plan restrictions versus project flexibility for vegetation management, recreation, and access. While it is responsive to the issue of designating places with rare and unique ecological values into the Ecological Interest Area MA, it also maintains much of the Forests in the Matrix MA, allowing for flexibility of active management to meet young forest habitat needs and respond to emerging forest health issues. This alternative establishes an old growth network sized between Alternatives B and C and then allows some project level additions where conditions are under-represented. This alternative provides moderate restrictions on new trail building and establishes a new tool-a trail bank-that can be used across the Forests to build sustainable trail miles. This alternative recommends only those areas with the highest

quality wilderness characteristics for wilderness designation, proposing a number between Alternatives B and C. A map of this alternative is available in Appendix I.

### **Response to Issue 1 - Vegetation Patterns and Wildlife Habitats**

- Alternative D achieves restoration of natural communities using silvicultural treatments that focus on moving toward the natural range of variation while also emphasizing early successional habitat for wildlife.
- Includes a moderate amount of forest acres allocated to the Matrix MA, allowing for the greatest amount of flexibility to manage for structural departure and respond to young forest habitat needs and emerging forest health issues.
- Includes an Ecological Interest MA, though on a smaller portion of the Forests than Alternative C. This MA emphasizes activities that focus on enhancing or maintaining high quality ecological communities and their local attributes. This is accomplished by restricting timber harvest, except where it is needed to improve desired species composition.
- Establishes a designated old growth network at the forest plan level comprised of large, medium and small patches. During project level analysis, additional existing small old growth patches shall be added to the designated old growth network only when their inclusion contributes designated old growth acres to an ecozone, elevation, or patch size of old growth forest that is underrepresented and/or not redundant within the designated network. Newly identified existing old growth forest that is not added to the designated old growth network will be managed consistently with the MA in which it is found.

### **Response to Issue 2 – Special Area Designations**

- Recommends ten extensions to existing wilderness and six standalone areas for wilderness designation (four of which are Wilderness Study Areas). This alternative seeks a middle ground related to recommended wilderness, recommending only those areas with the highest quality wilderness characteristics for wilderness designation.

### **Response to Issue 3 – Access**

- Provides a moderate amount of opportunities for motorized public access on open forest roads in the Matrix and Interface MAs.
- This alternative provides moderate restrictions on creating additional non-motorized trail miles. This alternative includes a trail bank concept that allows new trails to be built where their economic, ecological, and social sustainability can be demonstrated, up to a limited number of miles identified in the forest trail bank.

### **Response to Issue 4 – Recreation**

- Provides a broad range of recreation experiences from semi-primitive non-motorized in Backcountry MA, wildernesses, and recommended wildernesses, to highly developed areas in the Interface MA.
- Moderately restricts new trail construction for non-motorized uses, incorporating public involvement via collaborative planning processes to identify trail construction needs. Similar to Alt C, trail construction is allowed when needed to mitigate unavoidable resource damage, safety issues, or user conflicts. Additionally, this alternative allows other trail construction when the geographic area has at least 50% of trails meeting standards or trails of the proposed use type are under-represented within the geographic area.

- Establishes a trail bank of miles that can be used to add new sustainable trail miles to the non-motorized trail system. The trail bank will begin with an initial number of miles that can be used, but not exceeded, when constructing new sustainable trails or adopting unauthorized routes as NFS trails. Additional miles will be credited to the trail bank when existing NFS trails are decommissioned and/or rehabilitated.

### **Response to Issue 5 - Economic Contributions of the Forests**

- Generates a mixed portfolio of contributions to the economy from timber receipts, outfitter and guide permits, recreation, and tourism.

### **2.5.5 Alternative E & Alternative E Modified**

**Summary:** Alternative E incorporates public comments between draft and final. This alternative increases the emphasis on prescribed fire, using fire and mechanical harvest to restore open forest conditions, and nonnative invasive species treatments in tiered objectives; establishes an old growth network that is larger than any of the other alternatives, and sets the footprint of the network for the life of the forest plan; addresses the challenge of trail management by working collaboratively with partners to focus on supply and demand issues in some Geographic Areas of the forest and ensuring that new trail miles are socially, ecologically and fiscally sustainable and recommends more acres and areas for wilderness compared to Alternatives A and C, but less than B and D, recommending areas with the strongest wilderness characteristics in combination with public comments and management needs for other multiple uses. A map of this alternative is available in Appendix I.

Alternative E Modified incorporates remedies, voluntary modifications, and clarifications identified during the Plan revision objection process, and incorporates corrections of errors that were identified as needed following the issuance of the January 2022 plan and EIS. A list of changes associated with Alternative E is shown in section 2.4. Except where noted below, Alternative E Modified responds to the themes similarly as Alternative E.

### **Response to Issue 1 - Vegetation Patterns and Wildlife Habitats**

- Emphasizes addressing habitat shortages in young forest, old growth forest, and open forest conditions.
  - Increases the pace and scale of young forest habitat creation. Objectives would double annual young forest timber harvest practices under Tier 1 (from 650 to 1,200), and accomplish even more with the help of partners or additional resources in Tier 2 (up to 3,200 acres).
  - Adds an emphasis on using fire and mechanical harvest to restore open forest conditions in tiered objectives.
  - Establishes a designated old growth network for this planning cycle that is approximately 52,000 acres larger than the current plan using best available science, representation analysis, information submitted in comments from collaborators, and data from the NC Heritage Program. Compared to the current plan, this adjusted network improves representation of ecozones and elevations, while providing larger patch sizes and improving the potential for a functional old growth network.
- Increases emphasis on prescribed fire with up to 20,000 annual acres as an objective in Tier 1, and up to 45,000 annual acres in Tier 2.

- Increases objectives for nonnative invasive species treatments, community and forest stand improvement practices, unique habitat restoration and watershed projects.
- Contains an ecosystem focus, with separate subsections for wildlife, the designated old growth network, forest health, timber and fire.
- Includes a moderate amount of forest acres allocated to the Matrix MA, allowing for flexibility to manage for structural departure and respond to young forest habitat needs and emerging forest health issues.
- Includes an Ecological Interest MA that emphasizes activities that focus on enhancing or maintaining high quality ecological communities and their local attributes. This is accomplished by restricting timber harvest, except where it is needed to improve desired species composition.

### **Response to Issue 2 – Special Area Designations**

- Recommends 14 areas and approximately 49,000 acres for wilderness designation, including eight extensions to existing designated wildernesses, four existing Wilderness Study Areas, and two new standalone areas. This alternative strikes a balance between the public's desires to actively manage and restore the forest for resiliency and biological diversity, to provide for semi-primitive non-motorized recreation settings without many of the restrictions of wilderness designation, and to preserve as recommended wilderness areas those which possess the highest degree of undeveloped and natural characteristics, opportunities for solitude or primitive and unconfined recreation, or other features of value.
- Identifies 8 newly eligible Wild and Scenic Rivers in Alternative E, and 9 in Alternative E modified
- Identifies approximately 118,000 (Alternative E) to 119,000 (Alternative E Modified) acres as Special Interest Areas to be managed in recognition for their unique characteristics, expanding this management area to be more than twice the size in the current plan.

### **Response to Issue 3 – Access**

- Provides a moderate amount of opportunities for motorized public access on open forest roads in the Matrix and Interface MAs.

### **Response to Issue 4 – Recreation**

- Responds to the challenge of trail management by addressing supply and demand needs for bicycling and equestrian trails on some areas of the forest, and ensuring that new trail miles are socially, ecologically and fiscally sustainable, and in good locations for future soil and water needs.
- Provides a broad range of recreation experiences from semi-primitive non-motorized in Backcountry MA, wildernesses, and recommended wildernesses, to highly developed areas in the Interface MA.

### **Response to Issue 5 - Economic Contributions of the Forests**

- Generates a mixed portfolio of contributions to the economy from timber receipts, outfitter and guide permits, recreation, and tourism.
- Recognizes the role of the forest in sustaining quality of life and economies in Western North Carolina.

## 2.6 Comparison of Action Alternatives

### 2.6.1 Maps

The maps in Appendix I should be used to compare differences between alternatives. Information on how the maps were created is available in Appendix B. Geographic Information System shapefiles are available for download at [www.fs.usda.gov/goto/nfsnc/nprevision](http://www.fs.usda.gov/goto/nfsnc/nprevision).

Maps are based on the best available data as of publication. Data was collected at various scales and sources, resulting in minor deviation between resource analyses, and minor acreage discrepancies can be expected based on use of computerized analysis.

### 2.6.2 Alternative Features by Comparison

The following tables compare alternatives by summarizing management area allocations and the ability to achieve desired conditions, focusing on selected indicators for the issues used for alternative development.

As stated above, there are instances where total forest acreage numbers of management areas may not be considerably different between alternatives, however the location of where those acres are identified across the landscape may be very different. The detail of how different places are proposed to be managed must be examined at a fine scale to appreciate the effects of those designations. Comparison of aggregate acres of management areas between alternatives at the broad landscape scale does not reveal the meaningful differences between alternatives. Therefore, a simple chart comparing acres should not be relied on for alternative comparison as much as reviewing management area maps.

**Table 1. Alternative Features Comparison, Organized by Issue**

Plan Decision	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E Modified (preferred)
Issue 1: Vegetation Patterns and Wildlife Habitats						
<i>Young forest creation (annual acres)</i>	650 acres <sup>7</sup>	Tier 1: 650-1200 acres Tier 2: 1200 to 3200 acres				
<i>Intermediate thinning treatments (annual acres)</i>	150 acres <sup>8</sup>	Tier 1: 150-400 acres Tier 2: 400- 600 acres				
<i>Thin and burn for open forest woodland (annual acres)</i>	N/A	N/A	N/A/	N/A	Tier 1: 300 to 600 acres Tier 2: 600 to 900 acres	

<sup>7</sup> Young forest and intermediate thinning acreage from Alt A represents the activity levels as implemented in the last 10 years, not as planned in the 1994 plan, which was much higher. See EIS Ch. 3 for more.

<sup>8</sup> Young forest and intermediate thinning acreage from Alt A represents the activity levels as implemented in the last 10 years, not as planned in the 1994 plan, which was much higher. See EIS Ch. 3 for more.



Plan Decision	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E Modified (preferred)
Land operable for timber management, all conditions (estimated acres)	206,000-430,000 acres	240,000-594,000 acres	238,000-488,000 acres	243,000-535,000 acres	233,000-505,000 acres	
Land operable for timber management, commercially viable currently (estimated acres)	98,000-216,000 acres	113,000-265,000 acres	111,000-235,000 acres	113,000-260,000 acres	108,000-245,000 acres	
Plan level designated old growth network (acres)	211,118 acres	202,524 acres	255,968 acres	226,015 acres	265,441 acres	
Adjustments to the old growth network expected at the project level	Project level adjustments may be made	Project level adjustments may be made	Network set at plan level; no project level adjustments	Project level adjustments must meet identified conditions	Network set at plan level; no project level adjustments	
Prescribed fire (annual acres)	8,500 acres	Tier 1: 6,500 to 10,000 acres Tier 2: 10,000 to 20,000 acres			Tier 1: 10,000 to 20,000 acres Tier 2: 20,000 to 45,000 acres	
Ecological Interest Area MA (acres)	N/A	0	79,550 acres	26,000 acres	22,195 acres	
Issue 2: Special Area Designations						
Special Interest Areas	50,519 acres	102,650 acres			118,810 acres	119,462 acres
Wilderness - Designated	6 areas; 66,400 acres					
Wilderness Study Areas	5 areas; 26,816 acres					
Recommended Wilderness	3 areas (3 WSAs); 15,226 acres	23 areas (5 WSAs); 126,333 acres	2 areas (2 WSAs); 11,193 acres	16 areas (4 WSAs); 74,173 acres	14 areas (4 WSAs); 49,098 acres	
Wild and Scenic Rivers - Designated	3 rivers					
Wild and Scenic Rivers - Eligible	10 rivers	19 rivers			18 rivers	19 rivers

<b>Plan Decision</b>	<b>Alt. A</b>	<b>Alt. B</b>	<b>Alt. C</b>	<b>Alt. D</b>	<b>Alt. E</b>	<b>Alt. E Modified (preferred)</b>
<i>Appalachian National Scenic Trail corridor<sup>9</sup></i>	16,100 acres	45,290 acres	51,660 acres	49,900 acres	48,152 acres	48,533 acres
<i>Heritage Corridors</i>	NA	8,370 acres	8,760 acres	8,530 acres	6,512 <sup>10</sup> acres	
<i>Scenic Corridors</i>	NA	23,310 acres	20,940 acres	23,770 acres	21,851 acres	
<b>Issue 3: Access</b>						
<i>Percent of the forest in management areas where road access is prioritized</i>	51%	60%	48%	59%	58%	
<i>Percent of the forest in management areas where road building is not allowed</i>	11%	23%	14%	19%	17%	
<b>Issue 4: Recreation</b>						
<i>Approach to adding trail miles to the system</i>	N/A	Least restrictive	Most restrictive	Moderately restrictive, with a trail bank	Moderately restrictive without a trail bank	
<i>Acres managed for semi-primitive non-motorized recreation (Estimated Acres)</i>	146,000 acres	177,000 acres	313,000 acres	206,000 acres	208,000 acres	
<i>Acres managed for primitive recreation (Estimated Acres)</i>	65,000 acres	194,000 acres	96,000 acres	145,000 acres	121,000 acres	

<sup>9</sup> The Appalachian Trail National Scenic Trail corridor will be managed comparably under all alternatives. Under alternative A, a smaller area was mapped in the forest plan than the area that is regularly considered in project design. The proposed plan in the action alternatives has been updated to incorporate the potential foreground acreage that is reviewed at the project level. Corridor acreage differs among action alternatives because of variations in recommended wilderness.

<sup>10</sup> Between the release of the proposed plan and final plan, the location of the Trail of Tears National Historic Trail was updated based on new information, resulting in an adjustment to this management area location. More information is available in the Tribal Resources section of Chapter 3.

<b>Plan Decision</b>	<b>Alt. A</b>	<b>Alt. B</b>	<b>Alt. C</b>	<b>Alt. D</b>	<b>Alt. E</b>	<b>Alt. E Modified (preferred)</b>
<i>Recreation focused management area</i>	N/A	67,150 acres	55,200 acres	66,980 acres	65,890 acres	66,305 acres
<b>Issue 5: Economic Contributions of the Forests</b>						
<i>Jobs Generated<sup>11</sup></i>	3,280	Tier 1: 3,421 Tier 2: 3,809	Tier 1: 3,417 Tier 2: 3,821	Tier 1: 3,420 Tier 2: 3,804	Tier 1: 3,425 Tier 2: 3,808	
<i>Labor Income</i>	\$109,110,000	Tier 1: \$116,702,000 Tier 2: \$134,394,000	Tier 1: \$116,484,000 Tier 2: \$134,923,000	Tier 1: \$116,653,000 Tier 2: \$134,207,000	Tier 1: \$116,862,000 Tier 2: \$134,141,000	
<i>Projected Wood Sale Quantity (PWSQ)</i>	3.8 MMCF	Tier 1: 6.1 MMCF Tier 2: 11.8 MMCF	Tier 1: 6.2 MMCF Tier 2: 12.3 MMCF	Tier 1: 6.1 MMCF Tier 2: 11.6 MMCF	Tier 1: 5.0 MMCF Tier 2: 11.1 MMCF	
<i>Projected Timber Sale Quantity (PTSQ)</i>	2.1 MMCF	Tier 1: 4.4 MMCF Tier 2: 10.1 MMCF	Tier 1: 4.5 MMCF Tier 2: 10.6 MMCF	Tier 1: 4.4 MMCF Tier 2: 9.9 MMCF	Tier 1: 3.3 MMCF Tier 2: 9.4 MMCF	
<i>Acres Suited for Timber Production</i>	361,176	405,657	321,670	409,337	459,175	458,027

### 2.6.3 Comparison of How Alternatives Move Toward Long Term Desired Conditions

Below is a summary of the effects of implementing each alternative. Information in the table is focused on activities and effects where different levels of effects can be distinguished quantitatively or qualitatively among alternatives.

<sup>11</sup> The estimated differences in job and labor income between alternatives are not meaningful given fluctuations in local and global market conditions and actual resource use. The meaningful difference is shown between Tier 1 and Tier 2 activity levels, not between alternatives themselves.

**Table 2. Summary of the Ability of Each Alternative to Achieve Management Needs and Key Desired Condition Concepts as Analyzed and Disclosed in Chapter 3**Key

++ = very effective at achieving desired conditions

+ = effective at achieving desired conditions

o = neutral contribution toward achieving desired conditions

- = ineffective at achieving desired conditions

-- = very ineffective at achieving desired conditions

Long Term Desired Condition	Ability to Move Toward Desired Conditions					
	Alternative A*	Alternative B*	Alternative C*	Alternative D*	Alternative E*	Alternative E Modified*
Plan theme: Sustaining Healthy Ecosystems						
<i>Increasing pace and scale of ecological restoration</i>	O	+	+	+	+	+
<i>Increasing open forest habitat in short supply</i>	O	+	+	+	++	++
<i>Increasing young forest habitats in short supply</i>	-	++	++	++	++	++
<i>Increasing old growth habitat in short supply</i>	++	++	++	++	++	++
<i>Provide a representative network of designated old growth</i>	+	-	++	+	++	++
<i>Protecting and restoring unique habitats</i>	+	++	++	++	++	++
<i>Providing for the persistence of rare species including Species of Conservation Concern</i>	++	++	++	++	++	++

Long Term Desired Condition	Ability to Move Toward Desired Conditions					
	Alternative A*	Alternative B*	Alternative C*	Alternative D*	Alternative E*	Alternative E Modified*
<i>Improving fire regimes for ecosystem health</i>	-	+	+	++	++	++
<i>Reducing risk to communities from wildfire</i>	+	+	+	++	++	++
<i>Addressing emerging forest health threats</i>	-	+	+	+	+	+
Plan theme: Providing Clean and Abundant Water						
<i>Maintaining healthy watersheds – priority watersheds</i>	+	++	++	++	++	++
<i>Improving aquatic organism passage</i>	+	+	+	+	+	+
<i>Reducing unneeded and unauthorized roads</i>	O	+	++	+	+	+
Plan theme: Connecting people to the land						
<i>Recognizing places and uses that are important to visitors</i>	O	++	++	++	++	++
<i>Recognizing cultural and Tribal values of the Forest</i>	O	++	++	++	++	++

Long Term Desired Condition	Ability to Move Toward Desired Conditions					
	Alternative A*	Alternative B*	Alternative C*	Alternative D*	Alternative E*	Alternative E Modified*
<i>Improving seasonal access to closed roads</i>	O	++	+	+	+	+
<i>Providing opportunities for solitude and unconfined recreation</i>	O	++	O	+	+	+
<i>Improving recreation sustainability</i>	-	O	+	++	++	++
<i>Contributing to local economies</i>	+	++	++	++	++	++
<i>Providing timber forest products</i>	+	++	++	++	++	++
<b>Plan theme: Partnering with Others</b>						
<i>Leveraging resources to achieve shared goals</i>	O	++	++	++	++	++
<i>Incorporating public involvement in project design</i>	+	++	++	++	++	++
<i>Recognizing opportunities to work across the Forest boundary</i>	O	++	++	++	++	++

\*In this table, Alternative A is analyzed as currently implemented. Alternatives B-E are analyzed as planned.

## 2.7 Alternatives Considered but Eliminated from Detailed Study

NEPA requires Federal agencies to evaluate reasonable alternatives to the proposed action and to briefly discuss the reasons for eliminating any alternatives that were not developed in detail (40 CFR 1502.14). Public comments received in response to the proposed action provided suggestions for alternative methods of meeting the purpose and need, a number of which were considered. Some of these alternatives were eliminated from detailed study because they either did not meet the purpose and need and address one or more significant issues, were outside the scope of the forest plan, were

financially or technologically infeasible, would result in unreasonable environmental harm, or were duplicative of the alternatives considered in detail. The rationale for eliminating potential alternatives from detailed consideration is summarized below.

- **An alternative that allows for only passive management of the Forests in which natural processes dominate without human intervention.** This custodial alternative was not considered in detail because it does not meet the purpose and need of the revised plan and does not meet law, regulation, or policy requirements to provide for multiple uses (National Forest Management Act of 1976 and the Multiple-Use Sustained Yield Act of 1960). The forest plan assessment shows that all forest ecosystems are departed from their natural range of variation; and restoration of structure, function, composition, and processes would not be possible under custodial management. Additionally, the diversity of species that depend on young forest conditions would not be provided for under this alternative. Minimizing human intervention would also increase susceptibility of the forest to insect and disease outbreaks, which would create increased fuel-loading and increase the risk to other resources and to adjacent private lands. This alternative would not have met the requirements of the 2012 Planning Rule, which calls for providing for ecological integrity and contributing to social and economic sustainability. Developing this alternative in detail would not have led to a viable alternative that could be selected for implementation because it does address the issues, nor does it meet the purpose and need of the revised plan.
- **An alternative that maximizes carbon uptake in response to climate change.** Suggested aspects of this alternative from public comments included emphasizing carbon storage, reducing harvest and thinning levels, lengthening harvest rotation, protecting old growth forest, and protecting characteristics of roadless areas. The responsible official determined that many aspects of this alternative had already been considered in the detailed analysis represented in alternatives B, C, D, and E. All action alternatives include a climate change section that focuses on maintaining and creating ecosystem resiliency and adaptability, forest management that reduces the forests' susceptibility to future climate-related stressors, maintaining a suite of adaptation and mitigation options for the future, and monitoring to enable adaptive management when needs are identified during plan implementation. A Desired Condition calls for sustaining ecosystem services under changing and uncertain conditions, including the regulating services of carbon sequestration and climate regulation. To focus exclusively on maximizing carbon and the other strategies named above might prevent the accomplishment of other climate adaptation and mitigation needs that arise during the planning period, such as maintenance and restoration of microsites, promoting habitat enhancement for species at risk of climate change, managing invasive species infestations, or restoring native vegetation in streamside zones. Furthermore, this alternative does not meet law, regulation, or policy requirements to provide for multiple uses, as required per the National Forest Management Act of 1976 and the Multiple-Use Sustained Yield Act of 1960. Additionally, another alternative was considered, but not analyzed in detail, that focused only on passive management (see above).
- **An alternative in which all active management is in a defined Ecological Restoration MA.** This alternative was proposed as a way to "meet ecological restoration needs while creating a broad geographic distribution of habitat diversity while minimizing the focus on forest age class distribution" (Nantahala Pisgah Forest Partnership 2017). However, our Assessment for the forest plan demonstrates that forest structure is severely departed. Managing for healthy forests and habitats while minimizing consideration of forest structure at the landscape level would not enable progress toward the full range of terrestrial ecosystem desired conditions for ecozone structure, function, composition and processes, and the Forest Service would not be able to manage for the diversity of age class habitats that many forest species depend on. Therefore,

this alternative would not meet the purpose and need of the plan. Further, this approach would also forgo the secondary and tertiary benefits of generating forest products and contributing to local economies, which is a forest plan desired condition.

This alternative is also fiscally infeasible. Without the tool of structural restoration, there would be reduced ability to package successful timber sales. Thus, there would not be enough financial resources to fund this work at such a large scale, nor would there be market demand to support creating these conditions. Sufficient timber harvest receipts are needed to support targeting compositional restoration.

Alternatives C, D, and E consider the intent of this alternative by allocating a portion of the Forests to Ecological Interest Area MA (EIAs). In these alternatives, EIAs are areas of the Forests where compositional restoration is the primary driver of management activities while other lands are identified in management areas where structural restoration can occur. This two-prong approach enables a focus on compositional restoration while still meeting forest health, habitat, and forest product goals. Furthermore, the value produced by meeting habitat and forest product goals would be available to reach a larger footprint of the landscape, expanding the reach of restoration activities. Across all alternatives, the plan is clear that timber production will not be the primary purpose for projects and activities and shall, instead, complement the ecological restoration desired conditions and objectives.

- **An alternative that includes the recommendation of National Recreation Areas on the Grandfather and Pisgah Ranger Districts.** While interest from many organizations toward a National Recreation Area Proposal was strongest in late 2015, several signatory organizations have since redacted their support for this proposal, and the signatory organizations did not advocate for this proposal during public involvement on alternative formation.

The Forest Service recognizes the unique recreation values on the Nantahala and Pisgah NFs and used other plan components to reflect these values within the draft plan. All action alternatives were modified to include the use of geographic area descriptions and goals to reflect the heavy recreation value of these areas. In the alternatives these areas have differing management area composition including differing amounts of Interface, which is recognized for its heavy recreation value; Backcountry, which is recognized for semi-primitive non-motorized settings and opportunities; and recommended Wilderness, which provides opportunities for solitude or unconfined recreation. The variation in the management area allocation in the range of alternatives adequately reflects the underlying interests within the National Recreation Area proposal.

- **An alternative that proposed specific management for the greater Craggy Mountain area including a National Scenic Area recommendation** for a 16,000-acre area of the Black Mountain Geographic Area including the Craggy Mountains, Coxcomb Mountain, Snowball Mountain, Shope Creek, and Ox Creek areas. Thousands of commenters wrote in support of a National Scenic Area recommendation in the Craggy Mountains/Big Ivy area of the Appalachian Ranger District with the purpose of ensuring protection and preservation of natural resources, scenic quality and recreation opportunities. The Forest Service recognizes the public interest in protection of this area and included a range of alternatives that respond to the desire for wilderness recommendation and resource protection in the Craggy Mountain area.

Following the comment period, elements of the National Scenic Area proposal were folded into Alternative E which recommends an expanded area for wilderness and allocates much of the remaining area as a Forest Scenic Area within the Special Interest Area (SIA) Management Area. In response to objections on this issue a voluntary modification to Alternative E allocated an



additional 708 acres to SIA at Shope Creek and Snowball Mountain, with 474 of those acres being added to the Big Ivy/Craggy Mountain Forest Scenic Area. The variation in the management area allocation in the range of alternatives adequately addresses the diverse public interests and values in the Craggy Mountain, Big Ivy, Snowball Mountain, and Shope Creek areas by recognizing their ecological diversity, scenic values, and recreational uses.

- **An alternative that recommends Wilderness for all areas included in the inventory for potential additions to Wilderness.** The Forests considered but did not include an alternative based on the comment to include all inventory areas as Recommended Wilderness. There is no requirement in the 2012 Planning Rule for all lands included in the inventory and subsequent evaluation to be carried forward in an alternative (FSH 1909.12, Ch 70.73). The Planning Rule requires that the responsible official shall identify which specific areas, or portions thereof, from the evaluation to carry forward as Recommended Wilderness in one or more alternatives to be analyzed for effects.

The inventory was based on a very inclusive process using criteria that included size as well as roads and other improvements. The total inventory of potential additions to Wilderness amounted to approximately 362,000 acres, roughly 35 percent of the total Nantahala and Pisgah NFs. As this was a broad inventory, not all areas within the inventory were identified as having wilderness characteristics. Only those areas that contain wilderness characteristics and meet the theme of an alternative were brought forward into the analysis. A more detailed explanation of which areas were brought into each alternative is described in Appendix E.

- **An alternative that includes no recommendations for Wilderness.** Some commenters expressed that the Forests should not be recommending any additional wilderness and that the designated wilderness on the Nantahala and Pisgah NFs already sufficiently represents wilderness conditions in WNC. Citizens and many county governments expressed concern with potentially negative economic impacts that may be realized by counties and the concern with potential loss of management opportunities and motorized access from recommending areas for wilderness.

This alternative was not considered in detail, because it is largely duplicative of Alternatives A and C, which only recommend a portion of the existing Wilderness Study Areas (WSAs) for wilderness. The five WSAs on the Nantahala and Pisgah NFs have been managed to maintain wilderness characteristics over the last thirty plus years and will continue to be managed as such until Congress acts to designate or release them from WSA status. As a result, Alternatives A and C already reflect alternatives that do not recommend additional acres to be managed for wilderness characteristics.

- **An alternative that reconsiders management of the Chattooga Wild and Scenic River.** In 2012, the Sumter NF, Chattahoochee-Oconee NF and Nantahala and Pisgah NFs signed decisions on managing recreation opportunities on the Chattooga WSR. In addition to amending forest plan direction, these decisions included a Monitoring Plan and Adaptive Management Strategy designed to characterize use and social impacts occurring with the upper segment of the Chattooga WSR corridor, identify changes since a previous study in 2008, and consider whether the capacity thresholds are effective at protecting and enhancing the river's ORVs, in particular the social/solitude values.

The 2012 decisions were challenged on numerous counts and in 2014, the U.S. Court of Appeals for the fourth circuit rejected challenges to the 2012 plan amendment decisions and found that the Forest Service's revised plan "carefully balance[s] the wide-ranging interests advocated by the several parties and participants." *American Whitewater v. Tidwell*, 959 F. Supp. 2d 839, 860

(D.S.C. 2013) (“Tidwell”). Following the 2014 court decision, the Forest Supervisor for the National Forests in NC maintained that the Nantahala and Pisgah National Forest plan revision would not revisit the management of the Chattooga WSR because the 2012 decision had not been fully implemented and the required monitoring of the decisions had not yet begun.

The first round of recreation use monitoring on the Chattooga WSR upstream of the Highway 28 bridge was conducted in 2017 and 2018 and the monitoring report was published in 2019. Additional monitoring is necessary to determine use trends and to determine whether changes to visitor use management on the Chattooga WSR should be appropriately contemplated. Considering changes now, without additional monitoring, would be premature and inappropriate. As the lead river management unit, the Sumter NF will assess current and future monitoring results and make adaptive management decisions in coordination with the National Forests in North Carolina and Chattahoochee-Oconee NFs. If a need to change visitor use management on the Chattooga WSR is identified, the three forest plans would be amended accordingly. This alternative was eliminated from detail study because it is outside the scope of the forest plan.

- The Nantahala-Pisgah Forest Partnership **provided a detailed and comprehensive alternative** with specific plan components and management area allocations across the Forests. This alternative included all “priority conservation areas” (NC Mountain Treasures, NC Natural Heritage Areas and old growth) in management areas not suitable for timber production. The Partnership alternative also provided more specificity about where and why active management should be prioritized, clearer sideboards on timber harvest and roadbuilding, an emphasis on utilizing partner investments for sustainable recreation, streamlining special use permits for outfitters and guides, and recommending adaptive management approaches.

This comprehensive alternative was presented as having full support of the Partnership *only if all recommendations were taken together*. The entire Partnership alternative was not analyzed in detail because some elements of this alternative are outside the scope of the plan revision, such as revising the boating prohibitions on the Chattooga River (discussed in alternative above). Other elements of the Partnership alternative such as ‘triggers’ and tiered recommendations for wilderness were not analyzed because they are inconsistent with how the Forest manages multiple resources (see below for further explanation of management triggers).

The EIS alternatives adequately present a range of options for MA allocation in places where there were diverse opinions regarding management. The issues, core components, and management area recommendations in the Partnership alternative were carefully considered and many recommendations are addressed in plan components of other action alternatives, including changes between draft and final in Alternative E, therefore, a specific alternative reflecting this comprehensive proposal was not developed in detail.

- Comments asked for **multiple alternatives to include adaptive management triggers**. Specifically, triggers were requested for management allocations, such as recommending more wilderness areas only after restoration projects have been accomplished on the ground. This was considered but found to be an implementation decision rather than a management area allocation decision, as any area recommended for wilderness in the plan would have to be managed to retain its wilderness characteristics from the time the forest plan is signed and could not adopt a status of Recommended Wilderness without a plan amendment. However, this idea could be implemented under any alternative through a forest plan amendment, such that public support for advancing wilderness recommendations could take place at such time that other aspects of plan implementation have been achieved. As a result, there was not a need to build an alternative to address this consideration.

Similarly, comments asked for adaptive management triggers to be included for objectives, such that Tier 2 objectives are not initiated until all objectives are accomplished at Tier 1 levels. Each Tier 2 objective has resource effects analyzed in this EIS, and language was added to the plan to clarify that activity levels for an objective can move from Tier 1 to Tier 2 for that activity when additional resources and capacity are available. For example, Tier 2 levels of nonnative species management can be accomplished independent of whether the Tier 1 work on aquatic organism passage or cultural heritage surveys is complete. However, if a Tier 2 objective for one resource is not desired to begin until a Tier 1 objective for another resource is accomplished, then under any alternative, management could choose not to undertake that Tier 2 objective. There is not a need to build a new alternative to address this concern. Adaptive management triggers can also be identified in the monitoring guide, developed after the forest plan.



## **Chapter 3: Affected Environment and Environmental Consequences**

### **3.1 Introduction**

Chapter 3 describes the existing physical, biological, social, and economic environments of the Nantahala and Pisgah NFs followed by the environmental consequences of implementing the alternatives. It also presents the scientific and analytical basis for the comparison of alternatives presented in chapter 2. More detailed information, including methodology, assumptions, and effects analysis are available in appendices B through H and in the administrative records of the plan revision process and the National Environmental Policy Act review.

The forest plan provides a framework that guides site-specific actions, but does not authorize, fund, or carry out any project or activity. Before site-specific projects may be implemented, project- and activity-level planning, environmental analysis, and decisions must occur. For example, the draft revised plan contains direction to treat vegetation by mechanical means or with fire to achieve desired conditions, however, a future site-specific analysis and decision must be made for each proposal that involves every future site-specific vegetation treatment. This EIS will provide information that may be incorporated by reference in future site-specific NEPA documents, but this EIS is not a decision document for future site-specific actions.

Because the forest plan does not authorize or mandate any site-specific projects or activities (including ground-disturbing actions), there are no direct effects. However, there may be implications, or long-term environmental consequences of managing the Nantahala and Pisgah NFs under this framework. Those environmental consequences are described in this chapter. All ongoing projects that are being conducted under the guidance of the current plan are analyzed as part of the indirect effects of each alternative. Cumulative effects consider the incremental impacts of the Forest Service in the context of the broader landscape of Western North Carolina. The consequences described in this chapter are based on predicted implementing activities and are meant to compare alternatives on a programmatic level, rather than provide exact measurements of effects.

Chapter 3 is organized into three sections: 1) physical environment, 2) biological environment, and 3) social and economic environment. Each resource section is organized and presented as affected environment, environmental consequences, and cumulative effects. The environmental consequences section analyzes the effects of implementing the proposed revised plan and the alternatives. The focus of the analysis is on how the revised plan components and management area allocations may affect a given resource as opposed to the effects of direct management actions on individual resources.

### **3.2 Physical Resources**

#### **3.2.1 Air**

The analysis of air resources focuses on two topics. The first analysis evaluates the impact of air pollution released from prescribed fires, because this is the most important Forest Service land management activity affecting air quality. The second analysis examines how air pollution, mostly from emissions released outside of the Forests, impacts sensitive areas of Forest Service ownership. These sensitive areas include where acid deposition, especially from sulfur compounds, has and continues to contribute to nutrient base cation (calcium, magnesium, and potassium) losses from soils and reduces the acid buffering capacity of streams. The sensitive areas are of concern, because long-term soil productivity and stream buffering capacity may not recover if timber harvesting removes too much nutrient cations

from catchments and total sulfur deposition remains the same as the 2013-2015 mean deposition (Knoepp et al. 2016; McDonnell et al. 2013; McDonnell et al. 2018).

## **Affected Environment**

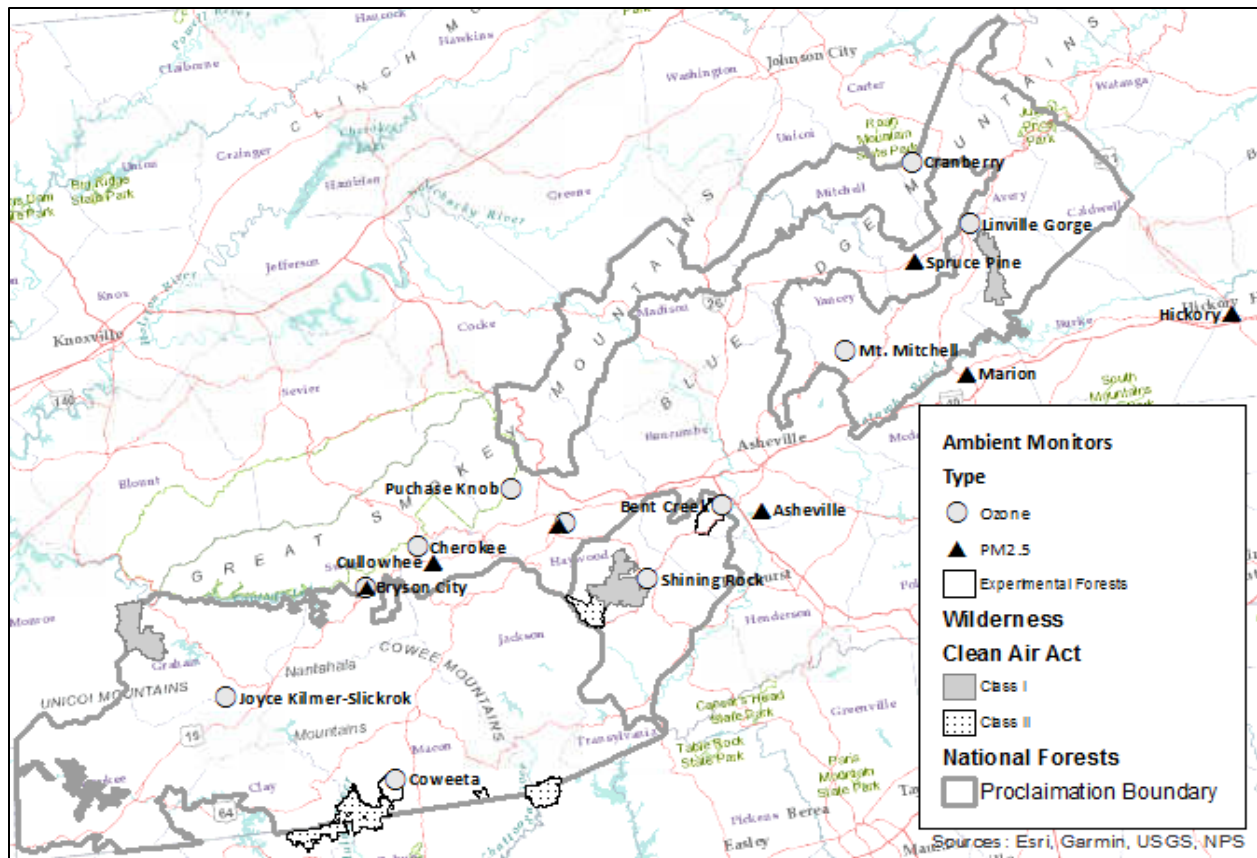
Affected environment describes the trend in air quality based upon ambient monitoring, and acid deposition estimates based upon statistical modeling and atmospheric modeling results.

### *Ambient Air and Acid Deposition Trends*

Prescribed fires release large quantities of fine particulate matter (PM<sub>2.5</sub>), and some nitrogen oxides that can contribute to ground level ozone formation. High concentrations of ozone and PM<sub>2.5</sub> can cause health impacts, especially for children, the elderly and anyone who suffers from respiratory or cardiovascular diseases. The Environmental Protection Agency (EPA) has the responsibility to set the National Ambient Air Quality Standards (NAAQS) based upon scientific information and an ambient concentration that protects the health of people sensitive to air pollution (Peterson et al. 2018). Figure 3 shows the locations of ambient air monitors for PM<sub>2.5</sub> and ozone used in this analysis.

Prescribed fires release about 0.3 pounds of nitrogen oxides for each ton of fuel consumed (Urbanski 2014). On warm, sunny days the nitrogen oxides combine with volatile organic compounds (trees are the primary emission source) to form ozone (Peterson et al. 2018). Ambient monitoring of ozone occurs at 11 locations within or near the Nantahala and Pisgah NFs (Figure 3). For 2013 – 2017, at all locations the trend in ozone concentrations remained below the NAAQS (Figure 4) set by the EPA to protect the public's health and welfare (such as forest health).

Prescribed fires release about 25 pounds of fine particulate matter for each ton of fuel consumed (Urbanski 2014). Ambient monitoring of fine particulates occurs at seven locations within or near the Forests. For all locations during the period of 2013-2017, the trend in the annual fine particulate matter concentrations was below the NAAQS (Figure 5 top). However, three locations exceeded the daily NAAQS in 2016 (Figure 5 bottom). The exceedances likely occurred during the wildfire events in November 2016.



**Figure 3. Ambient fine particulate matter (PM<sub>2.5</sub>) and ozone monitors located within and near the Nantahala and Pisgah National Forests. Data downloaded on May 7, 2018 from <https://www.epa.gov/outdoor-air-quality-data/monitor-values-report>.**

Near Shining Rock Wilderness (Figure 3), measurements of fine particulate matter track the long-term trend in visibility and determine the type of compounds contributing to visibility impairment. On the days categorized to have the worst visibility<sup>12</sup>, ammonium sulfate is typically the PM<sub>2.5</sub> contributing the most to visibility impairment. In 2016, the combined light absorbing carbon and organic carbon were greater than the previous four years; and organic carbon caused more light extinction on days classified with the worst visibility than ammonium sulfates (Figure 6). Prescribed fires in the southeast release about 32 pounds of non-methane organic carbon (Urbanski 2014) and the amount released during the dry conditions of a wildfire are probably greater. Most likely, the North Carolina Division of Air Quality either has or will submit paperwork to the EPA to exclude, under the Exceptional Events Rule<sup>13</sup>, the high daily concentrations associated with fine particulates released from the wildfires. Excluding these 2016 data, and using the remaining concentrations, the 2016 daily results in the bottom of Figure 5 are likely to become similar to the range for 2013, 2014, 2015 and 2017.

<sup>12</sup> All of the daily visibility metric results are arranged for a year from the clearest to the haziest days and the worst day is the 98<sup>th</sup> percentile.

<sup>13</sup> See: <https://www.epa.gov/air-quality-analysis/exceptional-events-rule-and-guidance>

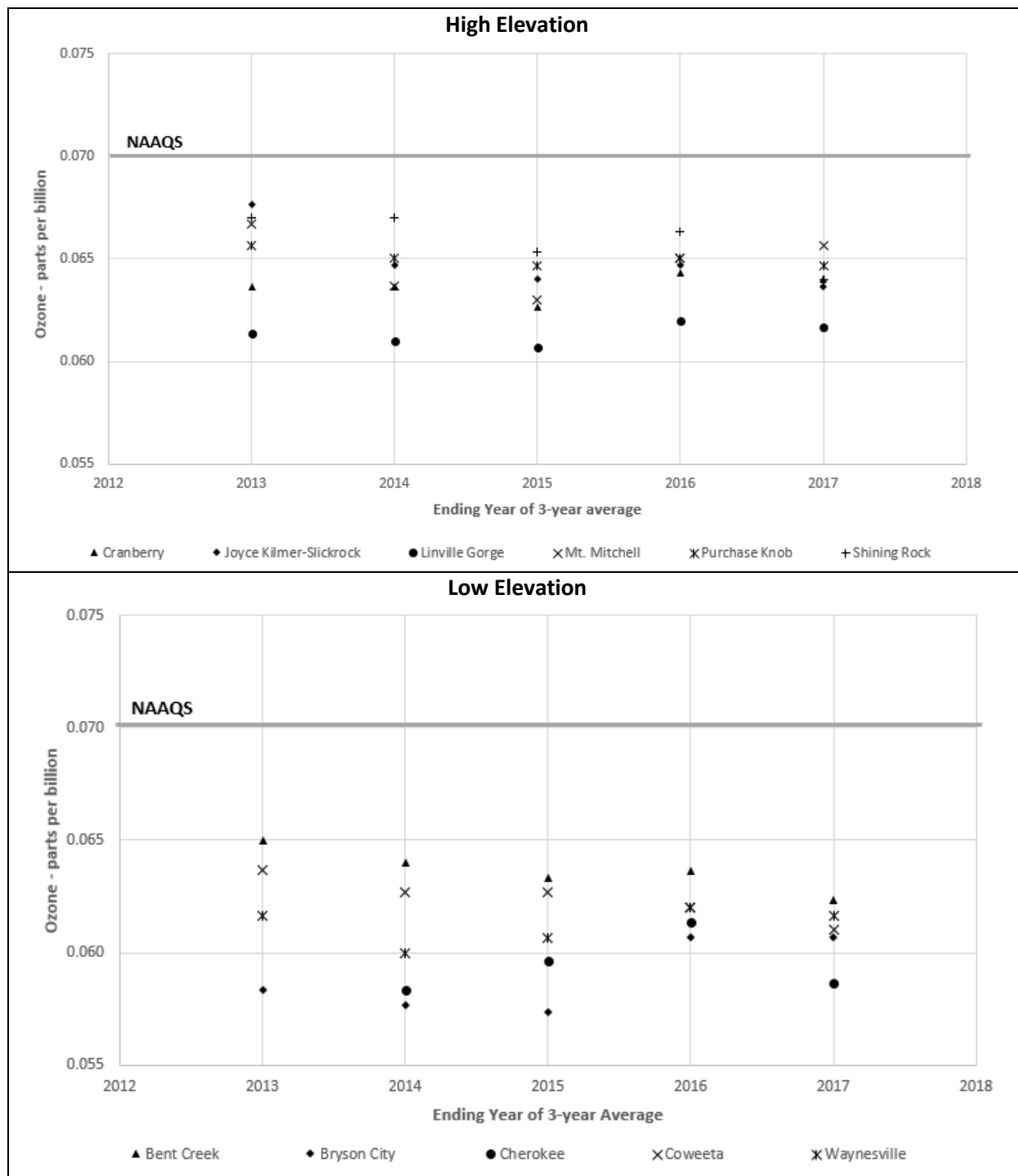


Figure 4. Three-year average ozone concentrations of the 98<sup>th</sup> percentile for ambient ozone monitors located within and near the Nantahala and Pisgah National Forests. Results are separated for monitors located at high elevations (3500 feet and greater – top) and low elevation (bottom). Data downloaded on May 3, 2018 from <https://www.epa.gov/outdoor-air-quality-data/monitor-values-report>.



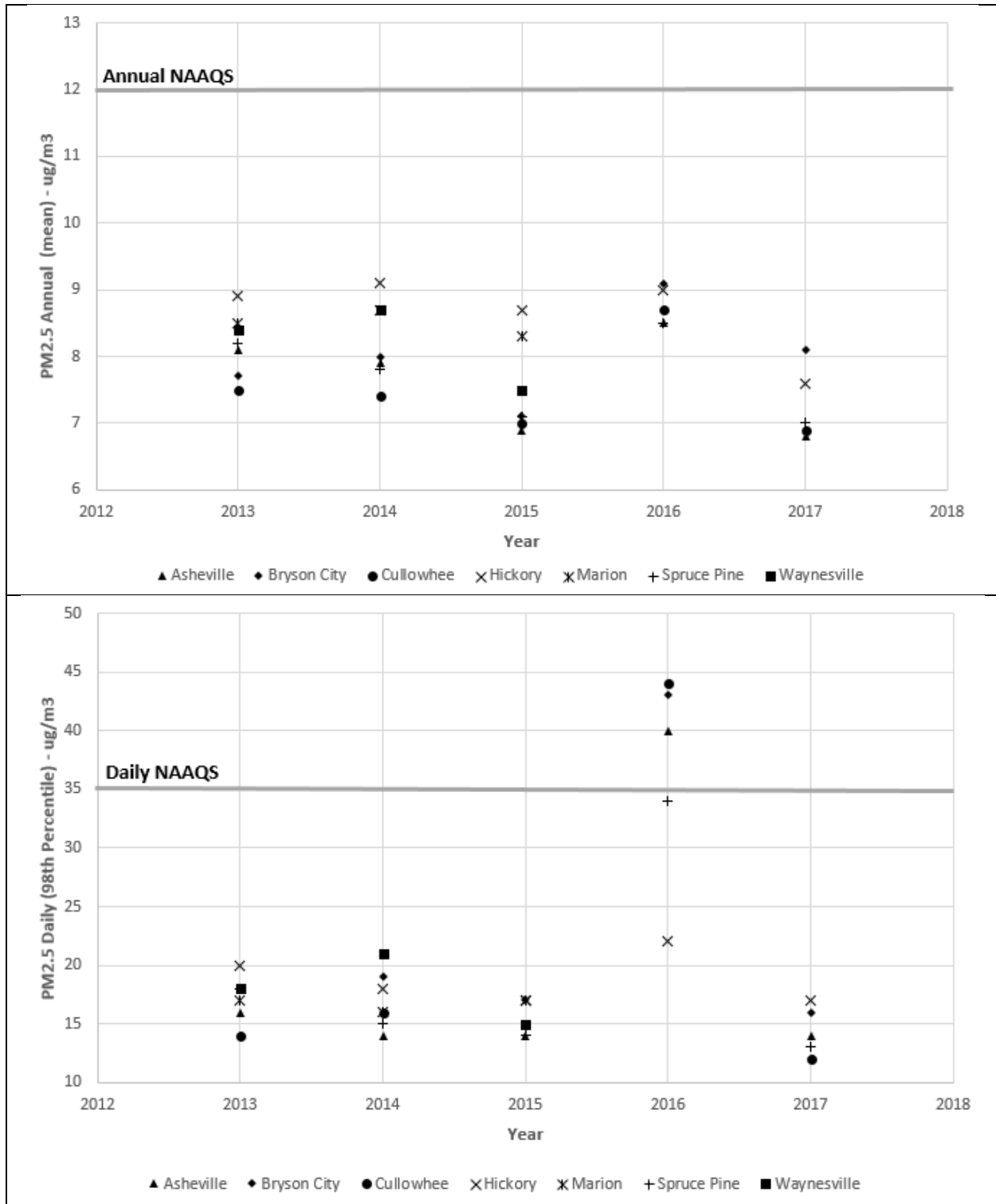
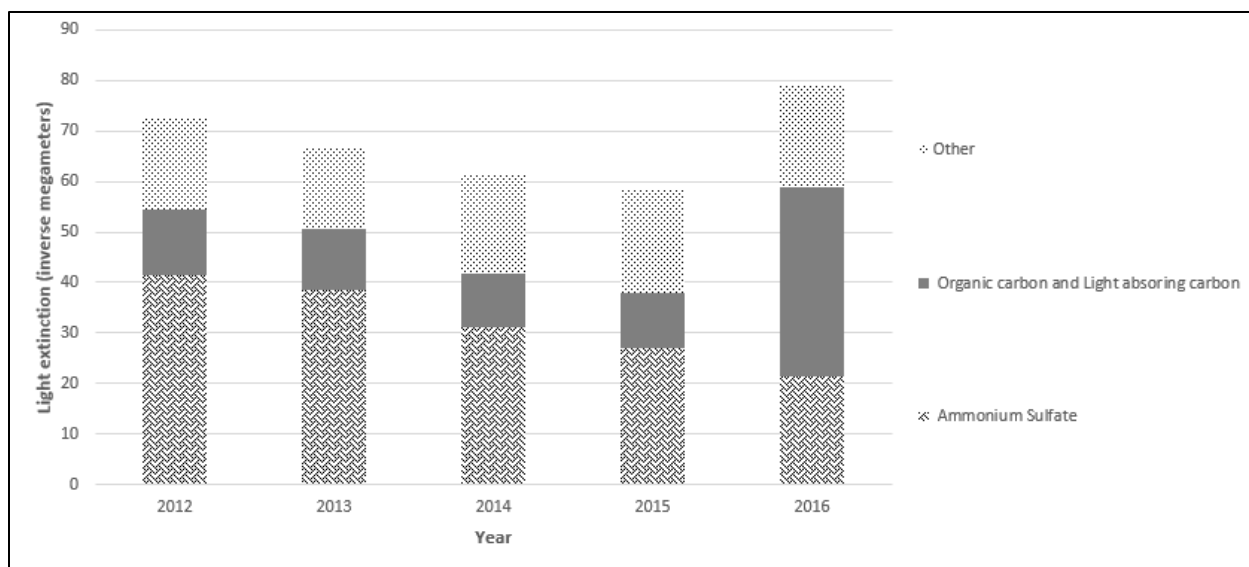
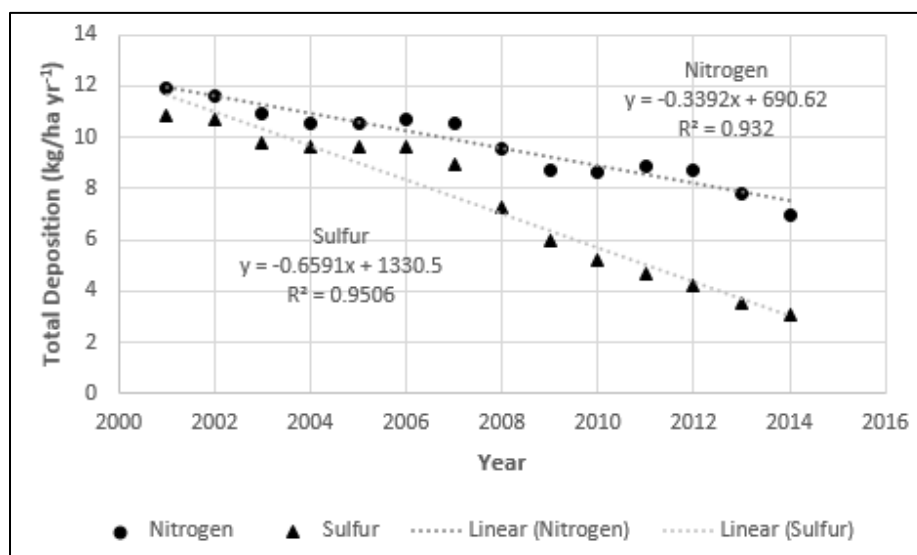


Figure 5. Annual average (top) and daily (bottom) fine particulate ambient monitoring results located within and near the Nantahala and Pisgah National Forests. Graphics include a line showing annual average and daily value for the National Ambient Air Quality Standards for PM<sub>2.5</sub>. Data downloaded on May 3, 2018 from <https://www.epa.gov/outdoor-air-quality-data/monitor-values-report>.



**Figure 6. Fine particulate matter categories contributing to visibility impairment as measured by light extinction at Shining Rock Wilderness. Results show the days classified to have the worst visibility conditions. Data downloaded on May 7, 2018 from <https://webcam.srs.fs.fed.us/graphs/vis/>.**

As shown in Figure 6, the amount of sulfates contributing to light extinction has been decreasing. The presence of a white or greyish veil that obscures scenic views on the Forests indicates the presence of sulfates in the atmosphere. Particles deposited on the landscape are dry deposition. Both sulfates and nitrates are contributors to acid deposition, and they come from the atmosphere as dry, wet (rain and snow) and clouds or fog deposits. The summation of the three forms is the total deposition (Sullivan et al. 2010). Both the three-year average of total nitrogen and sulfur deposition has been significantly decreasing ( $\alpha < 0.01$ ) between 2000 and 2015 (Figure 7). As discussed in the next section, both the legacy and current acid deposition continue to be of concern, as the deposition contributes to an accelerated loss of nutrient base cations.



**Figure 7. Trend in the three-year average total nitrogen and total sulfur deposition. The number on the X-axis is the middle year of the three-year average. For example, 2002 is the average of 2001, 2002, and 2003.**

### *Reductions in nutrient base cations*

Sulfur is the primary acidifying agent affecting the Forests. The amount of nitrogen compounds in water samples collected within the Nantahala and Pisgah NFs reveals little percolates into the streams, except for in the Roan Mountain area. After deposited, some soils retain a portion of the sulfur while releasing the remainder into the soil water solution. The release of retained and recent sulfur deposition accelerates the loss of nutrient base cations from catchments. Adequate supplies of these are essential for healthy terrestrial plants, animals, and aquatic organisms. If lacking, some species may suffer from nutrient deficiency, and the catchment will lack the ability to buffer strong acids entering the ecosystem, causing acidification. Too much acidity will decrease the soil and water pH and may release previously soil-bound aluminum. In high concentrations, aluminum is toxic to both terrestrial and aquatic species (Lawrence et al. 1999). The release of soil bound sulfur will endure perhaps for decades or more than a century and continue to decrease base cation reserves (McDonnell et al. 2018; Rice et al. 2014).

The current form of the sulfur dioxide and nitrogen oxide NAAQS does not protect the Forests. However, the EPA does conduct a periodic review of the NAAQS and decides if any changes to the NAAQS should occur. The EPA is exploring the use of critical loads to identify what levels of sulfur and nitrogen deposition will protect sensitive resources. A critical load is “a quantitative estimate of an exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge.” We have relied upon the work of McDonnell and others (2018) to evaluate if sulfur deposition is too high and soils and streams may lack the ability to buffer incoming sulfur deposition and protect acid sensitive species.

McDonnell and others (2018) evaluated if recent sulfur deposition (mean 2013-2105) was below the critical load to achieve or maintain a threshold for a stream acid neutralizing capacity of 50 micro-equivalents per liter (ueq/L). The authors noted that some catchments would never achieve the threshold because they were never 50 ueq/L prior to European settlement. Likewise, selecting only 50 ueq/L may not provide protection for areas that can maintain or achieve an ANC above 100 ueq/L, a threshold where no impacts from acidification are likely to occur.

The Nantahala and Pisgah’s ANC threshold categories were calculated, assuming no anthropogenic removal of base cations by acid deposition or timber harvesting in any catchment. Across the Nantahala and Pisgah, 53 percent of the land has an ANC<sub>t</sub> category of  $\geq 100$  ueq/L. About 43 percent of the Forest Service ownership has an ANC<sub>t</sub> category of  $\geq 50$  -  $< 100$  ueq/L, and in these catchment there can be moderate effects on macroinvertebrates and fish species richness, but brook trout populations should be sustainable if other environmental factors are favorable. Below 50 ueq/L there can be episodic acidification impacts to aquatic biota and impacts to brook trout are greater as the ANC decreases (Lawrence et al. 2015; McDonnell et al. 2018). Only four catchments (1,120 acres, or  $< 1\%$ ) near Linville Gorge Wilderness were classified in the lowest category of  $\geq 10$  -  $< 30$  ueq/L.

McDonnell and others (2018) reported a low likelihood that terrestrial vegetation is suffering from aluminum toxicity that can occur when soils acidify.

The Forests have areas of concern that lack the base cations to support healthy terrestrial and aquatic ecosystems. In some cases, timber harvesting from these catchments may reduce the likelihood of achieving the acid neutralizing capacity threshold. Today, approximately 36 percent of the forest is within catchments where the ANC<sub>t</sub> is classified as uncertain or unlikely to be attained. The calculations included both sulfur and nitrogen deposition effects on catchments and assume that one day harvesting<sup>14</sup> will

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<sup>14</sup> The calculations assumed removal (harvested) of 65% of the bark and boles (trunks) from a catchment (McNulty et al. 2007).

occur where either a portion or all of a catchment is accessible. In the future, the total area of concern is likely to decrease because of anticipated additional reductions in sulfur deposition.

In addition to impacts from acid deposition, impacts from warmer air temperatures will affect brook trout populations. High elevation streams that are below an ANC of 50 ueq/L can decrease brook trout populations. Therefore, brook trout may favor higher ANC waters found further downslope. However, streams segments at lower elevations may have too high a stream temperature to support brook trout. This may lead to a situation where brook trout populations are “squeezed” between colder, high elevation streams that are too acid and lower portions of the stream that are too warm. This situation will lead to increased competition among brook trout for limited food resources and inhibit dispersals to another catchment, which favors increasing genetic diversity (McDonnell et al. 2015).

## **Environmental Consequences**

### *Prescribed fires*

In Alternative A, there is approximately 6,500 acres that are annually treated with prescribed fires. Figure 5 shows monitoring data is attaining both the daily and annual PM<sub>2.5</sub> NAAQS as well as the ozone NAAQS (Figure 6).

Alternatives B, C, D, and E propose annually treating more acres with prescribed fire and propose more growing season burning than Alternative A. Alternatives B, C, and D would put more particulate matter, nitrogen oxides, and non-methane organic carbon into the air over time than Alternative A. However, all alternatives would meet state air requirements, as the Southern Region Smoke Management Guidelines state that prescribed fire smoke will not contribute to or cause an exceedance of a NAAQS. In addition, proper implementation of plan standards FR-S-01 and FR-S-02 will protect the public’s health and safety.

### *Base cations*

For this analysis, we assumed timber harvests would remove nutrient base cations from the portion of the catchments that are accessible. However, this assumption over-estimates the impacts to ANC<sub>t</sub> because harvesting will not occur in all of the accessible catchments during the next forest plan implementation. We also assumed sulfur and perhaps nitrogen deposition would continue to remove base cations, especially at the highest elevations.

## **Alternative A**

This alternative does not have any plan components that address nutrient base cations.

## **Action Alternatives B, C, D, and E**

The action alternatives include an objective which states, “Annually, conduct a site specific analysis of base cations in 1 to 2 project locations where there is a concern for base cation depletion. Develop mitigation or restoration strategies when these strategies are necessary to restore or protect at-risk water, soils, flora and fauna” (WSD-O-02). Potential mitigation techniques used to restore or protection resources will be dependent on the needs of the site but may include designing the timber harvests with acidification risks in mind, adding lime to soils or streams, increasing the pH of aggregate material in the catchment, or increasing monitoring. Additionally, the action alternatives include an objective WSD-O-02 to assess acid neutralizing capacity in one priority watershed annually. This information will be utilized to inform watershed management and restoration. As a result of these objectives, more catchments may attain the ANC<sub>t</sub> when compared to Alternative A.

## **Cumulative Effects**

The Clean Air Act requires periodic review of the science and revises the NAAQS as needed. During this next planning period, there will be a review of the ozone and PM<sub>2.5</sub> NAAQS. If the science indicates a

more protective and stringent air quality standard is necessary in order to protect public health or the environment (regardless of the cost of meeting such a standard), the Environmental Protection Agency (EPA) will propose and typically adopt a lower standard. Thus, even if an area meets the current NAAQS, it may not meet future standards. If a portion of a national forest does not meet the NAAQS, the EPA would designate it as nonattainment. In nonattainment areas, an assessment of significant emissions from federal actions (including prescribed burning activities) is necessary to ensure the new emissions do not cause or contribute to a NAAQS exceedance<sup>15</sup>. Activities associated with plan implementation will not likely result in NAAQS exceedance under any alternative and will not likely contribute to a broader cumulative effect.

Implementation of the Regional Haze Rule will continue, and achieving the national goal of natural background visibility in federally mandated Class I areas is to occur by 2064. During the next 10 years, there will be additional regional emission reductions that will decrease the amount of sulfates and nitrates in the atmosphere. Utilities in the southeastern United States are choosing to shut down coal-fired boilers used to generate electricity. Most of the electrical generation is likely to rely upon natural gas, nuclear, and renewable (mostly solar) energy. This large reduction in burning coal will result in less sulfur and nitrogen compounds in the atmosphere and deposition, which will aid in achieving the ANCD, improve visibility at a faster rate than reasonable progress under Regional Haze Rule, and continue to provide healthy air quality for people visiting the National Forests. Activities associated with plan implementation will not interfere with achieving the national visibility goal of no man-made impairment to visibility for any alternative, not likely contributing to a broader cumulative effect.

There is uncertainty on when and how much recovery of nutrient base cations will occur in sensitive catchments in response to a decrease in sulfur deposition. Timber harvesting does remove nutrient base cations, and this can be important to future forest health in catchments where nutrient base cation in the soil are currently low. The weathering of the rocks in the soil is the main source of nutrient base cations (Knoepp et al. 2016; McDonnell et al. 2013). Current scientific understanding indicates there will be a delayed response in forest soil recovery with decreasing sulfur deposition (Lawrence et al. 1999; Rice et al. 2014). As the previously stored sulfur moves into the soil water, it will remove base cations from catchments. Future scientific advances will improve estimates on the rate of base cations weathering in forest soils. However, the rate will change as increasing air temperature results in more soil microbial activity that produces weak acids that weather base cations from rocks. Changes in precipitation can also influence the amount of base cation removal, because an increase in precipitation will increase the amount of base cations leaving the soil and over time decrease the buffering capacity of streams (McDonnell et al. 2018).

### **3.2.2 Climate and Carbon**

Federal agencies consider climate change and carbon in the evaluation of all proposed federal actions, including revising forest plans. This analysis considers the following:

- The potential impacts of climate change on the Forests as indicated by consideration of changes in climate (e.g., temperature and precipitation patterns) and the effects of climate change impacts on ecological, social, and economic resources; and
- The potential effects of management actions on climate change as indicated by consideration of changes in carbon sequestration and storage arising from natural and management driven processes.

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<sup>15</sup> See: <https://www.epa.gov/general-conformity>

Climate change is a particularly complex challenge given its global nature and inherent interrelationships among its sources, causes, mechanisms of action, and impacts. The effects of climate change observed to-date and projected to occur in the future include changes in temperature, precipitation, and disturbance patterns that drive and stress ecosystems and the benefits they provide, including degraded air quality, water resources, wildlife, and the quality of recreational experiences. This section includes a summary of potential effects relevant to the Forests.

## **Climate**

### **Methodology and analysis process**

No applicable legal or regulatory requirements or established thresholds exist for climate, climate change, or its effects on resources. The 2012 Planning Rule and Final Directives requires an assessment of climate change and integration of this information in development of plan direction that addresses ecological sustainability on national forests (36 CFR 219.8(a)(1)(iv); 36 CFR 219.6(b); Forest Service Handbook 1909.12.3; Forest Service Handbook 1909.23.1).

The affected environment is characterized based on climate and resilient landscape characteristics. Climate is analyzed based on indicators of observed and modeled climate variables (temperature and precipitation) with an emphasis on evaluating departure from historical conditions. Resilient landscape characteristics are analyzed in terms of indicators of local connectedness and landscape diversity which is measured in relative terms to the surrounding region. Environmental consequences are discussed through a meta-analysis of peer-reviewed literature describing effects on key resources which are broadly defined around resource areas of emphasis in the plan.

Key indicators:

- Climate
  - Temperature – average annual daily maximum and minimum temperature
  - Temperature – number of days per year with average daily maximums greater than 90°F
  - Temperature – number of days per year with average daily minimums less than 32°F
  - Precipitation – average annual total precipitation
  - Precipitation – average number of dry days per year
- Landscape resilience
  - Local connectedness
  - Landscape diversity
- Environmental consequences
  - Biological diversity
  - Forest health
  - Plant communities
  - Animal communities
  - Extreme weather
  - Water resources
  - Recreation

Due to the nature of climate change and its effects, this section utilizes multiple geographic and temporal scales. The geographic analysis unit is typically forestwide, though some analyses required consideration of issues at larger or smaller geographic scales, including those that encompass the entire Southern Appalachian region. Due to the long-term effects of climate change, temporal analysis periods typically extend beyond the life of the plan with mid- or end-of-century being the most commonly used in this report, and it reflects the scientific literature about climate change.

The climate summary in the affected environment section is based on climate models originally developed for the United Nations Intergovernmental Panel on Climate Change, downscaled by Pierce et al. (2014) and available from the USDA Southeast Climate Hub's Climate by Forest tool, which is an adaptation of the National Oceanic and Atmospheric Administration's Climate Explorer (US Govt. 2018). The Climate by Forest tool produces graphs and tables showing historic and future projected conditions for two possible greenhouse gas emissions scenarios (USFS 2018). The climate data considered in this report are based on both historical observations and future projections:

*Historic climate:* For all observed data, the gray bars are plotted with respect to the 1961-1990 mean using Livneh et al. dataset. The black line shows gridded historical observations.

*Future climate:* The modeled future climate projections are Localize Constructed Analogs (LOCA) downscaled from the Coupled Model Intercomparison Project Phase 5 (CMIP5) model realizations. This includes the hindcast (historical) and the projected (future) climate for the RCP4.5 (low) and RCP8.5 (high) emission scenarios. Each year, the range is defined by the highest and lowest model values for that year across all 32 models, and the central line represents the weighted mean across all models (Taylor et al. 2012, Sanderson et al. 2017).

The results summarized in the affected environment represent an analysis area defined by a bounding box surrounding the Southern Blue Ridge Mountains ecological subsection (Keys et al. 2007). Data are retrieved dynamically from a NOAA-funded site at Cornell University (DeGaetano et al. 2014).

## **Affected Environment**

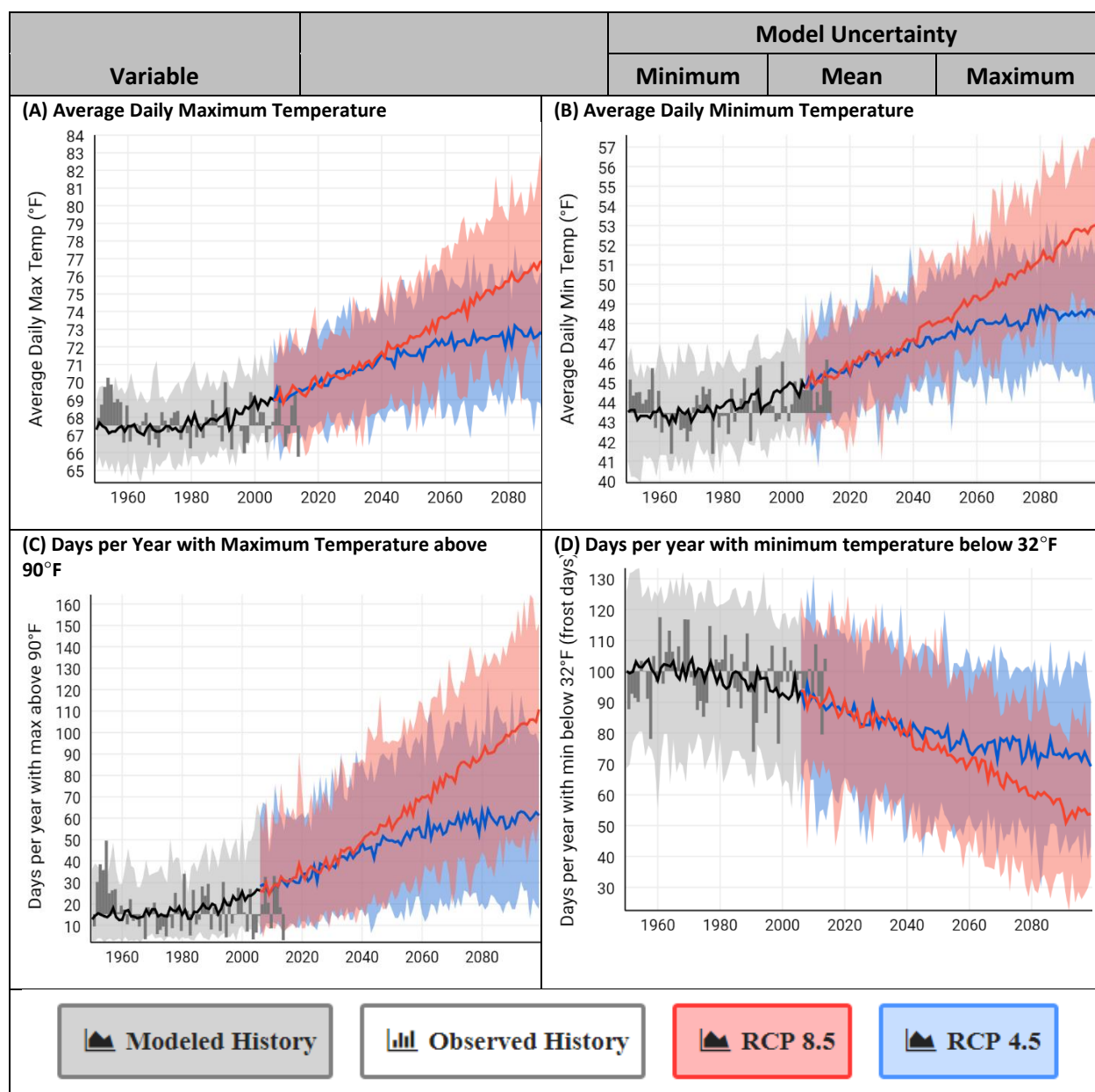
### **Temperature**

Model results for temperature variables are consistent and precise in that the average projected changes in values greatly exceeds the difference between average maxima and minima for the projections. Both greenhouse gas concentration pathways (i.e., RCP 4.5 and 8.5) indicate that by mid-century (2036-2065) the Southern Blue Ridge Mountains (M221Dc) would see statistically significant increases (compared with 1961-1990 baseline) in the average daily maximum and minimum temperatures, increase in the average number of days per year above 90°F, and a decrease in the average number of days with lows below freezing (32°F) per year across all levels of model uncertainty (Table 3; Figure 8). The temperature trajectories under these two emissions pathways differ by a consistent 0.9°F. Mean temperature would increase by an average 4.1° F for RCP 4.5 and 5.0° F for RCP 8.5. The average spread of all models for both maximum and minimum temperature was 2.5°F, which is substantially less than the 4.1°F and 5.0°F increases noted for mean values. Increases in average daily maximum temperature would be, on average, 0.4°F greater than the increases in daily minimum temperature. The number of days per year with maximum temperature above 90°F would increase by more than a full month over the course of a year by mid-century, with values of 33 days and 42 days for RCP 4.5 and RCP 8.5, respectively. Freezing temperatures are important for botanical, silvicultural, and pest management processes. The number of days per year with minimum temperatures below 32°F would decrease by an average of 20 to 24 days for RCP 4.5 and RCP 8.5, respectively. The average range of model results for average days per year with minimum temperature below 32°F is 1.8 days and 2.1 days for RCP 4.5 and RCP 8.5, respectively, which amounts to approximately 5 percent of the average predicted change.

**Table 3. Projected Range of Change in Temperature and Precipitation Variables by the Period 2036-2065, Using RCP 4.5 and RCP 8.5 Over the 1961-1990 Baseline Period**

Variable		Model Uncertainty		
		Minimum	Mean	Maximum
Average Daily Maximum Temperature (F)	RCP 4.5 Change	2.6	4.1	5.1
	95% Confidence Interval	0.3	0.2	0.4
	Statistical Significance	S	S	S
	RCP 8.5 Change	3.5	5.0	6.0
	95% Confidence Interval	0.4	0.4	0.6
	Statistical Significance	S	S	S
Average Daily Minimum Temperature (F)	RCP 4.5 Change	3.2	3.7	4.4
	95% Confidence Interval	0.3	0.2	0.4
	Statistical Significance	S	S	S
	RCP 8.5 Change	4.1	4.6	5.2
	95% Confidence Interval	0.4	0.3	0.5
	Statistical Significance	S	S	S
Average Days per Year Maximum Temperature above 90F	RCP 4.5 Change	11.8	32.9	51.2
	95% Confidence Interval	1.5	1.8	3.8
	Statistical Significance	S	S	S
	RCP 8.5 Change	20.0	42.5	62.0
	95% Confidence Interval	2.7	3.3	4.5
	Statistical Significance	S	S	S
Average Days per Year Minimum Temperature below 32F	RCP 4.5 Change	-20.6	-19.6	-18.8
	95% Confidence Interval	2.6	1.5	2.3
	Statistical Significance	S	S	S
	RCP 8.5 Change	-24.2	-23.5	-22.1
	95% Confidence Interval	2.9	1.8	2.6
	Statistical Significance	S	S	S
S = Statistically significant at the 95% (or higher) confidence level. NS = Not statistically significant at the 95% confidence level. The 95% confidence interval is plus or minus (+/-).				





**Figure 8. Projected temperature variables for the Southern Blue Ridge Mountains – M221Dc under RCP 4.5 and RCP 8.5 for (A) average daily maximum temperature, (B) average daily minimum temperature, (C) days per year with maximum temperature above 90°F, and (D) days per year with minimum temperature below 32°F**

### Precipitation

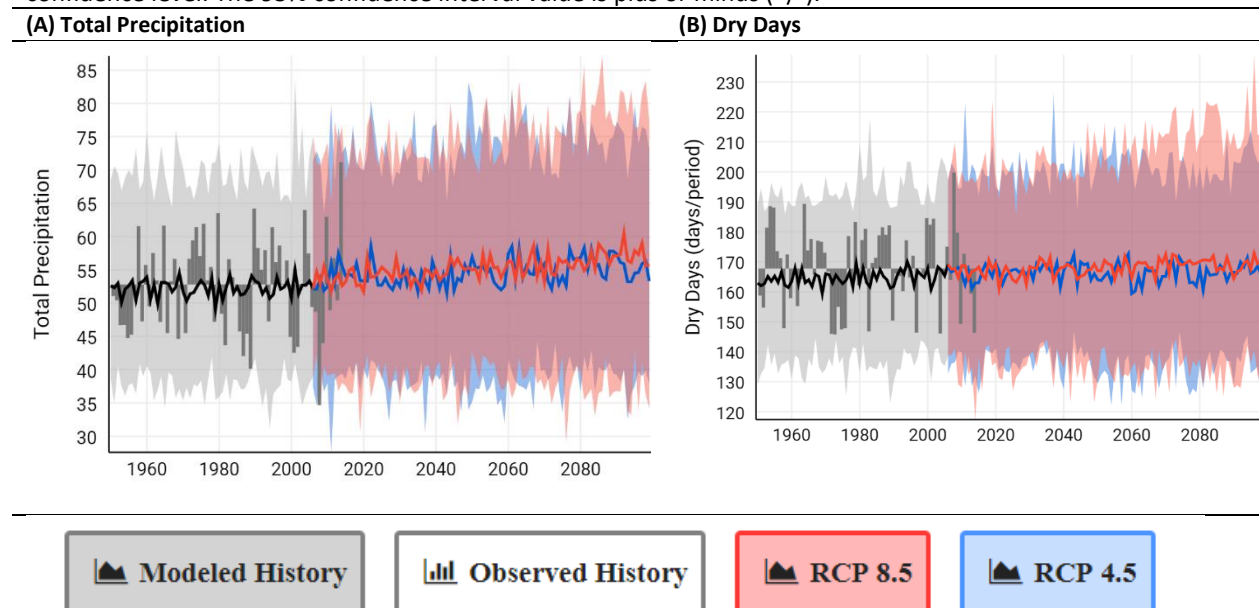
Changes in total precipitation for the Southern Blue Ridge Mountains (M221Dc) suggest the region would experience a statistically significant increase in total precipitation for both RCP 4.5 and RCP 8.5 (Table 4). The mean change would be 2.3" for RCP 4.5 and 2.8" for RCP 8.5. The magnitude of projected change is 5-10 percent of the total historical annual average precipitation, so these changes would not be as substantial as projected changes in temperature. The average range of model results is 5.1" for RCP 4.5 and 4.1" for RCP 8.5. This range is larger than the projected change between climate epochs and underscores the lack of precision in precipitation estimates among models. The number of dry days per year was statistically different between epochs for the annual maximum values for RCP 4.5 and for mean

and maximum annual values for RCP 8.5. The magnitude of change would be less than 5 percent of the annual average number of dry days.

**Table 4. Projected Range of Change in Precipitation Variables by the Period 2036-2065, Using RCP 4.5 and RCP 8.5 Over the 1961-1990 Baseline Period**

Variable		Model Uncertainty		
		Minimum	Mean	Maximum
Average Total Precipitation (in)	RCP 4.5 Change	-0.1	2.3	5.0
	95% Confidence Interval	1.2	0.8	1.9
	Statistical Significance	NS	S	S
	RCP 8.5 Change	1.1	2.8	5.2
	95% Confidence Interval	1.1	0.7	1.8
	Statistical Significance	NS	S	S
Average Dry Days per Year	RCP 4.5 Change	-1.7	1.6	8.6
	95% Confidence Interval	2.8	1.6	3.6
	Statistical Significance	NS	NS	S
	RCP 8.5 Change	-2.0	2.9	9.4
	95% Confidence Interval	2.5	1.2	3.3
	Statistical Significance	NS	S	S

S = Statistically significant at the 95% (or higher) confidence level. NS = Not statistically significant at the 95% confidence level. The 95% confidence interval value is plus or minus (+/-).



**Figure 9. Projected precipitation variables for the Southern Blue Ridge Mountains – M221Dc under RCP 4.5 and RCP 8.5 for (A) average total precipitation and (B) average dry days Landscape resilience**

The “Resilient Sites for Terrestrial Conservation” (Resilient Sites) modeling product is produced by The Nature Conservancy to capture landscape characteristics that can buffer an area from changing climate by providing microclimates that allow species to persist (Anderson et al. 2016). The Resilient Sites model

is informed by landscape diversity and local connectedness metrics that are derived from multiple landscape characteristics:

**Local connectedness (Table 5 and Figure 10)** is a measure of landscape structure (not individual species movements) which characterizes the hardness of barriers, the connectedness of natural cover, and the arrangement of land uses that influence ecological processes and the movement of many types of organisms. Forestwide, 97.1 percent of the Nantahala and Pisgah NFs have average or greater local connectedness with 68.4 percent of the area categorized as above average (1 to 2 standard deviations above the regional average). The spatial pattern of local connectedness shows higher scores in interior areas with lower scores along the margins of NFS lands. The distribution of local connectedness across ranger districts is generally quite similar, with the exceptions being the Cheoah and Pisgah Ranger Districts having relatively more area categorized as far above average (>2 standard deviations above the regional average) and the Nantahala Ranger District having relatively more area categorized as only slightly above average (0.5 to 1 standard deviations above the regional average).

**Landscape diversity (Table 6 and Figure 11)** represents the variety of microclimates present in a landscape and is intended to estimate the capacity of the site to maintain species and functions. Landscape diversity is calculated as a function that combines landform variety, elevation range, wetland density, and soil variety. Forest-wide, 97.1 percent of the Nantahala and Pisgah NFs have average or greater landscape diversity, with 72.5 percent of the area categorized as above average (1 to 2 standard deviations above the regional average). The spatial pattern of landscape diversity shows no discernable pattern. The distribution of landscape diversity scores across ranger districts is generally quite similar with less than a 5 percent difference between the forestwide average score and the score for any individual ranger district.

**Resilience (Table 7 and Figure 12)** is a measure calculated by averaging landscape diversity and local connectedness and reflects an integrated score where both landscape diversity and local connectedness are present. Forestwide, 97.1 percent of the Nantahala and Pisgah NFs have slightly above average or greater landscape diversity, with 86.1 percent of the area categorized as above average (1 to 2 standard deviations above the regional average). The spatial pattern of resilience shows no discernable pattern on NFS lands, though the contrast with lower scoring surrounding lands arising for lower local connectedness is quite apparent. The distribution of resilience scores across ranger districts is generally quite similar with less than a 5 percent difference between the forest-wide average score and the score for any individual ranger district, with the exception of the Nantahala Ranger District which has about 10 percent less 'above average' and 10 percent more 'slightly above average' than the forestwide average.

**Resilient and Connected Landscapes** further integrate resilience, permeability (connectedness), and diversity to identify connected networks of sites representing the full suite of characteristics needed to allow species to rearrange in response to change (Anderson et al. 2016):

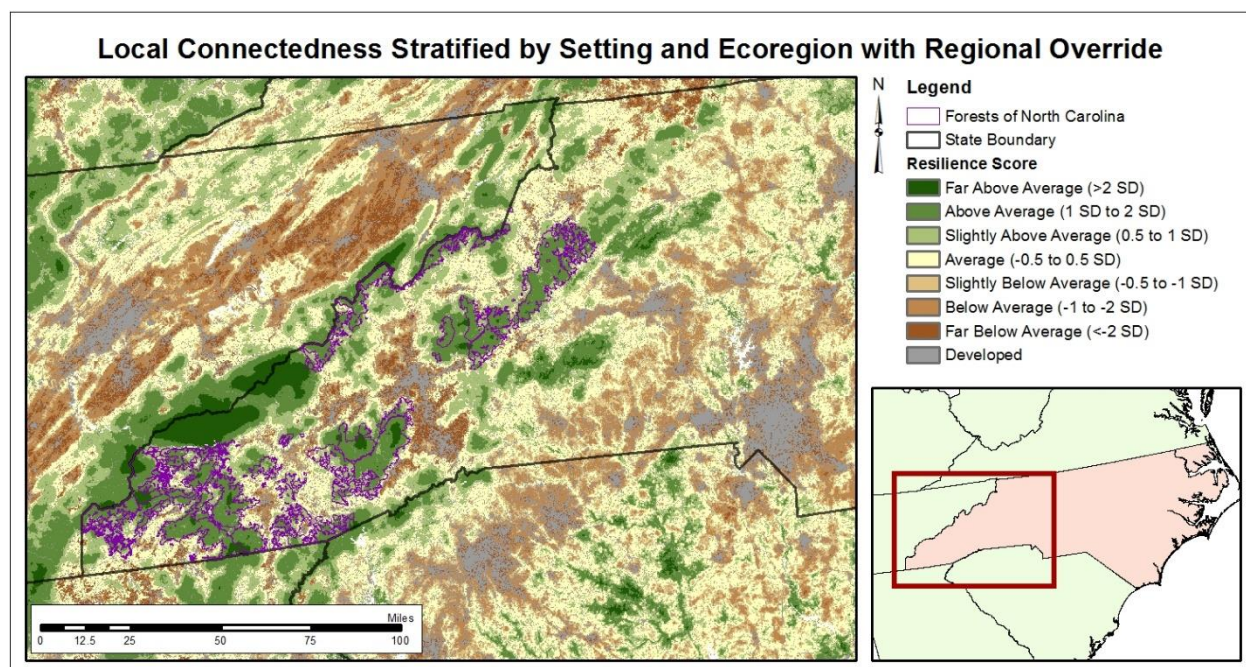
**Resilient areas** are places buffered from climate change, because they contain many connected micro-climates that create climate options for species. Some resilient areas also have **confirmed diversity**, which is when they are known to contain rare species or unique communities based on ground inventory (unconfirmed areas may contain the same species).

**Climate corridors** are narrow conduit in which the movement of plants and animals becomes highly concentrated, often a riparian channel or linear ridgeline. Some climate corridors have **confirmed diversity**, which is when they are known to contain rare species or unique communities based on ground inventory (unconfirmed areas may contain the same species).

**Climate flow zones** are areas with high levels of plant and animal movement that are less concentrated than in a corridor, typically an intact forested region. Flow refers to the movement of species populations over time in response to the climate. Some climate flow zones also have **confirmed diversity**, which is when they are known to contain rare species or unique communities based on ground inventory (unconfirmed areas may contain the same species).

**Table 5. Local Connectedness Stratified by Setting and Ecoregion with Regional Override**

	Far Above Average (>2 SD)	Above Average (1 SD to 2 SD)	Slightly Above Average (0.5 to 1 SD)	Average (-0.5 to 0.5 SD)	Slightly Below Average (-0.5 to -1 SD)	Below Average (-1 to -2 SD)	Far Below Average (<-2 SD)	Developed
Grandfather	1.3%	79.0%	17.0%	0.7%	0.0%	0.0%	0.0%	2.0%
Tusquitee	6.7%	75.4%	13.7%	2.2%	0.0%	0.0%	0.0%	2.1%
Cheoah	15.6%	61.4%	18.3%	1.4%	0.0%	0.0%	0.0%	3.2%
Pisgah	10.7%	68.9%	14.9%	2.8%	0.0%	0.4%	0.0%	2.3%
Nantahala	2.9%	51.4%	34.4%	6.9%	0.1%	0.7%	0.1%	3.7%
Appalachian	2.5%	79.8%	14.2%	1.1%	0.0%	0.0%	0.0%	2.4%
Forest-wide	5.8%	68.4%	20.0%	2.8%	0.0%	0.2%	0.0%	2.7%

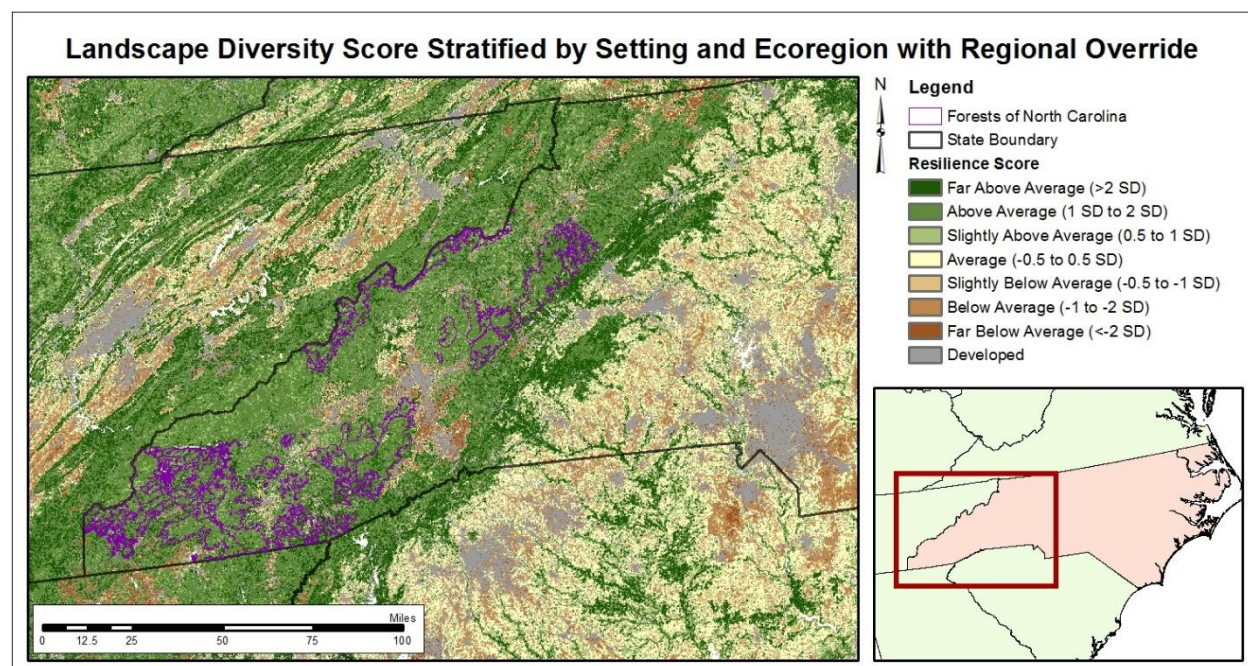


**Figure 10. Local connectedness stratified by setting and ecoregion with regional override**



**Table 6. Landscape Diversity Stratified by Setting and Ecoregion with Regional Override**

	Far Above Average (>2 SD)	Above Average (1 SD to 2 SD)	Slightly Above Average (0.5 to 1 SD)	Average (-0.5 to 0.5 SD)	Slightly Below Average (-0.5 to -1 SD)	Below Average (-1 to -2 SD)	Far Below Average (<-2 SD)	Developed
Grandfather	15.4%	73.9%	8.3%	0.3%	0.0%	0.0%	0.0%	2.0%
Tusquitee	11.6%	75.2%	11.0%	0.2%	0.0%	0.0%	0.0%	2.1%
Cheoah	10.7%	72.8%	13.2%	0.1%	0.0%	0.0%	0.0%	3.2%
Pisgah	13.2%	72.1%	11.4%	0.6%	0.2%	0.2%	0.0%	2.3%
Nantahala	14.3%	70.0%	11.2%	0.1%	0.5%	0.2%	0.0%	3.7%
Appalachian	9.1%	71.9%	15.9%	0.7%	0.0%	0.0%	0.0%	2.4%
Forest-wide	12.7%	72.5%	11.6%	0.3%	0.1%	0.1%	0.0%	2.7%

**Figure 11. Landscape diversity stratified by setting and ecoregion with regional override****Table 7. Final Resilience Stratified by Setting and Ecoregion with Regional Override**

	Far Above Average (>2 SD)	Above Average (1 SD to 2 SD)	Slightly Above Average (0.5 to 1 SD)	Average (-0.5 to 0.5 SD)	Slightly Below Average (-0.5 to -1 SD)	Below Average (-1 to -2 SD)	Far Below Average (<-2 SD)	Developed
Grandfather	2.7%	90.9%	4.4%	0.0%	0.0%	0.0%	0.0%	2.0%
Tusquitee	2.3%	91.3%	4.3%	0.0%	0.0%	0.0%	0.0%	2.1%

	Far Above Average (>2 SD)	Above Average (1 SD to 2 SD)	Slightly Above Average (0.5 to 1 SD)	Average (-0.5 to 0.5 SD)	Slightly Below Average (-0.5 to -1 SD)	Below Average (-1 to -2 SD)	Far Below Average (<-2 SD)	Developed
Cheoah	4.3%	85.5%	6.9%	0.0%	0.0%	0.0%	0.0%	3.2%
Pisgah	4.6%	86.7%	6.1%	0.0%	0.0%	0.3%	0.0%	2.3%
Nantahala	3.0%	75.6%	17.0%	0.0%	0.2%	0.6%	0.0%	3.7%
Appalachian	1.7%	90.9%	5.0%	0.0%	0.0%	0.0%	0.0%	2.4%
Forestwide	3.0%	86.1%	8.0%	0.0%	0.0%	0.2%	0.0%	2.7%

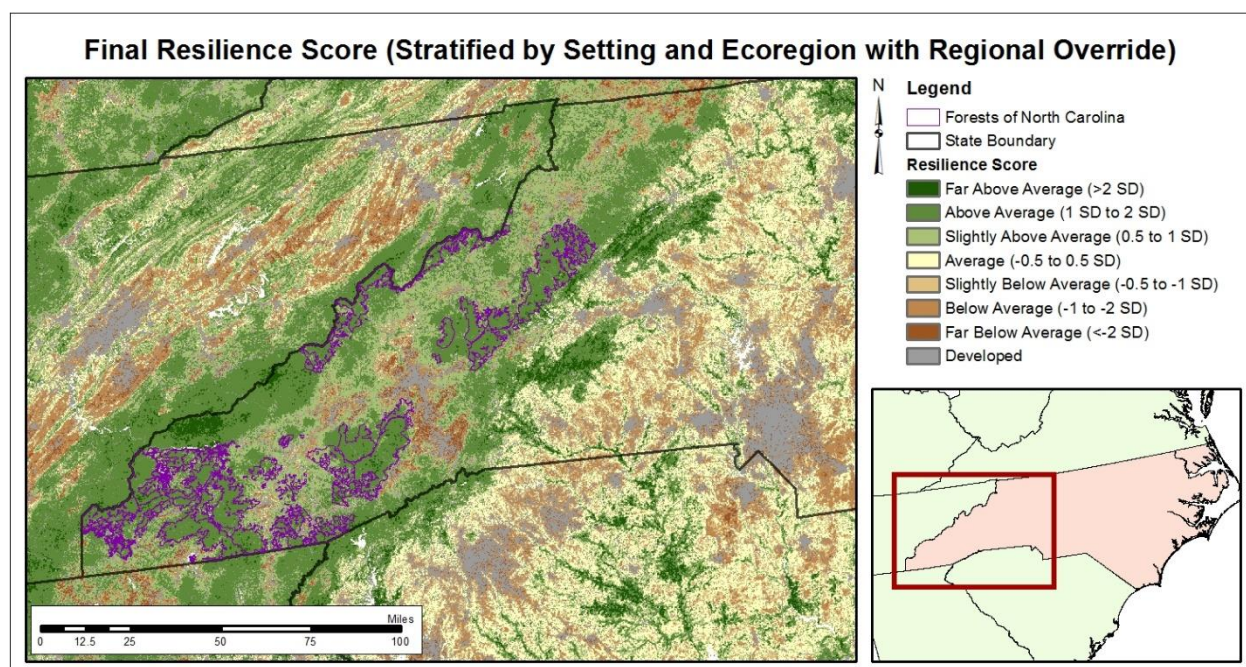


Figure 12. Final resilience stratified by setting and ecoregion with regional override

Table 8. Resilient and Connected Networks (5 Classes)

	Resilient	Resilient Area with Confirmed Diversity	Climate Flow Zone	Climate Flow Zone with Confirmed Diversity	Climate Corridor
Grandfather	1.1%	49.0%	0.1%	49.8%	0.0%
Tusquitee	6.4%	32.5%	0.5%	60.5%	0.1%
Cheoah	0.6%	10.9%	0.7%	87.7%	0.1%
Pisgah	0.9%	43.6%	0.0%	55.4%	0.0%
Nantahala	1.8%	53.1%	0.5%	44.5%	0.1%
Appalachian	0.4%	64.3%	0.0%	35.3%	0.0%
Forestwide	1.9%	44.5%	0.3%	53.3%	0.0%



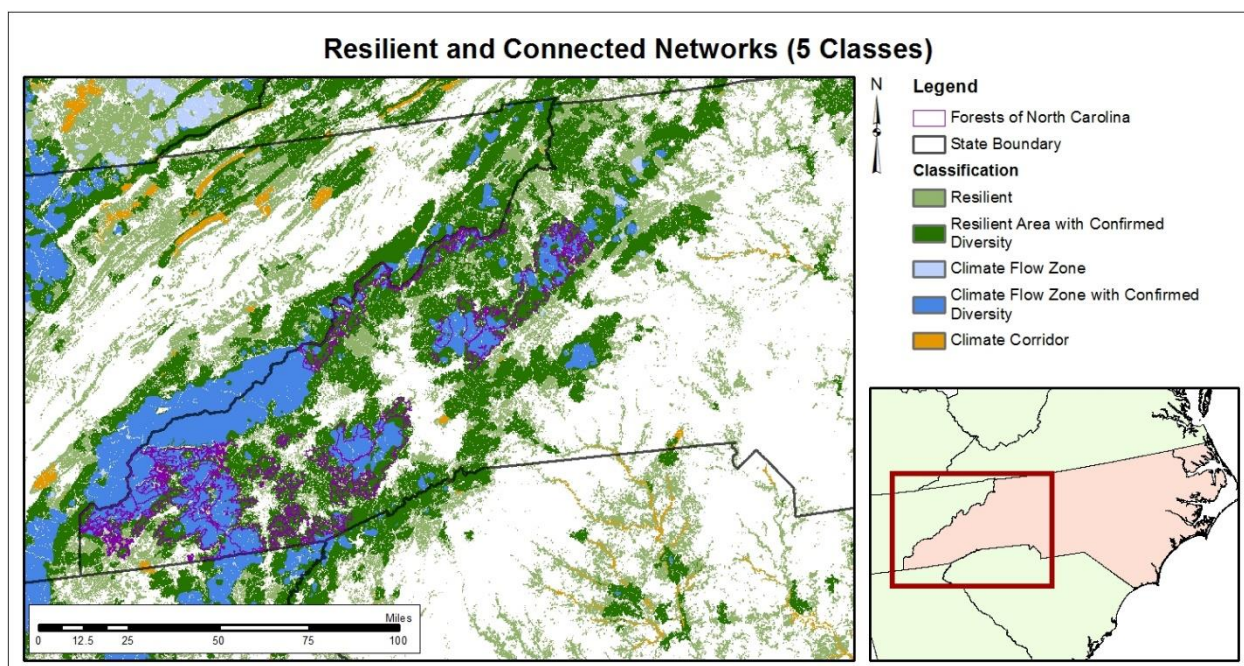


Figure 13. Resilient and connected networks (5 classes)

## Environmental Consequences

### Common to all alternatives

Ecosystems across the region and on the Nantahala and Pisgah NFs are experiencing increased threats from fire, insect and plant invasions, disease, extreme weather, and drought. Scientists project increases in temperature and changes in rainfall patterns (see Affected Environment section above) that can make these threats occur more often, with more intensity, and/or for longer durations. Although many of the effects of future changes are negative, natural resource management can help mitigate these impacts. The analysis presented in this section is derived from queries of the Template for Assessing Climate Change Impacts and Management Options, an online database populated with peer-reviewed literature (Treasure et al. 2014).

Table 9. Potential Effects of Climate Change on Nantahala and Pisgah National Forests

	Effects
<b>Biological Diversity</b>	<p>Plants and animals at risk will respond to environmental changes by adapting, moving, or declining. Species with high genetic variation will be better able to survive in new conditions. Higher temperatures will cause many species to shift ranges, generally moving to track their suitable habitat (e.g., north or up in elevation). However, in some cases, the rate of warming combined with land use changes will restrict the ability of plants and animals to move into suitable habitat. The species most likely to be negatively impacted by climate change will be highly specialized and habitat restricted (Hutchinson 2007, Pickles 2012, Hitch 2007, Aitken 2008, Rodenhouse 2009, Heller 2009).</p> <p>Forest decline may lead to reduced oak dominance and species change in the canopy (Bendixsen et al. 2015).</p>

	Effects
<b>Forest Health</b>	Non-native and invasive plant and insect species may increasingly outcompete or negatively affect native species in the future. Winter freezes currently limit many forest pests, and higher temperatures will likely allow these species to increase in number. Destructive insects, such as bark beetles, will be better able to take advantage of forests stressed by more frequent drought. Certain invasive plant species, including kudzu, are expected to increase dramatically as they are able to tolerate a wide range of harsh conditions and already cover a large expanse, allowing them to rapidly move into new areas (Duehl et al. 2011, Dukes et al. 2008, Gan 2004, Hansen 2001, Hellmann et al. 2008, Morrison et al. 2005).
<b>Plant Communities</b>	<p>Changing temperature and rainfall patterns may threaten the survival of high-elevation communities in mountain forests. Rising temperatures will allow species from lower elevations to migrate up-slope, changing the forest communities seen today. Populations of species now existing on mountain peaks, including spruce-fir forests, will be most at risk in the future. Hardwood-dominated forests may experience stress from higher temperatures, allowing pines and other fast-growing species to become more dominant at the expense of slower-growing species such as hickories and oaks (Allen et al. 2010, Elliott et al. 2015, Ibáñez et al. 2008, Iverson et al. 2008, Potter et al. 2010, Soulé 2011, Walther 2003).</p> <p>Japanese Stiltgrass is capable of surviving in undisturbed forests, although individuals in forest-interior plots tend to be small and have lower survival rates than individuals in roadside plots (Manee et al. 2015).</p>
<b>Animal Communities</b>	Wildlife species will be affected in different ways, depending on their needs. Amphibians may be most at risk, due to dependencies on moisture and cool temperatures that could be altered in a future climate. Populations of large mammals such as deer and bears may increase with warmer winter temperatures due to a higher winter survival rate. Birds, on the other hand, may decrease in population size as vegetation types change and heat stress makes migration more difficult. In order to adapt, arrival date and nesting times of some common birds may start earlier in the year (Ayres et al. 2000, Blaustein et al. 2010, Corn 2005, Currie 2001, Matthews et al. 2004, Torti et al. 2005).
<b>Extreme Weather</b>	<p>The potential for severe storms is expected to increase in the future, including more intense hurricanes making landfall in the southern US, with potential increases in flooding and landslides in mountainous landscapes. Conversely, extended periods of drought and forest stress may lead to drier fuels which will burn more easily and at hotter temperatures, and contribute to more and larger wildfires. More cloud-to-ground lightning due to warming may increase wildfire ignitions, even in mountainous areas where fires are historically less common (Emanuel 2005, Flannigan et al. 2000, Heilman et al. 1998, Knutson et al. 2010, Laseter et al. 2012, Pavelsky et al. 2012).</p> <p>Shifting weather patterns throughout Appalachia and the southeastern U.S. will have a variety of effects on forest health. Increasing variability in precipitation distribution can impact both forest productivity and carbon sequestration (Elliott et al. 2015).</p>



	Effects
<b>Water Resources</b>	Shifts in rainfall patterns will lead to periods of flooding and drought that can significantly impact water resources. Increases in heavy downpours and more intense hurricanes can lead to greater erosion and more sedimentation in our waterways. Increased periods of drought may lead to decreasing dissolved oxygen content and poor water quality in some areas. Groundwater-fed wetlands such as high-elevation bogs will be particularly vulnerable to a changing climate as temperature and rainfall changes have the potential to lower groundwater table levels, altering the length of time that wetlands hold standing water (Carpenter et al. 1992, Erwin 2009, Karl et al. 2009). Warmer air and water temperatures and changes in stream flow will affect the abundance and distribution of fish species. With higher water temperatures, fish communities in northern streams will begin to resemble communities in more southerly locations. Altered stream flow patterns can lead to decreases in water quality and oxygen content. Cold-water species, such as trout, will be the most vulnerable to population declines with future warming. The native brook trout may be most at risk, as warmer stream temperature and competition with invasive species will continue to reduce their populations (Ahn et al. 2000, Clark et al. 2001, Flebbe et al. 2006, Mohseni et al. 2003, Warren et al. 2012)
<b>Recreation</b>	Environmental changes may negatively impact recreational experiences due to changes to the plant and animal communities that make those recreational experiences unique, along with an increase in haze that may reduce the visibility of mountain views. While more days above freezing could increase use in some forest areas in the cooler seasons, more days with extreme heat could decrease use in the summer if temperatures impact visitor comfort. The fall foliage season may be affected as leaves change color later in the season and increasing stresses on forests impact the vividness of fall foliage displays (Irland et al. 2001, Joyce et al. 2008, Prideaux et al. 2010, Richardson et al. 2004, Scott et al. 2004).

### Common to all action alternatives

Alternatives B through E acknowledge that forests across the Southern Appalachians are experiencing increased threats from fire, insects, invasive plant species, extreme weather and drought, and that scientists have predicted increases in temperature and changes in rainfall patterns. In comparison to Alternative A, these alternatives are more explicit that the desired condition is to have a forest that is resilient and adaptive in response to climatic changes. A section in the plan is dedicated to outlining the desired conditions for this resiliency, and this section also provides management approaches that can be used to achieve the desired conditions. Some of these management approaches were modified between draft and final to respond to public comments.

Implementing these management activities can provide forests with an opportunity to reduce the susceptibility of their resources to multiple threats, including drought, invasive species, disease, and wildfire. By using sound natural resource management practices that keep predicted future conditions in mind, the Forest Service can promote the immediate and long-term health of its forests. Specific approaches will vary with site and species of concern. The plan includes management approaches such as the following:

- Managing ecosystems in the face of climate change focuses on maintaining or creating resiliency and adaptability. In the face of climate uncertainty, maintain a suite of adaptation and mitigation options, focusing on sustaining process and function.

- Identify and prioritize maintenance and restoration in the microsites most resilient to changing conditions, considering geological settings as well as biological characteristics (Jeltsch et al. 2011).
- Where there are species at risk that are susceptible to the effects of climate change, promote activities that support suitable habitat enhancement (Shoo et al. 2011).
- Monitor for new invasive species moving into areas where they were traditionally not found, especially in high-elevation communities (McDougall et al. 2011). Utilize the monitoring information to assess threats and prioritize treating highly invasive infestations.
- Restore native vegetation in streamside zones to help moderate changes in water temperature and stream flow and enhance habitat (Mulholland et al. 1997, Rahel et al. 2008).
- Anticipate and plan for disturbances from intense storms. Prepare for intense storms and fluctuations in base flow using methods that maintain forest health and diversity, including controlling soil erosion, relocating high risk roads and trails, and constructing appropriately sized culverts and stream crossings while retaining stream connectivity.
- Consider and address future climate and potential species range shifts when planning restoration projects, facilitating species migration and adaptation when possible.

By including these desired conditions and management approaches, the action alternatives are more responsive to changing climatic conditions than Alternative A.

### **Cumulative Effects**

Considering cumulative effects in the context of climate change effects on the Forests requires broader bounds of time and space to adequately account for and describe the additive and synergistic effects of climate change that ultimately speak to sustainability. For the Forests, cumulative effects from climate change arise from effects on the resources that make up the broader landscape, of which the Forests make up an important part (described in Table 9). As was shown in the resilience analysis above (Affected Environment), the Forests are a regional hub of above average resiliency, which is driven by patterns of above average landscape diversity and connectedness relative to regional scale patterns. Cumulative effects from climate change are occurring across this regional context, resulting in diminished ecological integrity on surrounding lands, which further emphasizes the need for and value of the Forests in providing for resiliency of ecosystems and the services they provide.

## **Carbon**

### **Methodology and analysis process**

No applicable legal or regulatory requirements or established thresholds exist for management of forest carbon or GHG emissions. The 2012 Planning Rule and Final Directives requires an assessment of baseline carbon stocks and a consideration of this information in management of the national forests (Forest Service Handbook 1909.12.4).

The Affected Environment section summarizes the Forest Carbon Assessment for the Nantahala and Pisgah NFs (Dugan and McKinley 2018). The carbon assessment draws largely from two recent U.S. Forest Service reports: the Baseline Report (USDA Forest Service 2015) and the Disturbance Report (USDA Forest Service, in review). Together they provide the best available quantitative assessment of forest carbon stocks, harvested wood products stocks, and the factors that influence carbon dynamics on the Forests. The primary sources to evaluate potential future conditions and the impacts of climate change on forest carbon dynamics were the Resource Planning Act (RPA) assessment (USDA Forest Service 2016) and a regional vulnerability assessment (McNulty et al. 2015). These reports incorporate

advances in data and analytical methods and collectively represent the best and most relevant scientific information available for the Nantahala and Pisgah NFs. These resources were explicitly selected for their consistent reliance on Forest Inventory and Analysis (FIA) data, which contains statistically valid sampling of ground-truthed monitoring data. They also use validated (peer-reviewed) modeling tools that integrate current remotely sensed and high-resolution products (e.g., Healey et al. 2018) with FIA data (Dugan et al. 2017, Dugan and McKinley 2018).

Key indicators:

- Carbon pools (carbon stocks) and carbon uptake
- Natural and human-caused influences on carbon stocks and carbon uptake

The spatial scale of this analysis includes the forested lands of the Nantahala and Pisgah National Forests (the Forests). The Forests were administratively combined with the Uwharrie and Croatan National Forests to form a single administrative unit, the National Forests in North Carolina (NFs in NC). Therefore, some of the model results presented here, including estimates of carbon stocks and impacts of disturbances and other factors, are available only for combined NFs in NC or at the regional scale. The Forests account for about 80 percent (about one million acres) of the forested area in the NFs in NC (FIA EVALIDator). Thus, the available information is a reasonable representation of the carbon trends and factors impacting carbon on the Forests.

Relative to the contribution of all the world's forests to carbon flux, the influence of the Forests is extremely small, so a meaningful analysis at the global scale is not practical. However, national and regional factors related to forests' influence on carbon dynamics are included here to provide context for the nature of the local effects of the Forests.

The temporal scale for analyzing carbon stocks and emissions focuses on the expected lifespan of the plan (10-15 years). However, this report includes analysis and discussion beyond this expected lifespan to provide context for potential forest carbon dynamics and factors influencing these dynamics in the future. Considering factors beyond the plan period is important because this plan covers only part of the life cycle of the forest.

The Forest Service is committed to using the best available information to support management decisions. In general, this means relying upon sources that are data-driven, locally calibrated, and consistent over both time and space. However, estimates of future carbon stocks (i.e., stored carbon) and their trajectory over time remain unclear because of uncertainty from the multiple interacting factors that influence carbon dynamics. These factors include environmental changes and changes in climate that affect the health, productivity, and diversity of forests. Although advances in research have helped to account for and document the relationship between greenhouse gases (GHGs) and global climate change, it remains difficult to reliably simulate observed temperature changes and distinguish between natural or human causes at smaller than continental scales (IPCC 2007).

### **Affected Environment**

Research strongly suggests that global average temperature is increasing. Most of the observed 20th-century increase is related to rising atmospheric concentrations of greenhouse gases, including carbon dioxide. Forests worldwide contribute greatly to the global carbon cycle by taking up and storing about 1.4 billion metric tons of carbon every year (McKinley et al. 2011), and forests already store over one trillion metric tons of carbon <sup>16</sup> in plants and soil (Domke 2018). Forest management can play an

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<sup>16</sup> Carbon mass is used here, not CO<sub>2</sub> mass, because carbon is a standard unit and can easily be converted to any other unit. To convert carbon mass to CO<sub>2</sub> mass, multiply by 3.67 to account for the mass of the O<sub>2</sub>.

important role in moderating the amount of carbon dioxide that enters and leaves the atmosphere (Ryan et al. 2010, McKinley et al. 2011, Skog et al. 2014).

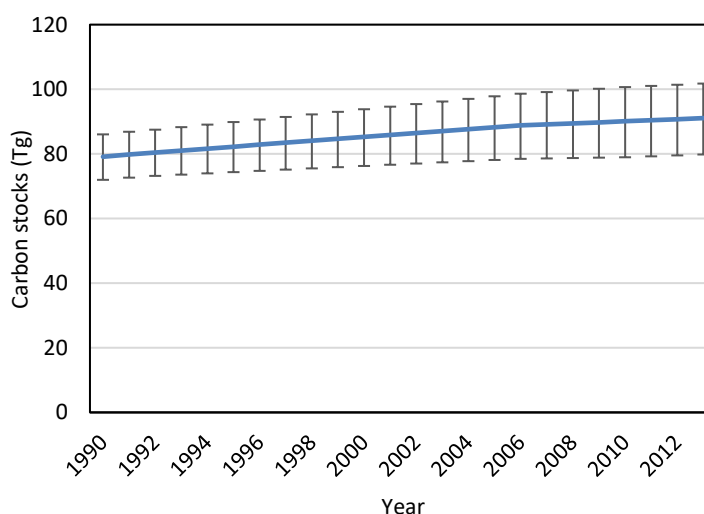
Given this evidence, carbon uptake and storage and accompanying potential climate regulation are key ecosystem services provided by forests. Through photosynthesis, growing plants remove carbon dioxide (CO<sub>2</sub>) from the atmosphere and store it in forest biomass, such as in plant stems, branches, foliage, and roots. Some of this organic material is eventually stored in forest soils through biotic and abiotic processes. This absorption and storage of carbon by plants from the atmosphere modulates greenhouse gas (GHG) concentrations in the atmosphere. The rate of carbon removal by plants from the atmosphere is influenced by many factors, including natural disturbances, management, forest age and successional pathways, climate and environmental factors, and availability of nutrients and water.

Forests both take up carbon and release it into the atmosphere. Forests are dynamic systems that naturally undergo ebbs and flows in carbon storage and emissions as trees establish and grow, die with age or disturbances, and re-establish and regrow. Management activities, such as timber harvests and prescribed fire, tend to approximate and promote natural processes that would also release carbon to the atmosphere. Many management activities initially remove carbon from the forest ecosystem, but they can also result in long-term maintenance or increases in forest carbon uptake and storage by improving forest health and resilience to various types of stressors. Carbon can also be transferred and stored outside of the forest system in the form of wood products, further influencing the amount of carbon entering the atmosphere. Wood fiber can substitute for products that generate more GHG emissions to produce, such as concrete and steel, and it may be used as a renewable energy source (“substitution effect”). Substitution of wood for fossil-fuel intensive materials and energy can lower net carbon emissions.

## Affected Environment

### Carbon stocks and influences

Forests in the NFs in NC are maintaining a carbon sink; carbon stocks increased by 15 percent from 1990 (79.1±7.1 teragrams of carbon [Tg C])<sup>17</sup> to 2013 (91.1±11.3 Tg C) (Figure 14). This increase indicates that negative impacts on carbon stocks caused by disturbances and environmental conditions have been modest and exceeded by forest growth. Most forest carbon stocks in the NFs in NC, about 47 percent, are stored in the above-ground portion of live trees. The second largest carbon pool is soil carbon, storing



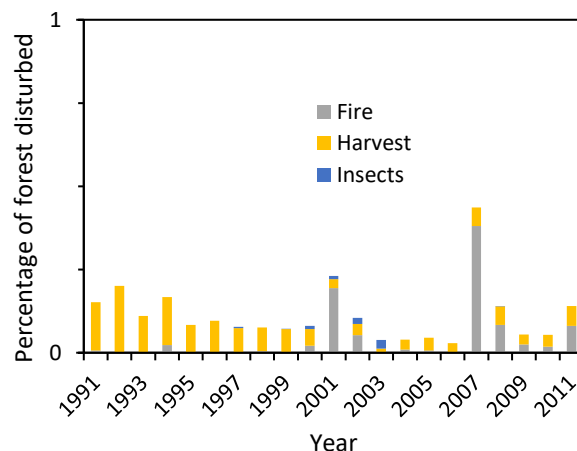
**Figure 14. Total forest carbon stocks for the baseline period 1990 to 2013 for National Forests in North Carolina bounded by 95 percent confidence intervals (error bars).**

<sup>17</sup> This report uses carbon mass, not CO<sub>2</sub> mass, because carbon is a standard unit and can easily be converted to any other unit. To convert carbon mass to CO<sub>2</sub> mass, multiply by 3.67 to account for the mass of the O<sub>2</sub>. 1,000 teragrams (Tg) = 1 petagram (Pg); 1,000 teragrams = 1 billion metric tonnes; 1,000 teragrams = 1 gigatonne; 1 teragram = 1 million metric tonnes; 1 megagram (Mg) = 1 metric tonne; 1 metric tonne per hectare = 0.4 U.S. long tons per acre; carbon (C) mass \* 3.67 = carbon dioxide (CO<sub>2</sub>) mass

another 32 percent. The Forests alone contain about 73 Tg of carbon.<sup>7</sup>

According to satellite imagery, the most prevalent disturbance during this period was timber harvesting. However, harvests were relatively small, affecting on average just 0.07 percent of the Forests forested area annually (Figure 14). Forest carbon losses associated with harvests have been small compared to the total amount of carbon stored in the NFs in NC, resulting in a loss of about 0.57 metric tonnes per acre (0.9 percent) of non-soil carbon from 1990 to 2011 (Figure 15). However, these estimates do not account for either continued storage of harvested carbon in wood products or the effect of substitution. Carbon storage in harvested wood products (HWPs) and landfills has increased across all national forests in the southeastern United States since the early 1900s. Recent declines in timber harvesting have slowed the rate of carbon accumulation in the product sector.

The second most common disturbance on the Forests during 1990-2011 was fire, affecting on average 0.06 percent of forested area annually. The area affected by fires (wildfires and prescribed) increased over this period (Figure 15). Some prescribed fires may have been undetected because they did not cause a change in canopy cover and instead just burned along the forest floor with very low intensity. Overall, fires detected over this 21-year period resulted in the loss of approximately 0.21 metric tonnes per acre (0.4 percent) of non-soil carbon (Figure 16).



**Figure 15. Percentage of the forested area disturbed in the Nantahala and Pisgah NFs by harvests, insects, and fire.**

The greatest influence on current carbon dynamics on the Forests is the legacy of intensive timber harvesting and land clearing for agriculture throughout the 19<sup>th</sup> century, followed by a period of forest recovery in the early to mid-20<sup>th</sup> century. As a result, stands on the Forests are mostly middle-aged and older (Figure 16). Although older forests store more carbon and can continue to take up significant amounts of carbon even as they age, the rate of carbon uptake generally declines as forests age. Therefore, in coming decades, aging stands on the Forests may have lower rates of carbon accumulation, although stocks are projected to continue to increase above current levels. Projections from the RPA assessment also indicate that forests under all land ownerships in the Southern region are experiencing a potential age-related decline in the rate of carbon accumulation that will continue through 2060.

Climate and environmental factors, including elevated atmospheric CO<sub>2</sub> and nitrogen deposition, have also influenced carbon accumulation on the Forests. Recent warmer temperatures and precipitation variability may have stressed forests, causing climate to have a negative impact on carbon accumulation since the 1990s. Conversely, increased atmospheric CO<sub>2</sub> and nitrogen deposition have potentially enhanced growth rates and helped to counteract ecosystem carbon losses from disturbance, aging, and climate.

The effects of future climate conditions are complex and uncertain. However, under changing climate and environmental conditions, the Forests may be at increasing risk of many stressors, including moisture stress, extreme temperatures and weather events, insects and diseases, and the spread of invasive species. These potentially negative effects might be offset somewhat by the positive effects of a longer growing season, more precipitation, and elevated atmospheric CO<sub>2</sub> concentrations. However, it is

difficult to judge the effects of these factors and their interactions on future carbon dynamics of the Forests

The population in the region is growing, and some conversion of forested lands to non-forest purposes is likely to occur on private lands adjacent to and near the Forests. Converting forest land to a non-forest use removes a very large amount of carbon from the forest and inhibits future carbon storage, because regrowth is inhibited. However, national forests tend to experience low rates of land-use change, and thus, forest land acreage is not expected to change substantially within the Forests in the future. Forested area on the Forests will be maintained as forest into the foreseeable future, which will allow a long-term continuation of carbon uptake and storage.

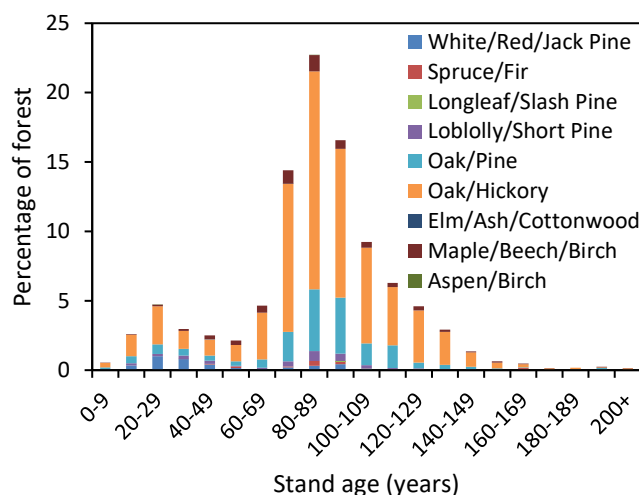


Figure 16. Stand age distribution in 2011 by forest type groups in the Nantahala and Pisgah National Forest.

## Environmental Consequences

### Common to all alternatives

In a global atmospheric CO<sub>2</sub> context, even the maximum potential management levels described by the plan alternatives would have a negligible impact on national and global emissions and on forest carbon stocks for reasons described below. As in this case, when impacts on carbon emissions (and forest carbon stocks) are small, a quantitative analysis of carbon effects is not warranted and thus is not meaningful for a reasoned choice among plan alternatives (USDA Forest Service 2009).

Carbon fluxes resulting in forest carbon accumulation and loss from forested ecosystems are difficult to measure because of ecological complexity and many sources of uncertainty. Even more difficult is the ability to quantify potential carbon consequences of management alternatives in the future; this is because of variation in possible future climatic conditions, stochasticity in disturbance and weather events, and limitations in data and modeling tools. The result of such variability is often a very low signal-to-noise ratio: small differences in carbon impacts among management alternatives, coupled with high uncertainty with estimates of carbon stocks and fluxes, make the detection of statistically meaningful differences among alternatives highly unlikely.

Therefore, rather than focus here on a strict but uncertain quantification of potential future changes in carbon stocks and emissions, potential carbon impacts are discussed qualitatively, with supporting estimates where possible. This is accomplished by drawing on the quantitative analysis of the effects of past management activities on forest carbon stocks and fluxes, as well as through future-looking analysis where available (see Affected Environment).

The Forests take up and store more carbon than they lose through disturbances and management activities combined. All of the proposed management activities would initially reduce carbon stocks on the Forests. However, these short-term losses and emissions are very small relative to both the total carbon stocks on the Forests and national and global emissions. Further, the proposed activities would generally maintain and improve forest health and supply wood for forest products. The initial negative carbon effects would be mitigated or even reversed with time, reducing the potential for negative

cumulative effects. The Forests will continue to be managed to maintain forests as forests to preserve many ecosystem services and co-benefits, including carbon uptake and storage.

All action alternatives provide the same desired conditions for terrestrial ecosystems and the standards and guidelines that help achieve or maintain those conditions. Specifically, all plan alternatives seek to do the following: maintain existing grass, forb and shrub openings, establish young forest conditions, provide for open forest woodland, develop old-growth conditions, improve composition, structure, and function of forest stands, restore fire-adapted ecozones, restore and enhance spruce fir and mesic ecozones, and provide for stable and improved forest health conditions. Using management activities to achieve this desired mix of conditions will enhance the overall ecological integrity of the forest ecosystems, improving their ability to adapt to potential stressors. These proposed activities will help maintain critical ecosystem functions into the future, in part by balancing the maintenance of carbon stocks and rates of carbon uptake.

All plan alternatives, including the no-action alternative, use the same suite of management tools and silviculture treatments to achieve desired conditions. These alternatives consist of the following treatments: 1) harvests – to regenerate specific stands and create new age classes; 2) thinning – to reduce stand densities; 3) prescribed fires – to reduce fuel loads, generate young forests conditions, and promote more natural fire-return intervals. Although management strategies are designed to support a wide array of ecosystem services and conditions (e.g., wildlife habitat, resilience to environmental change), they can also have secondary, and often desirable, consequences for carbon. The following management strategies are incorporated into forest plan direction under all alternatives that also influence carbon uptake and storage potential:

- Manipulate the forest to provide for new young forest conditions to support wildlife habitat. This can cause a decline in carbon stocks, but compared with older stands, doing so promotes relatively high rates of carbon uptake over time as forests regrow (Pregitzer and Euskirchen 2004).
- Enhance or accelerate the development of old-growth conditions to support higher carbon stocks in mature forests compared with younger stands (Harmon et al. 1990).
- Decrease forest densities and fuel conditions to reduce the risk of large, stand-replacing disturbance from insect, disease, and fire. Although this strategy initially reduces carbon stocks, it can lower risk for greater carbon stock losses and emissions in the future (Wiedinmyer and Hurteau 2010).
- Ensure successful reforestation after harvest or mortality-inducing disturbances to ensure continued carbon uptake and storage (IPCC 2014).
- Promote desired composition, structure, function, and pattern (ecological integrity) to support long-term carbon uptake and storage in the face of changing environmental conditions (Millar et al. 2007).
- Use harvested wood for valuable and renewable products to store carbon over the long-term and substitute for energy-intensive materials or fuels, reducing the net amount of carbon emissions into the atmosphere (Lippke et al. 2011).

The actions proposed by the plan have different effects on carbon over time. The proposed actions will initially decrease carbon stocks and cause carbon emissions. However, these effects will be very small and transitory. The initial small adverse effects on carbon by these proposed actions will likely be balanced, and possibly eliminated or reversed, in a relatively short time. Negative effects will be offset when the forest stands in the proposed managed area regenerate and recover, as well as by facilitating carbon storage in HWP. The plan also describes goals to restore natural forest structure, improve forest

health, maintain and promote ecosystem services, and enhance adaptation to more severe disturbances, which will help sustain carbon uptake and continued carbon storage over the long term (Millar et al. 2007, D'Amato et al. 2011).

One management objective is to enhance the development of old-growth conditions. This would be accomplished through activities such as retaining downed woody debris and snags, creating woodlands by thinning or prescribed burning, and enhancing native species by removing nonnative vegetation and using it in wood products. Older forest stands are desirable because they provide a range of ecosystem services, including storing more carbon than do younger stands. However, depending on forest type, rates of carbon uptake are typically lower than in younger to middle-aged stands. The current stand-age structure on the Forests indicates that these forests are mostly middle-aged and older (Figure 16). If disturbance and management regimes follow the same trends since 1990 (Figure 15), the Forests will continue to age. As the Forests age, rates of carbon uptake may decline after several decades, but carbon stocks will continue to increase. The RPA assessment projects a similar trend in net carbon sequestration for all land tenures in the southeastern United States. However, in the central and Southern Appalachian region, stands treated with periodic low-intensity harvests and thinnings can have higher productivity and carbon uptake due to growth releases (Davis et al. 2009, Keyser and Zarnoch 2012, McNulty et al. 2017), indicating a positive cumulative effect.

Another management objective is to create young forest conditions to produce early successional habitat. This would be accomplished through silvicultural practices that can be used in tandem, such as harvesting, thinning, and prescribed burns. In the absence of thinning and harvesting, the forest will thin from natural disturbances and other processes associated with natural succession (e.g., age-related mortality, competition). The resulting dead trees will continue to store carbon, and they will also decay over time, emitting carbon into the atmosphere. In the southern and central Appalachian region, clear-cuts and higher-intensity harvests typically result in lower carbon stocks in the short-term but have higher rates of carbon uptake as forest regrow and reach productive ages (Davis et al. 2009, McNulty et al. 2017). However, the plan also includes lower-intensity harvests that will maintain higher forest carbon stocks and promote higher rates of carbon uptake (Keyser and Zarnoch 2012).

Management activities involving timber harvesting and thinning can result in both long-term carbon storage off-site and substitution effects through the use of HWPBs. Carbon can be stored in wood products for days to centuries, depending on the commodity produced and end use. Just over half of timber sourced from North Carolina is used for saw and veneer logs (Gray et al. 2017). These types of logs are typically used for longer-lived wood products like building materials and furniture that result in long-term storage of carbon. As more commodities are produced and remain in use, the amount of carbon stored in products increases, creating a cumulative benefit when considered with forest regrowth. Even as more wood products are discarded, the carbon stored in solid waste disposal sites also increases. Harvested wood products can also substitute for more fossil fuel-intensive materials like steel, concrete, and plastic, resulting in a net decline in emissions (Gustavsson et al. 2006, Lippke et al. 2011, McKinley et al. 2011, Dugan et al. 2018). Likewise, harvested wood and discarded wood products can be burned to produce heat or electrical energy (including about four percent of roundwood removals in North Carolina), also producing a benefit by substituting for more carbon-producing energy sources. The IPCC recognizes wood and fiber as a renewable resource that can provide lasting climate-related mitigation benefits that, with active management, can accrue over time (IPCC 2000).

The plan alternatives also propose to continue to use prescribed fire to produce young stand conditions, reduce hazardous fuels, promote fire-adapted species, and encourage natural fire-return intervals. Historical fire suppression has allowed these fire-dependent forests to become unnaturally dense and surface fuels to build up in some areas of the southeast, possibly increasing the risk for wildfires in the Forests (Fowler and Konopik 2007). As climate conditions change in the Southeast, warmer temperatures and more frequent and severe droughts are expected to increase, and they may also contribute to



increased wildfire risk across forests (McNulty et al. 2015). Consequently, the fire-dependent forests (e.g., shortleaf pine, dry mesic oak, pine/oak/heath) in the plan area may be more at risk to more frequent and severe wildfires, resulting in the loss of ecosystem services and potentially increasing carbon emissions and lowering carbon stocks. High-severity fires can also cause the permanent transition of forests to non-forest ecosystems in some circumstances (Roccaforte et al. 2012, Anderson-Teixeira et al. 2013).

Prescribed fires proposed in the plan typically target surface and ladder fuels and are less severe than wildfires (Agee and Skinner 2005), because they are conducted within predetermined conditions. Fire-dependent forest types that are targeted for prescribed burning also typically contain species with thicker bark, which offers protection from heat-related damage. Thus, in some situations, prescribed fires and thinning can lower overstory tree mortality (Carter and Foster 2004, Hurteau and North 2009), potentially reducing amounts of carbon emissions that might be emitted if the same area were to burn in a high-severity wildfire (Wiedinmyer and Hurteau 2010). By promoting natural fire-adapted ecozones through the use of thinning and prescribed burns, thereby reducing the threat of wildfire, the proposed plan alternatives might create more advantageous conditions to support long-term forest health in a changing climate (adaptation) and reduce carbon emissions and maintain carbon stocks (mitigation) (IPCC 2007).

The proposed alternatives will not convert forest land to non-forest uses. The largest source of GHG emissions in the forestry sector globally and within the United States is deforestation, defined as the removal of all trees on forested land to convert it to other land uses. Maintaining forest land is necessary to ensure carbon storage over time and to realize potential carbon benefits from management activities through regrowth. The population of the Southern Appalachian region is growing rapidly, and the conversion of forested lands to non-forest purposes is likely to occur to some degree on private lands adjacent to and near the Forests. However, under all plan alternatives, the Forests would remain as forests. Forests would not be converted to other land uses but rather would be retained and managed to maintain a vigorous and healthy condition. This management goal supports tree growth and productivity, which contributes to long-term carbon uptake and storage. Consequently, the plan alternatives for the Forests will not result in major sources of GHG emissions relative to local, national, and global emissions and can be important in maintaining forest carbon uptake and storage and other ecosystem services in the region.

### **Alternative A**

Alternative A seeks to achieve these objectives with the same management capacity and intensity as under the existing plan. Although Alternative A would treat fewer acres than the action alternatives, this direction would support the Forests towards continued resilience at both the stand and landscape scales. The action alternatives would increase the likelihood of sustaining the ability of the Forests to take up carbon at higher rates and continue to store carbon in the near and long term.

The effects of actions under Alternative A would result in a similar pattern of carbon storage and flux as described in the section on Affected Environment, because Alternative A represents continuation of the status quo. For instance, in 1990-2011, harvesting and thinning affected about 0.07 percent (700 acres)<sup>18</sup> of the total forested area of the Forests per year, mostly in the low-intensity category (0-25 percent change in canopy cover). Ecosystem carbon losses from harvests in 1990-2011 across the NFs in NC totaled 0.57 metric tonnes per acre (0.0271 Tg C acre yr<sup>-1</sup>) by 2011, or about 0.9 percent of vegetation

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<sup>18</sup> Estimate derived from Landsat satellite imagery (USDA Forest Service in review).

(non-soil)<sup>19</sup> carbon stocks. When considering the total ecosystem carbon stocks, which includes soil carbon, losses of carbon are even smaller, perhaps less than half of a percent. For context, during about this same period (1990-2013), total ecosystem stocks in the NFs in NC, including the Forests, increased by about 15 percent (Figure 14), indicating that carbon removed from the ecosystem through harvesting and fires was more than offset during this period by an increase in carbon stocks from forest growth. Given that the Forests contain about one million acres of forest land, ecosystem carbon losses from harvests have been about 27,100 metric tonnes (0.0271 Tg C) of carbon annually from 1990 to 2011, which is a small fraction of the estimated 73 million metric tonnes of carbon stored on the landscape. When considering product streams and stand regeneration over time, the net effects of harvesting on carbon storage and emissions are likely even more minimal.

Alternative A would also move toward achieving the desired conditions of restoring fire-adapted ecozones and lowering hazardous-fuel loads through the use of prescribed fire treatments, though not as quickly as the action alternatives. Between 1990 and 2011, fires (prescribed and wildfire) affected roughly 0.06 percent (600 acres) of forest annually on the Forests and resulted in the estimated loss of about 10,000 metric tonnes of carbon per year, a tiny fraction of the total carbon stocks on the Forests. Furthermore, this carbon loss due to fires may represent the upper bounds of estimated carbon losses, because the historical analysis covering 1990-2011 may have included a greater proportion of wildfires (relative to prescribed fires), which typically burn at higher severities and result in greater carbon losses.

### **Common to all action alternatives**

Under all action alternatives, the forest management strategies incorporated into the plan direction focus on the goal of maintaining or increasing forest resilience to changing environmental conditions. The action alternatives include a tiered objective approach that assumes an increase in activity based on existing capacity and budgets (Tier 1), and then a greater amount of increase if additional capacity and resources are brought to bear (Tier 2). Tier 2 represents the maximum area of the land base that would be impacted by silvicultural objectives and, therefore, the maximum possible level of influence on carbon dynamics. Refer to the terrestrial ecosystems analysis for a full discussion of the tiered objective approach and treatment areas under each action alternative.

### **Alternatives B, C, and D**

Alternatives B, C, and D include the same number of acres to be treated, thus they are projected to have similar effects on carbon.

The maximum treatment area for harvests and thinning under Tier 2 of the action alternatives would be 3,000 to 4,000 acres per year or about 0.3 to 0.4 percent of total forested area on the Forests. This is about a five-fold increase in annual harvest area compared to Alternative A and past harvest levels in 1990-2011 (Figure 16). Assuming that the annual carbon impact also increases up to five times above past levels, harvest treatments under Tier 2 may result in a maximum removal of about 135,500 metric tonnes (0.14 Tg C) of carbon per year from aboveground pools.<sup>20</sup>

Tier 2 also includes a considerable increase in prescribed burning of up to 20,000 acres annually. Under Alternatives B, C, and D, if maximum levels of prescribed burning are achieved, this would result in a potential loss of about 330,000 metric tonnes of carbon annually, as estimated from the historical

<sup>19</sup> Estimate is for all National Forests in North Carolina. The N-PNF accounts for about 80 percent of the forested area in the NFs in NC, but only about 41 percent of the harvesting from 1990 to 2011. Thus the effect of harvests on carbon storage on the N-PNF alone likely causes less than a 2 percent decline in non-soil carbon stocks.

<sup>20</sup> Estimate assumes that harvesting in the Tier 2 results in about five times the carbon removed as compared to historical harvesting levels. Alternative A is roughly equivalent to historical levels and realizes a removal of approximately 27,100 metric tonnes of carbon annually. Values are estimated from model results (USDA Forest Service, in review).

analysis.<sup>21</sup> However, the historical period included wildfires which generally burn at higher severities and result in greater carbon losses than prescribed burns. By reducing hazardous fuels, additional prescribed burning up to maximum levels described in Tier 2 may further reduce the risk of more severe wildfires and greater carbon losses in the future.

Considering the maximum area treated with harvesting and prescribed fire, the amount of carbon that might be removed is small relative to the approximately 73 million metric tonnes (Tg) of carbon stored in the forest ecosystem of the Forests.<sup>22</sup> With maximum intensification, potential management actions would affect up to less than three percent of the forested area and much less than 1 Tg C annually. The Tier 2 action alternatives will not significantly, adversely, or permanently affect forest carbon storage, but rather would achieve a more resilient forest condition that will improve the ability of the Forests to maintain carbon stocks and enhance carbon uptake, possibly reducing potential carbon emissions in the future.

### **Alternative E**

The maximum treatment area for harvests and thinning under Tier 2 of the action alternatives would be slightly higher in Alternative E because of the additional objective for thin and burn with Tier 2 levels of up to 900 acres annually. This would provide slightly more removal of metric tonnes of carbon per year at 170,000 metric tons.

More prescribed fires would be accomplished under Alternative E with up to 45,000 acres annually under Tier 2 objectives. In Alternative E, if maximum levels of prescribed burning are achieved, this would result in a potential loss of about 750,000 metric tonnes of carbon annually. As in Alternatives B, C, and D, this level of activity is contrasted with the historical period included wildfires which generally burn at higher severities and result in greater carbon losses than prescribed burns. By reducing hazardous fuels, additional prescribed burning up to maximum levels described in Tier 2 may further reduce the risk of more severe wildfires and greater carbon losses in the future.

Considering the maximum area treated with harvesting and prescribed fire, the amount of carbon that might be removed is small relative to the approximately 73 million metric tonnes (Tg) of carbon stored in the forest ecosystem of the Forests.<sup>23</sup> With maximum intensification, potential management actions would affect up to less than five percent of the forested area and much less than 1 Tg C annually. The Tier 2 action alternatives will not significantly, adversely, or permanently affect forest carbon storage but rather would achieve a more resilient forest condition that will improve the ability of the Forests to maintain carbon stocks and enhance carbon uptake, possibly reducing potential carbon emissions in the future.

### **Cumulative Effects**

Climate change is a global phenomenon, because major greenhouse gases mix well throughout the planet's lower atmosphere. Estimated emissions of GHGs in 2010 were 13,336 ± 1,227 teragrams carbon globally (IPCC 2014) and 1,881 teragrams carbon nationally (US EPA 2015). All of the plan alternatives are projected to contribute negligibly to overall GHG emissions. The action alternatives are directed at a very

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<sup>21</sup> Estimate assumes that prescribed burning in Tier 2 results in about 33 times the carbon lost as compared to historical fire levels. Alternative A is roughly equivalent to historical levels and realizes a loss of about 10,000 metric tonnes of carbon annually. Values are estimated from model results (USDA Forest Service, in review). The historical period included a greater proportion of wildfires that burned at higher-severity and likely resulted in larger carbon losses than prescribed burns which are typically low-severity and result in little overstory mortality.

<sup>22</sup> U.S. Federal Government. 2018. U.S. Climate Resilience Toolkit Climate Explorer. [Online] <https://climate-explorer2.nemac.org> Accessed August 8, 2018

<sup>23</sup> U.S. Federal Government. 2018. U.S. Climate Resilience Toolkit Climate Explorer. [Online] <https://climate-explorer2.nemac.org> Accessed August 8, 2018

small percentage of the total forest land on the Forests; even in the near-term, these alternatives would have a minimal direct effect on carbon emissions and carbon stocks relative to total carbon stocks in the Forests. Furthermore, considering the proposed actions in a global atmospheric CO<sub>2</sub> context, even the maximum treatment levels would contribute infinitesimally to GHG emissions and, therefore, would have a negligible effect on GHG emissions and climate change. Moreover, because local GHGs emissions mix readily into the global pool of GHGs, it is difficult and highly uncertain to ascertain the indirect effects on global climate of emission from multiple, generally small projects that make up these action alternatives. At the global and national scales, each of the plan alternatives direct and indirect contribution to GHGs would be negligible.

Because the potential direct and indirect effects of alternatives would be negligible, the contribution of the plan's proposed actions to cumulative effects on global atmospheric GHG concentrations and climate change would also be negligible. The proposed activities under all action alternatives generally maintain and improve forest health and provide for the supply of wood for forest products. Potential negative effects are mitigated and may be completely reversed with time, reducing or eliminating potential negative cumulative effects on carbon. Carbon emitted during the initial implementation of the management actions (e.g., harvest, thinning, prescribed fire) would have only a temporary influence on atmospheric carbon concentrations, because carbon would be removed from the atmosphere over time following management as the forest regrows. Over the longer term, the activities proposed in the plan are likely to increase carbon storage and reduce emissions. These net outcomes would be the cumulative result of forest regrowth, enhanced productivity of young stands and growth releases from lightly thinned stands, reduction in the risk of high-severity wildfires, carbon storage off-site in products, and substitution benefits of wood products and wood-based energy (IPCC 2007, McKinley et al. 2011, Keyser and Zarnoch 2012, Bergman et al. 2014, Skog et al. 2014). The management mechanisms applied in all plan alternatives are consistent with internationally recognized climate change adaptation and mitigation practices identified by the IPCC (IPCC 2000, IPCC 2007).

### **3.2.3 Geologic Resources**

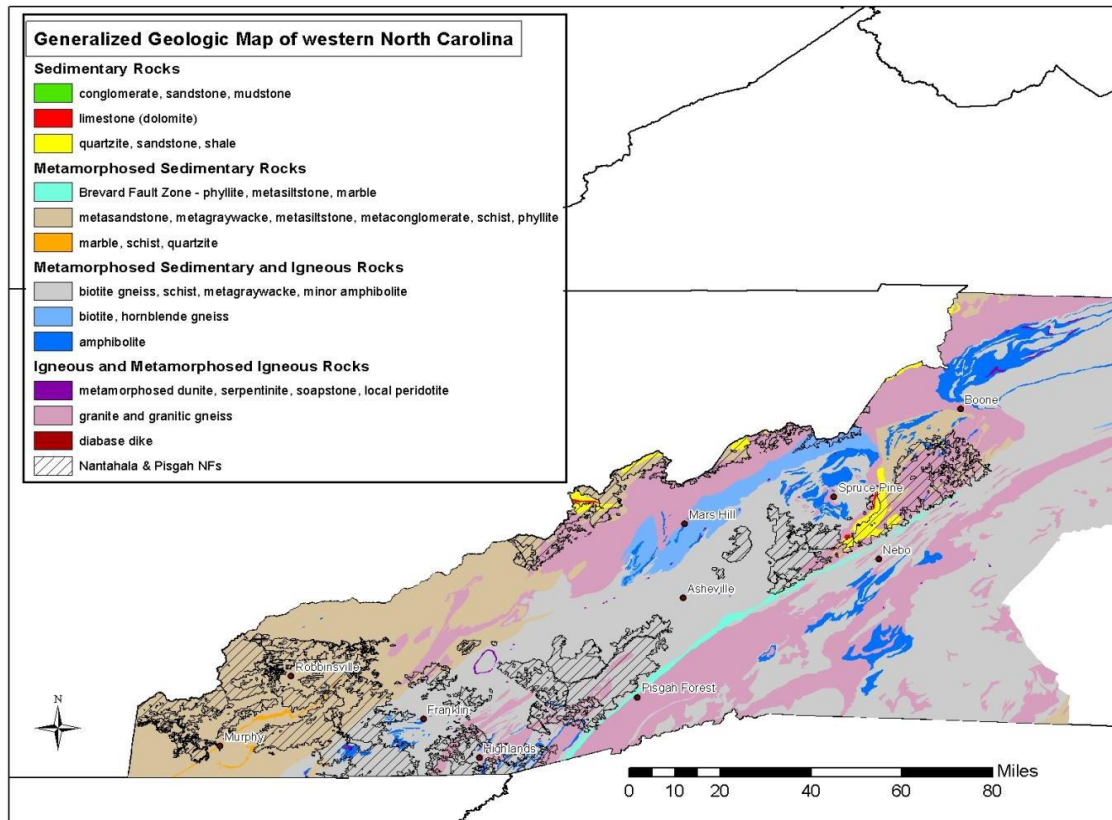
#### **Affected Environment**

##### **Geologic resources**

Geological resources on the Nantahala and Pisgah NFs include a wide range of surface and subsurface resources such as groundwater and groundwater-dependent ecosystems, springs, scenic and unusual landforms, waterfalls, caves, minerals, soils, field records of catastrophic events (floods and landslides), paleontological resources, and underground space. These resources are significant to natural resource management, human health and safety, or have use or value to society for scientific, ecological, scenic, recreational, historic, paleontological, educational, interpretive, provisioning services, economic, or other qualities that require management. Minerals and energy resources are considered in the Minerals and Energy section of the Affected Environment under Social Environment.

Soils, water resources, and mineral resources are discussed, respectively, in Sections 3.2.4, 3.2.5, and 3.4.11; and geologic features that are attractions for visitors are discussed in the recreation and scenery sections, Section 3.4.4 and 3.4.5.

The Forests are located in the Blue Ridge Physiographic Province (Blue Ridge) of the Southern Appalachian Mountains. The Blue Ridge forms a southwest to northeast mountain range through Western North Carolina with many areas over 4,000 feet in elevation. The Forests generally occupy the upper slopes of dissected, steep terrain, and narrow mountain valleys. This belt consists mostly of igneous and metamorphic rocks and small areas of sedimentary rock on the western margins (Figure 17).



**Figure 17. Generalized geologic map of bedrock on Nantahala & Pisgah NFs in Western North Carolina. Map modified from Generalized geologic map produced by North Carolina Geologic Survey for Western North Carolina Vitality Index (North Carolina Mountain Resources Commission, 2012a).**

The geologic foundation of ecosystems and watersheds on the Forests include geologic processes (stream processes, landslides, groundwater movement, weathering, etc.); geologic materials (bedrock, soils, surface water and groundwater, etc.); geologic structures (fractures, folds, faults, joints, etc.); and geologic landforms at all scales (Blue Ridge Escarpment, waterfalls, granitic domes, caves, stream cascades/riffles/pools, etc.). These geologic features and conditions control or influence a host of other ecological factors, such as slope aspect (solar radiation); slope steepness; the distribution and composition of soil parent material and associated vegetation; the characteristics of flooding and floodplains, wetlands, riparian areas, and streams; the quantity and quality of surface water and groundwater; natural disturbance regimes such as flooding and landslides; the physical properties and chemical compositions of watersheds; and acid deposition sensitivity of soil and water due to air pollution in the Southern Appalachians (Peper et al. 1995; Newell and Peet 1998; Pittillo et al. 1998).

There is increasing recognition that diverse geologic settings are the foundation for diverse ecosystems and biological diversity. Geologic conditions affect habitat and species diversity in various ways including influencing chemical and physical properties of soils and water and influencing weather patterns. The 2005 Southern Research Station report “Ecological Zones in the Southern Appalachians: first approximation” noted:

“Forest environments of the Southern Appalachian Mountains and their characteristic plant communities are among the most varied in the Eastern United States.... The presence or absence of ecological zones... were modeled as multivariate logistic functions of climatic, topographic, and geologic variables... Results of this project suggest that bedrock geology is an important factor affecting the distribution of vegetation.” (Simon, et al. 2005)

Research from The Nature Conservancy (Anderson and Ferree 2010) reported on the geological diversity foundation of biological diversity and proposed geological diversity as the foundation for a new strategy to adapt to climate change:

“...because geology defines the available environments, determines the location of key habitats, and stimulates diversification [7]... In essence, geology directly shapes species diversity patterns through its influence on the chemical and physical properties of soil and water, and by creating topography that redistributes climatic effects creating predictable weather patterns and microclimates...Our results suggest that geological diversity, elevation range and latitude explain regional species diversity patterns within eastern temperate North America...Thus, as we head into a period of dramatic climate-driven rearrangement of species distribution patterns, we assert that conserving a full spectrum of different geology classes stratified across elevation zones and latitudes, may offer an approach to conservation that protects diversity under both current and future climates.”

The Nature Conservancy 2013 report “Southern Blue Ridge: an Analysis of Matrix Forests” used geology to develop Ecological Land Units in the Southern Blue Ridge, including the Nantahala and Pisgah NFs, and noted that “[t]he Southern Blue Ridge is a forested landscape of steep slopes, high mountains, deep ravines, and wide valleys. The combination of intact temperate forest over a diversity of landforms, elevation zones, and bedrock geologies, makes it one of the most biologically diverse areas in North America.” (Anderson, et al. 2013).

One example of the significance of a particular geologic setting is the Blue Ridge Escarpment which extends along the east side of the Blue Ridge and includes most of the Grandfather Ranger District and portions of the Nantahala and Pisgah Ranger Districts along the NC/SC state line. The Blue Ridge Escarpment has several effects on the ecology of the region including abrupt elevation changes with a vertical relief ranging from 1,300 to 2,500 feet and impacts to weather patterns with high rainfall. The Escarpment influences weather patterns, tourism, and transportation (North Carolina Mountain Resources Commission 2012b). For more information about diverse geologic settings that provide the foundation for ecosystems and biological diversity, refer to the Soils, Water, and Terrestrial Habitat sections.

Surface geologic processes are part of the natural disturbance regime in the mountains and are also an important part of the natural disturbance regime in the Forests. These processes affect the Forests in varying degrees every year and include mass wasting or landslides; flooding; stream processes; groundwater movement; waterfall processes; and the erosion, transport and deposition of sediment. Some processes result in geologic hazards.

### **Geologic hazards**

Geologic hazards are geologic processes or conditions (naturally occurring or altered by humans) that are a potential danger to public health and safety, infrastructure, and resources. Geologic hazards on the Forests include landslides, floods, acid-producing rocks, waterfall hazards, ultramafic rocks with asbestos minerals, radon, and abandoned mines.

Like fire hazards, some geologic hazards on the Forests affect public safety and infrastructure on the Forests and off the Forests in adjacent communities (Gori and Burton 1996; Collins 2005; Wieczorek and Morgan 2008; Wooten 2008; Collins 2008). The increase in population and infrastructure next to the National Forests increases the risks to public safety from geologic hazards associated with the Forests and adjacent private land.

## **Floods**

The steep mountainsides and narrow valleys characteristic of the Forests produce powerful floods, including flash floods. In September 2004, Hurricanes Frances and Ivan resulted in widespread flooding across the Forests. In 2011, 2013, 2017 and 2018, rainstorms resulted in major flooding at various locations in the Forests.

The loss of 20 lives in a June 11, 2010 flash flood at Albert Pike Recreation Area on the Ouachita National Forest prompted the Forest Service WO and RO direction to conduct assessments of floods and other hazards at developed recreation sites. As a result, the Nantahala and Pisgah NFs has completed flood studies for campgrounds.

In 2011, the Forests developed a list of campgrounds for accelerated floodplain study. A partnership between the Forest Service and the State of North Carolina Floodplain Mapping Program (NCFMP) led to NFs in NC Campground Flood Mapping Project using FEMA approved models and analysis procedures. The Flood Mapping Project for these sites was completed in 2013. Since then, the Forests have used the floodplain information along with existing FEMA maps to make decisions on management of the campgrounds; for example, the Forests have decommissioned some sites at Mortimer Campground on the Grandfather Ranger District.

## **Landslides**

Landslides are part of the natural disturbance regime on the Nantahala and Pisgah NFs (Wooten 2015). Debris flows originate as debris slides on mountainsides. Some debris flows travel hundreds or thousands of feet downslope, enter stream channels, and travel downstream in the floodplains and adjacent riparian areas. Whether due to a fill slope failure or a natural slope failure, a debris flow typically moves down through a watershed rapidly and poses a risk to public safety, resources, and infrastructure far downslope from the slope failure source area (initiation zone). Debris flows initiated high on a mountain have a “snowball effect” that increases the debris flow volume and destructive power as it gouges downslope scraping off and incorporating colluvium, weathered bedrock, trees, stream banks and bedload (Collins 2008). Debris flows can impact wider areas than the calculated 100 year floodplains. While debris flows often occur at times of flood events, debris flows are landslide hazards that require different assessments than flood assessments.

In September 2004, Hurricanes Frances and Ivan triggered hundreds of landslides across the Nantahala and Pisgah NFs and Western North Carolina and disrupted transportation corridors throughout the region. The Peaks Creek debris flow originated on steep, natural slopes of an inholding, travelled more than a mile across National Forest, then onto private land, resulting in several fatalities and destroying at least sixteen homes. The landslides on the Nantahala and Pisgah NFs damaged roads, bridges, trails, and infrastructure across the Forests, impacted streams and riparian areas, and required millions of dollars for storm recovery. In response to the destruction, the North Carolina General Assembly passed the Hurricane Recovery Act of 2005, authorizing the North Carolina Geological Survey (NCGS) to prepare county-scale landslide hazard maps for 19 mountain counties (Wooten et al. 2008).

The NCGS and other landslide hazard map projects have provided new information on landslide hazards on the Forests that was not available when the 1987 forest plan was prepared. Landslide hazard maps prepared by the NCGS are available in a GIS format for Macon, Watauga, Buncombe and Henderson Counties (Wooten et al. 2006, 2008, 2009, 2011) and include Nantahala and Pisgah NFs lands within those counties. These maps show where landslides have occurred or may occur; where landslides like debris flows may start on the Forests; and where debris flows may travel downslope onto private land. In addition, landslide hazards maps prepared by Appalachian Landslide Consultants, PLLC, (2018) are available for Jackson County and portions of Haywood County.

A Forest Service GIS analysis intersected the Nantahala and Pisgah NFs developed recreation sites with the landslide hazard maps for the six counties. The analysis showed 29 developed recreation sites, including several campgrounds and recreation residence lots, are located in landslide hazard map units related to debris flows. This landslide hazard screening indicates the need for more detailed debris flow hazard and risk assessments for the 29 developed recreation sites and more landslide hazard mapping in other counties where NFS lands are located.

Debris flows are not only a natural landslide hazard, but a project-induced hazard. Debris flows can be caused by failure of fill slopes such as those constructed for roads or log landings. Ground disturbance for management activities (such as road construction and reconstruction, timber harvest activities, trail construction and reconstruction) has the potential to result in project-induced landslides (cut slope failures, fill slope failures, and resulting debris flows).

Rockslides and rockfalls are geologic processes inherent in the development and continuing evolution of waterfalls and are hazards at every waterfall on the Nantahala and Pisgah NFs. The degree of hazard is determined by the site-specific geology at each waterfall, such as the extent and orientation of fractures in the bedrock or the presence or absence of rock overhangs. The magnitude of risks to visitor safety is influenced by the access provided (e.g., the presence and condition of roads, trails, and parking lots). Bridal Veil Falls, Dry Falls, and Moore Cove Falls have rock overhangs with the potential for rockfall from the overhang as well as from the steep slopes next to the overhang.

### **Waterfalls**

The Nantahala and Pisgah NFs are home to many waterfalls, and visitors enjoy waterfall-based recreation such as viewing waterfalls, hiking along trails near waterfalls, or wading and swimming near waterfalls. Waterfalls are geologic wonders, but they are also geologic hazards and have inherent risks due to the natural setting in which they occur. Visitors that ignore signs or leave system trails or designated viewing areas can be met with multiple hazards: slippery rock; vertical drop hazards from the tops or sides of waterfalls; stream current hazards at the top and the base of falls; submerged rock and woody debris in pools at base of falls; icefall hazards in winter and spring-melt months; rockfalls and rockslides; flash floods; bedload and woody debris toppling over; and down falls. The total fatalities associated with waterfalls exceed the total fatalities combined for all other geologic hazards on the Forests. Additionally, the number of serious waterfall-related injuries outnumber fatalities.

In 2016, the Southern Region of the Forest Service developed a new incident protocol for incidents involving death or significant injury to assist in reporting and analyzing visitor fatalities and serious injuries at waterfalls. The Nantahala and Pisgah NFs have taken structural and non-structural measures for public safety at waterfalls. Such measures include warning signs on trails, view platforms, guard rails, and barriers; safety information in kiosks, brochures and on websites, such as waterfall warnings on the Forest's Special Places webpage; and coordinating with local counties and municipalities to develop key messages for communicating the hazards associated with waterfalls.

### **Acid-producing bedrock**

Some areas in Western North Carolina contain bedrock formations that can produce acidic reactions and acidic runoff when exposed to the atmosphere (North Carolina Mountain Resources Commission 2012c). When acidic runoff enters streams, sudden decreases in pH may occur that can degrade water quality, causing significant mortalities among acid-intolerant aquatic organisms. Acid-producing rocks can adversely affect the stability of slopes, particularly if untreated material is used in the construction of road fill slopes or log landings or if acid-producing rock weathers in road cut slopes. Examples include embankment slope failures of Swain County in 2003 and Haywood County in 2006 or rockslides in road cuts on the Blue Ridge Parkway in 1999 and 2006. The soil and highly weathered rock derived from sulfidic rock is generally not a hazard because the iron sulfide minerals like pyrite have long been leached



out through the natural weathering process. However, in fresh bedrock the degree of potential acid runoff depends on the concentrations of sulfide minerals present and the amount of surface area exposed.

Guidelines for handling acid producing material were developed by the N.C. Division of Water Quality and the North Carolina Geological Survey. This guidance is used during project development; layout of log yarding corridors, system roads, and temporary roads; and the reconstruction of system roads to avoid any exposure of iron sulfide rock and reduce the risk of road cut and fill slope failures of this material.

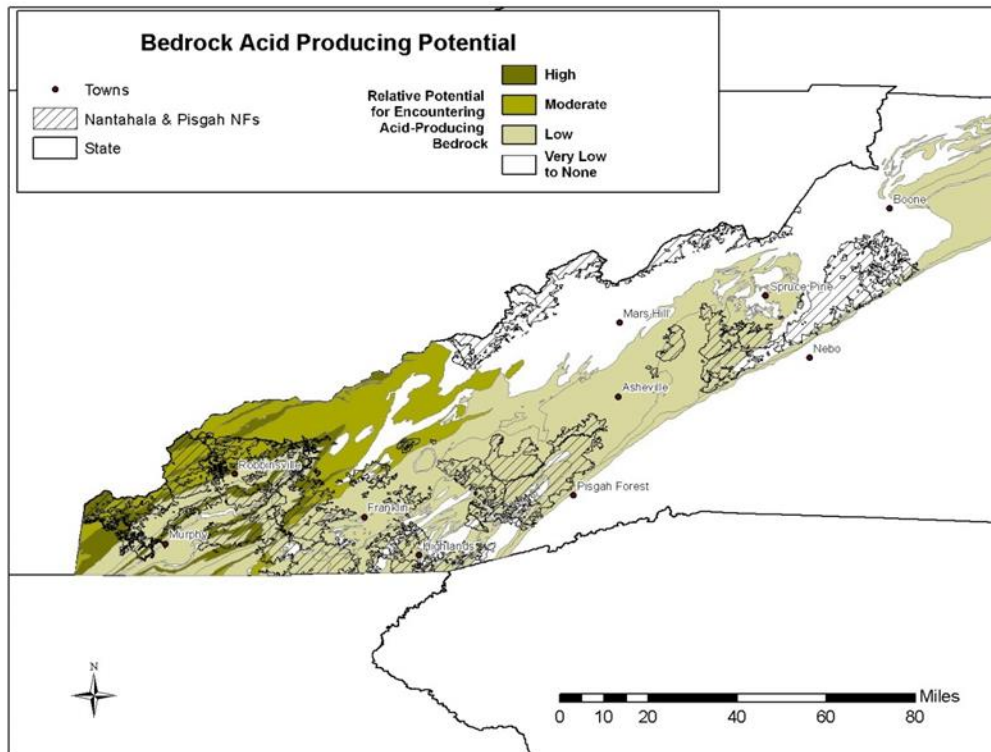


Figure 18. Bedrock Acid Producing Potential

### Ultramafic rocks with asbestos

Ultramafic rocks are much less common than acid-producing rock on the Nantahala and Pisgah NFs. Economically, ultramafic rocks are important sources of olivine, talc, chromite, nickel, vermiculite, and asbestos minerals, all of which have been commercially produced in Western North Carolina. There are, however, potential hazards associated with ultramafic rocks. Because of the rock's susceptibility to weathering and erosion and the presence of weak minerals like talc, these rocks can contribute to slope instability that can lead to landslide occurrences. Similarly, excavating or disturbing asbestos-containing ultramafic rocks can expose the small, needle-like fibers to the environment, where inhalation or ingestion of these fibers can pose serious health risks (North Carolina Mountain Resources Commission 2012c).

## **Environmental Consequences**

### **Geologic Resources**

#### **Common to all alternatives**

Under all alternatives, the plan provides direction to protect unique geologic features of regional and national significance such as Looking Glass Rock, Big Bald, and Cullasaja Gorge. These areas are managed to protect, and where appropriate, foster public use and enjoyment of unique scenic, geological, botanical, or zoological attributes. Special Interest Areas that were identified in the current plan would continue to be recognized in all alternatives on the basis of their unique geology/scenery.

#### **Alternative A**

The current Plan contains limited direction on some geologic resources, for example, at Buck Creek Serpentine Olivine Barrens and Nantahala Gorge Blowing Springs, and Roan Mountain Massif. The current plan does not have comprehensive direction on the wide range of geologic resources, on geology as the foundation of ecosystems, nor on geologic diversity as the foundation for ecological and biological diversity. Design of vegetation management and restoration projects need to consider the opportunities, limitations, controls, and influences inherent in the geologic setting of a project. Vegetation management and restoration projects that do not consider the suitability of the geologic setting have the potential to be unsustainable and to adversely affect the environment.

Management activities that involve ground disturbance, such as roads, timber harvest, trails, and developed recreation facilities, have the potential to adversely affect geologic resources. The current plan has direction that would protect some known geologic resources but does not have plan components to screen for a variety of geologic resources during design and implementation of multiple use projects.

#### **Action alternatives**

The action alternatives have the following new forestwide desired conditions and standards:

- GEO-DC-01** As the foundation of the Forests' ecological and biological diversity, geological settings provide diversity that enables ecological restoration as well as adaptation in a changing climate.
- GEO-DC-02** Geologic resources provide economic, ecological, scientific, educational, interpretative, scenic, recreational, paleontological, and other benefits.
- GEO-DC-03** Groundwater systems, as well as groundwater-dependent ecosystems, are sustained within the natural range.
- GEO-S-01** Management activities consider geologic setting and are located and designed to avoid, minimize, or mitigate adverse effects on groundwater, groundwater dependent ecosystems, and other geologic resources with identified values.

This new plan direction for action alternatives would have the beneficial effects of integrating the geological foundation of ecosystems and biological diversity in the management of vegetation, restoration, soil and water resources, sustainable recreation, and climate change adaption.

### **Geologic Hazards**

#### **Common to all alternatives**

The Forests would continue assessing flood hazards and reducing risks to campgrounds and roads by using the FEMA study area information and floodplain studies completed by State of North Carolina Floodplain Mapping Program (NCFMP) in 2013, as well as local knowledge. As a result, the Forests would

continue to reduce risks to campgrounds and roads. Risks to visitor safety from flooding and flash flooding would be managed by temporarily closing campgrounds based on weather forecasts, or when flash flood risks are identified by continuous monitoring of water levels.

### **Alternative A**

The current plan contains general direction to provide “a safe, esthetically pleasing, nonurban atmosphere.” It does not contain specific direction and plan components to assess geologic hazards and manage the associated risks to public safety, employee safety, infrastructure, and resources. More specifically, the plan does not provide direction for assessing floods, managing risks to public safety at existing campgrounds and other facilities located in floodplains, nor for assessing flood hazards and associated risks to public safety of future projects in riparian areas. Hazards that are briefly mentioned include hazardous trees and fire hazards. If geologic hazards are known in the project area, the Forests will consider the potential effects during project analysis and design and will adopt best management practices from the state for project design and implementation.

Without direction to conduct landslide hazard screening or detailed landslide hazard and risk assessments, existing fill slopes or new fill slopes constructed for roads and log landings on steep slopes could have the potential for a fill slope failure and, in some cases, may result in debris flows that could pose a risk to public safety, resources, and infrastructure downslope on National Forest land and non-Forest land.

Existing plan direction does not address the high number of serious injuries and fatalities at waterfalls and does not establish any mechanisms for accident tracking.

### **Action alternatives**

The action alternatives establish plan direction specific to geologic hazards and risks to public safety and infrastructure. The action alternatives have the following forestwide plan components that collectively increase hazard detection, reducing risks to visitor safety and infrastructure:

- GEO-DC-04** Geologic hazards (e.g., rockslides, waterfalls, acidic rock, etc.) are recognized, and associated risks to public health and safety or facilities and infrastructure are minimized.
- GEO-DC-05** Ground-disturbing activities do not cause or contribute to geologic hazards such as acid rock drainage and landslides.

The action alternatives have the following standard:

- GEO-S-02** The location of proposed roads, trails, facilities, and management activities shall be screened for the presence of geological hazards relevant to the geologic setting. If geologic hazards are present, then location and design measures shall be provided for management activities that may affect or be affected by the geologic hazards.

The action alternatives also have guidelines and management approaches to geologic hazards and risks to public safety and infrastructure including the following in the Recreation section:

- REC-G-03** New campsites and restrooms should be located based on site-specific considerations of public safety and floodplain risk. When replacing or rehabilitating existing facilities that might be a floodplain risk, consider the feasibility of relocation outside of the floodplain, and document rationale in project decision if relocation does not occur.

Collectively, this comprehensive set of new plan direction for the action alternatives is a significant improvement over the current plan. Under this direction, the Forest Service and the public would have the information and analysis needed to assess how proposed projects and existing management may affect or be affected by geologic hazards and risks to public safety and infrastructure (Collins 2017). The new plan direction would be most effective for projects proposed during plan implementation, such as

proposals for a new or expanded campground. Applying the direction to existing forest infrastructure would have some implementation challenges due to the difficulty in modifying existing uses or facilities.

Ground disturbance for management activities (such as road and trail construction and reconstruction and timber harvest activities) has the potential to result in project-induced landslides (cut slope failures, fill slope failures, and resulting debris flows). The direction to assess proposed ground disturbing management activities on project-induced slope failures (cut slope failures, fill slope failures and resulting debris flows) would increase hazard detection and reduce risks to public safety for new projects as well as existing infrastructure. There will still be some risk for campgrounds and roads that remain subject to debris flow hazards due to the nature of the geological resources.

Landslides can also be triggered by existing roads and trails, although the action alternatives include objectives to reduce both road and trail maintenance backlogs.

The action alternatives increase the timber harvest program, which will include ground disturbance from skid roads, skid trails, and log landing construction, and construction, reconstruction, operation, and maintenance of roads. Therefore, the action alternatives have greater potential to adversely affect these geologic hazards than Alternative A. However, unlike Alternative A, the action alternatives have a comprehensive set of plan components to manage geologic hazards and risks including a standard to screen for geologic hazards in the siting and design of management projects. This comprehensive set of plan components for geologic hazards provides direction to identify geologic hazards and manage risks that is commensurate with the increased timber volumes of the action alternatives.

Guideline REC-G-03 would reduce the risks of flash flood hazards in new locations. In existing locations that may be at risk for flash floods, moving the features outside of the floodplain would be considered when replacing or rehabilitating is considered at the location. Those that are not relocated would remain subject to flood hazards and associated risks to visitor safety.

The action alternatives also have an objective that would facilitate managing risks associated with geologic hazards and understanding safety management needs:

**REC-O-03** Tier 1: Establish a forestwide accident analysis system of cumulative fatalities to determine if additional safety measures and risk management may be appropriate within the planning period.

The direction to screen new projects for acid-producing bedrock and asbestos bearing rock hazards would reduce risks and would enable more focused hazard and risk assessments where needed.

### **Cumulative Effects**

The analysis of cumulative effects considers the 18 counties in Western North Carolina.

Ground disturbance from future management under each alternative will add to the ground disturbance from past activities including roads, timber harvesting, log landings, trails, recreation developments and mining. Ground disturbances such as road construction would result in alterations of geologic conditions affecting slope stability such as changes in the quantity, spatial distribution, and mass strength properties of unconsolidated materials overlying bedrock; excavating and remolding intact colluvium, residuum and bedrock and placing the material back on steep slopes as fill; changes in surface and subsurface drainage. Projects can be implemented after hazards have been identified and hazards and risks mitigated. Mitigation measures and additional screening called for in the action alternatives would reduce but not eliminate the long-term potential project-induced landslide hazards, including debris flow hazards with risks to non-federal lands downslope from NFS lands. Reclamation and decommissioning roads may mitigate and reduce potential for slope instability.

Ground disturbance from future management under each alternative could add to the ground disturbance from past activities on NFS lands or non-federal lands that may be in areas with acid-

producing bedrock or in areas with ultramafic rock with asbestos, although additional screening standards in the action alternatives should reduce that risk.

Ground disturbance generally is more prevalent on lands outside NFS lands than on NFS lands. Residential, commercial and industrial development, and highways and high density roads networks are found on lands outside NFS lands. As WNC continues to grow, these types of ground disturbances necessary for economic development can be expected to continue on lands outside NFS lands. The ground disturbance on the NFS lands contributes to the overall ground disturbance in WNC, but it is less intense than ground disturbance on lands outside NFS lands. As a result, the cumulative impacts from ground disturbance on geologic resources is expected to be less on NFS lands than on lands outside NFS lands.

### **3.2.4 Soils**

#### **Affected Environment**

##### **Background**

##### **Soil morphology**

The Nantahala and Pisgah National Forests are within the mountain belt of the Blue Ridge physiographic province. This belt consists mostly of igneous and metamorphic rocks and small areas of sedimentary rock on the western margins (Trapp and Horn 1997). Soils form from parent material prone to weathering, influenced by high rainfall and moderate air temperatures.

General soil descriptions can be broken down into the Broad Basins, River Terraces, and Floodplain System, the Low and Intermediate Mountain System and the High Mountain System. The Broad Basins, River Terraces, and Floodplain System is characterized by wide valleys and low, rounded hills with few steep slopes. These soil profiles have higher nutrient supply and water-holding capacity due to a high rate of organic material decomposition. Low and Intermediate Mountain System soils are found at elevations between 1,400–4,600 feet above sea level. Soil formation is influenced by elevation, slope aspect, exposure, and vegetation present, and have well developed profiles. They are acidic and highly weathered, and their principal topography includes steep slopes and ridges, as well as steep, narrow, and wet valleys. The High Mountain System soils are generally found above 4,600 feet and have unique ecological systems and soils that are directly related to the severity of the environment. Their formation is limited by frigid temperatures, resulting in less developed soil profiles with minimal microbial activity. Vegetative cover includes Red spruce and Fraser fir stands as well as heath and grassy balds.

##### **Soil productivity**

Soils vary widely in productivity, behavior, and response to management. While natural fertility and mineralogy are influenced by the type of materials from which the soils developed, site quality often is more closely related to landscape position and elevation. However, the soils derived from granites and gneisses generally are more productive than soils from metasedimentary rocks on similar landscape positions. Within a given area, the most productive soils generally are those in the coves and at the toe of slopes. Such sites are characterized by very deep, colluvial soils, which can support high quality cove hardwoods.

Residual soils on side slopes and ridgetops, which constitute the majority of any given area, vary widely in productivity. Below an elevation of approximately 4,800 feet, productivity is greatly influenced by soil depth (rooting depth) and moisture supply. Soils commonly range from shallow to deep, with moderately deep soils predominating. Within a local area, slopes that face north or east or that are sheltered by higher mountains are cooler, moister, and more productive than south- and west-facing slopes. Cool slopes generally sustain high-quality cove and upland hardwoods, except on some very

steep slopes where shallow or outcropping bedrock limits rooting depth and/or growing space. Warm slopes vary widely, ranging from sites with moderately deep to deep soils capable of sustaining good growth of upland hardwoods and pines to droughty sites with shallow soils and very low productivity. Generally, within a local area, broad ridgetops have deeper soils with more available water for vegetation, and thus are more productive than narrow ridgetops.

Above 4,800 feet, productivity is limited by the short growing season and severe climate. Soil formation is limited by cold temperatures, resulting in less developed soil profiles with minimal microbial activity. *Frigid soils* occur in these areas, occupying 55,270 acres of the planning area. They are characterized by organic, rich soils and cool, moist microclimates. Sheltered positions can support good growth of northern hardwoods and, at the higher elevations, spruce-fir as well as heath and grassy balds. Tree growth on positions that are exposed to the strong prevailing wind is limited by ice and wind damage.

*Hydric soils* are defined by the National Technical Committee for Hydric Soils (NTCHS) as soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (59 Federal Register 35680, 7/13/94). These soils are either saturated or inundated long enough during the growing season to support the growth and reproduction of hydrophytic vegetation. Hydric soils occur across the landscape in areas along stream channels, on floodplains, and in isolated springs and seeps. Based on data from NRCS, hydric soils occupy 594 acres in the planning area, and there are an additional 74,205 acres of partially hydric soils. Hydric soils are a primary indicator of wetlands and are used in the assessment of Forest Service compliance with Executive Orders 11988 and 11990, directives relative to the management and disposition of floodplains and wetlands.

There are 3,498 acres of *prime farmland soils* in the planning area. Farmland of local and statewide importance and potential prime farmland also occur. These soils have been identified by Congress, in the Farmland Protection Policy Act, Section 2 [7 USC 4201], and management is “to minimize the extent to which Federal programs contribute to the unnecessary and irreversible conversion of farmland to nonagricultural uses, and to assure that Federal programs are administered in a manner that, to the extent practicable, will be compatible with State, unit of local government, and private programs and policies to protect farmland.” Therefore, the Forest Service is to avoid activities that would contribute to unnecessary and irreversible conversion of these farmland areas to nonagricultural uses. Such development could include roads, buildings, and campgrounds.

### **Forest management and soil quality**

Historically, with the increasing influence of human activity, the occurrence of wildfire increased as Native Americans used fire to create meadow conditions for wild game management. These activities likely caused the consumption of more forest litter and the surface soil organic layer, possibly leading to increases in soil erosion following rainstorm events on steep slopes. Across the forest however, these impacts were likely small and soil development was not adversely impacted. With the colonization of the area by European settlers, small subsistence farms, ranches, and small towns appeared and a slight shift in land use occurred from forested to more open areas.

The importance of timber to the growing American economy in the early 1900s led to the harvest of vast timber resources in the mountains. Some of the largest impacts to soil stability are likely to have occurred during this period due to the extensive transportation network needed to remove timber for processing. With heavy rains, these disturbed mountainous areas likely suffered extensive soil movement in mass as landslides and debris flows occurred on steep and shallow soil areas. Certainly, some areas appear to have been more active than others, such as the Bent Creek drainage (USFS 2005), but evidence of landslides from a century ago appear across the landscape. As regrowth of the forest occurred and tracts of land were consolidated under federal ownership, land management practices improved and soils began to recover.

The operation of coal burning energy plants to the west and southwest brought a more silent threat to soil quality as prevailing winds delivered elevated levels of sulfur and nitrogen that fell in the rain, clouds, or dry deposition on the naturally acidic soils. Once in the soil, sulfur and nitrogen molecules attached to calcium, magnesium, and potassium (cations), and reduced these important nutrients from vegetation uptake. Where soils had abundant amounts of cations, they are considered to have a high “buffering capacity” to the adverse effects of the sulfur and nitrogen deposition, and were impacted the least. However, over time, the loss of cations was extensive and the soil’s ability to effectively buffer incoming levels of acid was diminished. Consequently, soils became more acidic and within these watersheds surface water in streams and reservoirs likely became more acidic.

Regulations on coal energy plant emissions began in the 1970s and steady reductions in sulfur and nitrogen emissions were established. In many watersheds damage to soils had already been done and soils will not likely recover for centuries. What this means to soil productivity is difficult to determine since reference soil nutrient conditions do not exist. Plant composition may have shifted to favor species like rhododendron, but this was more likely a result of historic clearcut harvesting. Plant health does not seem to indicate notable degradation of soil productivity.

#### **Timber harvest impacts on soil quality**

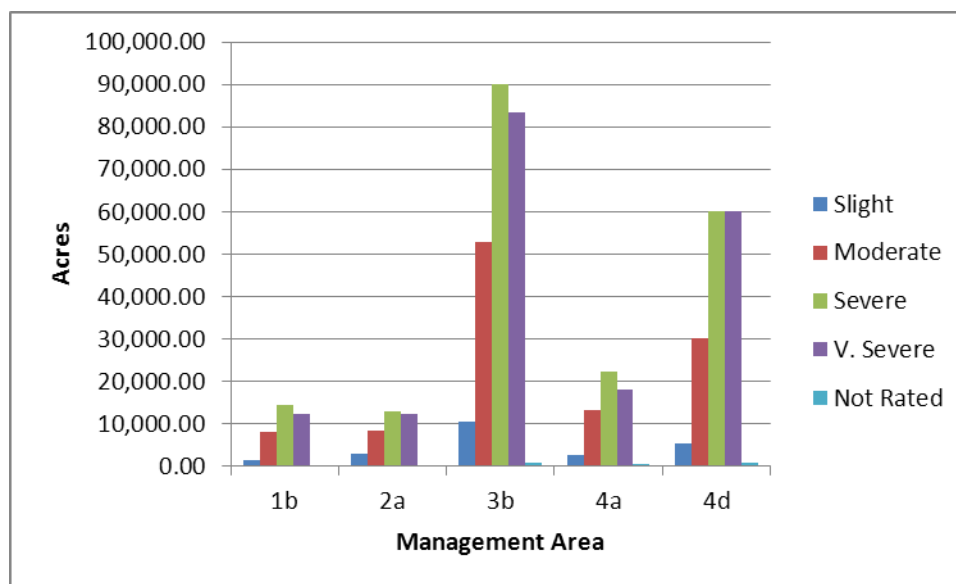
Extensive logging in the early 1900s, resulted in an extensive network of skid and haul roads on the landscape. Overtime many of these roads were abandoned; some were closed while others left to stabilize on their own. The stabilization of these “old woods” roads has been an ongoing effort of the Forest Service since the land was acquired to reduce erosion and improve soil productivity. Areas of soil compaction, such as on these old woods roads, continue to improve as compaction is reduced by natural processes, such as frost heave and disturbance by roots and ground dwelling animals, thus slowly improving soil productivity.

Soil disturbance can occur as a result of heavy equipment use during logging. Areas of concentrated use, such as log landings and skid roads are most affected. Compaction of these areas would increase the bulk density of the soils and result in a decrease in pore space, soil air, infiltration rate, and the water holding capacity of the soils and would increase water runoff. These effects are considered detrimental to plant growth. The degree and depth of compaction depends on several factors, such as on the number of passes the equipment makes and the moisture content of the soil at the time the passes are made. Changes in pore space do not normally occur on well-drained soils, such as those that occur over most of the Nantahala and Pisgah Forests, until three or more passes have occurred.

A review of the soil data and interpretations from the NRCS Web Soil Survey Site shows that a majority of the planning area has soils sensitive to erosion if a majority of the surface organic layer was removed. Because timber harvest has the greatest potential for disturbing the largest area of soil, the current Plan (Alternative A) Management Areas that promote active harvest of timber were assessed (these include MA 1b, 2a, 3b, 4a, and 4d). Table 10 and Figure 19 summarizes the NRCS Erosion Hazard Rating for soils on general forested lands, excluding excavated roads or trails, which will be addressed below. A “very severe” and “severe” hazard rating exists for 35.5 percent and 38 percent, respectively, (a total of 74 percent) of the area in these management areas if activities, such as timber harvest and prescribed fire, expose bare soil.

**Table 10. Summary of Acres of Erosion Hazard Off Roads and Trails by Current Plan “Timber Production” Management Areas**

Sum of Acres of Erosion Hazard Off Roads and Trails by “Timber Production” Management Areas						
Management Area (Current Plan)	Erosion Hazard Rating - Off Roads & Trails					
	Slight	Moderate	Severe	V. Severe	Not Rated	Grand Total
1b	1,528.54	8,094.75	14,325.78	12,374.80	319.62	36,643.49
2a	2,799.78	8,351.83	13,013.33	12,220.98	341.00	36,726.91
3b	10,575.96	52,943.29	90,098.75	83,465.44	922.68	238,006.12
4a	2,551.14	13,290.18	22,213.34	17,900.11	346.49	56,301.26
4d	5,202.27	30,230.96	59,985.49	59,972.76	738.38	156,129.86
<b>Grand Total</b>	<b>22,657.69</b>	<b>112,911.01</b>	<b>199,636.69</b>	<b>185,934.08</b>	<b>2,668.17</b>	<b>523,807.64</b>
<b>Percent</b>	<b>4.33</b>	<b>21.56</b>	<b>38.11</b>	<b>35.50</b>	<b>0.51</b>	

**Figure 19. Summary of acres of erosion hazard off roads and trails by management areas that are suitable for timber production**

### Forest practices monitoring

Monitoring indicates very little long-term soil disturbance from activities other than roads and trails over the past planning period. Forest Practices Best Management Practices (BMP) monitoring from 1992 to 2000 compared to recent years (2009 to 2013) shows a notable improvement in the implementation and effectiveness of management practices (Table 11). This improvement means less soil disturbance including compaction and erosion. Harvest activities are improving in the type of BMP applied, such as the increased use of slash on skid roads and trails, choosing a temporary bridge over installing a culvert at stream crossings, and planning unit boundaries to exclude sensitive soils and streamside zones.



**Table 11. Best Management Practices (BMP) Monitoring Summary Data Comparing Forestry BMP Implementation and Effectiveness Monitoring on the NFs in NC, Between 1992-2000 and 2009-2013**

BMP Monitoring Period	Implementation				Effectiveness					Visible Sediment		
	Meets or Exceeds	Minor Departure	Major Departure	Gross Departure	Improvement Over Past	Adequate Protection	Minor/Temp. Impact	Major Short-Term Impact	Major Long-Term Impact	No Visible Sediment	Non-Critical Visible	Critical Visible
1992-2000 Total	785	310	56	2	5	833	219	83	3	435	84	20
Percent in Class	68.1%	26.9%	4.9%	0.2%	0.4%	72.9%	19.2%	7.3%	0.3%	80.7%	15.6%	3.7%
2009-2013 Total	1861	63	35	5	9	1862	53	28	12	1146	35	5
Percent in Class	94.8%	3.2%	1.8%	0.3%	0.5%	94.8%	2.7%	1.4%	0.6%	96.6%	3.0%	0.4%

An important factor considered in evaluating effects to soil resources is the extent of the area where long-term soil productivity might be impacted. Effects to the soils from projects are considered not significant on the Forest when 85 percent of the activity area is unaffected and retains its potential long-term soil productivity. In other words, no more than 15 percent of the activity area and each individual harvest unit are affected and lose potential long-term soil productivity.

Soil Quality Monitoring (SQM) was conducted on the Nantahala and Pisgah NFs using the Forest Soil Disturbance Monitoring Protocol (Page-Dumroese et al. 2009). The monitoring was done to determine if there was significant change in land productivity due to timber harvest activities. "Significant change" is defined as detrimental soil disturbance exceeding 15 percent of each individual harvest unit.

A summary of the 2009 - 2012 SQM is presented in Table 12. All timber sale units surveyed had predominantly ground-based harvested and had some degree of detrimental soil disturbance. Only two of the 30 post-harvest units were found to have disturbance above the significant level. The detrimental soil disturbance found in Farmers Branch Timber Sale in harvest Unit 4 in 2010 (15.7 percent detrimental disturbance) was mitigated in 2011 by subsoiling detrimentally compacted soils on skid roads and landings (Figure 20). Detrimental soil disturbance in this unit is now well below the 15 percent standard and soil productivity has been restored too much of the area. Likewise, Eagle Fork Timber Sale Unit 2, determined to have a detrimental soil disturbance of 16.3 percent in 2009, was also mitigated in 2012 (Figure 20), bringing the detrimental soil disturbance in this unit well below the 15 percent threshold. Several units, surveyed pre-harvest in 2009 and 2010, were resurveyed in 2011 following logging. Although an increase in disturbed area occurred from pre-harvest, the units surveyed maintained appropriate soil productivity.

**Table 12. NFs in NC 2009 - 2012 Soil Quality Monitoring Results with Detrimental Soil Disturbance**

Forest	Timber Sale	Unit #	Pre-harvest (Pre) or Post-harvest (Post)	Unit Area (acres)	Percent Detrimental Soil Disturbance		
					Skid Roads & Landings	Other within Unit	Total
Pisgah	Baldwin Gap	2	Post	11	9.4	0	9.4
		3	Post	27	3.2	0	3.2
		8	Post	23	9.1	0	9.1
Pisgah	Case Camp	3	Post	13	9.2	1.6	10.8
		6	Post	8	2.5	0.1	6.2
		8	Post	12	1.7	3.3	5
Pisgah	Shope Creek	23-12A	Pre/Post	12	4.7/9.3	0/2.2	4.7/10.9
		23-13	Pre/Post	9	1.2/2.5	0/0	1.2/2.5
		23-12B	Pre/Post	6	0/5.0	0/0	0/5.0
Pisgah	Mulberry Globe	2	Post	37	0.3	0	0.3
		3	Post	22	12.3	0	12.3
Pisgah	Pressley Fields	1	Post	17	1	0	1
		2	Post	11	3.5	0	3.5
		3	Post	2	10	0	10
		7	Post	16	8.2	0	8.2
Pisgah	Stateline	1	Post	30	7	0	7
		2	Post	19	11	0	11
Nantahala	Eagle Fork	1	Post	25	2.4	0	2.4
		2	Post	16	16.3	0	16.3
		3	Post	25	9.6	1.4	10.8
Nantahala	Locust Cove	1	Post	10	0.7	0	0.7
		2	Post	18	1.1	3.2	4.4
		3	Post	17	0.5	0	0.5
Nantahala	Slipoff	8	Post	8	4.4	3.1	7.5
		10	Pre/Post	24	0.3/3.6	0/3.3	0.3/7.0
		11	Pre/Post	19	0/6.3	0/0	0/6.3
Nantahala	Farmer Branch	1	Pre	25	0.6	0	0.6

Forest	Timber Sale	Unit #	Pre-harvest (Pre) or Post-harvest (Post)	Unit Area (acres)	Percent Detrimental Soil Disturbance		
					Skid Roads & Landings	Other within Unit	Total
		2	Post	20	3.2	0	3.2
		3	Post	10	6.5	0	6.5
		4	Post	14	15.7	0	15.7
		5	Post	18	9.8	0	9.8

Soil quality monitoring shows that the level of soil disturbance is minimized during operations and is often well below the 15% guidance. As a result, the majority of the harvested area maintains an organic layer that protects the soil from erosion. Therefore, the high hazard ratings within these management areas have been mitigated through proper application of effective best management practices.



Figure 20. Farmers Branch Timber Sale in harvest unit 4 (left) and Eagle Fork Timber Sale unit 2 (right) subsoiling to reduce soil compaction and detrimental soil disturbance from skid roads and landings

### Recreation impacts on soil quality

Recreation activities that can expose large areas of bare soil, such as camping, do not typically occur on NRCS designated sensitive soils since the severe and very severe erosion hazards occur on steep side slopes that are often too steep to accommodate such activities. Concentrated use from the public often occurs on flatter areas often located near streams and can have detrimental impacts to soil productivity from compaction and rutting from vehicles. Exposed soils in these locations can pose often small but chronic erosion and sedimentation.

### Road and trail impacts on soil quality

Roads and trails are often a long-term alteration of soil properties converting productive forest soils to a dedicated non-productive state. Assuming a 25 feet wide corridor of road disturbance, there is approximately 11 square miles of Forest land dedicated to roads, and assuming 7 feet wide corridor for

trails, another two square miles of Forest land dedicated to trails. Where these features are on erosion-sensitive soils they can be of particular concern for erosion since they often cut into hill slopes exposing soil to weathering and interrupt flow of both surface and ground water. Roads and trails constructed in soils sensitive to erosion are important to identify and manage to address potential soil erosion concerns and sedimentation to nearby waters.

Table 13 shows miles of road and trail, and where they intersect with NRCS Erosion Hazard Ratings for such features. This information is useful in determining the need for erosion control mitigation measures, such as gravel surfacing and increased frequency of water diversion structures. Existing roads and trails on the transportation system predominantly occur within soils rated as having a “Severe” erosion hazard (81% and 86% respectively) (Table 13). Therefore, the application and maintenance of erosion control mitigation measures are essential to reducing erosion and maintaining soil quality. On the NFs in NC, very few roads are in a native surfaced condition due to erosion concerns. Roads predominantly have gravel surfacing applied and/or are planted in a ground cover type vegetation. Trails on the other hand depend largely on appropriate drainage that removes surface runoff from the trail before erosion begins.

**Table 13. Miles and Percent of Road and Trail by Road and Trail Erosion Hazard Ratings**

	Erosion Hazard Rating - On Roads & Trails				
	<i>Slight</i>	<i>Moderate</i>	<i>Severe</i>	<i>Not Rated</i>	<i>Total</i>
Total Road Miles	50.2	282.2	1907.8	108.9	2349.0
<i>Percent</i>	<i>2.1</i>	<i>12.0</i>	<i>81.2</i>	<i>4.6</i>	-
Total Trail Miles	41.8	156.8	1391.3	25.9	1615.9
<i>Percent</i>	<i>2.6</i>	<i>9.7</i>	<i>86.1</i>	<i>1.6</i>	-
Total Road/Trail Miles	92.0	439.0	3299.1	134.8	3964.9
<i>Percent</i>	<i>2.3</i>	<i>11.1</i>	<i>83.2</i>	<i>3.4</i>	-

Note: Erosion Hazard Rating calculated for road and trail miles on Nantahala and Pisgah Forests managed lands only, therefore will be less than presented in the Transportation and Recreation analysis, which consider different geographical analysis scales.

Across the Forest most roads and trails are properly designed, constructed and maintained to mitigate the hazard of erosion by effectively draining storm runoff with frequent rolling-dips and ditch relief culverts, and the application of gravel surfacing. In some situations, however, roads and trails were constructed with unsustainable practices decades ago and are in need of frequent maintenance or relocation or obliteration.

## Environmental Consequences

### Common to all alternatives

**Fire effects** on soil properties and processes is quite varied. Effects to the organic layers and soil organisms depend greatly on heat penetration into the soil. Heat penetration depends upon the duration of the fire and soil moisture (Swift et al. 1993). Fire generally affects soil erodibility if mineral soil is exposed, however, reports show little to no erosion after the typical light to moderate intensity fires in the southeastern United States (Swift et al. 1993; USFS 2010c). Overall, published scientific studies have concluded that prescribed fire, implemented under managed or controlled conditions, have negligible to beneficial effects on the physical, chemical, and biological properties of soils and soil

productivity (Douglas and Van Lear 1983; Sanders and Van Lear 1988; Elliot et. al. 2004; Knoepp et. al. 2009).

**Connected actions with prescribed and wildfire** include the potential construction of bladed or plowed firelines. Fireline blading or plowing exposes the mineral soil by removing vegetation, leaf litter and duff. Blading would increase the exposed area's susceptibility to soil erosion and displacement of nutrients and organic matter offsite, thereby reducing productivity. Firelines can recover quickly when they accumulate litter from a forest canopy and are treated with erosion control measures to control concentrated flow and reduce soil exposure through revegetation efforts. Firelines that are needed for frequent or regular burning cycles are designed and maintained to provide for both long term use and ability to control concentrated flow and erosion by employing relatively permanent drainage dips, reverse grades, out-sloping and lead-off ditches along with reinstalling and maintaining of other erosion control measures when not used.

Since prescribed and wildfire have a minimal impact on soil productivity, impacts under the proposed alternatives are expected to be similar to current management relative to soil productivity.

Soil concerns associated with **timber harvesting activities and other connected actions** center around disturbance associated with rutting, compaction, displacement/erosion, soil exposure, organic surface removal, and an overall loss in productivity. Soil disturbance during timber harvest varies depending upon both the type of soil and harvest method (Swank et al. 1989), as well as topographic, soil, and climatic characteristics of the affected area. Areas subject to soil productivity loss include skid roads, temporary roads, and log landings, and thus have a spatial and temporal context. NFs in NC monitoring indicates that about 7 percent of a given area harvested by conventional logging equipment (rubber tired skidders/forwarder) is impacted long-term.

All alternatives ensure that when activities are proposed on steep slopes the Forest follows NC Forestry Practices as well as additional forest plan measures to ensure that soil erosion is minimized. All alternatives are consistent on this point, noting that a site-specific review is needed to determine the appropriate logging systems for management on sustained slopes (> 200ft) over 40% slope. (Alternative A includes a two-part standard to "[u]se cable logging that suspends at least one end of the log on sustained slopes over 40% unless site-specific analysis determines that other logging methods meet soil and water protection standards (Veg management Standard 7a); determine appropriate logging system for intermediate (thinning), selection or shelterwood cuts on sustained slopes over 40% site-specific analysis" (Vegetation management Standard 7b). Alternatives B through E include a standard to "[c]onduct a site-specific review to determine the appropriate logging systems for management on sustained slopes (> 200ft) over 40 % slope" (ECO-S-06 in Alternatives B, C, and D or TIM-S-06 in Alternative E).) Determining appropriate logging systems at the project level enables practitioners to make the best decision for the site conditions as well as account for future advances in logging technology while ensuring management that prevents erosion. Under all alternatives, during project analysis, steep slopes are evaluated by the assessment team along with needs to restore the logging access system of roads. All soil disturbance, including temporary haul and skid roads, during and after logging is stabilized with approved Forestry BMPs to reduce the risk of erosion. Project-level environmental analysis will be performed to ensure there are no significant environmental impacts.

Monitoring of soil quality shows a high success rate for implementation of effective forestry Best Management Practices (BMPs) including those that protect soil productivity. Planning during harvest layout typically includes using existing landings, roads and skid trails unless those features pose resource concern that cannot be mitigated or exceed a 15 percent disturbance threshold. These techniques result in limiting additional impacts to soil. For example, where an existing network of access is absent, new skid road construction is often only necessary on steeper slopes. Here excavating of the skid roads is kept to a minimum to be sure that stabilization of the skid road is successful in a cost-efficient manner. On

less steep slopes, skid routes can occur over the forest floor without excavation and thus often have less of an impact to soil. Repair of skid roads is occurring under all alternatives and is an effective BMP to reduce soil impacts such as compaction to restore soil productivity.

The action alternatives call for increased levels of timber harvest. However, with continued implementation of planning and operational BMPs, these activities would not adversely impact long-term soil productivity, and other soil improvements that are often funded by the timber project would result in overall beneficial impacts to soil by reducing erosion and long-term soil impacts.

Since **developed recreation areas** are largely established on the Forests they would have minimal additional effects to the soil resource. Within the last decade soil productivity has improved where developed camp sites have been decommissioned to reduce the human risk from flood events. Other sites such as trailhead parking and boat launches/takeouts have been reconstructed and expanded, thereby reducing soil productivity due to a long-term conversion of use. Overall trends in soil productivity relative to developed recreation is static unless notable expansion occurs, which is not anticipated to vary by alternative. In the event of notable expansion, trends in soil productivity would decrease slightly.

Under all alternatives, **dispersed recreation areas** are likely to have additional adverse impact on the soil resources due to increasing recreational use. Under all alternatives the Forest will continue to monitor and address dispersed recreation sites causing resource damage, particularly in focus/priority watersheds, where trends would be static for soil productivity. The effects of the trail network on soil conditions varies by alternative, as described below.

Currently, and in the action alternatives, vegetation management activities, road and trail design, and other proposed infrastructure projects are being screened for the presence of highly erodible soils to reduce erosion potential and effects to natural resources. It was not clear in the draft plan that this action applied to more than vegetation management and road and trail design, so “and other proposed infrastructure projects” was added to a standard (SLS-S-01) in Alternative E to provide clarification in the final alternative.

## Effects that vary by alternative

### Priority watersheds vs other watersheds

An important difference with Alternatives B, C, D, and E is the identification of priority watersheds in these alternatives. Priority watersheds are a required element in the 2012 planning rule, and in Alternatives B, C, D, and E watershed improvement projects will have focused restoration activities in these locations in order to maintain or improve ecological conditions. Under the current plan they are only our best and current practice.

In the action alternatives, objectives established in priority watersheds include improving water quality and aquatic habitat to properly functioning condition, restoring stream ecosystems, performing road and trail maintenance, and decommissioning roads as needed. Maintenance and decommissioning is emphasized in locations that are adversely impacting aquatic health. Tier 2 objectives call for doing more water quality and habitat condition improvements and more watershed restoration with the help of additional capacity and partners. As a result, **priority watersheds** will likely see a greater improvement in soil quality and productivity than other watersheds on the forest. Where Tier 2 objectives for timber are being met, new road construction would reduce soil productivity in those areas where productive soil is converted to a road corridor. The extent of the new road network would vary between watersheds depending on the amount of Matrix management area and silvicultural planning of timber stand treatments. In priority watersheds where both Tier 2 watershed restoration and timber production

occur, trends in soil productivity could be static as a balance is reached between decommissioning and construction.

**Outside of priority watersheds, other watersheds** under the action alternatives, a static to improving trend is assumed under Tier 1 objectives depending on the amount of Backcountry management area and unneeded roads that would be decommissioned. If meeting Tier 2 objectives, soils impacted by road construction would have a declining trend in soil productivity with the conversion of productive soil to dedicated road corridors, although the difference across the forest would not be significant.

### **Alternative A**

Under current management, **open roads and trails** would continue to adversely impact soil productivity over the long-term where they are located. These features on the landscape would continue to expose compacted soils, concentrate runoff, and alter surface and subsurface water flow patterns. The open road network would continue a static trend in soil productivity.

There are many miles of **old “legacy” roads** on the Forest, and **system road closed to use**, kept in storage for future management. These features often vegetate where their surfaces are stable, however soil impacts continue long into the future as altered soil structure lingers for many decades. Thus, soil recovery to a semblance of pre disturbance condition and function is unlikely without active restoration. Road and trail decommissioning, such as recontouring the road or trail prism and restoring natural drainage patterns, would continue with Alternative A; restoring soil productivity. Several miles of this occurs annually. Construction of new road would also continue as needed to accommodate management access. With continued implementation of Alternative A, approximately 6.0 additional miles of road will likely be needed annually, including an estimated 1.2 miles of new road prism construction, 1.9 miles of existing road prism added to the system, and 2.6 miles of temporary road construction that is decommissioned after use (see transportation and access). Soil productivity impacts would be the greatest on the 1.2 miles of new construction. Success of restoring soil productivity on temporary roads is often marginal and adverse impacts frequently remain. Alternative A also has an average of 2.1 miles of road annually decommissioned, which would improve soil productivity.

Most commonly, **new trail construction** would occur as the Forest continues to move trails off old road beds and onto properly constructed trails. Thus, with the construction of new trails, old trails (commonly with resource concerns) are often decommissioned. Where old trails are recontoured to slope, there is often a net improvement to soil productivity.

There are not limitations on **new trail construction for recreation opportunities** in Alternative A, so this would allow the most new trail miles and largest potential impact on soil productivity of any of the alternatives.

**Noncommercial recreational mineral collection** can disturb the soil notably when the organic layers (duff and humus) are removed, leaving bare mineral soil, particularly on steep slopes where soils are more prone to erosion. Current guidance keeps disturbance to less than a square foot in area, and rocks are removed only from the surface. Therefore, adverse impacts to the soil are minimal from rock hounding, and trends in soil productivity are static.

### **Alternatives B, C, D, and E**

As described above, all alternatives ensure that when activities are proposed on steep slopes, the Forest follows NC Forestry Practices as well as additional forest plan measures to ensure that soil erosion is minimized. In addition to the effects described above under “Common to all alternatives,” Alternative E includes management approaches in the Geological Resources section for slope stability with an emphasis on risk assessment when landslide hazards may be present. (See Geological Resources for additional information).

Forest-wide objectives place a great deal of emphasis on maintaining the necessary system **road network** in the Matrix and Interface Management Areas (MAs) while removing the network of roads considered unneeded by way of decommissioning, with an emphasis on roads in Backcountry. To accomplish the Tier 1 ecological objectives, the transportation system would be managed similar to existing in Alternative A with an average of 1.2 miles of new system road construction and 2.1 miles of decommissioning on an average annual basis. However, if Tier 2 timber management objectives were implemented, an additional 0.8 to 1.2 miles would be built annually to access additional timber in Alternatives B through E (See Transportation and Access section). Managing recreation and access would also include opening of closed roads and occasional road construction. See the transportation and access section for more information.

Given this, soil productivity would decline in locations where new roads and trails are located, but overall impacts to forestwide productivity would be small. Plan direction provides protections for waterways through the design and construction of roads. Alternatives B through E offer more direction on managing for geologic hazards (such as sulfidic rock) and slope stability when designing roads. Watersheds with larger areas in the Backcountry MA would be more likely to experience an improving trend in soil productivity as unneeded roads are focused on for decommissioning. Alternative C has the most amount of Backcountry compared to the other alternatives and thus is likely to have the most decommissioning of unneeded road. Where currently unroaded areas are recommended for wilderness (most in Alternative B) these areas would have a static trend in soil productivity since these areas are currently unroaded.

In Alternatives B-E, there is an objective that calls for **trail realignments** to reduce soil loss, prioritizing those that are needed in priority watersheds:

- WSD-O-01** Tier 1:  
iv. Perform trail maintenance activities on approximately 15 miles of trails, emphasizing trails within 100 feet of streams. Relocate trails that are adversely affecting aquatic health.

There is also the following objective for recreation:

- REC-O-06** Tier 1: Increase trail miles meeting National Quality Standards to 50% over the life of the Plan.  
Tier 2: Increase trail miles meeting National Quality Standards to 60% over the life of the Plan.

With the implementation of these objectives and the attainment of goals presented in several of the Geographic Areas (e.g. PL-GLS-06, Continue to improve trail conditions at Graveyard Fields, Black Balsam, and Sam Knob areas to accommodate high visitation and mitigate erosive impacts to fragile soils) there would be an improving trend in soil stability and quality associated with the developed trail network.

A new forestwide standard (REC-S-11) would limit equestrian and bicycle use to NFS **trails** designated or managed for those uses, and on open or gated NFS roads. This standard would not be in effect immediately but would be implemented through a forestwide Forest Supervisor order following collaborative trail planning to address equestrian and/or bicycle trail supply/demand issues. Once enacted, this standard will provide the FS an additional tool to decrease impacts to soil productivity off trail by reducing the footprint of unmanaged recreation.

Additionally, the development of new trail miles under all action alternatives will require that trail layout incorporates the most current design principles and minimizes adverse impacts to natural resources (REC-S-14). Alternatives C, D, and E provide even greater restrictions on new trail development. Alternative C requires that new trail miles be offset by a comparable length of decommissioned mileage, resulting in the most stringent restriction on the overall size of the designated trail network. Alternative



D establishes a trail bank for controlling the overall size of the forest trail system. In Alternative E, while there is not a cap on overall trail miles or a trail bank, provisions associated with new trail construction or adoption of unauthorized routes as system trails include long-term commitment for trail maintenance from partner organizations; or that new trail mileage will be offset by a comparable length of existing system trail decommissioning or unauthorized route closures; or that new trail construction address critical health and safety needs or supply/demand issues. Therefore, compared to Alternative A, recreation impacts are expected to have a greater trend in improving soil quality and productivity under all action alternatives with Alternatives E, D, and C having the greater potential to limit impacts, respectively.

In the action alternatives, the use of surface-penetrating tools for **noncommercial, recreational mineral collection** would be restricted to specific locations following the identification of those areas. Overall, this would reduce areas available for this activity, thereby further protecting soil quality from potential adverse impacts.

### Cumulative Effects

Cumulative effects are assessed at the 6<sup>th</sup> level watershed special scale, across all ownerships in the 18-county region.

On the forest, management activities generally result in a localized loss in soil productivity due to soil disturbance from compaction, rutting, soil displacement, erosion, unstable slopes, or the alteration of soil nutrient status. Activities with the greatest long-term potential impact to soils are associated with construction of roads, log landings, primary skid roads, and timber harvest on steep slopes using conventional equipment. The re-opening and use of these areas during successive harvest operations generally result in a longer term decrease in soil quality on these sites but limits the extent of disturbance on the landscape. Rehabilitation of disturbed sites can decrease the duration of the recovery period for soils and lessen the potential for cumulative degradation of soil conditions.

In general, impacts on soils resulting from timber harvests normally recover before a new cycle of harvesting begins, and as a result, cumulative impacts relative to compaction and displacement from successive harvesting operations would be expected to be minimal. Areas having temporary productivity losses resulting from timber harvest would be dispersed across a small fraction of the overall area. Where affected areas are not adequately restored following compaction, soil density will slowly revert to normal levels based on the frequency of freeze-thaw cycles, plant root penetration, soil microorganisms, earthworms, moles, etc.

Cumulative impacts on soil productivity from prescribed burning and connected actions are considered minimal for the majority of the analysis area. The extent of impacts is relative to organic surface removal, compaction, displacement and subsequent erosion from past prescribed burning and connected actions. Soil would recover over time depending on burn severity. Severely burned areas lose productivity and are subject to erosion, but do not frequently occur.

Cumulatively, environmental consequences to soils from past, present, and foreseeable actions are minimized through careful planning, design, implementation, and monitoring. With improving trends in soil quality on the Forest through active restoration efforts these alternatives would continue to improve soil productivity.

Off Forest, trends in soil productivity loss across the 18-county area of Western NC are likely static to declining, depending on location. Agriculture and forest conversion to urban development contribute to large scale, long-term decreases in soil quality.

Overall, the alternatives would not contribute to the decline in soil productivity occurring cumulatively across all lands.

### 3.2.5 Water Resources

#### Affected Environment

##### Watershed Condition

The Eastern Continental Divide crosses the Nantahala and Pisgah National Forests, separating the nine major river basins found on the Forests. The Hiwassee, Little Tennessee, French Broad, Watauga, and New river basins form part of the Interior Drainage Basin, which drains to the Mississippi River and the Gulf of Mexico. The Savannah, Broad, Catawba, and Yadkin-Pee Dee river basins are included in the Atlantic Slope Drainage Basin, which flows to the Atlantic Ocean. Each side of the Continental Divide contains distinct aquatic communities supporting flora and fauna unique to their side of the divide.

A watershed or drainage basin is the area of land that drains water, sediment, and dissolved materials to a common outlet at some point along a stream channel (Dunne and Leopold 1978). Watersheds are an effective way of understanding the hydrologic regime of an area and the hydrologic affects from management activities; although they are often not sufficient to explain the larger ecosystem. In 2010, 6th-level watersheds (typically, 10,000 to 40,000 acres) were used to define areas of restoration across the Forest using the national Watershed Condition Framework (WCF) (USF S 2010a). A watershed condition was assigned following an assessment of existing data, knowledge of the land, and professional judgment.

Watershed condition is the state of the physical and biological characteristics and processes within a watershed that affect the soil and hydrologic functions supporting aquatic ecosystems. Watershed condition reflects a range of variability from natural pristine (functioning properly) to degraded (impaired). The Forest Service Manual classification defines watershed condition in terms of “geomorphic, hydrologic and biotic integrity” relative to “potential natural condition.” In this context, integrity relates directly to functionality. Integrity is evaluated in the context of the natural disturbance regime, geoclimatic setting, and other important factors within the context of a watershed (USFS 2010a).

The three watershed condition classes are directly related to the degree or level of watershed functionality or integrity: Class 1 - Functioning Properly, Class 2 - Functioning at Risk, and Class 3 - Impaired Function (USF S 2010a). A watershed is considered to be functioning properly (Class 1) if the physical attributes are appropriate to maintain or improve biological integrity. By contrast, a Class 3 watershed has impaired function because some physical, hydrological, or biological threshold has been exceeded. Substantial changes to the factors that caused the degraded state are commonly needed to set them on a trend of improving conditions that sustain physical, hydrological, and biological integrity (USFS 2010a).

The WCF uses 12 indicators composed of attributes related to watershed processes. Of these, the indicator of grazing “range” was not used by the NFs in NC since the Forest does not manage for range. The indicators and their attributes are surrogate variables representing the underlying ecological functions and processes that affect soil and hydrologic function. Management activities that affect the watershed condition class are not limited to soil and water improvement activities but include a broad array of resource program areas: hazardous fuel treatments, invasive species eradication, riparian area treatments, aquatic organism passage improvement, road maintenance and obliteration, and others. To change a watershed condition class will, in most cases, require changes within a watershed that are significant in their scope and include treatments from multiple resource areas. Sound management or improving management practices can often be as effective as implementing restoration projects and must not be overlooked (USF S 2010a).

The outcome of the WCF analysis of condition classes for the Nantahala and Pisgah National Forests denotes the abundance of watersheds with “Functioning at Risk” classifications, only a few “Properly

Functioning” and one “Impaired Function” watershed. In general across the analysis area, physical attributes occur that put watersheds at risk of functioning at a potential natural condition, and thus may not be able to maintain biological integrity. Trends are likely improving in most watersheds, but the risk is high that a catalyst of change, such as a large storm event, could result in impaired conditions. The one impaired watershed is the Upper Chattooga River watershed, one of three watersheds draining the Chattooga River. This watershed is shared by the Nantahala N.F., Chattahoochee N.F., and Francis Marion – Sumter N.F. The impairment status was determined by the Francis Marion – Sumter N.F. (since they manage a dominant portion of the watershed) as a result of aquatic habitat and biota, the road and trail network, and soils concerns. Although almost half of the watershed on the Nantahala is within the Ellicott Rock Wilderness there are State, private and Forest roads present in the headwaters that may be contributing to the impaired designation in North Carolina and South Carolina.

Attributes found to have the greatest adverse impact on watershed condition ranking in the WCF are associated with water quality problems, absence of large woody debris, terrestrial invasive species, roads and trails, soil contamination and fire condition class. Water quality problems included a compilation of acidification from sulfur and nitrogen deposition from the atmosphere, consumption advisory, and knowledge of impaired conditions in the watershed.

### Municipal Watersheds

From the Nantahala and Pisgah NFs, drinking water is provided to seven cities or towns by either a reservoir or water diversion, four towns by a spring or well, and eight water/homeowner’s associations and small farms. Approximately 67 springs and small reservoirs on the forests provide water to individual homes, churches, camps, and a fire house. The health of surface water sources is good from these largely protected watersheds. State assessments indicate “good” water quality where assessments were completed in the North Fork Mills River and Mackey Creek (Table 14). The quality or sustainability of ground water is not monitored by the Forest Service, thus little is known.

**Table 14. Summary of Water Quality Status of Drinking Water Provided to Large Communities by the National Forest**

Community	Specific Use	County	Stream Name	State Stream Water Quality Assessment Status (USEPA 2010)
Town of Weaverville	Reservoir	Buncombe	Ox Creek	No Assessment Available
Town of Robbinsville	Reservoir	Graham	Long Creek	No Assessment Available
City of Hot Springs	Reservoir	Madison	Cascade Branch	No Assessment Available
Town of Old Fort	Reservoir	McDowell	Jarrett Creek	No Assessment Available
Town of Marion	Reservoir	McDowell	Mackey Creek	Good
City of Hendersonville	Reservoir	Henderson	N. Fork Mills R. Bradley Creek	Good No Assessment Available
City of Brevard	Water Intake/Leaf	Transylvania	Catheys Creek	No Assessment Available
Town of Highlands	Spring	Macon		Unknown
Marble Community Water System	Wells (4)	Cherokee		Unknown
Town of Santeetlah	Wells (5)	Graham		Unknown

## **Ground water and dependent ecosystems**

Ground water resources are largely intact in the planning area. Ground water extraction from wells and springs occurs in 77 locations; supplying water to individual homes, small businesses and communities. Information on the quality and quantity of ground water at these locations is not available, but activities that pose a risk to ground water, such as landfills, mining, oil and gas extraction and associated fracking, are not occurring in the planning area, therefore, water quality is assumed to be good. Where such activities occur on adjacent private lands there is a risk to larger aquifers that may extend below the surface under federal lands. This information is also not available.

Ground water extraction by humans modifies the pre-existing hydrologic cycle. It can lower ground water levels and alter the natural variability of these levels. The result can alter the timing, availability, and volume of ground water flow to dependent ecosystems. Ground water-dependent ecosystems vary in how extensively they depend on ground water, from being wholly dependent to having occasional dependence. Unique ecosystems that depend on ground water, fens or bogs for example, can be entirely dependent on ground water, which makes them very susceptible to local changes in ground water conditions.

Demands on ground water are likely to increase as a result of increasing populations in both rural areas and cities. Cities as far away as Atlanta, Georgia are likely to be in need of water from the mountains of North Carolina as their ground water resources become inadequate. More home sites and developments are likely to occur adjacent to Forest land that may desire to tap into surface and ground water sources. With this increasing use looming on the horizon, special attention will need to be given to ground water and ecosystems dependent on ground water.

## **Threats to Watershed Health**

### **Hemlock loss**

The loss of the eastern hemlock from the southern Appalachians as a result of Hemlock woolly adelgid is likely to have a notable impact on water yield, large woody debris, stream shading, and riparian composition. Annual water yield increased, in an infested Coweeta watershed, 8% and 9% for 2008 and 2009 respectively, but decreased significantly in 2011 (Brantley et al. 2011), likely due to the rapid growth response observed in co-occurring species (Ford et al. 2011). Hemlock loss also resulted in a higher frequency of high discharges during the dormant season of October through March. Increases in peak streamflow and quick flow (amount of flow from a storm) also significantly occurred during the dormant season (Brantley et al. 2011). These results demonstrate that loss of a canopy evergreen, even in small amounts, may have significant impacts on the timing and magnitude of stream discharge and may enhance the risk of flooding during large storm events in the dormant season.

### **Climate change**

Shifts in rainfall patterns would lead to periods of flooding and drought that can significantly impact water resources. Increases in heavy downpours and more intense hurricanes can lead to greater erosion and more sedimentation in our waterways. Increased periods of drought may lead to decreasing dissolved oxygen content and poor water quality in some areas. Groundwater-fed wetlands such as high-elevation bogs will be particularly vulnerable to changing climate as temperature and rainfall changes have the potential to lower groundwater table levels, altering the length of time that wetlands hold standing water. (TACCIMO 2013)

### **Flooding and slope instability**

Flooding of streams and rivers on the Forest is a natural process largely functioning within natural patterns and magnitudes. Exceptions might include watersheds with large areas of compacted surfaces such as parking lots, roofs, and roads, and where man-made impoundments are present. Flooding in

Western North Carolina is often the result of intense rain events derived from localized thundershowers or larger scale hurricanes that have moved inland. More important than the threat to watershed health is the potential for loss of life from flood events. This is discussed in the Geological Hazards section of the EIS.

On landscapes susceptible to mass soil movement saturated soils can give way and move under the force of gravity downslope in the form of landslides and debris avalanches (read more in the Geological Hazards section). Such events can add to the damaging effects of water alone since rocks, trees, and other debris are often incorporated in the flow. For example, debris avalanches occurred across the forests during the 2004 hurricane derived storms. Hurricanes Frances and Ivan, in succession, produced large rainfall events and subsequently large flood stages that equated to larger than a 100-year return period in drainages such as the Linville River and South Toe River, and a 500-year return period in the Pigeon River watershed. Most streams on the Forests processed these extremely high flows without notable adverse impacts to stream channels and adjacent riparian areas. Exceptions occurred where channels had been previously altered by railroads, agriculture, loss of in-stream large wood, roads, developed recreation, and heavy foot-traffic areas such as dispersed recreation sites. Where stream channels remain connected to their adjacent floodplains, flood flows are not expected to be a threat to watershed health.

### Roads and Trails

Roads generally pose the greatest risk to streams, both stream channels and water quality. Roads can affect stream channels by intercepting, concentrating, and diverting flows from natural flow paths. These changes in routing can result in increases in peak flows by both a volumetric increase and changes in timing of storm runoff to streams (Wemple et al. 1996). A stream channel susceptible to erosion, such as one without sufficient bank protection, could scour under an elevated flow regime.

Forest roads can contribute to stream impacts where road drainage is inadequate and soils are prone to erosion. The Forest Service and local groups keep a close watch on road conditions and are efficient at identifying issues. Following high rainfall events, district personnel often review the open road system and other areas of concern. Solving issues of erosion and sedimentation can at times be slow however due to declining personnel and budgets.

Erosion hazard ratings for unsurfaced (native-surface) roads and trails, as defined by the National Resource Conservation Service (NRCS), National Cooperative Soil Survey, are presented in (Table 15) for roads and trails within 100 feet of a stream channel, by Forest Service ownership in 6<sup>th</sup>- level Watersheds. There exist 154 miles of road and 132 miles of trails (Table 15). These road and trail segments are expected to require more frequent maintenance and implementation of erosion control measures than other segments.

**Table 15. Summary of Miles of Road and Trail Within 100 Feet and Outside 100 Feet of a Stream for Each of the Erosion Hazard Ratings on Roads and Trails**

Erosion Hazard	Miles of Road within 100 ft Stream	Miles of Road outside 100 ft Stream	Miles of Trails within 100 ft Stream	Miles of Trails outside 100 ft Stream	Total
Severe	154	1,746	132	1,094	3,126
Moderate	88	207	63	99	457
Slight	23	30	44	19	116
Unknown/Not Rated	0	7	2	11	20

Erosion Hazard	Miles of Road within 100 ft Stream	Miles of Road outside 100 ft Stream	Miles of Trails within 100 ft Stream	Miles of Trails outside 100 ft Stream	Total
<b>Total</b>	<b>265</b>	<b>1,990</b>	<b>241</b>	<b>1,223</b>	<b>3,716</b>

Note: Erosion Hazard Rating calculated for road and trail miles on Nantahala and Pisgah Forests managed lands only, therefore will be less than presented in the Transportation and Recreation analysis, which considers different geographical analysis scales.

Monitoring of road BMPs, conducted at the time of the Forestry BMP monitoring, found that Roads BMPs on the Nantahala and Pisgah NFs were properly implemented and effective at controlling sedimentation at 93.1 and 94.7 percent of the sites surveyed, respectively (Table 16). Non-critical visible and critical visible sediment was observed 4.3 and 1.1 percent of the time, respectively. Sediment delivery to streams was primarily due to legacy system roads located along a stream channel, within the Management Area 18 (Streamside Management Zone).

**Table 16. Summary of Nantahala and Pisgah NF Roads and Road Stream Crossings Best Management Practices for 2009-2013 Monitoring Data**

BMP Category	Implementation %				Effectiveness %					Visible Sediment %		
	Meets or Exceeds	Minor Departure	Major Departure	Gross Departure	Improvement Over Past	Adequate Protection	Minor/Temp. Impact	Major Short-Term Impact	Major Long-Term Impact	No Visible Sediment	Non-Critical Visible	Critical Visible
Roads	93.1%	5.0%	1.2%	0.7%	0.7%	94.0%	3.3%	1.2%	0.7%	94.6%	4.3%	1.1%
Road Stream Crossings	88.5%	5.1%	5.9%	0.5%	0.0%	89.5%	3.8%	4.3%	2.4%	92.6%	6.6%	0.8%
<b>Total Percent</b>	<b>94.8%</b>	<b>3.2%</b>	<b>1.8%</b>	<b>0.3%</b>	<b>0.5%</b>	<b>94.8%</b>	<b>2.7%</b>	<b>1.4%</b>	<b>0.6%</b>	<b>96.6%</b>	<b>3.0%</b>	<b>0.4%</b>

Sixty-seven Road Stream Crossings were also monitored during the 2009 to 2013 Forestry BMP monitoring (Table 17). In the planning area there are approximately 2,178 locations where roads cross streams. The monitoring results are a small sampling (3% of the total), but are assumed to give an indication of current conditions and effectiveness at protecting water quality across the area. Implementation and effectiveness rates were 88.5 and 89.5 percent, respectively (Table 17). Sediment from the road crossings was controlled at 93 percent of the sites. The remaining seven percent of the crossings had some level of sediment entering the stream channel, but only one crossing was found to be a major concern, needing immediate attention. These implementation and effectiveness ratings could be improved over time by correcting road grade declines over stream channels and correcting fish migration blockages.

Much of the road network is a remnant of decades ago and often not designed to current standards. New road construction is assumed to apply improved standards that would reduce potential for sedimentation compared to older roads. Many system roads would benefit from more frequent and

improved drainage features, e.g. rolling dips, properly sized culverts and provision of aquatic organism passage. During the Watershed Condition Framework assessment, roads in general were identified as not maintained to standard across the Forest, therefore culverts are more prone to plugging and failure, road surfacing is not maintained and replenished and thus more prone to rutting, concentrating runoff and road failure. Aquatic organism passage (AOP) improvements have reduced the risk of larger crossing failures and improved passage of aquatic and riparian organisms. Should predictions of increased storm runoff associated with climate change come to fruition, risk of road erosion would likely increase.

#### **Sulfidic rock**

Some thin beds of metasedimentary rocks contain sulfur compounds and produce a yellowish acid leachate. These formations are considered to have a high potential to produce acidic runoff when sulfidic rocks are exposed to weathering. The soil and highly weathered rock derived from the sulfidic rock is generally not a hazard because iron sulfide minerals like pyrite and pyrrhotite have long been leached out through the natural weathering process. In freshly exposed rock however, the degree of potential acid runoff depends on the concentrations of sulfide minerals present, and the amount of surface area exposed to the atmosphere in the excavated area and used in embankments or stockpiled in waste areas (Email from Rick Wooten, NCGS, 2008). When this leachate enters nearby streams, damage to aquatic communities can occur (Sherrill, Unknown year).

Guidelines for handling acid producing material were developed by the N.C. Division of Water Quality and the North Carolina Geological Survey (NCDWQ 2007). This guidance is adhered to during project development and the layout of skid roads, system roads, temporary roads and the reconstruction of system roads to avoid any exposure of iron sulfide rock and reduce the risk of road cut and fill slope failures of this material.

### **Forest Management Impacts on Water Quality**

#### **Timber harvest and nutrients**

Research on the Nantahala National Forest determined that soil nitrogen (N) availability increased following a two-age harvest and stream nitrate ( $\text{NO}_3\text{-N}$ ) moved below the rooting zone and became available for leaching to the stream (Knoepp and Clinton 2009). These new levels were attributed to changes in vegetation that has altered the nutrient cycling patterns of the watershed. Clinton 2011 documented the importance of streamside zones to help buffer increases in nutrient delivery to streams.

#### **Timber harvest, water yield and sediment**

In recently harvested areas on the Forest, there exists an elevated risk to stream channels from flooding since the removal of trees reduces water loss from the soil. Following vegetation removal, the soil saturates quicker during a storm event and stays saturated longer, thus more water is available to move to streams and at a faster rate than if the preexisting vegetation remained.

Streamflow from the Coweeta watershed study (Swank et al. 2001) experienced a 28% increase during the first year following clearcut harvest of the entire watershed. With a rapid recovery of vegetation, streamflow returned back to pre-harvest within six years (Swank et al. 2001). The larger increases in streamflow occurred in the low flow months of August to October, and initial flow and peakflow rates also increased. Sediment yield from Coweeta roads was greatly reduced during logging by implementation of forest road BMPs and yields were insignificant after logging when road surfaces stabilized with vegetation. Still, it took 15 years for the majority of road derived sediment to move out of the watershed stream system.

The hydrologic response from Coweeta's results could be similar for much of the planning area, depending on the treatment type. Where timber treatments do cause a flow increase, increases during stream lowflow periods would be beneficial to aquatics; however peakflow increases may be a concern

where channels are not stable due to infrequent woody debris or disconnection from floodplains. In both cases, increased flow energy could scour stream bed and banks.

Existing forest plan standards have done well to mitigate potential adverse effects of short-term increases in peakflow. The establishment and management of Management Area 18 - Riparian Protection Areas (MA-18) under the current Forest Plan are instrumental in this. These areas are managed only for the benefit of riparian and aquatic ecosystems. Where stream channels are present within a harvest unit the MA-18 buffers streams from potential adverse effects from increases in streamflow. Swank et al. (1989) found that where leave strips along streams are in place, vegetation partially utilizes the extra soil water from the harvested area, and thus diminishes streamflow increases.

On the Nantahala, Pisgah and Uwharrie National Forests between 2009 and 2013, Forestry Best Management Practices (BMPs) were monitored to determine whether or not BMPs were implemented and effective at controlling sediment and other pollutants during timber sale and road reconstruction and maintenance activities. One hundred and two harvest units and 70 roads from 25 different timber sales were selected for the reviews. Specific BMPs were selected from the Nantahala Pisgah Land and Resource Management Plan, the North Carolina Forest Practice Guidelines Related to Water Quality Regulations and the 7730/2520 letter dated November 28, 1990, "Specified Road Construction and Water Quality."

A total of 1,964 individual BMPs were checked over the last five years for implementation and effectiveness. Of these, 1,186 BMPs were related to sediment delivery to streams. By determining implementation rates, monitoring is attempting to answer the question, "Have the rules been properly applied?" By determining effectiveness, monitoring is attempting to answer the question, "Were the rules effective in preventing sediment or other pollutants from impacting water quality?"

The overall implementation rate was 94.8% (1,861 out of 1,964 times the practice met or exceeded the BMP rules) (Table 17). In 63 instances (3.2%), there was a minor departure from the rules; 35 times (1.8%) there was a major departure from the rules and five times (0.3%) there was a gross departure from the rules. The overall effectiveness rate was 95.3 %; 1,871 out of 1,964 times the practice prevented the pollutant from impacting water quality. In 53 instances (2.7%), there was a minor or temporary impact to the stream. Twenty-eight times (1.4%), there was a major short-term impact that requires corrective action. Twelve times (0.6%), there was a major long-term impact. The 12 "major long-term impact" ratings were related to legacy system road problems and fish passage obstructions. These identified problems all preceded the timber sale activities.

The last observation was to determine if visible sediment was entering streams. In 1,146 of 1,186 BMP checks (96.6%), sediment was not entering the stream channel. In 35 instances (3.0%), non-critical visible sediment reached the stream and five times (0.4%) critical visible sediment flow reached the stream channel.



**Table 17. Forestry Best Management Practices Implementation and Effectiveness Monitoring Summary for 2009-2013 Data**

BMP Category (2009-2013)	Implementation %				Effectiveness %					Visible Sediment %		
	Meets or Exceeds	Minor Departure	Major Departure	Gross Departure	Improvement Over Past	Adequate Protection	Minor/Temp. Impact	Major Short-Term Impact	Major Long-Term Impact	No Visible Sediment	Non-Critical Visible	Critical Visible
Harvest Area Including Skid Trails/Log Decks	97.8%	1.7%	0.6%	0.0%	0.1%	97.5%	2.0%	0.5%	0.0%	99.7%	0.3%	0.0%
Skid Trail Stream Crossings	92.9%	5.1%	2.0%	0.0%	5.1%	88.8%	4.1%	2.0%	0.0%	92.3%	7.7%	0.0%
Roads	93.1%	5.0%	1.2%	0.7%	0.7%	94.0%	3.3%	1.2%	0.7%	94.0%	4.3%	1.1%
Road Stream Crossings	88.5%	5.1%	5.9%	0.5%	0.0%	89.5%	3.8%	4.3%	2.4%	92.6%	6.6%	0.8%
<b>Total Percent</b>	<b>94.8%</b>	<b>3.2%</b>	<b>1.8%</b>	<b>0.3%</b>	<b>0.5%</b>	<b>94.8%</b>	<b>2.7%</b>	<b>1.4%</b>	<b>0.6%</b>	<b>96.6%</b>	<b>3.0%</b>	<b>0.4%</b>

A non-critical amount of visible sediment is a low volume, short term sediment source that does not adversely affect aquatic habitats. A critical amount of visible sediment is a large volume, which may be deposited over a long term. The component structure of the stream is altered, which adversely affects aquatic habitats. A stream that has a critical sediment source is obvious, even to the casual observer.

Implementation and effectiveness rates for the BMP category Harvest Area Including Skid Trails/Log Decks was 97.8 and 97.6%, respectively (Table 17). This is a very good implementation and effectiveness rate that indicates the application of BMPs is working in this category and sediment or other pollutants are generally not reaching streams.

Implementation and effectiveness of BMPs in the category Skid Trail Stream Crossings was 92.9 and 97.6%, respectively (Table 17). Non-critical visible sediment was delivered to the stream 7.7% of the time. Critical visible sediment was never observed coming from skid trails. Because it is difficult to not contribute some sediment to the stream with skid trail crossings, these practices are avoided to the extent possible during timber sale planning.

The 2009-2013 Forestry BMP monitoring was compared to BMP implementation and effectiveness monitoring done between 1992 and 2000 (Table 18). The difference in BMP implementation, effectiveness and visible sediment between these two data sets is substantial. BMP implementation

improved from 68.1 to 94.8% while BMP effectiveness improved from 73.3 to 95.3%. Visible sediment delivery to streams declined from 19.3 to 3.4% of the practices.

**Table 18. Best Management Practices (BMP) Monitoring Summary Data Comparing Forestry BMP Implementation and Effectiveness Monitoring on the NFs in NC, Between 1992-2000 and 2009-2013**

BMP Monitoring Period	Implementation				Effectiveness					Visible Sediment		
	Meets or Exceeds	Minor Departure	Major Departure	Gross Departure	Improvement Over Past	Adequate Protection	Minor/Temp. Impact	Major Short-Term Impact	Major Long-Term Impact	No Visible Sediment	Non-Critical Visible	Critical Visible
1992-2000 Total	785	310	56	2	5	833	219	83	3	435	84	20
Percent in Class	68.1%	26.9%	4.9%	0.2%	0.4%	72.9%	19.2%	7.3%	0.3%	80.7%	15.6%	3.7%
2009-2013 Total	1861	63	35	5	9	1862	53	28	12	1146	35	5
Percent in Class	94.8%	3.2%	1.8%	0.3%	0.5%	94.8%	2.7%	1.4%	0.6%	96.6%	3.0%	0.4%

From the information collected and analyzed over this five-year period it is evident that the Nantahala and Pisgah National Forests are implementing Best Management Practices during timber sales that are effective in protecting streams and water quality. There has been a dramatic improvement in BMP implementation and effectiveness and a decrease in sediment delivery to streams since the last decade of BMP monitoring. It is expected that this improving trend will continue with the design of new and more effective practices, such as the placement of logging slash on skid trails/roads and the use of temporary bridge crossings of streams.

### Prescribed and wildfire

Fire has proven to be an effective tool for maintaining and restoring ecosystems of the National Forests in North Carolina (Clinton et al. 1998, Elliot et al. 2004), although it does not come without its challenges. Unless properly managed, fire can have adverse effects on soil and water where the forests litter and humus layers are consumed, exposing mineral soil.

In Macon County, NC on the Blue Valley Experimental Forest, Clinton et al. (1998) found the consumption of litter and humus layers (duff layer) on the forest floor was positively correlated with flame temperature during an understory burn in a mixed white pine-hardwood stand. Over all stands, 50 percent of the mass in small wood and litter was lost during burning, and 20 percent of the humus layer was consumed. The humus layer is an important nutrient reservoir for plant growth. Maintaining this layer through careful selection of burning conditions minimizes losses during burning and maintains long-term site productivity (Clinton et al. 1998). Burned areas are most vulnerable to surface erosion immediately post-fire and during extreme rainfall events (Elliott and Vose 2006).

Wildfire has little to no adverse impacts to water quality on the Forest. Often, wildfire burns over the landscape in a mosaic pattern, leaving patches of unburned area. Burned areas are often left with unburned duff where moistures were high enough to minimize damage and consumption. In 2016 the

Forest experienced some of our most severe fire conditions in decades where fire burned rapidly up slope, consuming the midstory and canopy vegetation. Still, full consumption of the forest floor was uncommon, and an extensive root structure remained intact, thus notably reducing soil erosion. On the Grandfather Ranger District wildfire-dependent ecosystems are present that burn relatively often, consuming the forest floor, duff layer, down to mineral soil over a hundred acres and more. Again, even in these areas, roots remain that sprout new growth within a year and soils are stoney, not prone to erosion.

### **Fire and soil erosion**

When mineral soil is exposed by fire the potential for soil erosion can increase, however this is not typically the case. Swift et al., (1993) found little to no erosion after light to moderate intensity fires in the southeastern U.S. Twenty three percent of the burned surfaces were covered by new growth and 62 percent by residual forest floor and woody debris at the end of the first growing season.

On the Appalachian Ranger District, the Burned Area Emergency Response assessment of the Stony Fork Wildfire of 2010 (USFS 2010b) also identified very little disturbance to the forest duff layer due to the low residence time of the fire in one give area. Exceptions were observed only where logs burned and retained heat for a longer time resulting in a localized loss of the duff layer, but in most cases the deeper organic duff layer remained intact. At no time were soils found to have hydrophobic characteristics.

Under more extreme fire conditions observed in the Linville Gorge following the Pinnacle Fire on the Grandfather Ranger District much of the burned area experienced overstory mortality, consumption of the duff layer, exposed mineral soil, and localized hydrophobic soil conditions (USFS 2010c). The burned area was treated with an aerial application of grass seed and lime (550 and 350 acres, respectively) (USFS 2007a). Because of drought conditions following the fire, grass seed did not germinate, but the site reestablished with natural regeneration within a 2-year period without notable soil erosion. The overwhelming success of natural revegetation may be attributed to the liming treatment since it was found to improve the cation depleted soils (USFS 2010c).

Connected actions with wildfire include the construction of dozer bladed or plowed fire lines. Fire line blading often exposes the mineral soil by removing vegetation, leaf litter and duff. Blading could increase the exposed area's susceptibility to soil erosion and displacement of nutrients and organic matter offsite, thereby potentially impacting water quality. One of the most direct impacts to water quality from wildfire suppression efforts comes from bladed fire line crossing streams. This occurs less frequently as fire managers implement fire suppression BMPs that avoid streams and eliminate blading through the channel.

Burns with previous soil disturbance such as skidding of logs would increase the probability of soil erosion after burning (Swift et al. 1993). Prescribed fire uses fire breaks or fire lines to contain the fire. Often, existing roads, old fire lines, and natural barriers (riparian areas, waterbodies, and rock outcrops) are used when available. However, new fire line construction by blading or plowing around recently regenerated or privately owned areas may be needed to protect lives and investments from prescribed burning activities. Fire line construction and reconstruction using heavy equipment exposes a relatively wide area of mineral soil by removing vegetation and the organic layer, therefore it is used only as necessary.

Fire line construction by hand is often implemented to minimize soil disturbance. Handline construction in the southeast typically involves the scarification of the surface leaf litter layer using fire rakes and leaf blowers. Thus the disturbance of the mineral soil is often minimal when handline is constructed. Often streams are used as fire line and are sometime cleared of woody debris that might carry fire. This clearing and cutting of brush and woody debris rarely would result in increases in sedimentation, but may reduce benefits to streams from woody debris.

Fire lines can recover quickly when they accumulate litter from a forest canopy and/or treated with erosion control measures to control concentrated flow and reduce soil exposure through revegetation efforts. Fire lines that are needed for frequent or regular burning cycles are best designed and maintained on the landscape to provide for both long-term use and ability to control concentrated flow and erosion, while keeping soil disturbance to a minimum. Designs often employ relatively permanent drainage features such as drainage dips, water bars, reverse grades, out-sloping and lead-off ditches along with reinstalling and maintaining of other erosion control measures.

### **Fire and nutrients**

Fire can alter the nutrient cycle and have both short- and long-term effects (Knoepp et al. 2004). Nutrient availability of forest soils is often limited and relies on the internal cycling of nutrients to sustain plant growth (Knoepp et al. 2004). Prescribed fire alters the cycle by consuming woody fuels and forest floor, potentially changing the quantity of materials and the patterns of nutrient release. Forest conditions including; community composition, site moisture regime, and fuel loads, influence forest ecosystem responses to burning, and also determine fire intensity and severity (Knoepp et al. 2009). Fire intensity is defined as the amount of energy or heat release per unit time or area during the consumption of organic matter (Keeley 2009), and is an important factor in determining ecosystem response to prescribed burn.

In the southern Appalachians on the Nantahala National Forest, Knoepp et al. (2004) and others (Vose et al. 1997, Clinton et al. 1998, Swift et al. 1993, Vose and Swank 1993) studied the effects of a fell (slash) and burn treatment in mixed pine/hardwood ecosystems occupying dry xeric sites. The prescribed burn was designed to restore the pine/hardwood ecosystem, and fire intensities ranged from low to high in the study area. Findings include increased exchangeable calcium and magnesium concentrations, soil pH, and nitrogen availability after treatment. Losses of nutrients via leaching were minimal and were not expected to limit future site productivity or diminish stream water quality (Knoepp et al. 2004 and Clinton et al. 2003).

Elliot et al. (2004) studied the effects of understory burning in a moist mesic mixed-oak stand in the southern Appalachians on the Nantahala National Forest. A single, dormant-season fire with a low to moderate intensity was conducted in a cove-hardwood forest. Overstory mortality occurred in 55% of the trees, predominantly those <10 cm at diameter breast height (DBH) and no trees >20 cm DBH were killed, and all the understory aboveground stems were killed. This study found that burning significantly reduced the total forest floor mass, carbon, and nitrogen of both the surface litter layer and duff layer. Soil nutrient availability increased after the burn, but diminished to no significant difference after one year compared to the control area. Elliot et al. (2004) concluded that a moderate intensity understory burn may be a useful tool to restore mixed-oak communities without detrimental effects on forest floor mass or nutrient pools.

Knoepp et al. (2009) studied prescribed fires in the same area as Elliot et al. (2004) and found that low intensity prescribed fire generally removes the litter layer, but retains a large portion of the duff layer. The reservoir of plant nutrients was retained on the site and the soil surface was protected from erosion. Knoepp et al. (2009) reported that available soil nitrogen increased and inorganic nitrogen was lost from the ecosystem through leaching. Still, they concluded that the low intensity, low severity prescribed fires applied to these mesic mixed-oak sites produced beneficial impacts.

Clinton et al. (1998) studied the effects of understory burning in a mixed-white pine-hardwood stand in the southern Appalachians on the Nantahala National Forest. Fire intensity and severity were both moderate. Fifty percent of the small wood and litter mass was consumed, and 20 percent of the humus (duff) layer was consumed. Clinton et al. (1998) concluded that burning conditions that produced a more intense and less severe fire would conserve more of the humus layer and associated nutrients.

Prescribed burns that have low residence time on the forest floor conserve more of the humus or duff layer and associated nutrients, benefiting the site by a slight, transitory release of plant essential nutrients (Clinton et al. 1998). Fire managers recognize the importance of this pool of nutrients when burning, and design prescriptions that minimize consumption of site nutrients and maintain long-term site productivity.

### **Watershed improvements**

Over the past planning period, thousands of acres of watershed improvements have been accomplished on the Forest. These projects stabilized soil erosion and reduced sources of sediment in numerous watersheds. It is likely that many tons of soil were stabilized that would have otherwise been eroded away and entered the stream network, where it would have adversely affected water quality and aquatic habitat. Watershed Improvement (WI) projects on the Forest have stabilized old eroding roads and trails by decommissioning and closing access to illegal motor vehicle traffic. System roads and trails were also closed including the Upper Tellico Off-Highway Vehicle Area that was closed and rehabilitated in 2009 and 2010. Benefits from this work are still being assessed, but sediment yields to streams have been dramatically reduced (Jones 2010 and USFS 2011b). The hurricanes of 2004 (hurricanes Frances and Ivan) were the catalyst for numerous WI projects across the Forest including landslide stabilization, road and trail improvements and decommissioning, and stream bank stabilization mostly in recreation areas and along road corridors.

Storm damage from 2004 flooding resulted in 12 stream reaches and about 4,000 feet of stream channel requiring rehabilitation work. These stream reaches were estimated to produce 464 tons of sediment per year because of bank erosion (USFS 2011a). Relative to natural rates of erosion, this rate was high and increased the risk of adverse impacts to protected existing uses. Following the rehabilitation of those sites, the rate of erosion and sediment delivered to streams decreased by an order of magnitude to an estimated 41 tons per year, a more natural rate of erosion. These larger projects along with the annual WI program of work (totaling from 50 to 200 acres per year of improvements) have taken great strides to improve water quality on NFS lands and cumulatively downstream.

Current Forest Plan guidance, in reference to stream rehabilitation, is to “Provide structural habitat improvements” and “Give priority to use of native materials and mimic naturally occurring structures”. This guidance is generally consistent with the latest stream channel design techniques that employ using reference stream conditions to reestablish natural function. The NFs in NC has designed and implemented numerous stream rehabilitation projects using natural channel design techniques. Such techniques design structures and channels that simulate the natural function of boulders and logs, and restore the dimension, pattern, and profile of stable reference streams of the same stream type, defined by Rosgen (1996). Structures have been installed in streams using boulders and trees to mimic flow deflectors and pool creators. Tall eroded stream banks have been laid back to stable slopes and vegetated with transplants and native grasses and trees and shrubs. Water quality, aquatic habitat, and riparian areas have been improved largely in stream reaches adversely impacted by roads and recreation. Over the past planning period the Forest has done well to meet the existing standard to “Use habitat restoration, improvement, and reintroduction to re-establish or expand native species populations and diversity” (USFS 1994).

As mentioned earlier, the Watershed Condition Framework (WCF) classified watershed condition and developed a means to help prioritize watersheds for restoration and watershed improvements. The Armstrong Creek Watershed was selected in 2010 as the Forest’s first priority watershed, and a restoration management plan was developed. In the years to follow the plan was approved and NEPA documentation was initiated. Planned activities include trail improvements, terrestrial wildlife habitat improvements and stream and riparian improvements. The WCF will guide the future prioritization of watersheds for restoration.

## Riparian areas

Since implementation of the existing plan, riparian and adjacent areas of influence (streamside zones) are removed from the suitable timber base as a Riparian Management Area (MA-18) where "...timber management can only occur in this area if needed to maintain or enhance riparian habitat values." Thus, activities are to benefit the form and function of the riparian area. Such activities have included the harvest of plantations of white pine and the subsequent planting of a diverse species composition, and the cutting and herbicide treatment of rhododendron, to improve vegetation diversity of the riparian area.

Over the years, plan monitoring has evaluated the implementation and effectiveness of forestry practices to meet the plan standards to enhance riparian values, e.g., preventing sediment and maintaining stream temperatures. Table 19 summarizes Forestry Best Management Practices (BMP) monitoring from the past 20 years (with some data gaps). Specifically, six of 44 reviewed BMPs were selected as a sub-set to characterize the protection of riparian areas (Table 19) and address the Forest Plan Monitoring Question "Are directions and standards being met for riparian areas?" The past five years of monitoring from 2009–2013 shows a 97.9 percent implementation of BMPs and a 98.1 percent effectiveness rating of meeting riparian area standards and directions. Comparing the 1992-2000 and 2009-2013 monitoring data seems to reveal an improving trend in the implementation and effectiveness of BMPs; a testimony to improved pre-harvest planning and administration of contracts during logging operations. Additionally, sediment delivery to streams has been notably reduced.

**Table 19. Number of Harvest Units by Category of "Implementation", "Effectiveness", and "Visible Sediment" for Selected Forestry BMPs Used to Characterize the Protection of Riparian Areas Relative to Forestry Activities Surveyed in 1992-2000 (in parenthesis) and 2009-2013**

Riparian Rule (BMP)	Implementation				Effectiveness					Visible Sediment		
	Meets or Exceeds	Minor Departure	Major Departure	Gross Departure	Improvement Over Past	Adequate Protection	Minor/Temp. Impact	Major Short-Term Impact	Major Long-Term Impact	No Visible Sediment	Non-Critical Visible	Critical Visible
<b>HARVEST AREA INCLUDING SKID TRAILS/LOG DECK</b>												
<b>3. Barriers Used if W/I 300ft P/I Channel</b>	(31) 85	(24) 2	(4) 0			(42) 86	(11) 1	(6) 0		(50) 87	(5) 0	(2) 0
<b>4. Drainage not to Stream Channel</b>	(114) 100	(11) 2	(3) 0			(115) 100	(8) 2	(5) 0		(121) 101	(5) 1	(2) 0
<b>5. No Skidding in Ephemeral Channel</b>	(6) 99	(4) 1	(1) 0			(6) 99	(2) 1	(3) 0		(7) 100	(1) 0	(1) 0
<b>6. Shade Strips in Place</b>	(15) 86	(5) 3	(4) 1			(15) 86	(6) 3	(3) 1				
<b>7. No Logging Debris in P/I Channel</b>	(3) 95	(4) 0	(2) 0	(1) 0		(3) 95	(4) 0	(2) 0	(1) 0			
<b>9. Violation W/IMA-18 (SMZ)</b>	(3) 94	(10) 2	(1) 1			(5) 94	(8) 2	(1) 1		(9) 97	(5) 0	
<b>Total</b>	(172) 559	(58) 10	(15) 2	(1) 0	(0) 0	(186) 560	(39) 9	(20) 2	(1) 0	(187) 385	(16) 1	(5) 0
<b>Percent in Class</b>	(69.9%) 97.9%	(23.6%) 1.8%	(6.1%) 0.4%	(0.4%) 0.0%	(0.0%) 0.0%	(75.6%) 98.1%	(15.9%) 1.6%	(8.1%) 0.4%	(0.4%) 0.0%	(89.9%) 99.7%	(7.7%) 0.3%	(2.4%) 0.0%

A study by Clinton et al. (2010) on the Nantahala Ranger District suggests that at a distance of 33-66 feet from the stream transitions occur that separate riparian from upland conditions. In the Ray Branch Study on the Nantahala R.D where cable-yarding technology was used, Clinton (2011) studied the effectiveness

of stream side buffers. He found that soil Nitrogen (N) availability had increased in the two-age harvest areas, and stream side buffers as small as 30 feet wide were effective at preventing N movement to streams compared with pre-harvest levels. Where the harvest did not leave a buffer width an increase in stream N did occur, although amounts were well below EPA drinking water standards. Stream nitrate concentration ( $\text{NO}_3^-$ -N) increased 2-fold during both base and stormflow following harvest, and all base cations, like calcium and magnesium, increased in concentration. Stream nitrate concentrations on the no-buffer site showed steady decline with time following the initial post-harvest increase (Clinton 2011). A small increase was noted in suspended sediment, and stream temperatures were slightly elevated in the no buffer stream. Consequently, where cable-yarding techniques are used, 30 feet wide buffers may afford effective protection from timber harvesting activities with respect to stream water chemistry, sediment, and temperature.

Trends in riparian area diversity are improving where a diversity of tree and understory species exists. These areas have been mostly excluded from harvest over the past planning period because of Management Area 18 designation and thus are maturing and providing natural riparian function. In many areas experiencing the loss of hemlock to hemlock wooly adelgid infestation, the hemlock will be replaced by a mix of hardwood species (maple, oak, birch, and beech) where establishment is not limited by rhododendron (Ford et al. 2011). However in areas where vegetation composition is predominantly hemlock with an understory of rhododendron, trends in riparian habitat diversity are likely to decline. The remaining rhododendron would dominant vegetation composition in these stands because of the exclusive nature of the rhododendron (Clinton 2003).

Trends in large woody debris in stream channels are improving where a diversity of tree and understory species exists in the streamside area. However, in areas where vegetation composition is predominantly hemlock with an understory of rhododendron, trends in large woody debris are likely to have a short-term improvement, followed by a long-term decline. As the dead hemlocks decompose there would be an influx of new wood into the channel, thus a short-term improvement, but when these trees are gone the remaining rhododendron would henceforth dominant vegetation composition.

Cutting and treatment of rhododendron, where it dominates the riparian area, has occurred in a few areas on the Forest. Treatment was followed by the planting of a mix of native riparian species, e.g., tag alder, sweetshrub, clethra, etc., to supplement the existing tree species. No adverse effects to available nutrients are expected from these treatments since rhododendron thickets play a relatively minor role in controlling nutrient export to headwater streams (Yeakley et al. 2003). However, potential stream temperature changes and bank stability must be considered in the design of these projects since rhododendron provide shading and root holding strength to a bank.

## **Environmental Consequences**

### **Common to all alternatives**

The following pages discuss the environmental consequences of the alternatives on water quality. The Forest Service doesn't expect a measurable change in surface or ground water quantity as a result of any alternative.

For all activities, the Forest Service will design, construct and maintain erosion control features to meet soil and water quality standards, and will follow North Carolina performance standards, such as North Carolina Best Management Practices.

Under all alternatives, The NPNF monitors the implementation and effectiveness of Forestry Best Management Practices annually to document our status for meeting forest plan standards, North Carolina State water quality standards, and ultimately the Clean Water Act. Review of forest practices effectiveness occurs annually as part of our program of work and a summary of monitoring findings is drafted. In response to monitoring results, less than effective practices are diligently corrected to meet

management direction. A summary of monitoring results is presented bi-annually in the Forest Plan Monitoring and Evaluation Report.

## **Alternative A**

### **Priority watersheds**

The current forest plan does not prioritize specific watersheds for watershed improvement and restoration activities.

As mentioned above, the forests completed a watershed condition analysis in 2010 that analyzed 135 6<sup>th</sup> level watersheds from 10,000 to 40,000 acres, and met with a collaborative working group to determine which watersheds are restoration priorities. Watershed action plans have since been developed for two watersheds, Armstrong and Cathey's Creek, and implementation activities have been underway for Armstrong Creek. Work in these watersheds would continue under the current forest plan, however, the plan does not specifically recognize these or other priority watersheds.

### **Effects of transportation system management (roads and trails)**

Under current management, roads and trails would continue to adversely impact water quality where these features hydrologically connect to stream channels, wetlands and other bodies of water. The transportation system is often located on an old network designed decades ago for quick extraction of timber and, therefore, not always situated on the landscape for the protection of water quality. Main access roads are often located in valley bottoms and are prone to be sources of sedimentation to nearby streams. The degree of impact to the stream would often be driven by numerous factors such as road/trail design, surface type, soil erodibility, frequency of large storms, maintenance and level of use. Current trends related to the transportation systems management appear to be in the direction of increasing visitor use and decreasing maintenance. Where existing roads and trails are poorly designed, and especially those on unstable soils, the trend for water quality maybe a declining one, particularly if rainfall intensities are on the rise. The old road and trail network would continue to be maintained and improved only as funding allows, therefore the focus would be in high use and special interest areas and where non-federal interests and funding are provided.

Watershed restoration planning would be used to help guide and focus road and trail improvements to reduce water quality impacts in high priority watersheds. Projects designed to improve aquatic organism passage at road/stream crossings would continue to be implemented at a rate of 2-3 projects annually. These projects often open several miles of stream to unrestricted aquatic movement and increase hydrologic capacity well beyond the 100-year flood event. Old roads and trails that pose a high risk of erosion and sedimentation would be considered for decommissioning or obliteration to protect water quality through timber project related funding and watershed improvement projects. Roads not needed in the short-term are placed in storage or used for administrative uses only and designed to be "stormproof" by replacing culverts with hardened fords at stream crossings, improving surface drainage and establishing a healthy vegetative cover over the road prism. New road and trail construction would implement current design standards that incorporate frequent drainage features, with climate change predictions in mind, that reduce the risk of erosion and sedimentation to nearby streams.

The implementation of Alternative A would mean an improving trend in water quality in those areas where watershed improvement work is emphasized, with road and trail systems being a priority for reducing sedimentation, and a static to declining trend in other watersheds where funding is not available for improvements.

### **Effects of timber harvest and related activities**

Under current management, timber harvest activities rarely have long-term adverse impacts to water quality. Monitoring shows a high success rate for implementation of effective forestry Best Management



Practices (BMPs) to protect water quality under the current plan. Forest planning teams and sale administrators ensure that logging operations meet the NFs in NC and State water quality standards by the implementation of effective practices. One of the most effective practices is the establishment of appropriate riparian area buffers.

Current plan standards establish a 100-foot buffer on either side of the perennially flowing stream channel. This buffer can be reduced to 30 feet from the channel following an evaluation from district resources to determine riparian area extent and restoration needs. For intermittently flowing streams the buffer width decreases to a 15 feet distance from either stream bank. These “riparian area” zones are available for management for the benefit of the stream and riparian ecosystems. Although it is not frequent, timber harvest has occurred in these buffer zones; for instance to improve stand composition and diversity, enhance bird habitat and restore large wood in streams. MA-18 riparian area standards have been, at times, interpreted differently by different managers. For example – some interpreted it as all management activities must stay out of this zone, which was not intended by the language, while others proceeded with active management that considered the ecology of the stream. The standard itself has been effective at meeting Forest Plan goals and objectives, although clarification was suggested in the action alternatives to enable more consistent interpretation and implementation.

Monitoring indicates that trends in implementation and effectiveness of protecting water quality are improving. Where water quality protection measures fail, Forest sale administrators make the appropriate adjustments, applying additional measures to correct the issues. If a change in rainfall intensities are likely to increase as is predicted, planning teams will need to pay close attention to design standards/practices and apply additional measures in areas with a dense drainage network and where soils are sensitive to erosion.

In watershed improvement projects, timber harvest has been included to improve terrestrial habitat and to improve streamside area conditions for the benefit of the riparian areas. With continued implementation of planning and operational BMPs these activities would not adversely impact water quality. An additional benefit of an active timber program is the funding made available (through timber sale receipts, stewardship, etc.) to make improvements in the project area when funding otherwise would not be available. Often these improvements include reducing erosion and sedimentation and improving water quality.

The implementation of Alternative A will mean a static to improving trend in water quality associated with the harvest of timber.

### **Effects of prescribed fire and wildland fire management**

Under current management, prescribed fire would continue to have minimal impact on water quality. Prescribed fire often uses existing fire containment line, including roads, trails, streams, etc. Thus, new fire line construction is typically minimal and located in well-designed areas that do not adversely impact other resources. When streams are used as fire line there is often little preparation done in the valley bottoms and riparian areas since fire rarely carries into these areas with much intensity.

Prescribed fire rarely burns deep into the forest duff layer due to fire prescription design that calls for soil moisture to be at a level that protects the soil. Some instances however call for a more complete consumption of the forest floor to expose bare soil for seed production. In these cases the potential for soil erosion and disturbance are mitigated to meet the objective of the prescribed burn.

Considering changes in the local climate, it is likely that managers of prescribed fire might need to be aware of increasing dry periods and subsequent intense rainfall in their prescriptions to protect water quality. However, prescribed fire would have a static trend in its adverse impacts on water quality under the current management strategy.

Wildfire has little to no adverse impacts to water quality on the Forest since wildfire often burns over the landscape in a mosaic pattern, leaving patches of unburned area. Burned areas are commonly left with unburned duff where moistures were high enough to minimize damage and consumption. Connected actions with wildfire include the construction of dozer bladed or plowed fire lines. One of the most direct impacts to water quality from wildfire suppression efforts comes from bladed fire line crossing streams. This occurs less frequently as fire managers implement fire suppression BMPs that avoid streams and eliminate blading through the channel.

Under the current plan fire lines are assessed for repair and quickly stabilized before damaging rainfall events. They can recover quickly when they accumulate litter from a forest canopy and are treated with erosion control measures to control concentrated flow and reduce soil exposure through revegetation efforts. Fire lines that are needed for frequent or regular burning cycles are designed and maintained to provide for both long term use and ability to control concentrated flow and erosion by employing relatively permanent drainage dips, reverse grades, out-sloping and lead-off ditches along with reinstalling and maintaining of other erosion control measures when not used.

Considering changes in the local climate, it is likely that wildfires would increase due to increasing dry periods and the potential for erosion would also increase due to more intense rainfall. Should drought conditions be severe enough to cause drying of the forest duff in places that have not previously experienced such conditions, the potential for soil erosion and the risk to water quality could increase. Therefore, wildfire would have a static to declining trend in water quality depending on the location on the Forest and trends in climatic change.

#### **Effects of dispersed and developed recreation management**

Under current management, dispersed recreation occurs with varying adverse impacts to water quality. Concerns often result from concentrated uses along streams and other waterbodies that trample vegetation, produce bare and compacted soil, and contaminate water and riparian areas with human waste. Designated dispersed camping sites are a good way to localize impacts in a popular area making them more manageable. However, this concentrated use is often locating people near streams and without restroom facilities. These sites are typically popular and people tend to occupy these sites year-round, excluding winter on occasion. As a result, adverse impacts to water quality from dispersed recreation are occurring in popular areas and trends are likely to be declining as more people use the Forest.

Recreational gold panning disturbs the stream bed allowing substrate to become more easily mobilized during storm runoff events. Current levels of use seem to have minimal adverse effects on aquatic organisms dependent on a stable substrate (e.g., aquatic macroinvertebrates, mussels, etc.).

Developed recreation sites are often well established with erosion control features in place, such as paved access roads and parking, graveled use areas and constructed storm drainage. Even with a growing population recreating in the Forest developed recreation use is controlled by a limited number of sites, therefore potential adverse impacts to water quality are addressed and controlled. The overflow from developed recreation will likely be seen as challenges in dispersed recreation.

Within the last 10 years the Forest has closed many developed sites located near streams and on floodplains. This action has improved the width and quality of streamside areas in several developed recreation areas as well as protected the public from flood dangers. Restroom facilities are typically provided at developed sites and reduce contamination from human waste. All recreation site disposal and processing of sewage occurs in facilities engineered and permitted to function properly. Therefore, even with an expected increase in use, trends in water quality remain static to improving in developed recreation.

#### **Action Alternatives B, C, D and E**

### Priority watersheds

An important difference with Alternatives B, C, D, and E is the codifying of priority watersheds in these alternatives. Priority watersheds are a required element in the 2012 planning rule, and restoration activities in these watersheds would be required in Alternatives B-E. Under the current plan they are only our best and current practice.

These priority watersheds and their proposed activities will concentrate on the explicit goal of maintaining or improving the Watershed Condition Framework (WCF) watershed condition class, which identifies each 6th-level watershed as properly functioning, functioning at risk, or impaired. The intent of this identification is to (1) protect high-value watersheds in good condition, (2) maintain the condition of watersheds to keep them from becoming threatened, and (3) improve impaired watersheds. Table 20 outlines thirty 6th-level watersheds identified by the collaborative for future prioritization for restoration by the Forests. From this list, the Forests will outreach to interested parties to select priority watersheds where watershed restoration action plans will be developed. In accordance with Planning Rule directives, changes as to which watersheds in the plan are “priority” are made by administrative change - no plan amendment is required.

**Table 20. Priority 6th Level Watersheds Organized by Geographic Area**  
(Note that some watersheds appear in multiple geographic areas.)

Geographic Area	Priority Watershed, 6th Level
<b>Bald Mountains</b>	060101060305 Cold Springs Creek-Pigeon River
	060101051202 Spring Creek
<b>Black Mountains</b>	060101050801 Dillingham Creek
	060101050803 Upper Ivy Creek
<b>Eastern Escarpment</b>	030501010502 Upper Wilson Creek
	030501010504 Lower Wilson Creek
	030501010501 Upper Johns River
	030501010505 Middle Johns River
	030501010506 Lower Johns River
	030501010303 Lake James-Catawba River
<b>Fontana Lake</b>	060102040107 Yellow Creek-Cheoah River
	060102040105 Santeetlah Creek
	060102020406 Alarka Creek
	060102020505 Lower Fontana Lake-Little Tennessee River
	060102020407 Upper Fontana Lake-Little Tennessee River
<b>Great Balsam</b>	060102020407 Upper Fontana Lake-Little Tennessee River
	060102030105 Caney Fork
	060102020406 Alarka Creek
	060102030107 Wayehutta Creek-Tuckasegee River
	060102030101 Wolf Creek-Tuckasegee River
	060102030104 Cedar Cliff Lake-Tuckasegee River
	060101050101 North Fork French Broad River
	060102020203 Lower Cullasaja River
	060102020201 Upper Cullasaja River
<b>Highland Domes</b>	060102020203 Lower Cullasaja River
	060102030104 Cedar Cliff Lake-Tuckasegee River

Geographic Area	Priority Watershed, 6th Level
	060102030101 Wolf Creek-Tuckasegee River
	060101050101 North Fork French Broad River
	030601020201 Headwaters Chattooga
	0306001020204 Upper Chattooga River
	030601020202 Headwaters West Fork Chattooga River
<b>Hiwassee</b>	060200020903 Shuler Creek
<b>Nantahala Gorge</b>	060102020407 Upper Fontana Lake-Little Tennessee River
<b>Nantahala Mountains</b>	060102020301 Buck Creek
	060200020202 Fires Creek
	060102020203 Lower Cullasaja River
	060101050402 South Fork Mills River
	060102030101 Wolf Creek-Tuckasegee River
<b>North Slope</b>	060101050402 South Fork Mills River
<b>Pisgah Ledge</b>	060101050202 Davidson River
	060101050705 Bent Creek-French Broad River
	060101050402 South Fork Mills River
	060101050403 Mills River
	060101050104 Catheys Creek
	060101050101 North Fork French Broad River
<b>Unicoi Mountains</b>	060102040107 Yellow Creek-Cheoah River
	060102040105 Santeetlah Creek
	060102020505 Lower Fontana Lake-Little Tennessee River
	060102020407 Upper Fontana Lake-Little Tennessee River

The associated plan objectives call for development of watershed restoration action plans for 10 priority watersheds, and implementing between two and four (WSD-O-01, Tier 1), or five to six (Tier 2). Activities under the umbrella of the action plans would improve the conditions of watersheds from “functioning at risk” to “properly functioning” over the life of the plan, and could include activities such as stream restoration, and assessing acid neutralizing capacity to inform watershed management and restoration (WSD-O-01, and WSD-O-02).

As a result of the above activities, the action alternatives will place increased emphasis and resources on the above watersheds and they are more likely to see an improvement in water quality conditions than other locations on the forest.

#### **Effects of transportation system management (roads and trails)**

In alternatives B, C and D, these forest-wide objectives state the following focus areas for the transportation system:

- TA-O-01** Tier: 1 Maintain 280 miles to standard annually across the Nantahala and Pisgah by performing maintenance, reducing road maintenance level, or decommissioning unneeded roads.  
Tier 2: Reduce the maintenance backlog by an additional 10% annually.
- TA-O-04** Unauthorized road and trail miles within priority watersheds and Inventoried Roadless Areas will be identified and prioritized for obliteration to minimize erosion and

sedimentation. A minimum of 20 miles of unauthorized roads and 30 miles of unauthorized trails will be restored to natural contours during the life of the plan.

**TA-O-06** Tier 1- No net decrease in the miles of open roads in Interface and Matrix over the life of the plan.

Tier 2 - Increase mileage of seasonally open roads in Interface and Matrix by approximately 5-10% over the life of the plan, prioritizing recreational access, such as hunting and fishing. Determine the amount of unneeded roads in backcountry and decommission 10% over the life of the plan.

Changes in the effects of the transportation system are often associated with changes in active timber management and recreation management. Forest-wide objectives place a great deal of emphasis on maintaining the necessary system road network in the Matrix and Interface Management Areas (MAs) while removing the network of roads considered unneeded by way of decommissioning. To accomplish the Tier 1 ecological objectives, the transportation system would be managed similar to existing in Alternative A, with 6.0 total additional miles of road will likely be needed annually, including 1.2 miles of new road prism construction, 1.9 miles of existing road prism added to the system, and 2.6 miles of temporary road construction that is decommissioned after use. Additionally, 2.1 miles of road decommissioning would continue annually. If Tier 2 management objectives were implemented, an additional 0.8 to 1.2 miles would be built to access additional timber in Alternatives B through E, plus an estimated 1.7 to 1.9 miles of new system road added to existing corridors and 2.6 to 2.9 miles of temporary roads. (See the transportation and access section.) Managing recreation and access would also include opening of closed roads and occasional road construction. Construction of temporary roads for timber management would have a short-term potential impact compared to system road construction since temporary road or trail would be decommissioned at the conclusion of the project or activity; e.g. remove drainage structures, recontour when needed and stabilize the final slope.

Given this, water quality could decline in some watersheds and improve in others largely depending on presence or absence of the new roads and their relationship to streams. Where new roads are hydrologically connected to streams, water quality is put at risk. However, new roads would be built to current standards that minimize stream crossings, avoid streamside corridors, and employ site specific mitigations that would minimize impacts to water quality. New roads constructed on old, unstable corridors and stream crossings could reduce existing sedimentation issues not previously addressed. Where new road stream crossings and their close proximity to streams cannot be avoided, mitigation measures would be employed to reduce the adverse effects of hydrologic connectivity. Additionally, Alternatives B through D offer more direction on managing for geologic hazards (such as sulfidic rock) and slope stability when designing roads.

At the same time, watersheds with larger areas in the Backcountry MA would be more likely to experience an improving trend in water quality as unneeded roads are focused on for decommissioning. Alternative C has the most amount of Backcountry compared to the other alternatives and thus is likely to have the most decommissioning of unneeded road. Where currently unroaded areas are recommended for wilderness (most in Alternative B) these areas would have a static trend in water quality where these areas are currently unroaded. However, in most areas recommended for wilderness, there is a network of old roads and other past disturbances that would need to be assessed and recommended for restoration prior to a wilderness designation. In these areas water quality would experience an improving trend.

The implementation of Alternatives B, C, D, or E will mean an improving trend in water quality in focus/priority watersheds, with road and trail systems being a priority for reducing sedimentation. In other watersheds, a static to improving trend is assumed depending on where funding is available for improvements to meet the objectives in the Backcountry MA.

Additionally, in Alternatives B-E, there is an objective that calls for trail realignments, prioritizing those that are needed in priority watersheds:

- WSD-O-01**     iv. Perform trail maintenance activities on approximately 15 miles of trails, emphasizing trails within 100 feet of streams. Relocate trails that are adversely affecting aquatic health.

There is also the following objective for recreation:

- REC-O-06**     Tier 1: Increase trail miles meeting National Quality Standards to 50% over the life of the Plan. Tier 2: Increase trail miles meeting National Quality Standards to 60% over the life of the Plan.

With the implementation of these objectives and the attainment of goals presented in several of the Geographic Areas (e.g. PL-GLS-06, Continue to improve trail conditions at Graveyard Fields, Black Balsam, and Sam Knob areas to accommodate high visitation and mitigate erosive impacts to fragile soils) there would be an improving trend in water quality associated with the developed trail network.

### **Effects of timber harvest and related activities**

Under the proposed alternatives, timber harvest impacts are expected to improve from current, and would continue to rarely have long-term adverse impacts to water quality. Under all action alternatives, timber harvest activities must be in compliance with NC forest practice water guidelines as well as FS standards.

One of the most notable changes from current condition is there would no longer be a Riparian Management Area. The revised plan direction moves away from focusing on riparian areas and instead establishes streamside zones that are more inclusive of the stream ecosystem as a whole (which includes riparian areas). In all action alternatives, streamside zones are dedicated to improving the condition and function of the larger stream ecosystem. This plan direction is clear that the streamside zone is not an equipment or management exclusion zone, but that activities must contribute to ecosystem restoration and not compromise long-term aquatic system and riparian function. For all action alternatives, this has the effect of projects considering whole stream ecology more so than the approach of the current forest plan, strengthening the ecosystem-based approach to project planning. The action alternative language is also clearer than the current forest plan about what management activities can occur near streams.

In the action alternatives, streamside zones are delineated as within 100 feet of either side of (or perimeter around) perennial waterbodies (streams, ponds, and reservoirs). The distance of the streamside zone in the action alternatives is the same as the distance of the riparian area in the current plan but serves a different purpose. In the action alternatives, this zone has the effect of changing the focus to be more about stream ecology and ecosystem benefits overall. Unless the team identifies a need to benefit the stream ecosystem, then timber harvest would stay 100 feet from a perennial waterbody. If forest management and timber harvest would benefit stream ecology, then that activity can occur up to the waterbody itself provided it is in compliance with best practices. Narrowing of the 100 feet widths are allowed in special circumstances when the project team determines that within "shallow valleys," where a break in topography occurs within the streamside zone, water flow is directed away from the protected waterbody.

In Alternatives B, C, and D, streamside zones are also identified as 15 feet from the stream channel bank of intermittently flowing streams. This distance is comparable to the current forest plan but again has the effect of changing the focus to be more about stream ecology and ecosystem benefits overall. In Alternative E, the distance around intermittent streams is expanded to 50 feet to match the distance in which NC forest practice water quality guidelines apply. Matching the distance of the streamside zone to the NC water quality guidelines will reduce confusion at the project level concerning what considerations apply at each distance.

Ephemeral streams do not have a set streamside zone distance. In streams that flow only ephemeral, the streamside zone differs from perennial and intermittently flowing streams due to the lack of development of riparian and aquatic habitat features. Plan language was added in Alternative E to recognize that ephemeral flowing streams are often headwater channels, connecting to a network of streams that support an abundance of aquatic life and other beneficial uses of water. Alternative E adds a desired condition that clarifies the role of ephemeral streams in sediment transport and adds plan management approaches to manage ephemeral stream channels and their areas of impact to reduce the risk of erosion and sedimentation by minimizing disturbance during management.

In Alternative E, a standard was also added to not remove large woody debris from streamside zones unless it poses a significant risk to stream flow, water quality, aquatic or riparian habitat, or downstream infrastructure (e.g., bridges or other stream crossings). This will improve the function of streamside zone ecosystems.

As with the current management, timber harvest would be included in priority watershed projects to improve terrestrial habitat and to improve streamside area conditions for the benefit of ecosystem function. With continued implementation of planning and operational BMPs, these activities would not adversely impact water quality, and other improvements associated with the timber project would result in overall beneficial impacts to water quality by reducing erosion and sedimentation. Forest-wide goals are to restore at least three acres on streamside zone annually. With other assistance and funding from non-agency partners that amount of area restored could double.

The implementation of Alternatives B, C, D, and E will mean an improving trend in water quality associated with the harvest of timber. The updated streamside zone direction in all the action alternatives will provide a more ecosystem-based approach to management than the current plan.

#### **Effects of prescribed fire and wildland fire management**

Under the proposed alternatives, Prescribed Fire and Wildland Fire Management impacts are expected to be similar to Alt A relative to water quality.

#### **Effects of dispersed and developed recreation management**

Under the proposed alternatives, Developed Recreation impacts are expected to have a greater trend in improving water quality compared to current management due to the improvements in the trail network previously discussed in the Transportation Management section. Additionally, the Clean and Abundant Water goals for several Geographic Areas specifically address water quality concerns, for example:

- EE-GLS-01** Improve watershed conditions across geographic area. Focus restoration efforts in the Johns River watershed and to mitigate effects in the existing off-highway vehicle use area.

Over time, noncommercial, recreational mineral collection would also be restricted to specific locations, which would open fewer areas to this activity, thereby further protecting water quality from potential adverse impacts.

The implementation of Alternatives B, C, D, and E will mean an improving trend in water quality in focus/priority watersheds, with recreation sites being a priority for reducing sedimentation. In other watersheds, a static to improving trend is assumed depending on where funding is available for improvements to meet the objectives in the Backcountry MA and for the overall trail system.

#### **Cumulative Effects**

Cumulative effects are assessed at the 6<sup>th</sup> level watershed special scale, across all ownerships in the 18-county region. Of the 6<sup>th</sup> code watersheds that include Nantahala and Pisgah National Forest lands, only 42% of lands are managed by the Forest Service, while 58% of the watersheds are comprised of land

managed by others. For this reason, the influence of activities outside of Forest Service jurisdiction has a substantial impact on water resources under all alternatives.

Sedimentation commonly poses the greatest risk to water quality from forest management. Therefore, potential impacts from the Forest come from uses which expose soil to the forces of erosion and where erosion is connected hydrologically to streams. Management activities are proposed to increase under Alternatives B, C, D, and E in watersheds dominated with Matrix and Interface Management Areas where there may be an increase in road and trail construction. These forest management activities can expose soil to erosion, but adverse impacts to water quality are unlikely as best management practices and watershed restoration activities address sources of sedimentation.

In many of the watersheds private ownership is a notable component. Potential impacts from private ownership largely come from poor agricultural practices and forest conversion to impermeable areas like parking lots and buildings. Poor agricultural practices can cause chemical and sediment contamination to streams and development can expose soil to erosion and increase storm runoff to streams. With development increasing on adjacent lands the trends in water quality in those watersheds having a high percentage of private lands, are likely to be static to declining. "Static" trends are likely if the state of North Carolina, watershed groups, etc. are effective at implementing storm runoff control measures to meet the state standards for water quality, and "declining" if not.

The Ecological Sustainability Evaluation Tool (ESE Tool) was used to help identify trends in potential sedimentation on the Forest by watershed. Results from this tool show trends for the entire watershed including other lands where management is largely outside of Forest Service influence. Looking at a 50-year period, the tool predicts that trends are remaining static to improving under Alternative A (without priority watersheds designations) in 45% of the watersheds and declining in 55%. Under Alternatives B, C & D, trends are remaining static to improving in 33% and declining in 67%. In the action alternatives, it is estimated that 75% of future restoration would be focused in the 30 priority watersheds. Therefore, fewer watersheds would experience restoration compared to Alternative A, but those that do will experience notable improvements to water quality not seen under Alternative A. Priority watersheds are predicted to have a 53% static to improving trend and a 47% declining trend. Declining trends may be reversed if watershed restoration can be adopted on non-Forest Service lands within the priority watersheds.

Under all alternatives, the Forest Service will not add to potential adverse cumulative impacts to water quality. Trends on Forest Service lands will be static to improving in most watersheds during the life of the plan under all alternatives. Under Alternatives B, C, D, and E specific watersheds would be improved as sources of sedimentation are reduced through priority watershed restoration work. Restoration needs within non-priority watersheds will still occur, but with less emphasis than priority watersheds.





## 3.3 Biological Environment

### 3.3.1 Aquatic Systems

#### Affected Environment

The overall richness of North Carolina's aquatic fauna is directly related to the geomorphology of the state, which defines the major drainage divisions and the diversity of habitats found within. There are seventeen major river basins in North Carolina. Five western basins are part of the Interior Basin (IB) and drain to the Mississippi River and the Gulf of Mexico (Hiwassee, Little Tennessee, French Broad, Watauga, and New River Basins). Parts of these five river basins are within the Nantahala and Pisgah NFs. Twelve central and eastern basins are part of the Atlantic Slope (AS) and flow to the Atlantic Ocean. Of these twelve basins, parts of the Savannah, Broad, Catawba, and Yadkin-Pee Dee basins are within the Nantahala and Pisgah NFs.

To gain perspective on the importance of aquatic ecosystems on the Nantahala and Pisgah NFs, it is first necessary to understand the value of these resources at regional and national scales. The southeastern United States supports the highest aquatic species diversity in the entire United States (Burr and Mayden 1992, Taylor *et al.* 1996, Warren *et al.* 2000, Williams *et al.* 1993), with southeastern fishes comprising 62% of the United States fauna, and nearly 50% of the North American fish fauna (Burr and Mayden 1992). Freshwater mollusk diversity in the southeast is 'globally unparalleled', supporting 91% of all United States mussel species (Neves *et al.* 1997). Similarly, crayfish diversity and global importance in the southeast rivals that of mollusks (Taylor *et al.* 1996). Crayfish in the southeast comprise 95% of the total species found in all of North America (Butler 2002).

Unfortunately, patterns of aquatic species imperilment are similar to the patterns of diversity discussed above. Greater than two-thirds of the nation's freshwater mussel and crayfish species are extinct, imperiled, or vulnerable (Williams *et al.* 1993, Neves *et al.* 1997, Master *et al.* 1998). A majority of these at-risk species are native to the southeast. Furthermore, the number of imperiled freshwater fishes in the southeast is greater than any other region in the country and the percentage of imperiled species is second only to the western United States (Minckley and Deacon 1991, Warren and Burr 1994). Aquatic species of conservation concern are discussed further in other parts of this analysis.

A long history of separation between drainage basins is reflected in different aquatic faunal compositions across the landscape. For example, aquatic zoogeographical differences are evident on each side of the Eastern Continental Divide (ECD), where there are relatively few native species in common. Additionally, within major drainage basins, individual river basins drain broadly diverse terrain and a wide variety of aquatic habitats exist among them. In an assessment of nine southeastern states, North Carolina ranked third highest in overall diversity of stream-types (Warren *et al.* 1997).

The mountains of the Blue Ridge Physiographic Province (BRPP) dominate the western third of North Carolina, and therefore the Nantahala and Pisgah NFs. Generally, streams in the BRPP are relatively high gradient, cool, have boulder and cobble or gravel bottoms, and are of low to moderate productivity. Larger streams and rivers historically supported exceptionally diverse warm-water communities. The five river basins of the IB (see above), along with the Savannah, are entirely within the BRPP in North Carolina. Headwaters of the Broad, Catawba, and Yadkin-Pee Dee river basins drain the eastern slopes of the BRPP.

In North Carolina, water quality has improved over the last several decades in many waters that were historically polluted primarily by point-source discharges; however, overall habitat degradation continues to threaten the health of aquatic communities. Increased development and urbanization, poorly

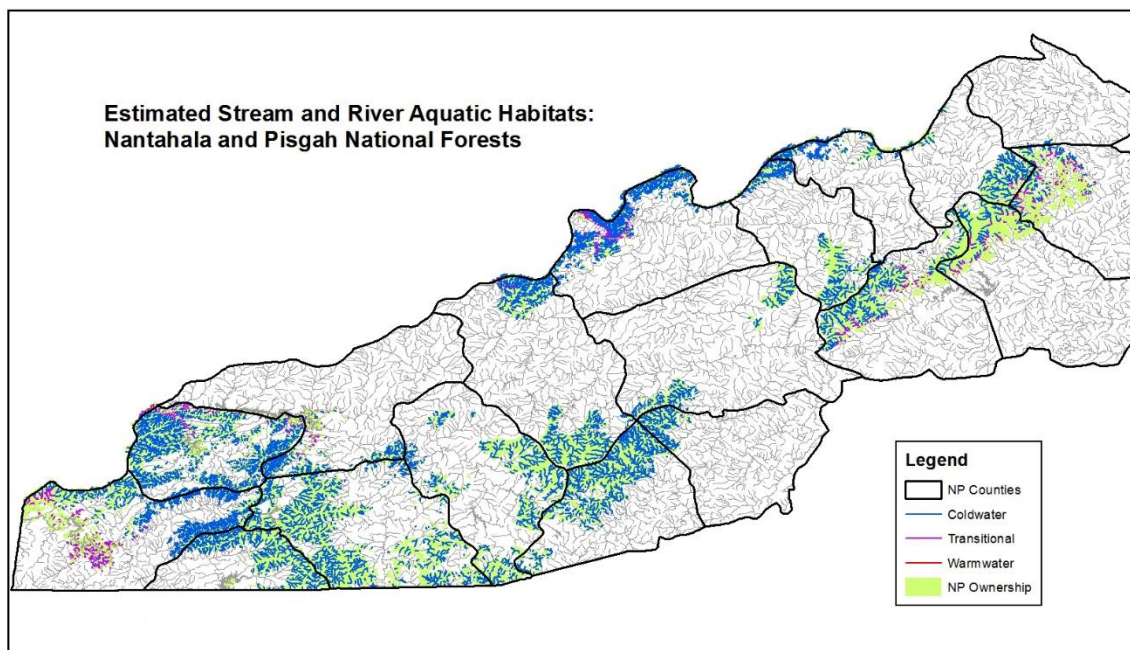
managed crop and animal agriculture, and mining impact aquatic systems with point and nonpoint source inputs. Additionally, impoundments on major rivers and tributaries drastically alter the hydrologic regime of many North Carolina waterways and result in habitat fragmentation, blockage of fish migration routes, and physical habitat alterations.

The Nantahala and Pisgah NFs include many miles of shoreline surrounding mountain reservoirs, but not the waterbodies themselves. The Forest Service actively manages access to these resources, which is addressed in other parts of this analysis. Authority under the Wyden Amendment allows the Forest Service to cooperate with partners and landowners such as the North Carolina Wildlife Resources Commission, Tennessee Valley Authority, and other utility companies to enhance habitat and angling opportunities associated with these reservoirs because they are important recreational opportunities on the Nantahala and Pisgah NFs. Additionally, several small lakes and ponds occur on the Forests, but their acreage is very small and each resource is distinct in its habitat, fauna, and management objectives. This section summarizes the three most prevalent aquatic ecosystems on the Nantahala and Pisgah NFs: coldwater, coolwater (transitional), and warmwater streams and rivers.

### Coldwater streams

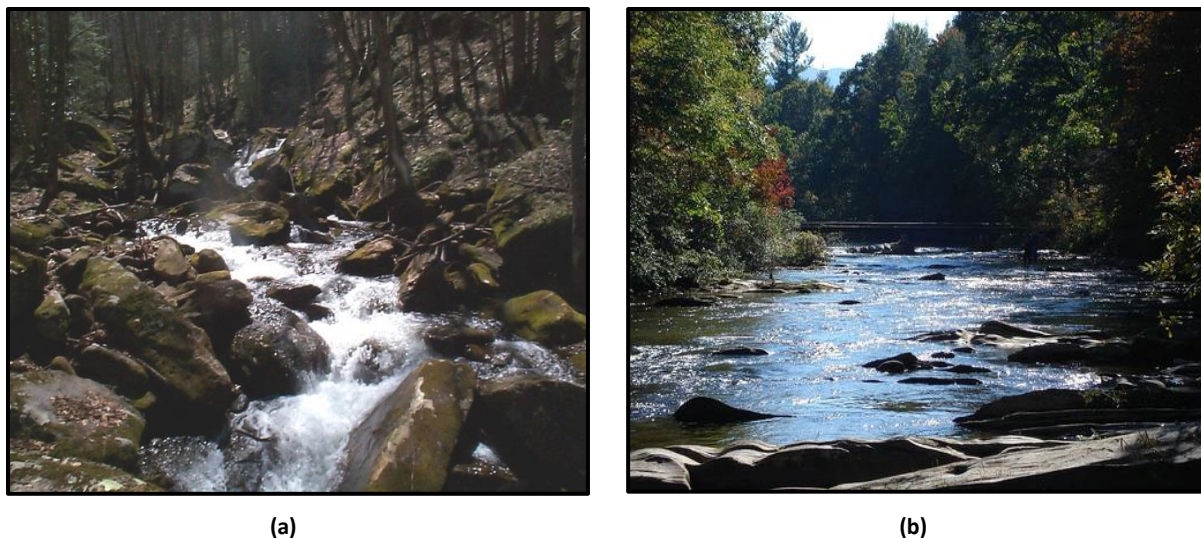
Coldwater streams are the most widespread aquatic habitat of the mountain region of North Carolina, representing approximately 91% of stream and river aquatic habitats in Western North Carolina and approximately 93% of these habitats on the Nantahala and Pisgah NFs.

There are approximately 15,400 miles of coldwater stream habitat in Western North Carolina with approximately 3,500 of that (23%) flowing through the Nantahala and Pisgah NFs (Figure 21).



**Figure 21. Stream classification on the Nantahala and Pisgah National Forests**

Most coldwater streams in North Carolina are of low stream order (i.e., 3<sup>rd</sup> order or less). This includes headwater reaches where perennial streams originate to downslope through several stream confluences to what most people identify as a small river (Figure 22). Higher order streams may be classified as coldwater if elevation (as a surrogate for water temperature) or groundwater influences dictate.



**Figure 22. Examples of coldwater stream habitats on the Nantahala and Pisgah National Forests: (a) headwaters of Bowlens Creek (1st–2nd order) and (b) South Toe River at Black Mountain Campground (3rd+ order). (Forest Service photos by Sheryl Bryan)**

Coldwater, by its very name, means the water is “cold” most, if not all, of the time. Trout and other species depend on this characteristic for their life history. For example, brook trout cannot exist in habitats where the water temperature exceeds 18° C for extended periods of time (similarly, lethal temperatures for rainbow and brown trout are 25° C and 27° C, respectively) (Schmitt et al. 1993, Raleigh et al. 1984, Raleigh et al. 1986). Because it is impossible to measure and monitor water temperature on every stream across the Nantahala and Pisgah National Forests, elevation is used as a surrogate to aid in defining coldwater ecosystems. Water temperature is directly correlated to elevation (Schmitt et al. 1993).

Due to the topography in Western North Carolina, most coldwater streams have high gradients. This lends itself to well-defined pool (deeper) and riffle (faster flow) habitat in stream reaches with higher gradient and more run (hybrid of deeper and faster flow) habitat in reaches with lower gradient. This habitat diversity contributes greatly to trout population stability over the long-term (Schmitt et al. 1993, Raleigh et al. 1984, Raleigh et al. 1986).

Other geochemical factors correlated with trout, particularly brook trout, density and population stability are underlying geology and stream pH (Schmitt et al. 1993). The revised forest plan addresses specific relationships with brook trout distribution and abundance with these physical factors.



**Figure 23. Example of clean, silt-free gravel suitable for brook trout spawning (Forest Service photo by Brady Dodd)**

Other than the stream productivity and habitat-limiting factors discussed above, the availability of suitable spawning habitat (i.e., clean, silt-free gravel, (Figure 23)) limits trout population density in southern Appalachian streams (Schmitt et al. 1993, Raleigh et al. 1984, Raleigh et al. 1986). This is particularly true where brook trout occur with other trout species. Therefore, it is critical that spawning habitat and juvenile age classes be monitored in future efforts.

### **Range-wide and local trends**

Brook trout (*Salvelinus fontinalis*) is the only salmonid native to much of the eastern United States. They have inhabited the East's coldwater streams and lakes since the retreat of the continental glaciers across New York and New England, and they have thrived in the Appalachian Mountains for several million years. Brook trout survive in only the coldest and cleanest water. In fact, brook trout serve as indicators of the health of the watersheds they inhabit. A decline in brook trout populations can serve as an early warning that the health of an entire system is at risk (Eastern Brook Trout Joint Venture (EBTJV) 2006).

In pre-colonial times, brook trout were present in nearly every coldwater stream and river in the eastern United States (EBTJV 2006). Sensitive to changes in water quality, wild brook trout began to disappear as early agriculture, timber, and textiles economies transformed the eastern landscape. As streams gained value as highways for log drives, water sources for farming, and prime locations for factories and mills, the resulting loss in brook trout populations mirrored the decline in the health of the region's lands and waters. Many of these threats to water quality and wild brook trout persist today, as our population and resource needs continue to expand, placing additional stresses on the eastern landscape and remaining brook trout habitat.

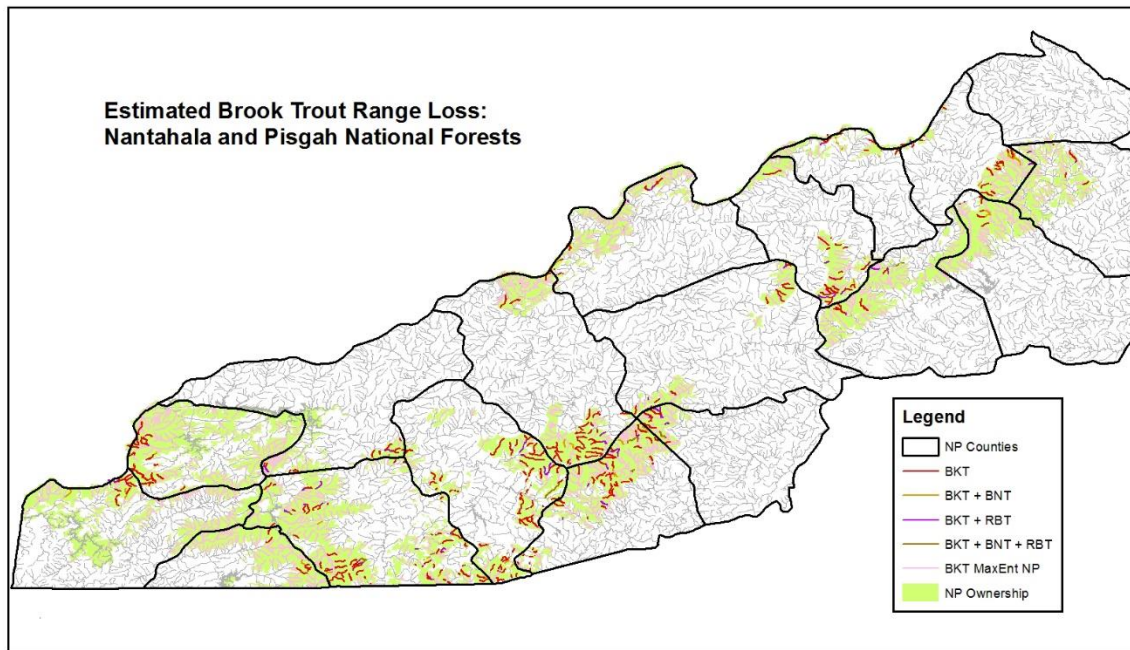
As alluded to above, the southern Appalachian Mountains suffered historically from poor land use practices, including large-scale log drives that affected and rearranged stream habitats on a very large scale, and poor land management associated with agriculture that increased erosion and exposed shaded streams to the sun. As water quality declined and native brook trout disappeared, rainbow trout and brown trout were introduced in an attempt to mitigate these changes. Subsequently, as cleared forests returned and aquatic habitat improved, these non-native fish expanded their range and now compete with brook trout for food and space. Today, most remaining high quality trout habitat is occupied by non-native trout species.

The EBTJV identifies the presence of nonnative trout (rainbow and brown trout) and urbanization as the largest threats to native brook trout, followed closely by poor land management and degraded



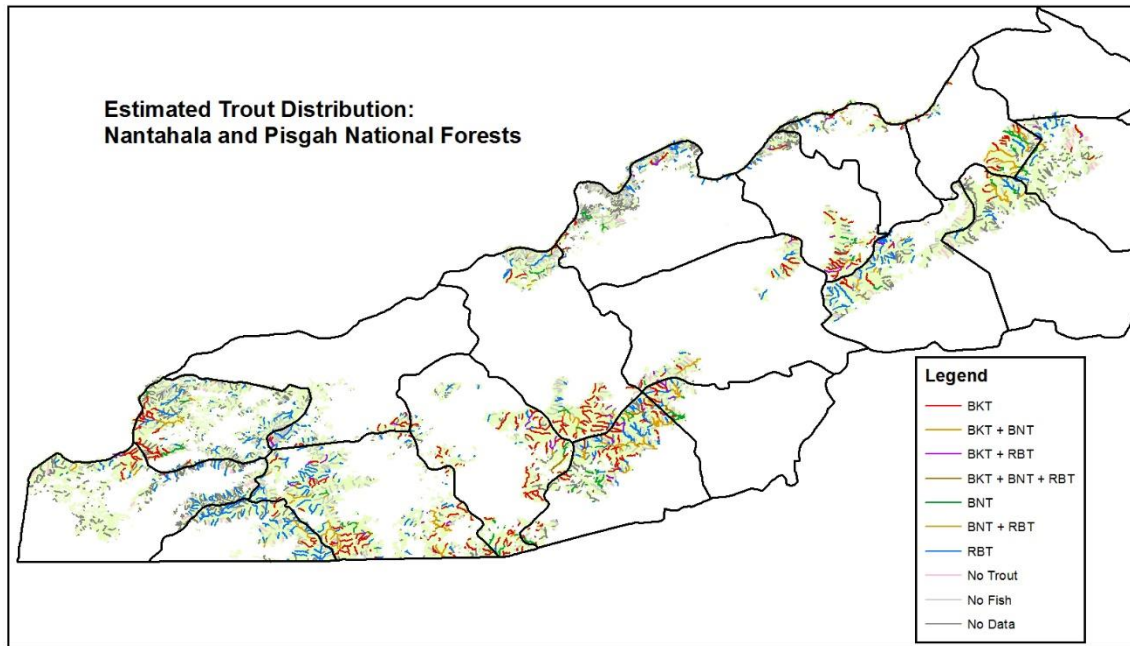
streamside habitat. Furthermore, the EBTJV identifies the Great Smoky Mountains National Park and the Cherokee, Nantahala, and Pisgah National Forests as supporting the highest quality trout habitat remaining in the Southeast (EBTJV 2006). Protection and connection of these small, fragmented brook trout populations to lower elevation rivers will ensure their long-term survival in the face of droughts and floods. Continued protection of forested land, cooperative restoration of streamside areas on private land, and selective removal of non-native fish can restore healthy populations of brook trout.

On the Nantahala and Pisgah National Forests 93% (3,498 miles) of the approximately 3,745 miles of perennial streams have been classified as coldwater. Brook trout currently occupy approximately 490 miles of this habitat. Under the assumption that brook trout occupied suitable habitat historically, this represents an almost 75% long-term reduction in range of the species (Figure 24), which mirrors larger-scale estimates of brook trout range loss over time by the EBTJV.



**Figure 24. Estimated brook trout range loss across the Nantahala and Pisgah National Forests. Map created from USGS National Hydrography (2012), USFWS Maximum Entropy (2013), and NCWRC Trout Distribution (2017) datasets. BKT = brook trout, BNT = brown trout, and RBT = rainbow trout.**

For the Nantahala and Pisgah National Forests, brook trout range loss can be attributed largely to the presence of rainbow or brown trout or lack of suitable (or unoccupied) habitat (Figure 25). In streams supporting brown or rainbow trout, inter-specific competition often controls brook trout population dynamics.



**Figure 25. Current trout distribution on the Nantahala and Pisgah National Forests. Map created from USGS National Hydrography (2012) and NCWRC Trout Distribution (2017) datasets. *BKT* = brook trout, *BNT* = brown trout, and *RBT* = rainbow trout.**

Over the years, several attempts have been made to quantify the effects of climate change and acidic deposition on aquatic species such as brook trout. It is surmised that acidic deposition affects brook trout populations in higher elevations and areas where local soils and geology cannot mitigate effects of low pH deposition. Similarly, it is surmised that climate change, as reflected in the potential for increased stream temperatures, will affect brook trout in areas where elevation cannot mitigate for increased temperature. Ultimately, this “squeeze play” will define the future of brook trout on the Forests. These issues are discussed in other sections of this analysis.

It is important to note that rainbow and brown trout, while not native to the mountains of North Carolina, are important socially and economically. There is a demand for high quality trout fishing in the mountains of North Carolina, and these species fill this niche. Angling as a form of recreation is addressed in other sections of this analysis.

The North Carolina Wildlife Resources Commission (NCWRC) has been collecting genetic information from brook trout in conjunction with trout distribution efforts. Recently, the U.S. Geological Survey genotyped 7,588 brook trout representing 406 collections from across North Carolina at 12 microsatellite loci. Results of this effort found genetic diversity within populations to be low and that little, if any, gene flow occurs among populations. In addition, the majority of populations show limited evidence of introgression by northern origin hatchery strains. These results represent a valuable baseline for management and restoration efforts of brook trout in North Carolina.

Long-term trout population monitoring conducted by the NCWRC and Forest Service from 1989 until 1996 (Borawa et al. 2001) enabled managers to visualize local trout population dynamics. Results of this effort are summarized below. Since 2001, the NCWRC and Forest Service have focused monitoring efforts on species’ genetics accurately defining the distribution of the species across Western North Carolina.

At the population level, trout populations exhibit high natural variability. Population stability is largely influenced by the availability of suitable spawning habitat and the recruitment of new age classes (i.e.,

young-of-year, (YOY)). Trout populations across the Nantahala and Pisgah National Forests have been stable to slightly increasing since 1990, although this trend is difficult to see given the natural variability of trout populations (Figure 26). Trout populations on non-Forest Service lands generally exhibit the same trends, although several streams have seen measurable declines (Figure 27).

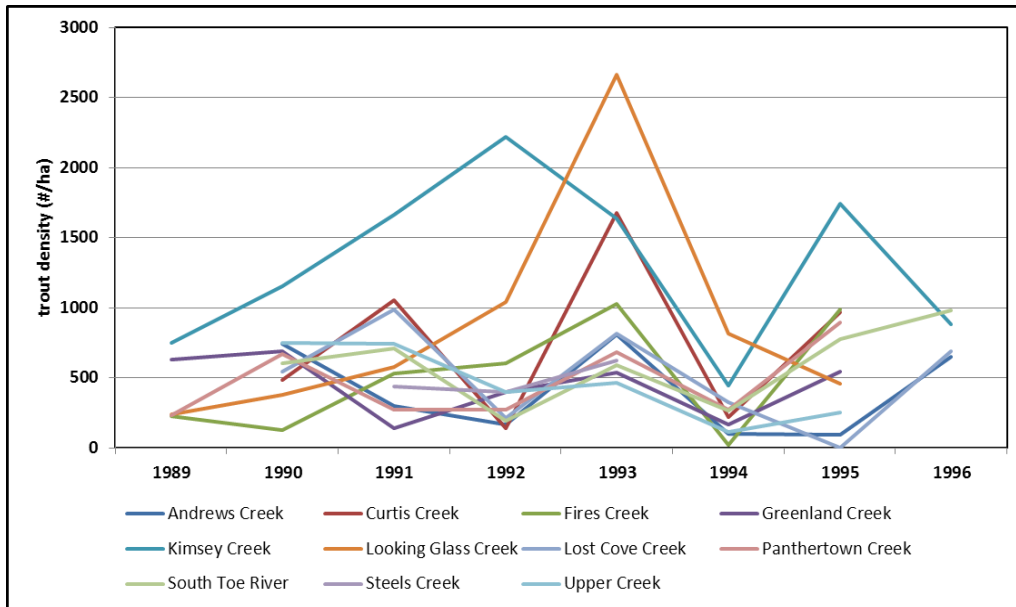


Figure 26. Trout young-of-year (YOY) densities from several streams across the Nantahala and Pisgah National Forests, summarized from Borawa et al. 2001.

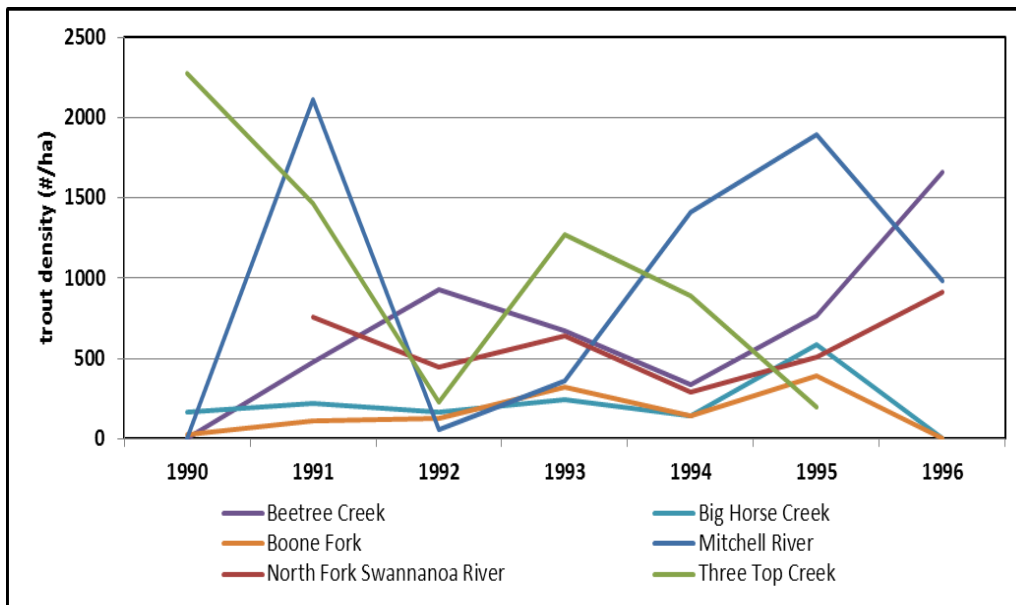


Figure 27. Trout young-of-year (YOY) densities from several streams across non-Forest Service lands within Western North Carolina, summarized from Borawa et al. 2001.

Within the monitoring data summarized above for streams across the Nantahala and Pisgah National Forests, allopatric (i.e., brook trout is the only trout species present) and sympatric (i.e., brook trout



occur with rainbow and/or brown trout) brook trout populations exhibited different trends. Allopatric brook trout populations exhibit stable to increasing trends across the Nantahala and Pisgah National Forests where no other trout species are present (Figure 28). Whereas sympatric brook trout populations exhibit stable to declining trends (Figure 29). This situation is consistent with the identification of interspecific competition as a threat to brook trout populations by the EBTJV (2006).

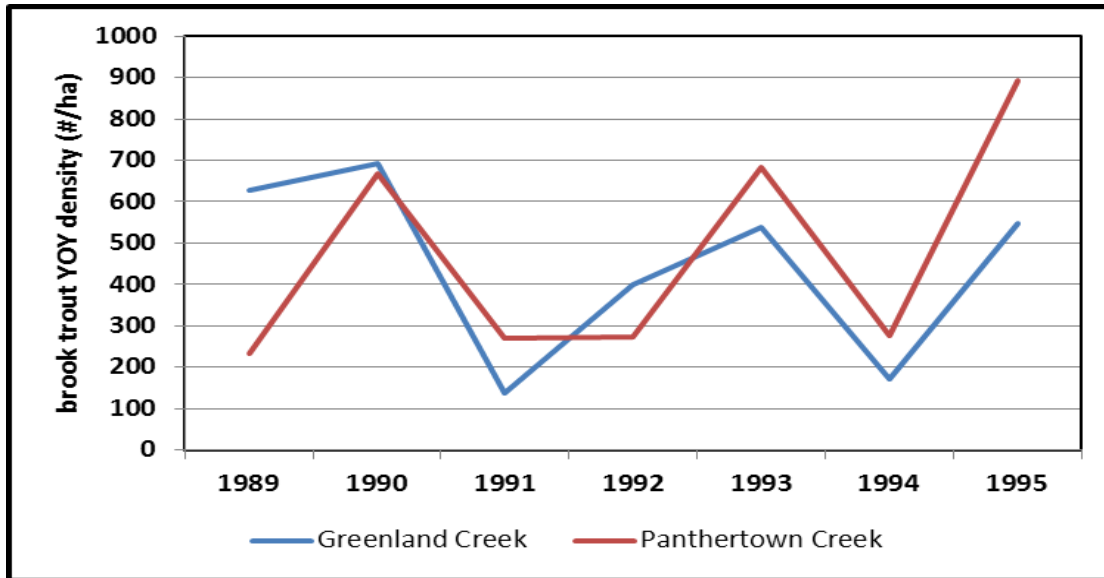


Figure 28. Allopatric brook trout young-of-year (YOY) densities from several streams across the Nantahala and Pisgah National Forests, summarized from Borawa et al. 2001.

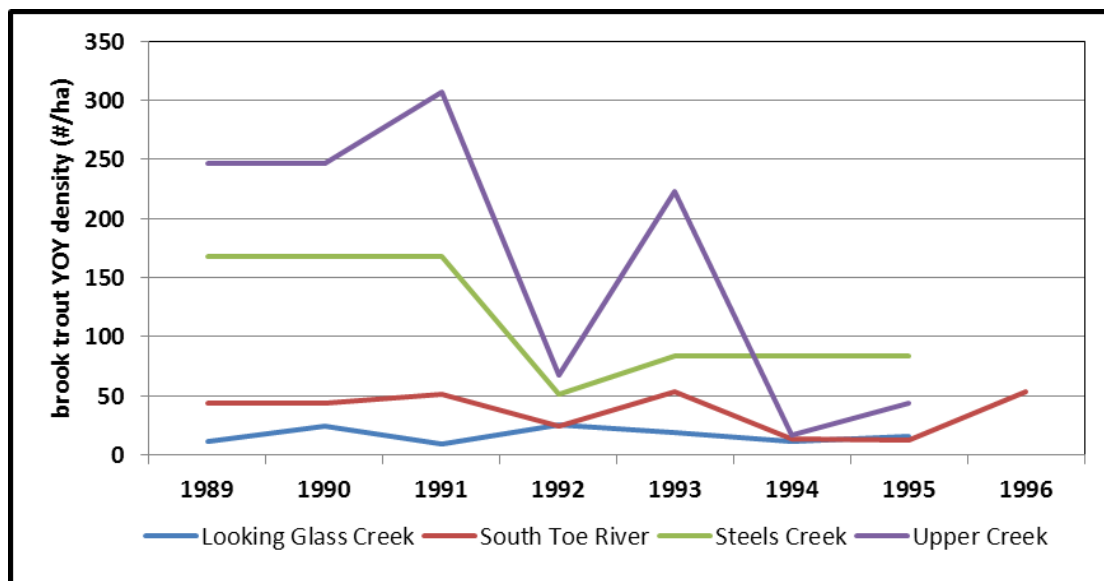


Figure 29. Sympatric brook trout young-of-year (YOY) densities from several streams across the Nantahala and Pisgah National Forests, summarized from Borawa et al. 2001.

Large-scale stochastic events such as droughts and floods are the primary factors influencing local trout population dynamics (Borawa et al. 2001, Schmitt et al. 1993). Forest management, particularly the use

of roads and trails near streams (including stream crossings), can affect brook trout populations by introducing sediment to stream habitats or blocking upstream movement. However, over the last 20 years, the Forest Service has actively implemented existing forest plan riparian standards, restored riparian habitats and brook trout populations, and restored aquatic organism passage at some stream crossings, resulting in the expansion of the range of brook trout on the Nantahala and Pisgah National Forests. It is estimated that the range of brook trout has expanded by approximately 30 miles across the Forests because of these efforts. While not measurable at the landscape scale, these changes are biologically significant at the local scale where restoration and enhancements took place. This analysis will focus on the relationship between suitable and occupied brook trout habitat across the Forests, as well as indicators of habitat quality such as sedimentation risk, water temperature regulation, and habitat connectivity.

### **Cool- and warmwater streams**

Cool- and warmwater streams are prevalent throughout the mountain region of North Carolina, generally occurring at lower elevations such as large river valleys and along the Eastern Continental Divide where the mountain region transitions into the piedmont region. However, because of ownership patterns, these habitats are present, but not in large amounts, on the Nantahala and Pisgah National Forests. There are approximately 246 miles of coolwater (transitional) habitat and 2 miles of warmwater habitat flowing through the Nantahala and Pisgah National Forests (reference Figure 21 above).

Most cool- and warmwater aquatic habitats in North Carolina are of medium and higher stream order (i.e., 4<sup>th</sup> order or greater) but also include low-elevation reaches where perennial streams originate (Figure 30). These habitats support the most diverse aquatic communities on the Nantahala and Pisgah National Forests and in some cases represent the most diverse aquatic communities in the southeast and across the United States.



**Figure 30. Examples of cool- and warmwater streams on the Nantahala and Pisgah National Forests: (a) Little Tennessee River (coolwater) and (b) French Broad River (warmwater) (Courtesy photos from the NC Department of Environmental Quality)**

Warmwater, by its very mnemonics, means the water is “warm” most, if not all, of the time. Hence, coolwater is the transition, or mixing zone between this and temperature-dependent coldwater habitats (see coldwater streams section of this assessment). The *river continuum concept* (Vannote et al. 1980) identifies a watercourse as an open ecosystem that is in constant interaction with the surrounding land, and moving from source to mouth, and therefore constantly changing. This metamorphosis is due to the gradual change of physical environmental conditions such as channel width, depth, and gradient, flow characteristics, and air and water temperature, as a system moves from its origin to the ocean. This progression is particularly evident in Western North Carolina, as stream networks originate in the highest elevations of the southern Blue Ridge Mountains, and flow east and west to more piedmont-like ecosystems of the Catawba and Hiwassee Rivers.

Because of the topography in Western North Carolina, most cool- and warmwater streams have lower gradients, and are wider, which increases solar radiation. As the influence of elevation on water temperature decreases (i.e. the water becomes warmer as streams flow through lower elevations), increased solar radiation also influences water temperature. In Western North Carolina, coolwater streams may retain well-defined pool and riffle habitat, whereas it is more difficult to discern where one habitat unit stops and another starts in many warmwater habitats on the Nantahala and Pisgah NFs.

Other geochemical factors correlated with cool-and warmwater aquatic communities include geology, low pH, environmental contaminants, and physical barriers such as poorly designed stream crossings and dams.

### **Range-wide and local trends**

The North Carolina Index of Biotic Integrity (NCIBI) (NCDWQ 2006) is a modification of the Index of Biotic Integrity (IBI) initially proposed by Karr (1981) and Karr et al. (1986). The IBI was developed to assess a stream’s biological integrity by examining the structure and health of its fish community. Scores derived from this index are a measure of the ecological health of the waterbody and may not always directly correlate with water quality. For example, a stream with excellent water quality but poor or fair fish habitat would not be rated excellent with this index. However, in many instances, a stream rated excellent on the NCIBI should be expected to have excellent water quality.

The IBI (hence the NCIBI) incorporates information about species richness and composition, trophic composition, fish abundance, and fish condition. The NCIBI summarizes effects of all classes of factors influencing aquatic faunal communities (water quality, energy source, habitat quality, flow regime, and biotic interactions). While change in a fish community can be caused by many factors, certain aspects of the community are generally more responsive to specific influences. For example: species composition measurements reflect habitat quality effects; information on trophic composition reflects effects of biotic interactions and energy supply; and fish abundance and condition information indicate additional water quality effects. It should be noted, however, that these responses may overlap—for example, a change in fish abundance may be due to decreased energy supply or a decline in habitat quality and not necessarily a change in water quality.

The NCIBI is a cumulative assessment of twelve parameters (or metrics) (Table 21). Values provided by each metric are converted into scores on a 1, 3, or 5 scale. A score of 5 represents conditions which would be expected for undisturbed reference streams in the specific river basin or region (the NCIBI takes into consideration physiographic region when defining the 1, 3, or 5 values), whereas a score of 1 indicates that conditions deviate greatly from those expected in undisturbed streams if the region. Each metric is designed to contribute unique information to the overall assessment. The scores for all metrics are then summed to obtain the overall NCIBI score.

The NCIBI score (an even number between 12 (extremely disturbed) and 60 (undisturbed)) is then used to determine the ecological integrity of the stream from which the sample was taken. Use of mean

values from all sites within the basin, forest, and relative sub-basins in the following summary explains why odd NCIBI values are displayed. (Such values cannot be calculated using valid NCIBI metrics for a site but can be a result of statistical analysis over one or more sites.)

**Table 21. NCIBI Scores and Classification for Fish Communities Within the Mountain Region of North Carolina (Note: There are two different scales for this region, recognizing differences between Interior and Atlantic Slope basins)**

Integrity Class	NCIBI Score (FBR, HIW, LTR, NEW, WAT)	NCIBI Score (BRD, CAT, SAV, YAD)
Excellent	58-60	54-60
Good	48-56	48-52
Good-Fair	40-46	42-46
Fair	34-38	36-40
Poor	</= 32	</= 32

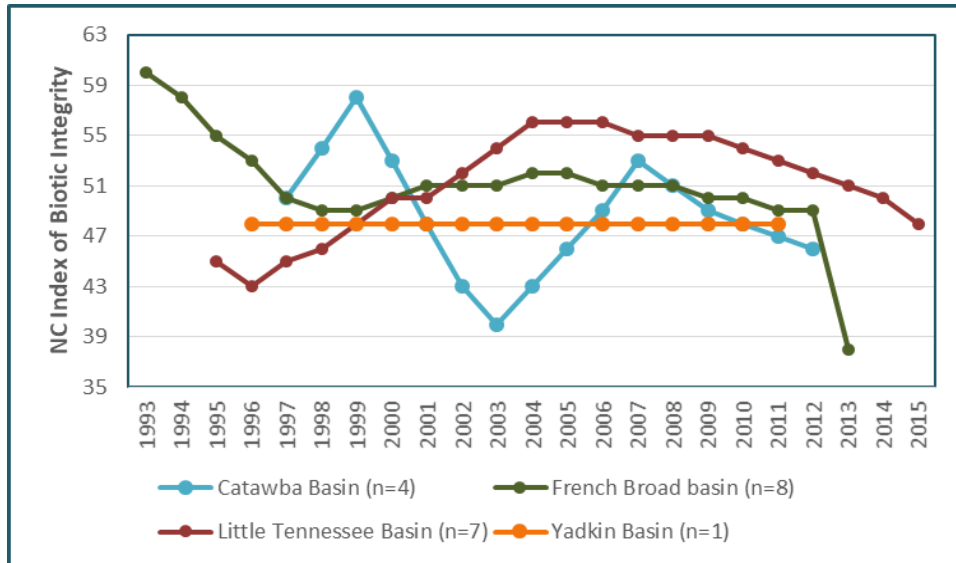
Because it is highly unlikely that any aquatic ecosystem has ever been completely undisturbed, an NCIBI value of 58 will be used as the baseline (or historical reference) for the analysis of trends in fish community structure within the French Broad (FRB), Hiwassee (HIW), Little Tennessee (LTR), New (NEW), and Watauga (WAT) River basins, and an NCIBI value of 54 will be used as the baseline (or historical reference) for the analysis of trends in fish community structure within the Broad (BRD), Catawba (CAT), Savannah (SAV), and Yadkin (YAD) River basins.

There are nineteen long-term NCIBI monitoring sites within the eighteen-county area evaluated in this assessment. Twelve of these are on or immediately adjacent to the Nantahala and Pisgah National Forests, and six of these have data consistent enough to establish trends.

Generally speaking, fish community composition and structure has remained stable to slightly improving within French Broad and Yadkin River Basins. Fish community composition and structure shows slight improvements within the Catawba River Basin, although high variability in NCIBI scores are noted. Fish community composition and structure remains stable within the Yadkin River Basin, although this is based on a sample size of one and is not statistically valid beyond site-specific interpretation. These trends are summarized in Figure 31.

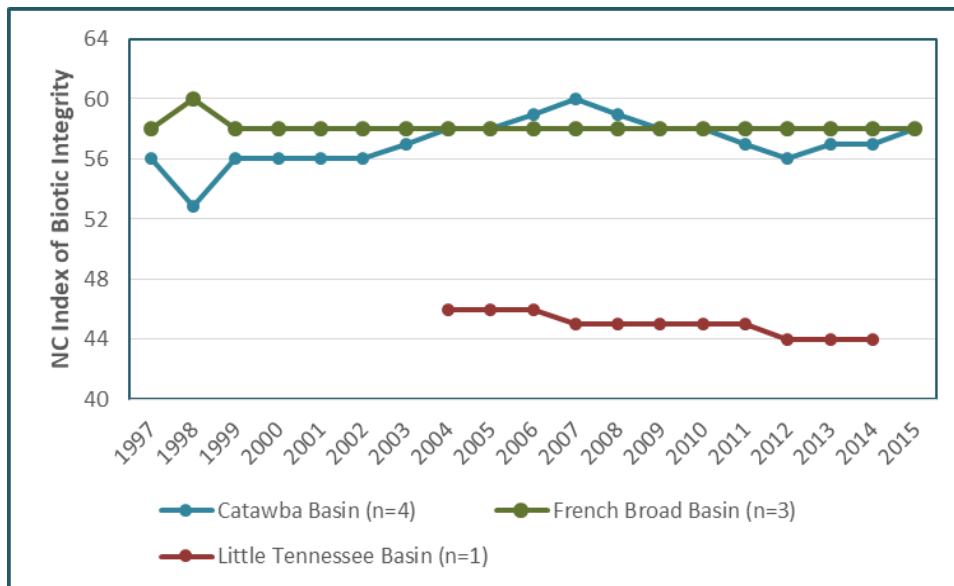
Fish community composition and structure has improved measurably within the Little Tennessee River basin since the mid-1990s (Figure 31) perhaps due to large-scale grassroots and resource agency efforts in the watershed. Recently, the Little Tennessee River basin was named the first native fish conservation area east of the Mississippi River by the National Wildlife Federation, again highlighting the importance of this system and its aquatic health to the planning area.

This does not relieve site-specific changes in fish community composition as a result of land use changes or land management (i.e., there are individual streams rating fair or lower in several parts of the basin), but rather reflects the overall health of the landscape. Fish community structure and health across the Forests do not differ significantly from established “historical” conditions, while values across the basin are slightly lower but not trending toward loss of structure or function.



**Figure 31. Mean NCIBI values from streams within river basins containing the Nantahala and Pisgah National Forests (NCDWQ 2017)**

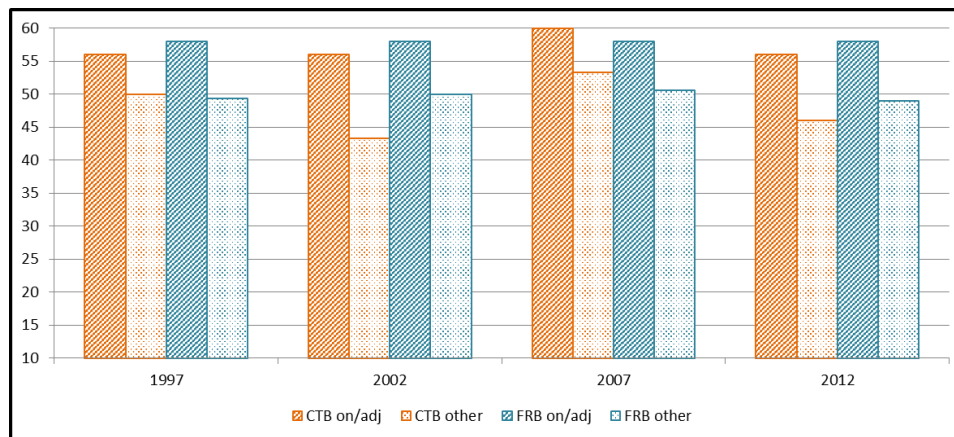
A closer look at NCIBI values from the Nantahala and Pisgah National Forests reveals that fish community health is stable within the French Broad River basin and slightly increasing in the Catawba River basin (Figure 32). However, very small sample sizes are likely limiting the reliability of these trends. Fish community composition and structure is slightly decreasing within the Little Tennessee River Basin, although this is based on a sample size of one and is not statistically valid beyond site-specific interpretation.



**Figure 32. Mean NCIBI values from streams on or adjacent to the Forests, within river basins containing the Nantahala and Pisgah National Forests (NCDWQ 2017)**

Maintaining an NCIBI rating of good or better for Forests streams is the desired condition-- high quality, high integrity fish communities across the Nantahala and Pisgah National Forests will ensure the continued existence of stable warmwater fish communities.

Overall, stream community, health, and function has been and remains good across the Nantahala and Pisgah National Forests, with only one site within the Catawba River basin during one year of this monitoring (1998) receiving a NCIBI score lower than the historical reference. Generally speaking, streams on the Forests are in better condition than those on other ownerships, as represented by mean NCIBI scores in basins with enough samples to summarize (Figure 33).



**Figure 33. Mean NCIBI values for sample sites on or adjacent to the Forests, and other ownerships, within the Catawba and French Broad River basins (NCDWQ 2017)**

Cool- and warmwater streams support a diversity of aquatic species, including many nongame fish, crayfish, and freshwater mussels. The NCIBI addresses this diversity; however, many of these species are rare or of conservation concern. From this perspective, these species are discussed in other sections of this analysis (see “Federally Listed Species and Species of Conservation Concern” in Terrestrial Ecosystems). This analysis will focus on habitat indicators such as water temperature regulation, sedimentation, and habitat connectivity.

### Management Emphasis

The National Forests in North Carolina maintains an active program of designing and implementing projects to avoid impacting, as well as restoring, aquatic ecosystems.

The current forest plan, Alternative A, includes limited general direction on the management of aquatic resources, including direction to “maintain and improve aquatic diversity” and a standard to “use habitat restoration, improvement and reintroduction to re-establish or expand native species population and diversity.” The plan also includes direction to “protect and improve fisheries habitat for self-sustaining fish populations.”

The proposed revised plan (action Alternatives B, C, D, and E) provides increased recognition of aquatic ecosystems. Desired conditions address diverse, properly functioning streams that provide high quality habitat for species to hide, spawn and forage; native vegetation; water temperature and nutrient input; native trout; game fish and recreational fishing; shoreline ownership, hydropower and impoundment features that minimize and mitigate impacts on native species; sedimentation; and stocking and population augmentation. The plan includes objectives to maintain or expand the occupied range of brook trout, freshwater mussels and other aquatic species of conservation concern and aquatic federally listed species (AQS-O-01, AQS-O-2), and working with partnership to complete the assessment of

aquatic organism passage needs and replace impaired stream crossings (AQS-O-03). A standard constrains management activities to avoid, minimize or mitigate negative impacts to aquatic habitats and species unless the management objective is to protect a native species from encroachment by a non-native species (AQS-S-01). Guidelines clarify management activities to follow applicable North Carolina and Federal Best Management Practices to meet laws, regulations, and policies, and provide management constraints on the use of pesticides and herbicides, installation of new stream crossings, and aquatic organism passage projects. Management approaches recognize aquatic ecosystem restoration and enhancement that the FS does with partners to achieve shared goals. Additionally, geographic area goals identify opportunities across the Forests to improve aquatic ecosystems and partner with others, under the plan's theme of Clean and Abundant Water. Two hundred forty-five plan components directly or indirectly support healthy and resilient aquatic habitats on the Forests. Providing clean and abundant water is a primary theme of the revised forest plan, which includes needs for healthy aquatic habitats. These plan components can be summarized from data presented in Appendix C.

In response to comments received on the proposed plan, in Alternative E, edits were made to the wording of several aquatics plan components and an additional management approach was added that speaks to sustaining and improving aquatic habitat to benefit native aquatic species including brook trout.

Upland, the revised plan establishes streamside zones where activities must contribute to improving the condition and function of the larger stream ecosystem. Between the draft and final plan, the distance of the streamside zone around intermittent streams was increased to 50 feet (from 15 in the current plan and proposed plan alternatives), which matches the distance to which state BMPs apply. The final plan includes a desired condition that clarifies the role of ephemeral streams in sediment transport and adds plan management approaches to manage ephemeral stream channels and their areas of impact to reduce the risk of erosion and sedimentation by minimizing disturbance during management. The plan language explains that streamside zones are not an equipment or management exclusion zone, but that activities must contribute to ecosystem restoration and not compromise long term aquatic system and riparian function.

### **Analysis Methods**

The remainder of this analysis is organized by the following categories to identify the impacts of proposed plan direction on multiple species groups.

- Species associated with aquatic ecosystems:
  - Stream Associates
  - Small River Associates
  - Medium and Large River Associates
  - Pond, Lake, and Reservoir Associates
- Species sensitive to threats:
  - Aquatic Species Sensitive to Sediment
  - Aquatic Species Sensitive to Nonpoint Source Pollution
  - Aquatic Species Sensitive to Point Source Pollution
  - Aquatic Species Sensitive to Invasive Species (Aquatic Community Health)
  - Aquatic Species Sensitive to Hydrologic Modification

For each species group, environmental consequences were estimated for one or more of these indicators for each USGS 6th level hydrologic unit on the Nantahala and Pisgah National Forests using the Ecological Sustainability Evaluation (ESE). This data was extracted from the National Forests in North Carolina



Watershed Condition Framework (WCF) (NCWCF 2012) or summarized from existing data sources for use in this analysis and documented in the ESE tool. Composite scores were generated to reflect overall effects of each alternative on the health and resilience of native aquatic communities. Effects of Alternatives B, C, D, and E are combined in these sections because all proposed action alternatives provide protection and management of this species group in the same way.

Appendix C and the project record provide detailed descriptions of the associated indicators and values for each analysis as well as species associated with each species group. Each species list is not all-inclusive but rather a compilation of federally listed species, species of conservation concern, focal species, and other closely-associated species.

It is important to note that several indicators for this aquatic ecosystem analysis incorporate all ownerships, and that in some watersheds total Forest Service ownership may not be high enough to influence a watershed's indicator score regardless of condition on Forest Service land. The intent of this analysis structure is to provide insight on the Forests' ability to contribute meaningfully to overall watershed health and condition.

For species associated with streams, small rivers, medium and large rivers, and ponds, lakes, and reservoirs, environmental consequences for each alternative considered in detail were estimated for six indicators:

1. Combined dam and stream crossing density, as an indicator of aquatic ecosystem connectivity;
2. Open road and motorized trail density (riparian), as an indicator of stream sedimentation threat;
3. Percent land use classified as urban or agricultural, as an indicator of non-point source pollution threat;
4. Percent riparian areas classified as forested, as an indicator of water temperature regime;
5. Percent suitable trout habitat occupied by nonnative trout, as an indicator of aquatic community health and composition; and
6. Presence of permitted discharges, as an indicator of point source pollution threat.

These indicators were evaluated for each USGS 6th level hydrologic unit on the Nantahala and Pisgah National Forests using the ESE. This data was extracted from the National Forests in North Carolina Watershed Condition Framework (WCF) (NCWCF 2012) or summarized from existing data sources for use in this analysis and documented in the ESE tool. Composite scores were generated to reflect overall effects of each alternative on the health and resilience of native aquatic communities. The first two indicators (combined dam and stream crossing density and open road and trail (riparian) density) are measured for Forest Service lands only since those indicators best reflect threats from forest management and serve as a gauge of the Forests' ability to influence overall watershed condition (based on the amount of ownership in the watershed).

Appendix C and the project record provide detailed descriptions of these indicators and values, as well as species associated with each species group. It is important to note that species lists are not all-inclusive but rather a compilation of federally listed species, species of conservation concern, focal species, and other closely-associated species.

Across the Forests, average Forest Service ownership is approximately 41%, and ranges from 6%-99% within each watershed (Appendix C). Within the ESE, watershed health (and therefore, associated species and communities) is expected to decrease slightly, from "good" to "fair" under all alternatives in the short-term, before returning to "good" (Table 22. Mean ESE Watershed Composite Scores by Alternative). It is important to note that the "fair" scores represented in Table 22. Mean ESE Watershed Composite Scores by Alternative are just barely "fair", on the cusp of "good", and that this potential



decline may not be measurable or observable on the ground. Individual watershed and indicator scores are available in Appendix C and the project record. This decline is related to ownership patterns across the landscape, and not necessarily to Forest Service management activity, as summarized in this analysis.

**Table 22. Mean ESE Watershed Composite Scores by Alternative**

	%FS	Existing	Alt A 10 years	Alt A 50 years	Alts BCDE 10 years	Alts BCDE- 50 years
All Watersheds	41.10%					
Priority Watersheds	54.52%					

Within priority watersheds, average Forest Service ownership increases to approximately 55%. Within the ESE, watershed health (and therefore, associated species and communities) across priority watersheds is expected to remain “good” under all alternatives over time, while dropping (slightly—see explanation above) in the short-term under Alternative A.

Appendix C summarizes watershed composite scores and references the amount of Forest Service ownership within each watershed. The project record contains detailed ESE outputs listing expected outcomes for each indicator for each watershed. Table 23. Mean ESE Watershed Indicator Scores by Alternative summarizes information presented in Appendix C, viewed with the detailed information in the project record.

**Table 23. Mean ESE Watershed Indicator Scores by Alternative**

Indicator	Existing	Alt A 10 years	Alt A 50 years	Alts BCDE 10 years	Alts BCDE- 50 years
Hydrologic Connectivity: dam and stream crossing density					
Sedimentation Threat: open road and trail density (riparian)					
Nonpoint Source Pollution Threat: percent urban and agricultural land					
Thermal regime: percent forested riparian area					
Aquatic Community Health: percent nonnative trout					
Point source pollution: Number of permitted discharges					

As referenced above, the top two rows in Table 23 describe expected outcomes for the two indicators on Forest Service lands. These results indicate that hydrologic connectivity will continue to improve, from “good” to “very good” on the Forests over time under all alternatives, as aquatic organism passage and other stream restoration projects continue to be implemented. Similarly, sedimentation threats on the Forests will continue to be mitigated under all alternatives of the revised forest plan, remaining “good” over time. The “very good” at 50 years under Alternative A is barely “very good”, meaning that results on the ground would not be noticeably or measurably different from Alternatives B, C, D, and E.

For the remaining four indicators, watershed- and landscape-level changes are not expected to be noticeable or measurably different over time under any alternative, remaining “fair”, despite the positive influences of the first two indicators. This is largely due to the amount of Forest Service ownership versus other ownerships across the landscape and watershed scales.

### **Stream (Orders 1-4) Associates**

#### **Affected Environment**

Across the Nantahala and Pisgah National Forests, most lower order streams are identified as coldwater ecosystems based largely on topography and elevation (as a water temperature surrogate). Coldwater streams are the most widespread aquatic habitat of the mountain region of North Carolina, representing approximately 91% of stream and river aquatic habitats in Western North Carolina, and approximately 93% of these habitats on the Nantahala and Pisgah National Forests. Aquatic communities within coldwater streams are generally anchored by one or more species of trout (brook, brown, and/or rainbow), and one or more species of dace (blacknose or longnose). Sculpins, fantail darters, chubs and other minnows also may be present, as well as crayfish and aquatic insects. Freshwater mussels may occur but are rarely associated with lower order streams.

#### **Environmental Consequences**

Under Alternative A, law, regulation, and policy ensures that Forest Service activities meet high standards for stream protection. As described above, the action alternatives have a theme around clean and abundant water, providing desired conditions that support whole stream ecology more so than the approach of the current forest plan, strengthening the ecosystem-based approach to project planning. However, because of the high standards that the FS is required to meet under any alternative, as well as the limited amount of the overall watersheds within FS management, the difference in environmental consequences from Alternative A to the action alternatives is not quantifiable.

As summarized above, aquatic connectivity will continue to improve and sediment sources will continue to be avoided or mitigated during plan implementation under any alternative. These improvements, while measurable at the Forest-scale, are not expected to influence overall watershed condition in the long term. There is simply too much other ownership on the landscape, making overall watershed health and resilience, and therefore aquatic species and communities, mostly out of Forest Service control. The Forests will continue good stewardship of aquatic resources under all alternatives. Additionally, the Forests will continue to work with partners across ownership boundaries to improve conditions across ownerships whenever possible.

Therefore, it is reasonable to assume that species associated with stream habitats on the Forests will continue to persist on the landscape, and even thrive, on the Forests over time under any alternative.

### **Small River (Orders 4-6) Associates**

#### **Affected Environment**

Across the Nantahala and Pisgah NFs, mid-order aquatic systems may be classified as cold-, cool-, or warmwater ecosystems based largely on topography and elevation (as a water temperature surrogate). Most of the time, small rivers are situated on the landscape such that both cold- and warmwater aquatic communities are represented. In this type of transitional ecosystem (i.e., coolwater ecosystems), it is not uncommon to find trout, as well as smallmouth bass, and a higher diversity of nongame species. Crayfish and aquatic insects are well-represented, and freshwater mussels may occur where flow and substrate conditions permit.

Small rivers are prevalent throughout the mountain region of North Carolina, generally occurring at mid- to lower elevations, and along the Eastern Continental Divide, where the mountain region transitions into the piedmont region. However, because of ownership patterns, these habitats are present, but not in large amounts, on the Nantahala and Pisgah NFs.

Although most cool- and warmwater aquatic habitats in North Carolina are of medium and higher stream order (i.e. 4th order or greater), this species group also includes low-elevation reaches where perennial streams originate. These habitats support the most diverse aquatic communities on the Nantahala and Pisgah NFs, and in some cases, represent the most diverse aquatic communities in the southeast and across the United States.

### **Environmental Consequences**

Under Alternative A, law, regulation and policy ensures that Forest Service activities meet high standards for stream protection. As described above, the action alternatives have a theme around clean and abundant water, providing desired conditions that support whole stream ecology more so than the approach of the current forest plan, strengthening the ecosystem-based approach to project planning. However, because of the high standards that the FS is required to meet under any alternative, as well as the limited amount of the overall watersheds within FS management, the difference in environmental consequences from Alternative A to the action alternatives is not quantifiable.

As summarized above, aquatic connectivity will continue to improve and sediment sources will continue to be avoided or mitigated during plan implementation under any alternative. These improvements, while measurable at the Forest-scale, are not expected to influence overall watershed condition in the long term. There is simply too much other ownership on the landscape, making overall watershed health and resilience, and therefore aquatic species and communities, mostly out of Forest Service control. The Forests will continue good stewardship of aquatic resources under all alternatives. Additionally, the Forests will continue to work with partners across ownership boundaries to improve conditions across ownerships whenever possible.

Therefore, it is reasonable to assume that species associated with small river habitats on the Forests will continue to persist on the landscape, and even thrive on the Forests over time under any alternative.

### **Medium and Large River (Orders 6+) Associates**

#### **Affected Environment**

Across the Nantahala and Pisgah NFs, higher-order aquatic systems (i.e. greater than 6th order) are classified as warmwater ecosystems based largely on topography and elevation (as a water temperature surrogate). However, coolwater (transitional) aquatic communities may occur in these systems depending on local conditions (see Small River Associates). In this type of ecosystem, bass, catfish, sunfish, and a diversity of nongame species are present. Crayfish and aquatic insects are well-represented. Freshwater mussels occur where flow and substrate conditions permit; however, occupied range of most mussel species is greatly reduced from historic levels (see Affected Environment, Aquatic Resources).

Medium and large rivers occur across the mountain region of North Carolina, generally occurring at mid- to lower elevations. However, because of ownership patterns, these habitats are present, but not in large amounts, on the Nantahala and Pisgah NFs. These habitats support the most diverse aquatic communities on the Nantahala and Pisgah NFs, and in some cases, represent the most diverse aquatic communities in the southeast and across the United States.

## **Environmental Consequences**

Under Alternative A, law, regulation, and policy ensures that Forest Service activities meet high standards for stream protection. As described above, the action alternatives have a theme around clean and abundant water, providing desired conditions that support whole stream ecology more so than the approach of the current forest plan, strengthening the ecosystem-based approach to project planning. However, because of the high standards that the FS is required to meet under any alternative, as well as the limited amount of the overall watersheds within FS management, the difference in environmental consequences from Alternative A to the action alternatives is not quantifiable.

As summarized above, aquatic connectivity will continue to improve and sediment sources will continue to be avoided or mitigated during plan implementation under any alternative. These improvements, while measurable at the Forest-scale, are not expected to influence overall watershed condition in the long term. There is simply too much other ownership on the landscape, making overall watershed health and resilience, and therefore aquatic species and communities, mostly out of Forest Service control. The Forests will continue good stewardship of aquatic resources under all alternatives. Additionally, the Forests will continue to work with partners across ownership boundaries to improve conditions across ownerships whenever possible.

Therefore, it is reasonable to assume that species associated with medium and large river habitats on the Forests will continue to persist on the landscape, and even thrive on the Forests over time under any alternative. It is important to remember that higher order, warmwater streams are not common on the Forests.

## **Pond, Lake, and Reservoir Associates**

### **Affected Environment**

The Nantahala and Pisgah NFs include many miles of shoreline surrounding mountain reservoirs, but not the waterbodies themselves. The Forest Service actively manages access to these resources, which is addressed in other parts of this analysis. Authority under the Wyden Amendment allows the Forest Service to cooperate with partners and landowners such as the North Carolina Wildlife Resources Commission, Tennessee Valley Authority, and other utility companies to enhance habitat and angling opportunities associated with these reservoirs because they are important recreational opportunities on the Nantahala and Pisgah NFs. Additionally, several small lakes and ponds occur on the Forests, but their acreage is very small, and each resource is distinct in its habitat, fauna, and management objectives.

Aquatic communities in these systems largely reflect the streams or rivers they impound. Additionally, many of them are highly managed for angling opportunities, so it is not uncommon to see additional species present. In this type of ecosystem, bass, catfish, sunfish, and a diversity of nongame species are present. Walleye, white bass, striped bass, perch, salmon, and a variety of forage species (e.g. shad) may also be present. Crayfish and aquatic insects are present, mostly in edge and shallow areas. Freshwater mussels occur, but are uncommon, due largely to alteration (i.e. flooding) of suitable habitat.

The National Forests in North Carolina maintains an active program of enhancing aquatic habitats (and thereby angling opportunities) within ponds, lakes, and reservoirs on the Forests.

## **Environmental Consequences**

Under Alternative A, law, regulation, and policy ensures that Forest Service activities meet high standards for stream protection. As described above, the action alternatives have a theme around clean and abundant water, providing desired conditions that support whole stream ecology more so than the approach of the current forest plan, strengthening the ecosystem-based approach to project planning. However, because of the high standards that the FS is required to meet under any alternative, as well as

the limited amount of the overall watersheds within FS management, the difference in environmental consequences from Alternative A to the action alternatives is not quantifiable.

As summarized above, aquatic connectivity will continue to improve and sediment sources will continue to be avoided or mitigated during plan implementation under any alternative. These improvements, while measurable at the Forest-scale, are not expected to influence overall watershed condition in the long term. There is simply too much other ownership on the landscape, making overall watershed health and resilience, and therefore aquatic species and communities, mostly out of Forest Service control. The Forests will continue good stewardship of aquatic resources under all alternatives. Additionally, the Forests will continue to work with partners across ownership boundaries to improve conditions across ownerships whenever possible.

Therefore, it is reasonable to assume that species associated with pond, lake, and reservoir habitats on the Forests will continue to persist on the landscape, and even thrive on the Forests over time under any alternative. It is important to remember that these habitats are not common on the Forests.

### Aquatic Species Sensitive to Sediment

For aquatic species requiring larger substrate particles and associated interstitial spaces, management activities designed to mitigate or eliminate stream sedimentation are critical to native aquatic species persistence. For example, loss of habitat quality and quantity resulting from stream sedimentation is identified as one of the largest threats to native brook trout persistence by the Eastern Brook Trout Joint Venture (EBTJV 2018).

The National Forests in North Carolina maintain an active program of designing and implementing stream sedimentation minimization features during all land management activities that are often more conservative than what is required by state, federal, and local law, regulation, and policy. Forest Service monitoring of Best Management Practice application and implementation shows that over 93% of the time, no visible sediment is reaching stream channels-- that design features are planned and implementing correctly (exceeding required standards), resulting in the reduction or elimination of sediment transport to local streams during project implementation (NFs in NC 2018).

### Environmental Consequences

Environmental consequences for each alternative considered in detail were estimated for a single indicator for each USGS 6th level hydrologic unit on the Nantahala and Pisgah National Forests using the Ecological Sustainability Evaluation: density of Forest Service roads and trails within 100 feet of a water body within each USGS 6th level hydrologic unit. Appendix C and the project record contain detailed information.

**Table 24. ESE Composite Scores (All Watersheds, FS Lands) for the Riparian Road and Trail Density Indicator**

Indicator	Existing	Alt A 10 years	Alt A 50 years	Alts BCDE 10 years	Alts BCDE- 50 years
Sediment sensitive species					

Ecological Sustainability Evaluation modeling for the Nantahala/Pisgah Forest Plan Revision (NPESE) shows that conditions for the Sediment Sensitive species group will remain “good” over the next 50 years under Alternatives B, C, D and E. Whereas, conditions will improve to “very good” over the next 50 years under Alternative A (Table 24). Alternatives B, C, D and E implement the priority watershed concept (see Water Resources section for description), and account for the slight decrease in 50-year composite scores when compared to Alternative A. Basically, the priority watershed concept focuses

work in a few watersheds to improve individual watershed condition, which can be reflected in forest-wide decreases in composite score given that in many watersheds, Forest Service ownership may not be high enough to influence indicator score, regardless of condition on Forest Service land. It is important to note that although the rating for this indicator is different between the no-action (Alternative A) and action (Alternatives B, C, D and E), there is no mathematical difference in the 50-year composite scores for this species group (3.3 vs. 3.2, respectively).

### **Aquatic Species Sensitive to Nonpoint Source Pollution**

Sediment is the largest contributor to nonpoint source pollution. For aquatic species requiring larger substrate particles and associated interstitial spaces, management activities designed to mitigate or eliminate stream sedimentation are critical to native aquatic species persistence. For example, loss of habitat quality and quantity resulting from stream sedimentation is identified as one of the largest threats to native brook trout persistence by the Eastern Brook Trout Joint Venture (EBTJV 2018).

The National Forests in North Carolina maintain an active program of designing and implementing stream sedimentation minimization features during all land management activities that are often stricter than what is required by state, federal, and local law, regulation, and policy. Forest Service monitoring of Best Management Practice applications and implementation shows that over 93% of the time no visible sediment is reaching stream channels and that design features are planned and implementing correctly (exceeding required standards), resulting in the reduction or elimination of sediment transport to local streams during project implementation (NFs in NC 2018). This species group is also affected by the amount of urban and agricultural land uses across the landscape.

### **Environmental Consequences**

The following discussion is related to the one above for the Species Sensitive to Sedimentation species group-- the difference being that this species group addresses all lands, whereas the previous section focuses on Forest Service lands only.

Environmental consequences for each alternative considered in detail were estimated for a single indicator for each USGS 6th level hydrologic unit on the Nantahala and Pisgah National Forests using the Ecological Sustainability Evaluation: percent of urban and agricultural land use within each USGS 6th level hydrologic unit. Appendix C and the project record contain detailed information.

**Table 25. ESE Composite Scores (All Watersheds) for the Percent Urban and Agricultural Land Use Indicator**

<b>Indicator</b>	<b>Existing</b>	<b>Alt A 10 years</b>	<b>Alt A 50 years</b>	<b>Alts BCDE 10 years</b>	<b>Alts BCDE- 50 years</b>
Nonpoint source pollution sensitive species					

Ecological Sustainability Evaluation modeling for the Nantahala/Pisgah Forest Plan Revision (NPSE) shows that conditions for the Nonpoint Source Pollution Sensitive species group will remain “fair” over the next 50 years under all alternatives (Table 25), despite condition and improvement on Forest Service lands described above. This is largely because the factors influencing these composite scores are out of Forest Service control. These ratings of “fair” should be viewed and interpreted in context with the composite scores from the Sediment Sensitive and Hydrologic Modification Sensitive species groups, as they are closely related.

## Aquatic Species Sensitive to Point Source Pollution

Point source pollution is regulated by the North Carolina Division of Water Resources (NCDWR) through implementation of the National Pollutant Discharge Elimination System (NPDES). These discharges can affect water quality and, subsequently, aquatic species if not managed properly.

NCDWR records indicate that in 2017, eleven permitted discharges occurred on the Nantahala and Pisgah National Forests representing approximately 10% of the permitted discharges within the planning area (see Appendix C, Permitted Discharges by Watershed, Table F). This indicates that point source pollution on public lands may not be the threat to aquatic systems, but that this threat is much greater when discharges on other ownerships are considered.

## Environmental Consequences

Environmental consequences for each alternative considered in detail were estimated for a single indicator for each USGS 6th level hydrologic unit on the Nantahala and Pisgah National Forests using the Ecological Sustainability Evaluation: number of permitted discharges, irrespective of ownership.

Appendix C and the project record provide detailed descriptions of this indicator and values as well as species associated with this species group. It is important to note that this species list is not all-inclusive but rather a compilation of federally listed species, species of conservation concern, focal species, and other closely-associated species.

All proposed action alternatives provide protection and management of this species group in the same way. Given that the Forests support only 10% of permitted discharges across the planning area, this species group can be used to reflect the influence of other ownerships on aquatic species.

In this sense, Ecological Sustainability Evaluation for the forest plan revision predicts that conditions for the Point Source Pollution Sensitive species group will remain “fair” over the next 50 years under Alternatives A, B, C, D, and E (Table 26). This is largely because the factors influencing these composite scores are out of Forest Service control.

**Table 26. ESE Composite Scores (All Watersheds) for the Permitted Discharges Indicator**

Indicator	Existing	Alt A 10 years	Alt A 50 years	Alts BCDE 10 years	Alts BCDE- 50 years
Point source pollution sensitive species					

## Aquatic Species Sensitive to Invasive Species (Aquatic Community Health)

For aquatic species sensitive to the presence of exotic, often invasive, species, general awareness and reasonable management actions are vital to native species’ persistence. The U.S. Geological Service (USGS) has compiled the most comprehensive list of nonindigenous aquatic species in the United States (USGS 2018). In Western North Carolina, seventy-one species have been identified as nonindigenous to all or part of the state. Of these species, fifteen have been identified as exotic species affecting aquatic community diversity (see Appendix C, Nonindigenous aquatic species associated with the Nantahala and Pisgah NF, Table F). Most of the remaining species have been moved to or across North Carolina as part of historic efforts to improve angling opportunity, enhance diversity, or through incidental introduction from bait buckets.

Of the exotic nonindigenous aquatic species, Asian clam (*Corbicula fluminea*) and brown trout (*Salmo trutta*) have exerted the most pressure on native mussel and trout communities across the Forests. Similarly, although native to the U.S., rainbow trout (*Oncorhynchus mykiss*), rusty crayfish (*Faxonius*

*rusticus*) and virile crayfish (*Faxonius virilis*) have exerted extreme pressure on native trout and crayfish communities.

This species group is addressed through the establishment of plan components (e.g., AQS-DC-01, AQS-DC-02, AQS-S-01, see also “Water Resources” section) to protect and improve water quality and quantity, and aquatic habitats, and to enhance aquatic diversity (mostly through population augmentation).

**Table 27. Summary (Number of Species by Group) of Nonindigenous Aquatic Species Associated with the Nantahala and Pisgah National Forests (USGS 2018)**

	Native to U.S., But Not Native to:					
Species Group	Exotic	North Carolina	Western NC	Atlantic Slope	Tennessee Basin	Total
Fish	11	7	18	20	7	63
Mussels	1	0	0	0	0	1
Snails	2	1	0	0	0	3
Crayfish	0	2	0	0	0	2
Turtles	0	0	0	1	0	1
Other	1	0	0	0	0	1
<b>Total</b>	<b>15</b>	<b>10</b>	<b>18</b>	<b>21</b>	<b>7</b>	<b>71</b>

### Environmental Consequences

Environmental consequences for each alternative considered in detail were estimated for two aquatic invasive species indicators for each USGS 6th level hydrologic unit on the Nantahala and Pisgah National Forests using the Ecological Sustainability Evaluation (ESE Tool): (1) presence of *Corbicula*, as a measure of effects on the native freshwater mussel community composition (not used for watersheds that do not support freshwater mussels), and (2) percent brook trout suitable habitat occupied by brown or rainbow trout, as a measure of effects of nonnative species on native brook trout. Since *Corbicula* is considered naturalized effects on native mussels diminished over time, the indicator is not summarized below. Data on exotic crayfish distribution is not complete enough to estimate effects on native crayfish species at this time.

All of the proposed alternatives provide the same protection and management of this species group. Given the limited capacity of species restoration across the Forests, even with partners, the Ecological Sustainability Evaluation modeling for the Nantahala/Pisgah Forest Plan Revision (NPESE) predicts that conditions for the Aquatic Species Sensitive to Invasive Species group, in terms of fish community composition, will remain “fair” in the next 50 years under all alternatives (**Error! Reference source not found.**).

**Table 28. ESE Composite Scores (All Watersheds) for the Aquatic Community Health Indicator**

Indicator	Existing	Alt A 10 years	Alt A 50 years	Alts BCDE 10 years	Alts BCDE- 50 years
Aquatic Community Health (fish community)					



Aquatic community health will be maintained under all alternatives, although native brook trout will continue to be displaced by brown and rainbow trout. Invasive species such as brown and rainbow trout and Asian clam have been present on the landscape for over a century. It is likely that aquatic communities have reached a new (although perhaps, undesirable) homeostasis. And it is possible, that cumulative effects of things out of Forest Service control, such as broad-scale changes in land use or climate change, could result in changes in this assessment.

### **Aquatic Species Sensitive Hydrologic Modification**

For aquatic species sensitive to hydrologic modifications (i.e., the quality and quantity of streamflow, including migration barriers such as dams and improperly installed trail and road stream crossings), general awareness and reasonable management actions are critical to native aquatic species persistence. Loss of aquatic habitat quality and sediment or large wood transport capacity and fragmentation of aquatic populations at barriers are threats to aquatic species persistence.

The National Forests in North Carolina maintain an active prioritization and restoration of stream channels and aquatic habitat including aquatic organism passage projects at man-made barriers, particularly on the Nantahala and Pisgah National Forests. This will continue in the future as an area of emphasis, described in revised plan objective AQS-O-03.

### **Environmental Consequences**

Environmental consequences for each alternative considered in detail were estimated for a single hydrologic modification indicator for each USGS 6th level hydrologic unit on the Nantahala and Pisgah National Forests using the Ecological Sustainability Evaluation: density of known dams and road-stream intersections on Forest Service land within each watershed.

All proposed alternatives provide protection and management of this species group in the same way. Ecological Sustainability Evaluation modeling for the Nantahala and Pisgah Forest Plan Revision (NPSE) shows that conditions for the Hydrologic Modification Sensitive species group will improve from “good” to “very good” over the next 50 years under all alternatives (Table 29). It is important to note that this indicator reflects improvement on Forest Service land. Although collaborative efforts to improve aquatic ecosystem connectivity are expected to occur on other ownerships, these actions are largely out of Forest Service control.

**Table 29. ESE Composite Scores (All Watersheds, FS Lands) for the Hydrologic Connectivity Indicator**

<b>Indicator</b>	<b>Existing</b>	<b>Alt A 10 years</b>	<b>Alt A 50 years</b>	<b>Alts BCDE 10 years</b>	<b>Alts BCDE- 50 years</b>
Hydrologic Connectivity Sensitive Species					

### 3.3.2 Terrestrial Ecosystems

This section discloses effects of the alternatives on terrestrial ecosystems at multiple scales, including an analysis of forestwide conditions, ecozones, species groups, unique habitats, other fine filter associations, and threatened, endangered, and demand species

#### 3.3.2.1. Background

##### Ecological Integrity

This analysis is built on the assumption that ecosystems are most resilient when they have high ecological integrity, which is characterized by having composition, diversity, and functional organization comparable to those of natural habitats within a region. An ecological system has integrity when its dominant characteristics (e.g., elements of composition, structure, function, and ecological processes) occur within their natural ranges of variation and can withstand and recover from most perturbations imposed by natural environmental dynamics or human influences (36 CFR 219.19).

The *natural range of variation* (NRV) is defined as the variation of ecological characteristics and processes over scales of time and space that are appropriate for a given management application. NRV is not the same as desired conditions. NRV is a tool for assessing ecological integrity and does not necessarily constitute a management target (FSH 1909.12 Sec 05). For purposes of this analysis, NRV serves as a guide for assessing whether alternatives are moving toward ecological integrity. In some locations on the forest, it is appropriate to be outside the range of desired conditions to achieve social, economic, cultural, or ecological objectives (FSH 1909.12 Sec 23.11a).

Ecosystems within their NRV have greater ecological integrity and will be more resilient to the effects of changing patterns and types of disturbance (Parrish et al. 2003). *Resilience* is generally defined as the ability of an ecosystem to absorb or recover from the effects of disturbances through preservation, restoration, or improvement of its essential structures and functions and redundancy of ecological patterns across the landscape (Hayward et al. 2016).

*Stressors* can be defined as factors that directly or indirectly degrade or impair ecosystem composition, structure, or ecological process in a manner that impairs its ecological integrity, such as invasive species, loss of connectivity, or the disruption of a natural disturbance regime.

*Ecological restoration* is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed. Ecological restoration focuses on reestablishing the composition, structure, pattern, and ecological processes necessary to facilitate terrestrial and aquatic ecosystems sustainability, resilience, and health under current and future conditions (2012 planning rule). Some ecosystem restoration objectives may be accomplished through passive management strategies, where no action or activity is needed, such as allowing forests to age towards desired conditions or allowing natural revegetation of roads and trails that are no longer in use. Other restoration objectives will require active management to maintain or restore ecological conditions. For example, restoration activities include prescribed burning to maintain or restore fire-adapted ecosystems.

Ecosystem *function* and processes influence terrestrial ecosystem composition and structure. The evaluation of function can be found throughout the EIS. For example, the soils section analyzes impacts on soil productivity; the air section analyzes impacts of biogeochemical cycling; the fire section analyzes the effects of alternatives on fire regime condition class, fire frequency and severity; the forest health section analyzes the potential impact from nonnative invasive species, etc. This terrestrial ecosystem section includes analyses of the successional pathways of major vegetation types and the ability of native species to use habitat that fulfills their life cycle needs of breeding, foraging, migration, and

sheltering. Therefore, while not provided its own heading, function of ecological processes is inherently part of the analyses.

Similarly, *connectivity* is part of the analyses distributed throughout the EIS. For example, connectivity is considered in the analyses of resilient and connected landscapes of the climate change section; the analysis of the designated old growth network section; and in evaluation of specific group indicators analyzed in this section, such as road density sensitive species.

This analysis examines the effects to ecological integrity through analysis of composition and structure of ecological systems on the forest. *Composition* refers to the biological elements that comprise the ecozone from genes, to species, to ecological communities and ecosystems. *Structure* refers to the organization and physical arrangement of biological elements such as snags and down woody debris, vertical and horizontal distribution of vegetation, stream habitat complexity, landscape pattern, and connectivity (FSM 1909.12).

### **Coarse-Filter, Fine-Filter Approach**

When an ecosystem has high ecological integrity and key ecosystem characteristics are within the natural range of variation, the biological diversity associated with the ecosystem has the greatest opportunity for conservation. Forest plans must ensure that the diversity of plant and animal communities in the plan area and the long-term persistence of native species in the plan area are sustained. By maintaining functionally viable populations of all species and the essential ecosystem processes that they provide, the long-term productivity of ecosystems and their ability to produce goods and services for human use (ecosystem services) will be sustained (Lindenmayer and Franklin 2002).

A combination of ecosystem- and species-specific strategies are included in the forest plan to provide for biological diversity and viable species populations. This ecosystem- and species-specific approach is referred to as the coarse-filter/fine-filter approach.

*Coarse-filter* strategies are based on providing a mix of ecological communities across a planning landscape rather than focusing on the needs of specific individual species, with the goal of providing for ecological integrity or biological diversity at an appropriate landscape scale (Kaufmann et al. 1994). The premise behind a coarse-filter approach is that native species evolved and adapted within the limits established by natural disturbance patterns, prior to extensive human alteration, and that a patchwork of variable habitat conditions shifted across the landscape. To reflect underlying ecological processes, these conditions function at large spatial (hundreds of square miles) and temporal scales (generations to centuries).

Across the landscape, providing or emulating a range of ecological conditions like those that sustained native species in the past offers the best assurance against losses of biological diversity and maintains habitats for a vast majority of species in an area. The underlying assumption is that the ecological conditions provided by an effective coarse-filter approach contribute to the overall biological diversity across the entire plan area. With a biologically effective coarse-filter approach in place, more costly and information-intensive fine-filter strategies can be focused on the few species of special concern whose habitat requirements are not fully captured by coarse-filter attributes (Seymour and Hunter 1999).

*Fine-filter* approaches for maintaining biological diversity are based on providing the specific habitat elements needed by individual species, or other groupings of species. Assumptions underlying this approach are that biodiversity can best be maintained by managing habitat for the needs of all species by either considering species individually or by aggregating species into groupings and that coarse-filter approaches might not adequately provide the ecological conditions necessary to support every species (Baydack et al. 1999). Fine-filter strategies rely on an understanding of individual species' life requirements and demographic information and on direct measurements of critical habitat elements needed for their survival, distribution, and abundance.

To analyze with a coarse- to fine-filter approach, this analysis begins at the forestwide scale, steps down to ecozones, unique habitats, species groups, and then addresses species such as Species of Conservation Concern, threatened and endangered species, demand species, and others. Sometimes an ecozone, unique habitat, or species group provides coarse-filter support; other times fine-filter plan components are added at these scales to address a particular species need that is not otherwise addressed.

### **Forestwide Structure**

The forestwide analysis focuses on the changes that are expected in the most limited structural classes on the forest: young forest, old growth forest, and open woodlands.

### **Ecozones**

The analysis then scales down to the ecological plant communities of the forest. An ecological zone, or *ecozone*, is a unit of land that supports a specific plant community or plant community group based on environmental factors such as geology, temperature, moisture, soil fertility, and solar radiation (Simon, 2011). Ecozone composition and structure result from ecological processes, such as natural succession, but also from disturbances such as fire and other biotic and abiotic stressors. Across the landscape, ecozones contribute to landscape integrity and diversity through varied age classes and structural components, susceptibility to various disturbance regimes, and species composition and diversity. Ecozones are impacted not only by historic events and management but also by present-day management, emerging threats, and a changing climate.

As part of the plan revision process, eleven ecozones have been mapped across western NC, including: spruce-fir, northern hardwood, high elevation red oak, acidic cove, rich cove, mesic oak, dry-mesic oak, dry oak, pine-oak heath, shortleaf pine, and floodplains. The assessment for the plan revision (pp 21-58) provides comprehensive detailed information about the individual ecozones. These ecozones are dynamic, open systems where the current state is not fixed but rather always in a state of change due to ecological processes and disturbances. The eleven ecozones are the foundation of a coarse-filter approach that provides ecological conditions to sustain associated plant and animal species. More information on the identification of ecozones is available in the project record.

The proposed plan includes desired conditions for each ecozone (Proposed Plan, Table 2) that describe the composition, structure, function and ecological processes that are constantly influencing the ecozone. These desired conditions were built with consideration of the NRV which serves as a guide to understanding how to restore a resilient ecosystem with structural and functional properties that will enable it to persist into the future.

In addition to desired conditions, the proposed plan includes objectives that outline the proposed path from current conditions toward desired conditions.

### **Unique Habitats**

Twenty-five unique habitats have been identified on the Nantahala and Pisgah NFs. Twenty-four are addressed in this EIS since Beech Gap Forest and Boulderfield Forest were combined (reference below and Appendix C). An analysis of these habitats and the species groups related to specific habitat elements (e.g., snags and den trees, coarse woody debris, etc.) provides a basis for evaluating whether the plan alternatives provide for the species that depend on these habitats.

More information about the unique habitats on the forest and the process used to evaluate them in this analysis is addressed in the “Unique Habitats” section below.

### **Species Groups**

For analytical purposes, 1,055 species (including Species of Conservation Concern, Threatened and Endangered Species, and others described below) were placed into 24 species groups based on general habitat needs, specific habitat requirements (e.g., snags, den trees, coarse woody debris, hard and soft mast, etc.), limiting factors, or threats (Appendix C). Many species occur in multiple species groups and where possible, species groups were associated with ecozones. These species groups, along with analyses of rare and unique habitats, provided a method for checking the coarse-filter approach for sustaining plant and animal diversity.

Threats discussed in this analysis are those that were used as indicators in the Ecological Sustainability Evaluation. Some emerging threats were not included in the ESE analysis because the extent of impacts of these threats were not available at the species group scale, however many insects and diseases are generally addressed in the “Forest Health” section of the EIS.

Anticipated indirect, and cumulative effects of forest plan coarse- and fine-filter plan components developed to ensure species viability, within the context of each species group, are disclosed below. A viable population is defined as a population of a species that continues to persist over the long term with sufficient distribution to be resilient and adaptable to stressors and likely future environments (36 CFR 219.19).

### **Species of Conservation Concern**

A comprehensive list of plant and animal species was compiled to assess revised the impacts of the proposed plan on species diversity. The 2012 National Forest Planning Rule requires that the regional forester identify Species of Conservation Concern (SCC) that are “known to occur in the plan area” for which “the best available scientific information indicates substantial concern about the species’ capability to persist over the long term in the plan area.” To identify SCC, during the plan revision assessment phase, a team consisting of a botanist/ecologist and a wildlife/aquatic biologist developed a comprehensive list of plant, wildlife, and aquatic species with the potential to occur on the Nantahala and Pisgah NFs. This list was developed via coordination with state, federal, tribal academic and nongovernmental organizations and was based on a variety of sources, including the existing Regional Forester’s Sensitive Species list and input from a diverse group of species and species group experts. This resulted in 339 Species of Conservation Concern identified for the Nantahala and Pisgah NFs in a letter from the regional forester dated July 2, 2015. The Regional Forester updated the Species of Conservation Concern list in December 2021 based on additional information learned during the planning process. The complete list of SCC is included in Appendix C.

Habitat conditions for all Species of Conservation Concern were evaluated through the analyses of species groups and unique habitats. Specific attention was given where stressors may directly or indirectly degrade or impair habitat conditions.

### **Threatened and Endangered Species**

Twenty federally listed threatened and endangered species have been identified as occurring on the Nantahala and Pisgah NFs. Additionally, eight species that potentially occur because the Forests are within the range of those species are included (Appendix C). To help comply with Section 7(1)a of the Endangered Species Act, each of these species was evaluated to assure conditions for recovery are provided.

More information about the threatened and endangered species on the Forests and the analysis used to evaluate them is found in the “Threatened and Endangered Species” section below.

### **Species Analyzed in the Ecological Sustainability Evaluation Tool**

In addition to Threatened and Endangered species and Species of Conservation Concern, an additional 689 plant and animal species were included in this analysis based on the request of the public or other

species experts involved in the development of the plan and EIS. These species do not have regulatory requirements for the Forest Service but were considered if (1) they were of general conservation concern to all or part of the local scientific community and (2) are known to occur on the Forests, or suitable habitat exists and species occurrence is proximal to the Forests. Species meeting the criteria above were evaluated through internal and external collaboration for relevancy to the Ecological Sustainability Evaluation (ESE) tool (see below for more information on the tool). Appendix C outlines the process for including and excluding species from the ESE tool analysis. Currently, the ESE tool includes the following species:

- Federally listed species (T&E),
- Species of Conservation Concern (SCC),
- Regional Forester’s Sensitive Species (RFSS),
- Proposed Focal Species (FS),
- Species identified as Species of Greatest Conservation Need (SGCN) in the North Carolina Wildlife Action plan (NCWAP),
- Species identified as Federal Species of Concern (FSC), Candidate (C), Bird of Conservation Concern (BCC), or Species at Risk (SAR) by the USFWS,
- Species petitioned for federal listing, and currently in the review process
- Species identified as Threatened or Endangered by the State of North Carolina,
- Species identified as “rare,” including some watch list species, tracked by the NC Natural Heritage Program,
- Species identified by the Eastern Band of Cherokee Indians as culturally important, and
- Species receiving attention due to environmental sensitivity, general rarity, or other conservation perspective from regional and range-wide scientific collaboratives such as the Partners for Amphibian and Reptile Conservation, Appalachian Mountain Joint Venture, Partners in Flight, and The American Fisheries Society.

Three animal species of conservation concern (golden winged warbler, cerulean warbler, and elk) and one species group (terrestrial salamanders) are discussed in detail in this section due to public comments during the NEPA process and scientific consensus on the need for additional attention based on severely declining trends and/or environmental sensitivity.

### **Demand Species**

The terrestrial ecosystems analysis concludes with a discussion of demand species (i.e. those gathered, hunted, or fished) that have significant public interest.

More information about the demand species on the forest and the analysis used to evaluate them is found in the Demand Species section below.

### **North Carolina Natural Heritage Natural Areas**

Some forest sites that contain special biodiversity significance are recognized as Natural Heritage Natural Areas (NHNA) by the North Carolina Natural Heritage Program. As part of their mission, the North Carolina Natural Heritage Program (NCNHP) seeks to identify, document, and consolidate rare species and natural community information across North Carolina, including the Nantahala and Pisgah NFs.

Rather than analyze effects to NHNAs as a separate indicator, this analysis addresses the ecological integrity of these areas by considering the ecozones and unique habitats, species groups, and rare species.

## Analysis Methods and Assumptions

### Forest Vegetation Simulator (FVS)

The Forest Vegetation Simulator (FVS) is an inventory-based growth and yield modeling system that is designed to aid analyses at multiple scales (Dixon 2002). To help the Pisgah and Nantahala National Forests in North Carolina revise their Land and Resource Management Plan, Forest Inventory and Analysis (FIA) data and FVS was used to create multiple resource related yield profiles for forested land managed by the Pisgah and Nantahala National Forests. The yield profiles were designed to meet the needs of the long-range planning model, Spectrum, as well as providing direct inputs to analysis done for the ecological sustainability evaluation. Refer to the white paper titled: *FVS Modeling for the National Forests of North Carolina Land and Resource Management Plan* (Keyser and Rodrigue, 2014) for more information.

### Ecological Sustainability Evaluation

The Ecological Sustainability Evaluation (ESE) tool is a strategic conservation planning tool used by the US Forest Service Southern Region for forest planning. Ecological sustainability in this context is defined as the capability of ecosystems to maintain ecological integrity (36 CFR 219.19). This analysis tool is based on the structure of the *Open Standards for the Practice of Conservation* (CMP 2018) planning tool and utilizes a standardized process that is adaptable to forest specific priorities and needs. The ESE tool employs prioritization algorithms utilizing rank, importance rating, attributes and indicators, stressors and threats, scope and severity ratings, and management opportunities to assist and support management decisions. The tool includes a process record with documentation for assumptions made within the tool.

The general approach to evaluating ecological sustainability and species diversity is to 1) define ecological systems (ecozones and unique habitats), key characteristics, stressors and threats to these systems; 2) identify species for these ecological systems and link them to species groups; 3) link species groups to ecological systems; 4) identify indicators and values to sustain all ecological systems and species groups; 5) estimate outcomes of the indicators for each alternative; 6) calculate ecological sustainability scores for each ecological systems and species group by alternative; 7) check plan components for species specific needs. Detailed information is documented in Appendix C of this EIS and in the project record.

A key consideration in using the ESE tool in this evaluation is the direction of change from current conditions to expected future conditions over time. The ESE tool has four broad categories of conditions calculated using the Ecological Sustainability scoring system: “poor,” “fair,” “good” and “very good.” Because many of the ecozones in western NC were damaged and degraded in the past, many are currently estimated to be of “poor” or “fair” condition (compared with desired conditions, Proposed Plan, Terrestrial Ecosystems, Tables 2 & 3), depending on the extent of recovery that has occurred over the last 80 to 100 years (Table 30), and may take multiple planning cycles to see improvement.

**Table 30. Overall Ecological Sustainability Scores**

Range of Condition Score	Condition	Definition of Ecological Sustainability Evaluation Score Applied to Planning Elements
3.25 – 4.00	Very Good	Element conditions are optimal
2.50 – 3.24	Good	Element conditions are acceptable

Range of Condition Score	Condition	Definition of Ecological Sustainability Evaluation Score Applied to Planning Elements
1.75 – 2.49	Fair	Element conditions are slightly inadequate
1.00 – 1.74	Poor	Element conditions are severely inadequate

An important interpretation of ESE tool conditions for this evaluation is whether the ecozone or species group scores would improve over the next 10 to 50 years, even if the condition remains in the same condition category. Using a coarse-filter perspective, when the ecological sustainability composite score improves over the existing condition by moving from a lower to a higher ranking, or by improving the score within the same ranking over time, it is assumed that plant and animal species associated with the ecozone or species group would persist and potentially even expand. Maintaining a stable composite score means that the current condition of the plant and animal species associated with the ecozone or species group would be maintained. Conversely, declining overall scores over time indicate that alternatives may not adequately protect ecosystem sustainability and the diversity of associated species. This analysis will also disclose when it is beyond the authority of the Forest Service, or not within the inherent capability of the plan area, to maintain or restore ecological conditions that would result in maintaining or improving the ecological sustainability score.

Additional assumptions regarding the ESE tool analysis are documented in Appendix C of this EIS and in the project record. Appendix C provides a list of species all the species in the tool, and the species groups, with their associated species. Additionally, it documents the indicators used to analyze each species group, and the values associated with those indicators, by alternative. Parts of this EIS analysis used data and summaries from outside the ESE framework to provide a more complete assessment.

### **Spectrum**

To analyze the alternatives of the EIS on vegetation, Spectrum software was used. Spectrum is a linear programming model that estimates outcomes of applying active or passive management practices to forested stands. The general approach is to 1) stratify the land base by Region 8 forest types, 2) estimate structural changes of forest stands (growth and yield) for active or passive management, and 3) identify objectives and constraints in the model based on plan direction, and 4) estimate outcomes for each alternative. Some outcome measures were used as inputs in the ESE tool.

Detailed information about the Spectrum analysis, including assumptions is documented in Appendix D of this EIS. Spectrum is better able to model changes to forest structure over time compared to composition.

### **Natural Disturbance Modeling**

Natural disturbances were estimated for the natural range of variation (NRV) using State and Transition Simulation (ST-SIM) software and used to develop the seral states of ecozones for NRV. It was useful to compare results of Alternative E between Spectrum and ST-SIM. There are noted differences between the model formulations. For example, Spectrum used FIA forest types as an analysis unit whereas ST-SIM used ecozones. It was difficult to generate a clean crosswalk among these different analysis units. ST-SIM uses annual timesteps whereas Spectrum used 10-year decadal planning periods. ST-SIM has 11 models, one for each ecozone, that are modelled and run independent of each other. Spectrum incorporates all analysis units and potential management actions in one model that allows for interactions among the analysis units. Regardless of the differences, it is useful to find where the model results converge or differ for Alternative E. Refer to Appendix D for further details.



In addition several climate scenarios were developed that changed the natural disturbance patterns. This was used to estimate potential changes to management goals under different levels of natural disturbances. These climate scenarios are documented in FEIS, Appendix D.

## **Summary of Proposed Plan Components for Terrestrial Ecosystems; Plant and Animal Diversity**

### **Alternative A**

Alternative A, the existing Forest Plan emphasizes a full range of functioning ecosystems, from old growth to early successional systems that are distributed across the landscape. Management of designated old growth patches as well as interior bird patches and black bear habitat are aimed at providing for a diversity of species that rely on diverse habitat across the forest. Ecozones are not discussed in the current plan.

### **Action Alternatives: Overview**

The revised plan takes an ecosystem approach to management, considers ecological needs across the landscape, and frames desired conditions and objectives relative to a modelled natural range of variation. The following highlights key facets of the revised plan (note: this is not a comprehensive list of all plan components that contribute to ecological integrity and sustainability).

Priorities for restoration include the following as Forest Plan Desired Conditions:

- Restoring key characteristics of composition, structure, and ecological processes;
- Reducing departure where composition and structure are departed from the natural range of variation;
- Improving ecosystems using both active and passive management that includes both natural disturbance and silvicultural practices, including prescribed fire;
- Fire-adapted systems are improved by restoring the natural fire regimes.

Active restoration is accomplished through vegetation management. This includes improving stand conditions using various methods and providing forest commodity and non-commodity products through active restoration on both land suited and not-suited for timber production. Lands suited for timber production have a regularly scheduled timber harvest program (See Appendix B of the Proposed Forest Plan). Standards and guidelines impose limits on projects that are designed for active restoration purposes. One key standard stipulates that: “timber production will not be the primary purpose for projects and activities and shall complement the ecological restoration desired conditions and objectives” (Alternative B/C/D ECO-S-01).

Desired conditions and objectives for Terrestrial Wildlife Habitat describe key habitats that are emphasized across all the ecozones (Proposed Plan, Terrestrial Ecosystems). Structural habitat conditions listed below are currently in short supply across the forest, and the proposed plan aims to increase these them over multiple planning cycles. The long-term desired condition (acres) for these habitat conditions is as follows:

- Young Forests, including Early Successional Conditions and open, grassy, herbaceous and shrubby areas: 60,000 - 90,000 acres
- Open Forest Conditions: 360,000 - 480,000 acres
- Interior Forest Conditions: 500,000 – 600,000 acres
- Mature Forests, including late seral stages and old growth forest: 565,000 to 730,000 acres

Desired conditions for fine scale habitat components are also emphasized across all ecozones. Examples include snags that provide roost and nest sites for bats and cavity- nesting birds, large diameter live and dead trees, coarse wood on the forest floor, edge and transition habitats, and hard and soft mast.

### **Action Alternatives: Terrestrial Ecosystem Plan Components**

The Proposed Plan identifies desired conditions and key characteristics at the landscape scale and for each ecosystem, as well as estimated amounts of terrestrial wildlife habitat needed over many planning cycles.

The Proposed Plan identifies a set of objectives that would advance the forests toward desired conditions. All alternatives include a two-tiered approach to objectives. Tier 1 objectives are what we would accomplish based on recent Forest Service budgets and capacity, while Tier 2 objectives reflect additional outcomes that may be possible with additional resources, personnel, partner, or volunteer support.

Objectives for the action alternatives are the same for Alternatives B, C and D and are contained in the proposed plan table titled “Consolidated Objectives for Terrestrial Ecosystems.”

Objectives were modified in Alternative E in response to public comments, primarily to improve clarity and to better frame the objectives in terms of annual actions that move toward desired conditions.

Objectives for prescribed burning and nonnative invasive species treatments were increased.

- Objectives for young forest, open forest woodlands and stand and community improvement were reframed in terms of annual acres rather than decadal.
- An objective was added for thin and burn activities to improve woodland and open forest conditions.
- The prescribed fire objective was increased to better reflect current capacity (Tier 1) and to enable greater activity level if additional resources become available (Tier 2).
- A second tier was added for stand and forest community improvement practices.
- The nonnative invasive species treatment objective was increased to better reflect current capacity (Tier 1) and to enable greater activity level if additional resources become available (Tier 2).

While these modified objectives result in a different pace of the achievement toward desired conditions, the context and intensity of effects are within the scope of effects that were analyzed in the draft EIS.

Additionally, between draft and final, the terrestrial ecosystem section of the plan was reorganized to provide a clearer delineation of subsections for Ecozones, Wildlife Habitat, Designated Old Growth Network, Forest Health, and Timber. As a result of this reorganization, the numbers of plan components changed. While most of the Alternative B, C and D objectives remained in Alternative E’s “Integrated Ecosystem and Wildlife Habitat Objectives” section, some objectives were distributed to other sections in the reorganization to improve the overall useability of the forest plan.

- The objective for old growth conditions was moved to the Designated Old Growth Network section (former ECO-O-03 became OGN-O-01).
- Objectives for forest health and nonnative invasives moved to the new Forest Health section (former ECO-O-08 and ECO-O-09 became FHL-O-01 and FHL-O-02).
- The objective for base cation analysis moved to the Watershed section where other watershed and soils conditions are discussed (former ECO-O-10 became WSD-O-02).

The re-numbering of these plan components makes it challenging to compare objectives across alternatives in this Environmental Impact Statement, so a crosswalk of Terrestrial Ecosystem objectives is provided here to show how objectives in Alternatives B, C, and D were updated or renumbered in Alternative E.

<b>Topic</b> <i>Summary of change</i>	<b>Objective in Alternatives B,C,D</b>	<b>Objective in Alternative E</b>
<b>Grass/forb/shrub habitat</b>  <i>No change between action alternatives.</i>	<p>ECO-O-01</p> <p>Tier 1: Over 10 years, maintain 3,750 acres of existing grass, forb, and shrub openings.</p> <p>Tier 2: Over 10 years, restore 1,450 acres of grass, forb, and shrub openings that are not currently present on the forest.</p>	<p>ECO-O-01</p> <p>Tier 1: Over the life of the plan, maintain 3,750 acres of existing grass, forb, and shrub openings.</p> <p>Tier 2: Over the life of the plan, restore 1,450 acres of grass, forb and shrub openings that are not currently present on the Forests.</p>
<b>Young forest</b>  <i>Reframed in Alt E as an annual action to move toward young forest desired condition. Specificity about priorities (elevation, ecosystems, and wildlife habitat) was moved to management approaches.</i>	<p>ECO-O-02</p> <p>Tier 1: Provide 11,000-17,000 acres of young forest conditions,<sup>24</sup> by steadily increasing new young forest conditions from 6,500 acres up to 12,000 acres through silvicultural practices with at least 70% above 2,500 feet elevation and 50% in oak-dominated, northern hardwood, and rich coves. Additionally, ensure at least 50% of these conditions are within NCWRC Wildlife Habitat Active Management focal areas.</p> <p>Tier 2: Provide up to 37,000 acres of young forest conditions by increasing new young forest conditions up to 32,000 acres through silvicultural practices with similar elevation and spatial arrangements described above. This tier includes more focused use of prescribed fire to generate young forest conditions.</p>	<p>ECO-O-02</p> <p>Tier 1: Increase new young forest conditions by using silvicultural practices on between 650 to 1,200 acres annually.</p> <p>Tier 2: Increase new young forest conditions by using silvicultural practices on between 1,200 to 3,200 acres annually.</p>
<b>Stand and Forest Community Improvement</b>  <i>Renumbered in Alt E when terrestrial ecosystem section was reorganized. Corrected to reflect that these are</i>	<p>ECO-O-05</p> <p>Tier 1: Conduct stand and forest community improvement practices, increasing from a minimum of 3,800 acres to approximately 6,000 acres.</p>	<p>ECO-O-03</p> <p>Tier 1: Conduct stand and forest community improvement practices on between 3,800 acres to approximately 6,000 acres annually.</p> <p>Tier 2: Conduct stand and forest community improvement</p>

<sup>24</sup> This includes 4,500 current acres that will move to the mid seral class during the first decade.

<b>Topic</b> <b>Summary of change</b>	<b>Objective in Alternatives B,C,D</b>	<b>Objective in Alternative E</b>
<i>annual actions. In Alts B/C/D Tier 2 was part assumptions in the analysis, where this was identified as a proposed and probable future action, and it was added as a part of the objective in Alt E.</i>		practices on between 6,000 acres to approximately 12,000 acres annually.
<p>Intermediate thinning treatments</p> <p><i>In Alt E, the relationship between intermediate thinning and open forest woodlands was clarified. As a result, this objective is unchanged, other than a reframe into annual actions, and the movement of ecozone, elevation and wildlife priorities to management approaches. A second objective (below) was added to distinguish thin and burn from intermediate treatments.</i></p>	<p>ECO-O-04</p> <p>Tier 1: Provide 1,500 to 4,000 acres of open forest woodland conditions that do not currently exist on the forest, by restoring and then maintaining sites for open conditions. Priorities will be given to pine types and oak dominated stands such as dry and mesic oaks. Additionally, ensure at least 50% of these conditions are within NCWRC Wildlife Habitat Active Management focal areas, and ensure these conditions provide for elk habitat when activities are within its currently occupied range or within the NCWRC elk focal area.</p> <p>Tier 2: Provide 4,000 to 6,000 acres of open forest woodland conditions that do not currently exist on the forest, by restoring and then maintaining sites for open conditions. Priorities will match those in Tier 1.</p>	<p>ECO-O-04</p> <p>Tier 1: Annually apply intermediate thinning treatments on 150 to 400 acres to address forest health, future composition, and structure desired conditions.</p> <p>Tier 2: Annually apply intermediate thinning treatments on 400 to 600 acres to address forest health, future composition, and structure desired conditions</p>
<p><b>Open Forest Woodlands</b></p> <p><i>In Alternative E, a more explicit focus on creating open forest conditions was added with the addition of this thin and burn objective.</i></p>	<p>N/A</p>	<p>ECO-O-05</p> <p>Tier 1: Annually thin and burn 300 to 600 acres to advance open forest woodland conditions.</p> <p>Tier 2: Annually thin and burn 600 to 900 acres to advance open forest woodland conditions.</p>
<p><b>Prescribed Fire</b></p>	<p>ECO-O-06</p> <p>Tier 1: Prioritize prescribe burns to</p>	<p>ECO-O-06</p>

Topic <i>Summary of change</i>	Objective in Alternatives B,C,D	Objective in Alternative E
<p><i>In Alt E, the amount of prescribed fire in both Tier 1 and Tier 2 objectives increased, and the objective was reframed to annual actions to move toward desired conditions. Priority actions, ecozones, the proportion of growing season burns, and species considerations were moved to management approaches.</i></p>	<p>restore the most fire-adapted ecozones and across ecozones where reducing fuel loads will improve public safety on adjacent private lands. Annually prescribe burn for 6,500 to 10,000 acres. Prioritize 50% of the annual burns within the following four types, consisting of the following desired acre ranges:</p> <p>Shortleaf Pine : 1000-1500 acres Pine-Oak/Heath: 1000-1500 acres Dry-Mesic Oak: 850-1300 acres Dry Oak: 400-600 acres</p> <p>To maximize restoration, include approximately 10% as growing season burns.</p> <p>Tier 2: Expand the extent of prescribed fire up to approximately 20,000 acres (annually) with emphasis on restoring the fire-adapted ecozones and across ecozones where reducing fuel loads will improve public safety on adjacent private lands. Include approximately 10% growing season burns, designed to ensure compatibility with federally threatened and endangered species needs.</p>	<p>Tier 1: Apply prescribed fire on 10,000 acres to 20,000 acres annually to restore and maintain priority fire adapted ecozones, create woodlands, and reduce hazardous fuels.</p> <p>Tier 2: Apply prescribed fire on 20,000 acres to 45,000 acres annually to restore and maintain priority fire adapted ecozones, create woodlands, and reduce hazardous fuels.</p>
<p><b>Spruce Fir</b></p> <p><i>In Alt E, the objective wording was simplified for clarity and the objective was more clearly framed as an annual action to move toward desired conditions.</i></p>	<p>ECO-O-07</p> <p>Tier 1: Restore 50 acres of spruce fir ecozones per year to restore 500 acres of the 3,900 acres departed from its characteristic vegetative composition.</p>	<p>ECO-O-07</p> <p>Tier 1: Restore 50 acres of spruce fir ecozones annually to improve ecozone composition.</p>
<p><b>Old Growth Conditions</b></p> <p><i>In Alt E, this objective was renumbered when Designated Old Growth Network became a</i></p>	<p>ECO-O-03</p> <p>Tier 2: Enhance or accelerate the development of old growth conditions over time, by actively managing 250 acres for each ten year interval through activities such as increasing downed</p>	<p>OGN-O-01</p> <p>Tier 2: Enhance or accelerate the development of old growth conditions over time, by actively managing 250 acres for each</p>

<b>Topic</b> <b>Summary of change</b>	<b>Objective in Alternatives B,C,D</b>	<b>Objective in Alternative E</b>
<i>subsection of the plan. Practices to achieve the objective were moved to a management approach.</i>	woody debris within all size classes by felling variable size trees, creating woodlands in appropriate ecozones by thinning and prescribe burning, enhancing the composition of native species, creating snags by girdling trees, and harvesting products as a side benefit of removing uncharacteristic vegetation.	ten year interval through activities.
<b>Forest Health Conditions</b>  In Alt E, this objective was renumbered when Forest Health became a subsection of the plan. Language was simplified and clarified to be reflective of the annual action that moves toward desired conditions. Priorities were moved to the management approach.	<b>ECO-O-08</b>  Tier 1: Provide stable or improved forest health conditions on at least 250 acres where current or newly established threats are present.  Prioritize actions on (1) maintaining effectiveness of existing treatment areas, (2) new threats and new areas when species viability is at risk and (3) expanding treatments for species impacted by known threats.  Tier 2: Improve at least 500 acres with cooperator involvement.	<b>FHL-O-01</b>  Tier 1: Provide stable or improved forest health conditions on at least 250 acres annually where current or newly established threats are present.  Tier 2: Improve at least 500 acres annually with cooperator involvement.
<b>Nonnative Invasive Species</b>  <i>In Alternative E, Tier 1 and Tier 2 levels of activity were increased. This objective was renumbered when Forest Health became a subsection of the plan. Language simplified and clarified to be reflective of the annual action that moves toward desired conditions. Priorities were moved to the</i>	<b>ECO-O-09</b>  Tier 1: Treat, control or eradicate NNIS plant species on 750 to 1500 acres. Select sites using the following priorities: unique habitats required for T/E or SCC; key characteristics of ecozones that provide habitat requirements for T/E or SCC. Inventory approximately 1,000 to 2,000 acres for NNIS occurrences.  Tier 2: Control or eradicate NNIS up to approximately 3,000 acres: to mitigate the spread to or from adjacent lands; where high human uses occur with high risks of NNIS establishment. Inventory up to approximately 4,000 acres for NNIS occurrences. Priority areas are high quality special interest areas, previously	<b>FHL-O-02</b>  Tier 1: Annually, treat, control, or eradicate NNIS plant species on 1,500 to 3,000 acres.  Tier 2: Annually, treat, control, or eradicate NNIS plant species on 3,000 to 5,000 acres: to mitigate the spread to or from adjacent lands, where high human uses occur with high risks of NNIS establishment. Inventory up to approximately 4,000 acres for NNIS occurrences.

<b>Topic</b> <i>Summary of change</i>	<b>Objective in Alternatives B,C,D</b>	<b>Objective in Alternative E</b>
<i>management approach.</i>	treated areas, NC Natural Heritage Program natural areas, and lands where control is completed cooperatively with adjacent state agencies or private landowners.	
<b>Base cations</b> - <i>No language change. This objective was moved to the watershed section since it relates to watershed health.</i>	ECO-O-10	WSD-O-03

Management approaches were also reorganized for clarity, where management approaches specific to individual objectives were placed directly with their corresponding objective, and management approaches that apply to multiple objectives were included under the heading “Integrated Ecosystem and Wildlife Habitat Management Approaches.”

#### **Action Alternatives: Plant and Animal Diversity Plan Components**

The Proposed Plan identifies twenty-two federally listed species.

The Proposed Plan identifies species groups and specifies that all species, including Threatened and Endangered and Species of Conservation Concern are within one or more species groups.

Desired conditions include:

- Habitats are consistent with USFWS recovery plans;
- Rare terrestrial habitats occur at natural distribution patterns;
- Rare habitats support plant and wildlife species dependent on those habitats;
- Unique ecological characteristics are maintained within the North Carolina Natural Heritage Natural Areas

A set of desired conditions for unique and rare habitats are identified in the Plant and Animal Diversity section. Plant and Animal Diversity objectives include a focus on rare habitats: glades and barrens, Carolina hemlock bluff sites, southern Appalachian bogs and balds.

Between draft and final an objective was added to manage and restore *Hudsonia montana* and *Liatris helleri* populations providing an open structure with limited competing woody species within Linville Gorge Wilderness and Woods Mountain, when they occur (Alternative E, PAD-O-05). This plan component was added based on the DEIS’ identification that these plants needed more fine filter protections.

Alternatives B, C, and D contained an objective related to coordination with the North Carolina Natural Heritage Program. This plan component was moved to a guideline in the final plan so it is triggered at all relevant projects rather than just once a year. (Note that it did not become a standard because we cannot require this coordination from another agency in the absence of law, regulation, or policy; however, it is the FS expressed intent to coordinate at the project level, thus a guideline is appropriate.)

The Proposed Plan identifies standards specific to individual rare species needs. For example, standards related to rocky habitats, bat hibernacula, Bald and Golden Eagles, Green Salamander, Rock Gnome Lichen, Spruce-fir moss spiders and others are included. An additional standard was added for *Hudsonia montana* and *Liatris helleri* populations, and other edits were made in consultation with the USFWS and in coordination with the NC Wildlife Resources Commission and NC Natural Heritage Program.

### **Action Alternatives: Management Area Plan Components**

In addition to forestwide direction, plan components are also identified for 15 management areas (MA's) across the forests. (Note: Management areas are parts of the forest that contain similar management direction, and each management area contains multiple ecozones.) For this analysis, management areas for the action alternatives are grouped by the opportunity and likelihood that active or passive management methods would occur to advance the forest toward desired conditions.

Management area groups and the expected restoration methods are described below. These groupings are generalized for purposes of aggregating potential effects; not all lands within a management area grouping would be impacted by the same intensity and duration of management. Acreages by MA group are shown in Table 31 for alternatives B, C, D, and E.

**MA Group 1: *Matrix and Interface*.** This management area group would include the most active management. Here, timber harvest and prescribed fire augment natural disturbance to provide greater resiliency for ecosystems and wildlife habitat by emphasizing composition, structure, function, or connectivity. To accomplish this work, road building may occur, and timber production and stand improvement activities complement the ecological restoration desired conditions and objectives. The greatest amount of active management is expected to occur in the Matrix MA, where there would be the most acres managed annually. Active management in the Interface MA would have the same tools available as in the Matrix, but the total number of acres treated in Interface would be substantially less, and treatments would be designed with consideration of high concentration of forest users and heavy public use. In both management areas, passive management would occur where actions are limited by steep slopes, riparian areas, the designated old growth network, or accessibility.

**MA Group 2: *Ecological Interest Areas, Appalachian Trail Corridor, National Scenic Byways, Heritage Corridors, Wild & Scenic Rivers, Experimental Forests, and Cradle of Forestry in America*.** In this management area group, active management is allowed consistent with the desired conditions of the management area but is expected to be less active than Group 1, with fewer tools available. This management area group is not suitable for timber production. Timber harvest is typically only allowed when it contributes to the recognized features of the area. For example, in the Ecological Interest Areas MA, timber harvesting and prescribed fire could be used to restore community composition, while in the Cradle of Forestry, silvicultural tools can only be used to demonstrate historical practices and provide educational opportunities. Road building is also limited to specific circumstances that are compatible with the unique features of the management areas. As a result, active management in this group is a moderate to low level of activity, compared to MA Group 1.

**MA Group 3: *Backcountry; Special Interest Areas; Roan Mountain*.** MA Group 3 involves primarily passive management where natural processes such as floods, storms, insects, disease, and fire shape the landscape. Prescribed fire is assumed to be the primary method of active restoration, occurring over large landscapes where possible and at varying intensities. Some timber management may occur, creating variable-sized gaps of young forest through tree cutting, though the cutting, removal, and sale of timber is expected to be infrequent. Existing roads needed for general forest access are maintained, but new permanent road construction and reconstruction are limited. Overall, these management areas will experience a low level of active management.



**MA Group 4:** *Congressionally Designated Wilderness; Recommended Wilderness and Wilderness Study Areas; Research Natural Areas.* MA Group 4 is dominated by passive management, except for minor instances where active management using prescribed burning would be desired for specific fire-adapted restoration priorities (e.g. Linville Gorge Wilderness). Although it is possible to employ active management methods in this group, the tools that would be used are limited, such as restrictions on motorized equipment. Therefore, it is assumed that lands in this group would have the lowest priority for active management, especially since many opportunities in other management area groups are available.

**Table 31. Management Area Group by Action Alternative (approximate acres)**

Management Area Group	Alt B	Alt C	Alt D	Alt E
MA Group 1	621,000	496,000	618,000	607,000
MA Group 2	102,000	186,000	134,000	113,000
MA Group 3	126,000	267,000	147,000	200,000
MA Group 4	193,000	94,000	144,000	121,000

Throughout this analysis, the terms “higher potential for restoration” are used to approximate the pace and scale of restoration that vary among the alternatives. Assumptions for these approximations follow.

While Alternatives B, C, and D have the same active management objectives, the rate of moving toward desired conditions varies by alternative because the amount of land available for different activities varies by alternative. In response to public comments and an increased woodland creation, Alternative E has more management activities proposed (the addition of up to 900 acres of thin and burn, and more prescribed fire and nonnative invasive species treatment).

Generally, project planning requires an analysis area larger than the final size of the project implemented on the ground. Regardless of the management area assignment in the forest plan, on-the-ground, site-specific conditions would likely further reduce the amount of land where active management is operable because of local topographic, mitigations necessary for public health and safety, presence of threatened and endangered species or rare ecological communities, cultural resources, scenery, and recreation, and others. Given this, generally, larger project areas provide greater flexibility to design management activities when the purpose and need involves active restoration.

Since Interface and Matrix have the most tools available for active management, more acreage in Matrix and Interface (MA Group 1) results in a higher likelihood of being able to achieve the estimated restoration activity levels for ecozones, especially restoring composition for oak dominated ecozones. Mechanical treatments have a higher probability of providing forest landscape structure of young forest and woodlands that are currently in short supply. Mechanical treatments are assumed to occur mostly in MA Group 1 but could occur in limited amounts in other MAs. There are more mechanical management activities planned in Tier 2 than in Tier 1.

Although prescribed fire has a lower probability of restoration outcomes compared to mechanical treatments, it is a and critical activity for restoring fire-adapted ecozones, maintaining woodlands and restoring their associated grass and forb component. Due to fewer constraints on access to the forests, MA Group 1 has more opportunity to provide a range of prescribed burn sizes and a greater likelihood of achieving restoration outcomes. For example, repeated landscape level burns may facilitate understory conditions that develop pockets of advanced oak regeneration, when aided by mechanical removal of the overstory or natural disturbance patterns, allows for successful young forest creation, contributing to the desired composition of oak dominated ecozones. MA Group 3, however, provide opportunities for

large landscape burning, because mechanical treatments are more restricted, that is likely to mimic patterns of natural disturbances across the forest.

Passive management for restoration of old growth forest would occur across all MA Groups and would be the primary focus in MA Groups 3 and 4.

### **3.3.2.2 Forestwide Structure**

#### **Background**

A majority of lands comprising the Nantahala and Pisgah NF today were in private ownership prior to the creation of the National Forests and were significantly impacted by past farming and harvest practices. Practices included burning, clearing for agriculture, and harvesting timber for wood products. Much of the forest land in the 18-county area has been harvested at least once. And because previous harvests occurred over a relatively short time, today's forest is characterized by a relatively uniform age class distribution, with most forest communities originating 80 to 120 years ago. Today, much of the forest is a more uniform age, with the least amounts of both young and old growth forests (Greenberg et al. 2011). About 40% of the Forest is 80-100 years of age, 22% is from 101-120 years of age, and 14% greater than 120 years of age.

Over time, forest ages will become more heterogenous. This will result from both natural disturbance and the transition from past even aged management to silvicultural systems that strive to restore compositional and structural complexity (see the Timber Resources and Fire sections for more).

Diversity of forest age is important because it generally equates to greater diversity in forest structure. Within the forest, the horizontal canopy is a mosaic of different densities and gaps that plays a major role in intercepting radiation in a light limited forest. Varying layers of vertical foliage and tree heights also affects the transmission of light through the forest and helps to control microclimates. Tree size and age are used to estimate growth capacities. Dead wood provides for habitat complexity. Greater variation in these structural components provides for a more diverse and heterogenous forest, which in turn provides a more diverse and heterogenous habitat for forest species.

Generally, active restoration, and some natural disturbance, would transition a portion of the late seral state to young forest and woodlands, while passive management would transition most of the mature late seral states to old forest seral states.

This analysis of forest structure focuses on the three most under-represented seral states on the forest: young forest, old forest<sup>25</sup> closed canopy, and open canopy woodlands. Young forest represents approximately 1% of the current seral state distribution; old forest closed canopy represents approximately 9% of the forest, and open canopy woodlands represent approximately 1%. To advance forest plan desired conditions and provide resilience within the ecozones, each of the structural classes discussed below needs to increase. Increases in these structural states will enhance wildlife habitat characteristics that support diverse, healthy, and resilient wildlife communities.

For each of the three seral states, the analysis uses results from the Spectrum model to estimate the amounts over near and long-range timeframes. This analysis focused on several variables: forest type, canopy condition, age, and moisture. Moisture classes are xeric, moderate, and moist. Table 32 displays

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<sup>25</sup> It is important to distinguish that the old forest discussion in this section relates to forest that has met a minimum age for an old growth state, but may not be functioning old growth forest. Old growth forest contains other important characteristics beyond just age.

model parameters about the relationship among forest types, age, and moisture class that were modeled in Spectrum. Canopies are classified as none or short tree height open; closed; and open (40 to 60% canopy density for xeric and moderate moisture class, and up to 80% for mesic sites.)

**Table 32. Relationships Among Forest Types, Ages and Moisture Classes in Spectrum Model**

Seral State	Xeric Forest Types						Moderate Forest Types			Mesic Forest Types		
	Short-leaf Pine	Shortleaf pine\Hardwood	Dry Oak	Pitch Pine	Pitch/Virginia Pine	White Pine	White Pine/Hardwood	Intermediate Oak	Mixed Hardwood	Spruce Fir	Cove Hardwood	Northern Hardwood
<b>Young</b>	0-20	0-20	0-20	0-20	0-20	0-20	0-20	0-20	0-10	0-30	0-10	0-20
<b>Mid</b>	30-70	30-70	30-70	30-70	30-70	30-90	30-90	30-80	20-100	40-70	20-100	30-80
<b>Late</b>	80-100	80-100	80-100	80-130	80-130	100-130	100-130	90-130	110-140	80-120	110-140	90-130
<b>Old</b>	110+	110+	110+	140+	140+	140+	140+	140+	150+	130+	150+	140+

The Spectrum model uses 10-year (decadal) timesteps, which has been standard practice in the forestry profession. As such, most of the numbers in this section are displayed on a decadal basis. Providing results by decade has limitations when ecosystems transition within a 10-year timeframe, such as when it would otherwise transition at age 35 rather than age 30 or 40. The 10-year timestep also explains the gaps between the end of one seral stage classification and the beginning of another in the rows above. As a result of the 10-year timestep, the spectrum model tends to transition forest types to older ages faster than other ecological models that use annual timesteps.

The environmental sustainability evaluation (ESE) identifies species groups associated with each structural class and evaluates potential impacts of each alternative. A summary of species associated with each structural class is provided in Appendix C. This list is not all-inclusive, but rather includes associated federally listed species and species of conservation concern, proposed focal species, and other closely associated species. This appendix also documents indicators used to analyze potential effects (environmental consequences) for each alternative over 10 and 50 years and composite scores reflecting the overall effect of each alternative on the health and resilience of the species group.

## Young Forest Seral State

### Affected Environment

Young forest is the early stage of development after a stand replacement event, which could be anthropogenic, such as timber harvest, or a natural disturbance event, such as wildfire or extreme winds. Generally, young forest structure contains a well-developed ground or shrub cover, a young tree component, and does not contain a closed, mature tree canopy.

Currently, the Forests contain about 13,000 acres in young forest seral states. Long-term (multiple planning cycles) desired conditions are to have 60,000 to 90,000 acres of forest in this seral state across all ecozones and elevations. Different forest types spend different time periods in the young forests after a stand replacement event. These ages vary from rapidly growing mesic moisture classes, such as rich cove forest at 10 years, to 35 years for slower growing high elevation site ecozones, such as spruce-fir. Age ranges of young forests were estimated using knowledge of forest dynamics, relative productivity of associated sites, growth rate of the dominate tree species, average time the community of tree species reaches canopy closure, and changes in shrub, grass, and herbaceous species dominance.

Species associated with young forest include ruffed grouse (*Bonasa umbellus*), northern bobwhite (*Colinus virginianus*), American woodcock (*Scolopax minor*), field sparrow (*Spizella pusilla*), golden-winged warbler (*Vermivora chrysoptera*), and a host of pollinator species, including the federally endangered rusty-patched bumblebee (*Bombus affinis*). All of these species are experiencing pronounced population declines as quality young forest habitat is lost on the Forests.

Sixty species associated with the young forest structural class were analyzed in the Ecological Sustainability Evaluation (ESE) (Appendix C).

### Environmental Consequences

Alternative A, the current plan as implemented over the past five years, would have the least amount of young forest, and maintain about 1 percent (current condition) of the seral state, which is well below desired conditions for the young forest seral state.

### Effects of the Action Alternatives

Table 33 displays the estimated amount of young forest seral states by action alternative and objective tier over time as generated from the Spectrum model.

**Table 33. Trends of Young Forest Seral States Sustained Over Time for Action Alternatives (average acres/decade over 200 years)**

Tier 1					Tier 2				
Alt	Year				Alt	Year			
	20	50	100	200		20	50	100	200
<b>B,C,D</b>	29,000	43,860	37,220	39,820	<b>B,C,D</b>	72,880	81,120	83,870	85,240
<b>E</b>	22,100	31,400	39,900	43,000	<b>E</b>	58,100	79,700	85,550	89,740

### Effects Common to Alternative B, C, and D

Alternatives B, C, and D have the same desired conditions and objectives and produce the same amount of output, and therefore, can be analyzed together for young forest seral states. Active management processes for creation of young forests in these alternatives are regeneration activities, such as shelterwood with varying overstory removal periods, irregular shelterwood, and group selection.

As shown in the Draft EIS, the young forest seral states vary widely among the planning periods, sometimes almost double the amount from one planning period to the next. These steep increases and decreases are usually due to changes in management activity as calculated in the Spectrum model; however, it would be difficult for management to increase and decrease workforce and budget, and to adapt to forest product market responsiveness in these timeframes. To smooth some of this variation and show general trends of sustainable young forest over the planning horizon, the averages over time are displayed.

The Spectrum modeling results show that there are young forests today that age out of the young forest seral stage over the next 20 years. This is because they are modeled with prescriptions that do not create young forest in the future. Examples of these prescriptions include passive management (known as minlevel in modeling terms), prescribed burning, and sanitation thinning. Table 34 displays estimated acreage that could age out of young forests over the life of the plan (20 years). The estimated total young forest seral state over the life of the plan for Alternatives B,C, and D are shown in

Table 35.

**Table 34. Estimated Amount of Young Forests Over 20 Years That Age Into Mid-Seral States (Alts B,C, and D) (Acres)**

Tier 1			Tier 2		
Alt	Year		Alt	Year	
	10	20		10	20
B,C,D	6,100	900	B,C,D	4,600	800

**Table 35. Estimated Amount of Young Forests Over 20 Years for Alternatives B,C, and D by Tier (Acres)**

Tier 1			Tier 2		
Alt	Year		Alt	Year	
	10	20		10	20
B,C,D	25,000	39,900	B,C,D	64,000	86,600

Under Tier 1 objectives, average per decade amount of young forests does not meet desired conditions. In Alternatives B, C, and D, young forests are created through active management, mostly mechanical regeneration treatments. Approximately 12,000 acres of regeneration acres per decade are modelled in Spectrum. The results from Table EEE and FFF show that with management at Tier 1 levels, the average decadal acreages of young forests do not meet desired conditions.

When a regeneration prescription is assigned in Spectrum, the model continues to manage that land unit over the 200-year planning horizon. Often, this results in multiple regenerations of the same land unit, and therefore, a smaller portion of the land base is used to meet regeneration objectives, rather than the entire forest. The approximate acreage of the forest used to meet Tier 1 objectives for young forest in Alternatives B, C, and D is displayed in Table 36. For Tier 1, approximately 143,000 acres are assigned to regeneration prescriptions. The assumption is that about 143,000 acres of land would be managed

systematically over 200 years in a mosaic of young, mid, and late seral states, and therefore would not advance to old forest seral states. Sustainable management of 143,000 acres in various seral states of young, mid, and late seral states would never reach desired conditions for young forest identified in the plan.

**Table 36. Acres Modeled with Regeneration Prescriptions for Alternative B,C, and D-Tier 1 (Acres)**

Tier 1			
Land Acreage	Alternatives		
	Alt B	Alt C	Alt D
<b>Regeneration</b>	143,700	142,500	143,900

Over the life of the plan (i.e. the next 20 years), young forests would increase, but under Tier 1 would not meet desired conditions. Compared with the current young forest condition of 13,000 acres, these alternatives would increase young forest seral states about 92 percent in 10 years, and about 200 percent in 20 years.

Under Tier 2 objectives, the average per decade acreages of young forests do meet desired conditions within 10 years and throughout the remaining planning horizon. Approximately 32,000 acres per decade of regeneration are modeled in Spectrum, which increases young forests substantially more than Tier 1.

A greater area of the forest is used to accomplish Tier 2 objectives, compared to Tier 1 objectives. The total land assigned for Tier 2, prescriptions for young forest in Spectrum is shown in Table 37. The assumption is that about 274,000 to 296,000 acres would be managed systematically over 200 years in a mosaic of young, mid, and late seral states, and therefore these acres would not advance to old forest seral states. Under Tier 2, Alternatives B, C, and D would reach desired conditions for young forest identified in the plan within 20 years.

**Table 37. Acres Modeled with Regeneration Prescriptions for Alternative B,C,D-Tier 2 (Acres)**

Tier 2			
Land Acres	Alternatives		
	Alt B	Alt C	Alt D
<b>Regeneration</b>	296,100	274,600	278,300

Over the life of the plan for Alternatives B, C, and D (Tier 2), young forest seral states would increase above the current condition at about nearly 500 percent in 10 years and nearly 560 percent in 20 years.

For Alternatives B, C, and D in the DEIS, variable size canopy gaps were modeled as a result of natural disturbance averaging background levels of 7,600 acres per decade under Tier 1 objectives and 3,500 acres with Tier 2 objectives.<sup>26</sup> Most of these gaps were assumed to be <0.15 acres based on a study of the 2005 Lidar (Lewis et al. 2017). Lewis et al. (2017) estimated about 36,000 acres of openings ranging from 0.15 to 747 acres in size but did not identify whether gaps were natural features of the landscape (e.g., rock outcrops, grass balds, watercourses), or resulted from anthropogenic (e.g., timber harvest, roads, etc.) or natural (e.g., wildfire, wind, etc.) disturbance. As these gaps were tracked in Spectrum as a background disturbance, there was no effect on the calculations of the amount of young forest over

<sup>26</sup> The differences between disturbances in Tier 1 and Tier 2 levels are a result of the way the model was designed, and this was corrected in Alternative E.

time. They did not reset the age classes to zero in the model. However, gaps did contribute to the overall constraint that limits young forest to 90,000 acres in the Spectrum model.

Most canopy gaps on the forest are ephemeral. Smaller gaps, such as those created by single and small multiple tree-fall events, can reach canopy closure in as little as two growing seasons, but this rate is related to gap size, shape, and site productivity (Runkle and Yetter 1987). Without regular maintenance to perpetuate early successional and young forest characteristics, openings are lost.

### Effects of Alternative E

The strategy used in Alternative E differs from the other action alternatives to be responsive to public comments received on the DEIS. Many commenters requested higher levels of activity that would create woodlands. In Alternative E, there is more emphasis on creating open canopy woodland states first, and then young forests, in the Spectrum model.

Commenters also request greater levels of prescribed fire. A prescription using prescribed fire that would create patches of young forests by deploying high severity burns in appropriate forest types is included in Alternative E. It is assumed that a small portion of burn units (approximately less than five percent) would create the young forest conditions in xeric and moderate moisture classes.

Comments on the DEIS draft also requested changes in the way the model considers natural disturbance. The Spectrum model was modified for Alternative E to incorporate a prescription for natural disturbances that create young forests. The amount of young forest created by wildfires, storms, and insects/diseases was estimated and tracked in the model. A higher proportion of xeric forest types are affected by wildfires than other moisture classes. Moist site are more affected by storms. Further details of this approach are documented in Appendix D.

Additional disturbance that is added to the model from prescribed fire or natural disturbance is shown in Table 38.

**Table 38. Additional Disturbance Creating Young Forests Over the Life of the Plan (Acres)**

Alt E	Tier 1		Tier 2	
	Year		Year	
	10	20	10	20
<b>Burning</b>	240	400	1,000	1,400
<b>Nat Dist.</b>	1400	3,500	1490	3,600

Estimated total young forest over the life of the plan under Alternatives E is shown in Table 39. Unlike Alternatives B, C, and D, there is no young forest aging out of that seral state in the Alternative E model because these acres are assigned to management prescriptions or natural disturbance.

**Table 39. Estimated Amount of Young Forests Over 20 Years for Alternative E by Tier (Acres)**

Tier 1		Tier 2	
Year		Year	
10	20	10	20
19,670	24,600	46,500	69,700

Under Tier 1 objectives, average per decade acreages of young forests do not meet desired conditions in Alternative E. Average amount of young forests are lower than the other action alternatives in first few planning periods but are higher in the later plan periods. This is due to lower regeneration upper limits

of approximately 10,000 acres per decade in early planning periods to allow prescribed fire to contribute to young forest creation. The output of young forests from prescribed fire in Alternative E is approximately 2-3 percent in the first planning periods, which is lower than the expected value described above. Therefore, most of the prescribed fire does not create young forest, but instead, is devoted to woodland creation.

Table 40 displays the amount of land the model assigned to regeneration prescriptions by moisture class in Tier 1 for Alternative E. For Tier 1, approximately 120,000 acres are assigned to regeneration prescriptions in Spectrum. The assumption is that about 120,000 acres of land would be managed systematically over 200 years in a mosaic of young, mid, and late seral states, and therefore would not advance to old forest seral states. Sustainable management of 120,000 acres in seral states of young, mid, and late would never reach desired conditions for young forest over the 200-year plan horizon.

**Table 40. Acres Modeled with Regeneration Prescriptions for Alternative E, Tier 1 by Moisture Class (Acres).**

Alternative E: Tier 1				
Land Acres	Moisture Class			Total
	Xeric	Moderate	Moist	
Regeneration	27,000	58,700	34,500	120,200

Over the life of the plan (i.e. the next 20 years), young forests would increase but would not meet desired conditions. Compared with the 13,000 acres current condition for young forests, this alternative would increase young forests by about 54 percent in 10 years, and about 92 percent in 20 years.

At Tier 2 levels, the average per decade acreages of young forests is slightly below desired conditions in early plan periods and meets desired conditions throughout the remainder of the planning horizon. Regeneration for young forest averaged approximately 30,000 acres per decade over the planning horizon in the Spectrum model. Prescribed fire for young forest creation averaged about 1,700 acres per decade.

Table 41 displays the amount of land the model assigned to regeneration prescriptions by moisture class in Tier 2 for Alternative E. Under Tier 2, approximately 270,000 acres are assigned to prescriptions for young forest creation. The assumption is that these acres would be managed systematically over 200 years in a mosaic of young, mid, and late seral states, and would therefore not age to old forest seral states. Alternative E (Tier 2) would reach 97 percent of desired conditions acres for young forest within 20 years, and then would meet desired conditions for the remainder of the planning horizon. Xeric moisture class acreages are much lower allocations for young forests because they are generally assigned to prescribed fire prescriptions that would create open canopy woodland conditions.

**Table 41. Acres Modeled with Regeneration Prescriptions for Alternative E, Tier 2 by Moisture Class (Acres)**

Alternative E: Tier 2				
Land Acres	Moisture Class			Total
	Xeric	Moderate	Moist	
Regeneration	41,100	156,800	72,400	270,300



Over the life of the plan, young forest seral states would increase above the current condition at about nearly 260 percent in 10 years and nearly 440 percent in 20 years.

### **Old Forests Closed Canopy Seral State**

Old forest closed canopy seral state is an advanced successional state. Anthropogenic disturbances are generally absent from the successional pathway for old forests closed canopy states. Natural disturbances form gaps that vary in size from single to multiple tree fall gaps, but generally do not change the seral state. Characteristics used in this analysis include the forest type, age, and moisture class. The old forests closed canopy seral state is not the same as “old growth forest” or the “designated old growth network,” which requires an additional set of characteristics included within the seral state described here. An analysis of potential impacts to the designated old growth network is disclosed in a later section of this FEIS.

Table 41 (above) shows the assumptions related the forest type, age, and moisture class for old forests. Currently, the forest has an estimated 95,700 acres that meet the minimum age for acquiring old, closed canopy forests. Long-term (multiple planning cycles) desired condition is to have 306,000 to 379,000 acres of old closed canopy forest across all ecozones and elevations.

Generally, passive management transitions most mature late seral state to old forest seral states. In Spectrum, the “minlevel” prescription is used to model passive management and is the primary driver in the successional pathway to old forests seral states. Sometimes active management activities do not change the seral state, such as following occasional prescribed fire. The analysis that follows considers both acres that age from passive management as well as acres that have modeled active management that still advance to old forest seral states.

Species associated with old forests seral states depend on structural components such as large trees, variable gap sizes, coarse woody debris, and well-developed canopies for all or part of their life cycle.

Eighty-four species associated with old growth forest were analyzed using the Ecological Sustainability Evaluation Tool (ESE), including cerulean warbler (*Setophaga cerulea*), black bear (*Ursus americanus*), upland salamanders, lichens, and bryophytes.

### **Environmental Consequences**

The complex relationship between forest tree species, site quality, and insects and disease, becomes more influential as trees reach old age (Manion 1991). As trees (and forests) age, forest health becomes more important and more apparent. For example, on poorer quality sites the interaction between shorter lived oak tree species (e.g. scarlet, black), drought, and secondary agents like root diseases may allow oak decline to express itself more. At older stages of forest development, certain levels of gap phase forest structure development are expected and desired. It should be noted the gaps will increase across the forest as it ages, and the interaction with non-native damage agents is likely to increase (see the forest health section). Given that a high proportion of the forest is aging into old forest seral states, monitoring forest health conditions is increasingly important.

### **Common to all alternatives**

Under all alternatives, the amount of the old forests closed canopy seral states increases steadily over time.

### **Alternative A**

Under Alternative A, the old forest closed canopy seral state would increase over time to more than 80 percent of the forests because of the low level of active management.

### **Alternatives B, C, D, and E, Passively Managed Areas**

For the action alternatives, Table 42 displays the estimated amount of old forests closed canopy seral state by alternative and tier over time that is driven by passive management. Under Tier 2 objectives, a lower amount of this seral state is estimated because of the relatively higher amount of active management desired.

**Table 42. Amount of Old Forest Closed Canopy Seral States from Passive Management Over Time by Action Alternative (Acres)**

Tier 1					Tier 2				
Alt	Year				Alt	Year			
	20	50	100	200		20	50	100	200
<b>B</b>	158,635	440,742	745,013	791,836	<b>B</b>	93,098	211,687	388,660	407,190
<b>C</b>	161,266	429,727	738,201	790,434	<b>C</b>	128,181	290,288	474,382	500,107
<b>D</b>	161,835	440,461	747,325	792,710	<b>D</b>	101,277	223,509	395,586	413,616
<b>E</b>	146,810	393,007	664,946	690,436	<b>E</b>	56,881	152,773	322,265	330,785

Under Tier 1 objectives, the amount of old forest closed canopy seral states that develop from passive management increase substantially over time. Modeling results show old forests in xeric and moderate moisture classes increase faster, with the largest increase between 20 to 50 years, whereas the moist forests would increase most from 50 to 100 years. Alternative E has fewer acres in this seral state than other alternatives due to the higher amount of active management, mostly resulting from increased prescribed fire. As such, Alternative E has lower amounts of passive management primarily in the xeric moisture class where much of the prescribed fire prescription is assigned. However, there is a caveat here: in some instances for Alternative E where prescribed fire has opened the canopy, it may revert to a closed canopy state if prescribed fire is not applied repeatedly. This is discussed further in the open canopy woodland section below. Relatively small canopy gaps would occur in all the moisture classes, but more frequent on moist forest lands. Gaps add structural diversity to the old forest seral states.

Under Tier 2 objectives, old forest closed canopy seral states that develop from passive management substantially increase on moist forests between 50 to 100 years and on xeric and moderate moisture classes between 20 and 50 years. Due to the relative high amount of active management on xeric forests compared with other action alternatives, Alternative E has less in this seral state, and generally does not increase over time. On moderate moisture class forests, Alternative C has higher amounts over time compared with other action alternatives, most likely due to the distribution of more passive management areas (e.g. Management Area Group 3) in this alternative. Gaps would occur but the combined amount would be less than Tier 1 because of the lower acreages in old forest closed canopy seral states.

Table 43 displays the amount of land in the Spectrum model where passive management occurs under Alternatives B, C and D Tier 1 objectives. Land allocations in Spectrum where vegetation management is undisturbed by humans or generally lightly disturbed by humans but where natural disturbances are likely is approximately 800,000 acres of land for Tier 1 in Alternatives B, C and D. This passive management strategy would generally reach desired conditions for old forest closed canopy identified in the plan in less than 50 years and would continue to age over time to more than desired over the 200-year planning horizon. There would be some reduction of this seral state due to natural disturbances that are not modelled in Alternative B, C, and D, but would be similar to natural disturbances as shown in Alternative E.

**Table 43. Acres Modeled with Passive Management Prescriptions for Alts B,C, and D, Tier 1 (Acres)**

Tier 1			
Land Acres	Alternative		
	B	C	D
Passive Mgmt.	806,100	805,400	807,280

Table 44 displays the amount of land in the Spectrum model where passive management occurs under Tier 2 objectives in Alternatives B, C, and D. Land allocations in Spectrum where vegetation management is undisturbed by humans or generally lightly disturbed by humans but where natural disturbances are likely range from 407,000 to 500,000 acres of land for Tier 2 in Alternatives B, C, and D. This passive management strategy would generally reach desired conditions for old forest closed canopy identified in the plan within 100 years, and would continue to age, but would be slightly higher than desired over the 200-year planning horizon.

**Table 44. Acres Modeled with Passive Management Prescriptions for Alts B,C, and D, Tier 2 (Acres)**

Land Acres	Alternative		
	B	C	D
Passive Mgmt.	407,000	500,000	414,000

Table 45 displays the amount of land in the Spectrum model where passive management occurs under Tier 1 objectives in Alternative E. In this alternative, the total amount of land that the model assigned to undisturbed by humans or generally lightly disturbed by humans but where natural disturbances are likely is approximately 707,000 acres of land in Tier 1. This passive management strategy would also reach desired condition before 50 years and be more than desired by the end of the planning horizon.

**Table 45. Acres Modeled with Passive Management Prescriptions for Alternative E Tier 1 (Acres)**

Alternative E: Tier 1				
Land Acres	Moisture Class			Total
	Xeric	Moderate	Moist	
Passive Mgmt.	115,100	308,200	284,000	707,300

Table 46 displays the amount of land the Spectrum model where passive management occurs under Tier 2 objectives in Alternative E. For Alternative E, the land allocations in Spectrum where vegetation management is undisturbed by humans or generally lightly disturbed by humans and where natural disturbances are likely is approximately 342,000 acres of land for Tier 2. This passive management strategy would also reach desired condition within 100 years and continue to be in the desired state over the 200-year planning horizon.

**Table 46. Acres Modeled with Passive Management Prescriptions for Alts E Tier 2 by Moisture Class (Acres)**

Alternative E: Tier 2				
Land Acres	Moisture Class			Total
	Xeric	Moderate	Moist	
Passive Mgmt.	22,700	81,800	237,600	342,100

### Action Alternatives, Actively Managed Acres

Under Tier 1 objectives, the amount of old forest closed canopy in Spectrum allocations in active management generally increases in the 20 and 50 years and then decreases over time. This is generally due to the timing of prescribed fire for Alternatives B, C, and D where burn prescriptions are assumed to occur early in a plan period but decrease over time. Therefore, most of the timing of burning and results in these alternatives occurs in the first 50 years.

Under Tier 2 objectives, since prescribed fire does not change the seral state, increases in prescribed fire in Alternative E would also allow more late seral states to age into old forest over time for all alternatives. As discussed above, one caveat would be if prescribed fire has opened the canopy, it may revert to a closed canopy state if prescribed fire is not applied repeatedly. Due to specific model adjustments for Alternative E and the substantial increases in prescribed fire, the amount of old forest remains relatively high throughout the plan horizon in comparison with other action alternatives.

Table 47 displays the estimated amount of old forests closed canopy in active management prescriptions that continue to age over time. Examples of these management prescriptions are sanitation thinning and prescribed fire.

**Table 47. Amount of Old Forest Closed Canopy Seral States Over Time (Acres) by Action Alternative and Tier.**

Tier 1					Tier 2				
Alt	Year				Alt	Year			
	20	50	100	200		20	50	100	200
<b>B</b>	31,900	22,900	4,600	3,900	<b>B</b>	79,600	173,000	9,100	9,200
<b>C</b>	30,900	31,300	5,900	4,900	<b>C</b>	51,500	42,100	2,800	2,800
<b>D</b>	29,100	22,500	4,700	4,000	<b>D</b>	73,400	152,570	9,700	10,000
<b>E</b>	37,300	35,700	9,900	11,400	<b>E</b>	107,000	113,000	64,500	99,800

### Open Canopy Woodlands

Open canopy woodlands are described as having a canopy density of 40-80% in fire-adapted oak and pine types. Pine types and dry oak have a more open structure, from 40-60%, while the more moderate and mesic oak types vary from 50-80% canopy cover. This structure provides for greater grass and herb diversity, typically with greater density within lower canopy densities.

Open woodland conditions are likely the largest deficit in eastern forests because they are a challenge to develop and maintain under current disturbance regimes and anthropogenic influences (Hanberry et al. 2018, Lorber et al. 2018).

The Buck Creek Serpentine Barrens (approximately 500 acres) are the only known managed woodlands on the Forests. In this area, it took approximately 15 years to reach an open canopy woodland condition. Long-term (multiple planning cycles) desired conditions are to have 360,000 to 480,000 acres of forest in open canopy woodlands, primarily across fire-adapted ecozones.

It is assumed that it takes repeated prescribed burning to develop woodland conditions. Open canopy woodlands take longer to develop than other types of restored forest structure. It is likely that the best combination of restoring open canopy woodlands would be through mechanical and or chemical operations followed by repeated application of prescribed fire. Mechanical and chemical treatments

provide higher likelihood of achieving desired composition than using prescribed fire alone, especially in mesic and dry mesic ecozones. If off-site species (e.g., red maple or white pine) are already well-established within the understory or main canopy, then mechanical removal and chemical control of hardwood species sprouting may be necessary prior to burning sites to prevent new establishment of non-desirable species and enhance understory conditions.

Species associated with open canopy woodlands are those that depend on a structure, as defined above varying by ecozones, that are typically created by repeated disturbance events including prescribed fire or wildfire. Grasses and herbs, such as many members of the aster and legume families, thrive under these conditions providing more optimal habitat for many common and rare pollinator species such as tawny crescents (*Phyciodes batesii maconensis*) or federally endangered rusty-patched bumblebee (*Bombus affinis*). Eighty-five species associated with woodland conditions were analyzed using the Ecological Sustainability Evaluation (ESE), including ruffed grouse (*Bonasa umbellus*), bobwhite (*Colinus virginianus*), wild turkey (*Meleagris gallopavo*), white-tailed deer (*Odocoileus virginianus*), and a host of rare herbs.

## Environmental Consequences

### Alternative A

Under Alternative A, there is no management direction to restore and maintain open canopy woodlands.

### Action Alternatives

Table 48 displays the estimated sustainable amount of open canopy states for the action alternatives restored and maintained by active management. This classification assumes that prescribed fire is applied frequently enough to restore the ecological zone, followed by repeated periodic burning for maintenance. This can be accomplished by thinning and burning, followed by repeated periodic burning in the future. Table 48 estimates do not factor in forest age because regeneration of woodlands was not modeled at this time. However, where woodlands continue to age, then most of the open canopy woodlands would be in the old seral state by the end of the planning horizon.

In Alternative E, another category of woodlands was estimated: ephemeral woodlands. Ephemeral woodlands are created by active management or natural disturbances and are not maintained through repeated or periodic burning. Gap clusters, which are small gaps that occur at high densities for a given area and appear to be in a woodland-like condition are one example. This analysis assumed that wildfire creates woodland like conditions that are ephemeral because repeated periodic fire on the same area is not assured. This is discussed further in effects of Alternative E.

Between the draft and final EIS, adjustments for all action alternatives were made to open canopy states computed in Spectrum to provide greater accuracy by using updated assumptions. These adjustments included incorporating several burns within a decade by forest type prior to achieving open conditions and the assumption that landscape level burns would also impact mesic sites peripherally, although these are not the primary emphasis of prescribed fire. More detail about the open forest assumptions is contained in the Fire and Fuels Section of Appendix B.

**Table 48. Open Canopy Woodlands Meeting “Restored and Maintained” Conditions (Average Acres/Decade Over Time) by Alternative and Tier**

Tier 1: Open Canopy States					Tier 2: Open Canopy States				
Alt	Year				Alt	Year			
	20	50	100	200		20	50	100	200
B,D	740	16,430	29,410	35,670	BD	3,860	42,720	78,995	97,090

Tier 1: Open Canopy States					Tier 2: Open Canopy States				
Alt	Year				Alt	Year			
C	950	17,820	30,060	35,890	C	4,390	49,850	79,960	94,580
E	19,496	60,505	79,546	85,635	E	35,530	140,023	176,077	187,450

### Effects Common to all Action Alternatives

Restoration and maintenance of open canopy woodlands is challenging and more difficult to reach desired conditions than any other forest state. One possible reason is that the conditions have changed so much due to human influence. Before European settlement, forest lands were more contiguous, and therefore, fire compartments were much larger than today. Wildfires were more widespread. Today, land development, fire suppression, smoke management and other laws, regulations and policies have restricted the widespread use of fire. Therefore, meeting a sustained level of open canopy conditions that meets desired conditions is not attainable over the planning horizon given the assumed levels of prescribed and wildfires.

To sustain a level of 360,000 acres of open canopy woodland, approximately 500,000 acres would need to be burned on a cycle of 75,000 or more acres per year. That is 10 times more than recent accomplishments on the forest, and more than the current levels in this analysis. For this planning cycle, the assumption is that this level of prescribed fire sets unrealistic expectations for reasons described above. Based on this analysis, it would be difficult in modern times to return to estimated NRV acres for open woodlands because of challenges doing prescribed fire at this scale, including burn barriers, smoke management, and land ownership patterns.

### Effects Common to Alternative B, C, and D

Under Tier 1 objectives, prescribed fire would be applied to 6,500 to 10,000 acres per year. At this level, the desired conditions would not be achieved throughout the plan horizon. Thin and burn actions were not emphasized in Alternatives B and D. There were no thin and burn actions in the first 20 years and over the 200-year planning horizon, the average would be about 100 acres per year. Alternative C did have thin and burn in first 20 years and therefore the amount of open states is slightly higher compared with Alternatives B and D.

Under Tier 2 objectives, prescribed fire would be applied to an increased acreage of between 10,000 and 20,000 acres per year. This increase use of prescribed fire provides for higher amounts of open canopy states but does not reach desired conditions over the planning horizon. Thin and burn actions were not emphasized and none would occur in the first 20 years in Alternatives B and D. However, Alternative C does have thin and burn applied over the first 20 years and has a higher amount of open states compared with Alternatives B&D.

Table 49 displays the amount of forest acreage assigned prescribed fire management in Spectrum. As described above, adjustments were made outside the model to estimate more realistic outputs reflected in Table 48 above. This discloses the difficulty in Spectrum to impute the complex assumptions for restoring woodlands. It not only difficult to restore and maintain woodlands but also to model. Spectrum assigned land to prescribed fire when only one prescribed fire occurred, and the adjustments were made to account for repeated prescribed burning.

**Table 49. Acres Modeled with Prescribed Fire Prescriptions (Unadjusted) for Alternatives B, C, and D, Tiers 1 and 2**

Tier	Land Acreage	Alternatives		
		Alt B	Alt C	Alt D

Tier	Land Acreage	Alternatives		
1	Burning	79,700	84,500	76,600
2	Burning	315,000	224,400	305,700

### Effects of Alternative E

Under Tier 1 objectives, prescribed fire is applied to between 10,000 to 20,000 acres per year. AS a result of a new objective added for this alternative, thin and burn actions would occur over the first 20 years at more than 500 acres per year. This increase in restoration activities provides for higher amounts of open canopy states, compared with other action alternatives, but would not reach desired conditions over the planning horizon.

Under Tier 2 objectives, the amount of prescribed fire increases above Tier 1 to between 20,000 and 45,000 acres per year. Thin and burn actions would occur over the first 10 years at more than 750 acres per year and progressively increases over the planning horizon. This increase in restoration activities provides for higher amounts of open canopy states over Tier 1 objectives, as well as when compared to Tier 2 of Alternatives B, C, and D, but would not reach desired conditions over the planning horizon.

Table 50 displays the modeled acres assigned for prescribed fire allocations in the Spectrum model. As cited above, adjustments were made to open canopy woodlands for all alternatives between the DEIS and FEIS based on updated assumptions. Comparing Table 50 with Table 49 at 200 years, there is approximately 60,000 acres less in prescribed fire prescriptions in Tier 1 and about 172,000 acres less in Tier 2. Table 50 also points out one other adjustment, that moister areas would have some level of burn due to the interspersed of xeric, moderate, and moist lands relative to each other. This assumption is listed above.

**Table 50. Acres Modeled with Prescribed Fire Prescriptions (Unadjusted) for Alternative E, Tiers 1 and 2**

Alternative E					
Tier	Land Acres	Moisture Class			Total
		Xeric	Moderate	Moist	
1	Burning	101,300	45,600	0	146,900
2	Burning	185,000	173,900	0	358,900

In addition to thin and burn activities, Alternative E considers the effect of ephemeral woodlands. Ephemeral woodlands are short-term open canopy states, where canopy closure occurs due to the absence of repeated prescribed fire or natural disturbances. The analysis assumed that there is a constant flow of canopy openings and subsequent canopy closures happening across the forests. The analysis assumed that when small gaps occur near each other, areas of woodland-like structure can be created. For example, wildfires create gap clusters that are woodland-like structures. These areas can provide similar benefits as sustained open canopy woodland as described above; however, these areas are temporary since they are not maintained by repeated burning. As a result, ephemeral woodlands difficult to quantify and more difficult to predict in the future. A review of the 2005 Lidar estimated for the DEIS that approximately 16,000 acres of ephemeral woodlands existed at that time.

Using preliminary estimates from wildfire data, it is assumed that at least 1,000 to 12,000 acres of ephemeral woodlands could occur at any time. These estimates are low because it is likely that other natural disturbances could create ephemeral woodlands, such as gaps from insect and disease, but those

data were not available for analysis at this time. Even though the ephemeral woodlands are cycling constantly, they augment the amount that is restored and maintained.

### **Cumulative Effects**

Cumulative effects of young forest seral state, open canopy woodlands, and old forest seral states are estimated in this section.

### **Young Forest**

The past, present, and likely futures of young forest are analyzed across the 18-county planning area. A review of FIA data for the same 18-county study area shows about 2.3 million acres of privately owned timberland. FIA has 2 categories: forestland and timberland, defined as follows:

- *Forestland.* Land at least 120 feet (37 meters) wide and at least 1 acre (0.4 hectares) in size with sparse trees capable of achieving 16.4 feet (5 meters) in height with a tree canopy cover of 5 to 10 percent combined with shrubs at least 6 feet (2 meters) in height to achieve an overall cover of greater than 10 percent woody vegetation. Trees are woody plants having a more or less erect perennial stem(s) capable of achieving at least 3 inches (7.6 cm) in diameter at breast height, or 16.4 feet (5 meters) at maturity in situ.
- *Timberland.* Forest land that is producing or capable of producing 20 cubic feet per acre or more per year of wood at culmination of mean annual increment. Timberland excludes reserved forest lands.

Timberland is a sub-category of forestland that excludes reserved forest lands. Therefore it is assumed young forests are more likely to occur on private lands in this sub-category. There are a few impacts for young forest creation from working rural forests on private lands. Land development has directly impacted the amount of working rural forests in the South. Indirect impacts on forest lands result from becoming fragmented into smaller blocks by roads, houses, and businesses and affects the ability to conduct forestry operations, including prescribed fire. Other indirect impacts are that forest landowners are changing and many new owners want to manage forests for aesthetic or cultural objectives rather than a working rural forest that produces young forests. (Planning for the Future of Southern Forests, USDA, 2010).

Figure 34 shows estimated existing acreages by age class for private and public timberlands over the 18-county study area. Approximately 3.4 percent of private timberlands are within 10-year age class and about 7.3 percent within the 20-year age class. About 2.7 percent of both public and private timberlands are within 10-year age class and about 3.3 percent are within 20-year ages. It is uncertain whether private lands would maintain the amount of young forest into the future. However, on Forest Service under Tier 2, the percentage of young forest contribution to western NC would rise.



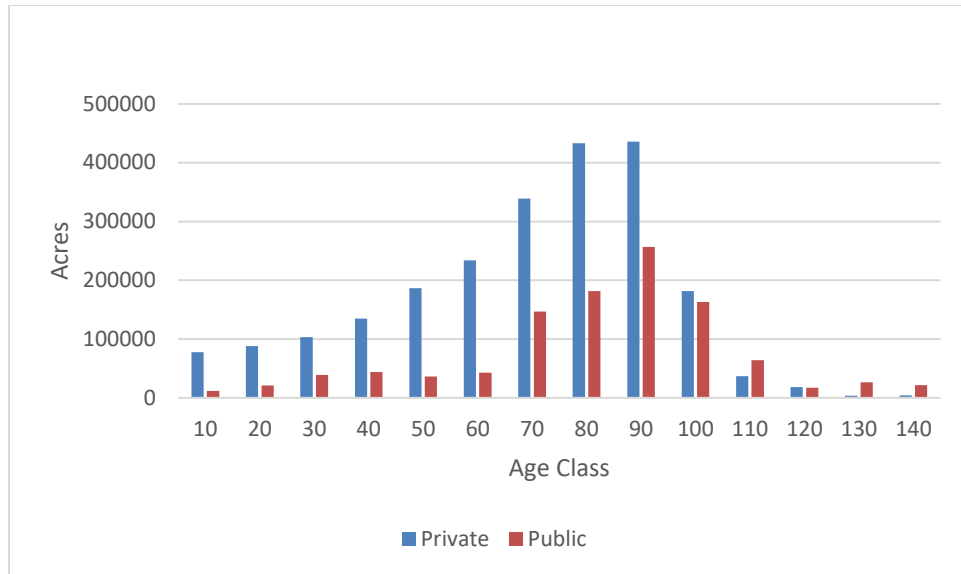


Figure 34. Age class distribution on private and public timberlands in the 18-county study area (Source: FIA data viewer)

### Old Forest Closed Canopy Seral State

*Western NC scale.* Chart www shows the age class distribution of forest land, which includes forest reserves. Within the 18-county study area, forest land on private lands comprises approximately 2.3 million acres and about 1.4 million acres on public lands. Private lands have a high proportion in the 70- to 90-year age classes. Should private landowner objectives change enough toward aesthetic, cultural, or recreational purposes, more private forest land would age to older forest seral states; however, substantial amounts would not age for another 50 years or longer. Currently, less than 2 percent of the forestland in the 18-county study area is 130 years or greater in age.

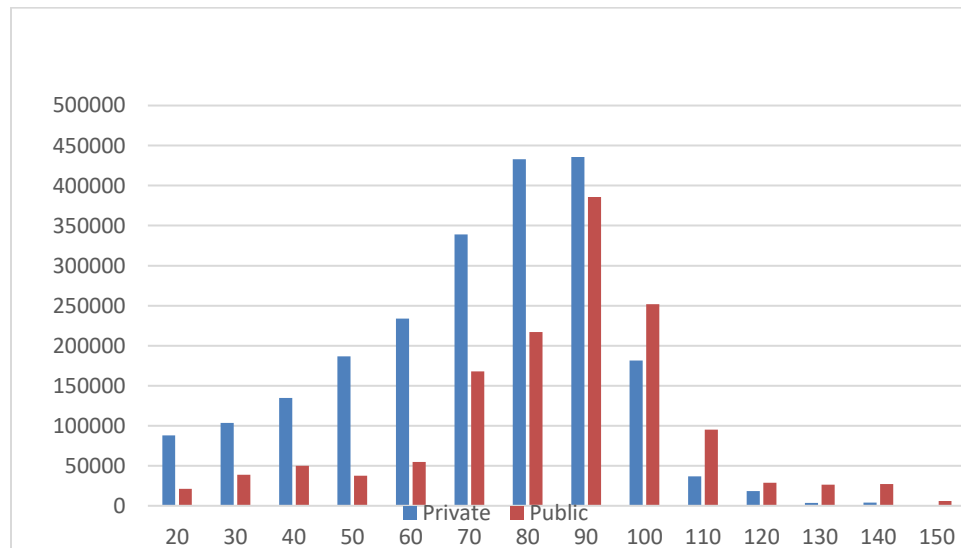


Figure 35. Age class distribution on private and public Forestlands across the 18 county study area

### Open Canopy Woodlands

Open canopy conditions would occur most frequently in fire-adapted ecozones. To create open canopy woodlands with a diverse grass forb layer requires fire. Wildfire can create open canopy woodlands but only temporarily as the canopy closes without frequent fire. A sustained amount of prescribed fire is

needed to maintain woodland conditions. With recurrent burns the understory layer, in particular the grass forb layer is much more diverse (Bowles, Jacob, and Mengler 2007, Aldrich et. al, 2010, Gasgow and Matlack 2007, Reilly, Wimberly, and Newell 2006).

Today, land development, fire suppression, smoke management and other law, regulations and policies have restricted the widespread use of prescribed fire. Benefits of prescribed fire are becoming more accepted among landowners and its use is becoming more widespread.

The amount of fire-adapted systems across the 18-county study area is approximately 2,490,000 acres, which is about 52% of western NC. Of the fire adapted ecological types across western NC, approximately 520,000 acres (20%) are on the national forests. These figures are ecological potential conditions (ecozones) and should not be confused with existing conditions. In 2019, approximately 14,000 acres were prescribed burned, about 9,000 acres were conducted by USFS and around 5,000 by state agencies, with the majority (about 3,500 acres) conducted by NC Forest Service (unpublished data, Margit Bucher). Under Tier 2, the Forest Plan would increase that amount of burning by more than 3 times with the expectation of restoring about 187,000 acres of fire adapted ecozones over the planning horizon.

### 3.3.2.3 Ecozones

This portion of the analysis evaluates the effect of alternatives on ecozones. As part of the plan revision process, eleven ecozones have been mapped across western NC (see above).

The proposed plan includes several plan components that provide management direction by ecozone. The Terrestrial Ecozones desired conditions include a description of key characteristics for each ecozone, including composition, structure, processes, disturbance gap sizes, community patch sizes and example wildlife species. The Proposed Plan also includes the modeled Natural Range of Variation structural classes by ecozone. Restoration priorities outline desired fire return intervals for restoring or maintaining fire-adapted ecozones (see Fire). Management approaches prioritize restoration of shortleaf pine, dry-mesic oak, spruce fir, mesic oak, dry oak, and pine-oak/heath ecozones to return these systems to their natural composition, structure, and function.

As context for this analysis, the affected environment includes an introduction to each ecozones as provided below, including a description of its extent and location on the forest.

Next, the composition of each ecozone is described, followed by an explanation of how the ecozone is impacted by both passive and active management. *Passive management* occurs when no action or activity is planned, allowing for forest dynamics to proceed subject to natural disturbances only. Passive management may be best at developing late and old growth structural conditions but is limited in its ability to address the composition and function of contemporary forests that are the result of historical disturbances and modifications to the environment (Deyer and Hutchinson 2019, Webster et al. 2018). *Active management* is defined as strategies where actions are planned to facilitate the advancement toward desired conditions and to restore and maintain ecological characteristics (increased diversity) and function (adaptability) that are degraded or damaged (Webster et al. 2018, Kern et al. 2016, Crow 2014, Puettmann 2014).

Each ecozone analysis considers potential effects of proposed plan components on associated plant and animal species. The analysis includes a summary of species associated with each ecozone, indicator measures used to analyze effects to the species group, and environmental consequences represented by ecological sustainability scores of the species group over 10 and 50 years for each alternative.

The existing condition for the Ecological Sustainability Score is provided as a baseline for alternative comparison. While continued implementation of the current plan (Alternative A) is considered in the

analysis for Ecological Sustainability Scores, this analysis and narrative primarily focuses on the action alternatives, because management for ecozones is not part of management framework for the current plan.

Appendix C provides descriptions of Ecological Sustainability Score indicators and values and a list of species associated with each coarse filter element (ecozones, unique habitats, and species groups). Each list of species is not all-inclusive but rather includes all associated federally listed species and species of conservation concern, proposed focal species, and other closely-associated species. Ecological sustainability scores were generated to reflect the overall effects of each alternative on the health and resilience of the coarse filter element.

The eleven ecozones on the Nantahala and Pisgah NFs are organized into groups based on elevation and/or vegetation as follows:

- High Elevation Forests – spruce-fir and northern hardwoods;
- Montane Oak Forests – high elevation red oak, mesic oak, dry-mesic oak, dry oak;
- Cove Forests – acidic cove and rich cove;
- Pine Forests – pine oak/heath, low elevation pine;
- Floodplain forests.

## **High Elevation Forests**

### **Introduction**

Spruce-fir and northern hardwood forests occur at the highest elevations on the Nantahala and Pisgah NFs. Together, these ecozones comprise approximately 70,000 acres, or about seven percent of the Nantahala and Pisgah NFs. Spruce-fir forests occupy about 16,000 acres, and northern hardwood forests approximately 54,000 acres. Due to past land use, it is likely that the organization of these two communities (along with high elevation red oak forests discussed in the montane oak section) has shifted and overlap significantly. Both communities share many common overstory tree species and high elevation species such as the Carolina northern flying squirrel (*Glaucomys sabrinus coloratus*) that depends on both for optimal habitat.

### **Spruce-Fir Forest**

#### **Affected Environment**

The spruce-fir ecozone occurs on the highest mountains at all exposures and topographic positions, generally from 4,500 to over 6,000 feet in elevation (Schafale 2019). Moisture content is not limiting and is present from fog deposition and ambient rainfall. Soils vary from shallow rocky substrates where Fraser fir dominates to deeper loamy soils with a well-developed organic layer for mixed spruce-fir forest. Low temperatures, high winds, hoar frost, and ice are important natural disturbances influencing this ecozone.

This ecozone ranges from Western North Carolina and eastern Tennessee to the southern Virginia and West Virginia Mountains (NatureServe 2021). Fraser fir dominated forests typically only occur above 6,000 feet in elevation, while the combination with red spruce can extend down to 4,500 feet in elevation (Schafale and Weakley 1990, Schafale 2019). This ecozone is rare across Western North Carolina, where it covers about 15,500 acres (1.5%) of the Nantahala and Pisgah NFs. All of the subtypes of this group are globally ranked G1, critically imperiled, or G2, imperiled (NatureServe 2021).

#### **Composition**

Various plant community associations have been delineated within this ecozone. Separate rhododendron and herb Fraser fir subtypes occur on the Nantahala and Pisgah NFs. Six subtypes occur across the Forests within mixed red spruce and Fraser fir forests: 1) herb-dominated, 2) mixed rhododendron-

dominated, 3) boulderfield, 4) birch transition herb, 5) birch transition shrub, and 6) *Rhododendron maximum* subtype occurring at the lowermost extent of the zone (NatureServe 2021, Schafale 2012, Watson-Cook 2017). In some areas, Fraser fir-dominated forests are less abundant and have been replaced with red spruce due to canopy tree mortality resulting from balsam woolly adelgid. Shrub density is variable with generally low herb diversity. Bryophyte, moss and liverwort diversity is high within this ecozone.

The uneven-aged structure that was likely present in large portions in the spruce-fir ecozone pre-European settlement was drastically altered during the intensive harvesting in the early 20th century (Pyle and Schafale 1998). In many areas, logging and fires allowed for expansion of hardwood forests (Nowak et al. 2010) onto spruce-fir sites. The mature even-aged structured spruce-fir forest that developed after the era of intensive harvesting and wildfires was subsequently altered a second time following the infestation of Fraser fir by the balsam woolly adelgid (Dull et al. 1998; Smith and Nicholas 1999). Balsam woolly adelgid is still impacting these forests.

Under passive management, the spruce-fir ecozone would likely increase in red spruce and northern hardwood species like yellow birch, with less Fraser fir in openings caused by the balsam woolly adelgid and other disturbances. Red spruce is also likely to expand its presence, at higher and lower elevations where it occurred historically. Herbaceous diversity would continue to be sparse within the spruce-fir ecozone which has a greater dominance of bryophytes and lichens than northern hardwood.

Under active management, planting red spruce and Fraser fir would be used to recover the compositional diversity. Thinning and release, various uneven-aged, and limited even-aged treatments will be beneficial to the structural and compositional development as well as creating more diverse habitat conditions for endangered species and species of conservation concern such as the Carolina northern flying squirrel and golden-winged warbler. Work with our partners may identify more opportunities for red spruce restoration where it occurred historically or where it can function in stream corridors in the absence of eastern hemlock. Considering the limited canopy manipulations, herbaceous diversity and nonvascular diversity should be similar to that which occurs under passive management. The greatest risk for non-native invasive plant species would be where rare communities such as grassy balds or manipulated openings, such as maintained meadows occur.

### **Wildlife habitat**

Spruce-fir habitats in North Carolina provide critical breeding habitat for many land birds, several of which are likely endemic to these high peaks (Pashley et al. 2000, Rich et al. 2004, Johns 2005), including the northern saw-whet owl (*Aegolius acadicus*), red crossbill (*Loxia curvirostra*), and olive-sided flycatcher (*Contopus cooperi*). Many landbird species that occupy spruce-fir habitats also occupy northern hardwood and high elevation red oak habitats. That is, they require habitat characteristics associated with higher elevation habitats rather than specific structural or compositional features of spruce-fir forests. Therefore, there is some overlap between this section and the northern hardwood and high elevation red oak sections.

Additionally, spruce-fir forests provide essential habitat for several animal species found nowhere else in North Carolina, including the northern pygmy salamander (*Plethodon organi*), and Weller's salamander (*P. welleri*), and the federally endangered Carolina northern flying squirrel (*Glaucomys sabrinus coloratus*) (CNFS) and spruce-fir moss spider (*Microhexura monitvaga*).

### **Associated species**

One hundred-fourteen plant and animal species are associated with spruce-fir forests in the Ecological Sustainability Evaluation, including eight federally listed species, forty-five Species of Conservation concern, and fourteen focal species. Species associations are identified in Appendix C. Species

associations are not meant to be all-inclusive, but rather a broad enough representation to assess potential effects at the coarse filter (i.e. ecozone) level.

### Environmental Consequences

Environmental consequences for each alternative considered in detail were estimated for five indicators of spruce-fir forest ecosystem health and resilience using the Ecological Sustainability Evaluation tool (ESE): (1) canopy composition as measures of forest species' composition, (2) total road density as a measure of forest fragmentation and connectedness, and (3) percent young forest, (4) percent old forest structural class, and (5) percent affected by balsam woolly adelgid. Ecological sustainability scores were generated to reflect overall effects of each alternative on the health and resilience of the spruce-fir forest ecosystem. Appendix C provides a list of these indicators and values.

The spruce-fir ecozone acres are distributed across the MA Groups in the following way:

**Table 51. Distribution of Spruce-Fir Ecozones Across Management Area Groups**

Management Area Group	Alt B (Acres)	Alt C (Acres)	Alt D (Acres)	Alt E (Acres)
MA Group 1	1,689	1,431	1,604	1,517
MA Group 2	1,085	1,124	1,216	719
MA Group 3	5,554	9,688	5,583	9,109
MA Group 4	7,201	3,287	7,172	4,182

See Management Area Plan Components section for a description of the Management Areas that fall within each management area group.

Spruce-fir forest restoration is not incumbent on activities occurring in a particular MA group. Areas prioritized for spruce restoration in the plan area include Flat Laurel Creek, Graveyard Fields and Roan Mountain. Therefore, one alternative's allocation is not better than another for achieving restoration objectives in this ecozone.

**Composition:** Under all alternatives, vegetative composition is estimated to improve slightly in this ecozone over time. The estimated proportion of this ecozone with characteristic vegetation is expected to follow forestwide trends which is maintained at current levels over 10 years and improves over 50 years under all alternatives. In the action alternatives, most of this ecozone is in passive management area groups (MA Groups 3 and 4). It is assumed that composition would be enhanced primarily through supplemental plantings and release of red spruce and Fraser fir.

**Structure:** Young forest trends for spruce fir ecozone differ from forestwide trends in that young forest would be maintained at current levels under all alternatives. Most young forest conditions would be created through passive management (i.e., natural disturbances) and canopy openings created by the balsam woolly adelgid, and potential group selection harvests that would occur with action alternatives using Tier 2 objectives.

The amount of old forest structural class follows forestwide trends over a 50-year period but would likely be stable or slightly decrease over 10 years due to impacts from the balsam woolly adelgid. This is because over time, the late and old growth structural classes would be recruited faster than the adelgid can impact the trees.

**Threats:** The balsam woolly adelgid will likely impact 30% of this ecozone under all alternatives. However, some of this impact may be favorable from a forest structure perspective because canopy openings in dense patches would be created. Open road density is approximately 0.42 mi/mi<sup>2</sup> in the

spruce-fir ecozone and is not expected to increase under any of the alternatives. The risk of invasive species spread from open roads is less in the spruce-fir ecozone compared to other ecozones because there is lower road density in spruce-fir. The high elevation zone and the primary evergreen cover discourages most non-native invasive plants. This ecozone is also especially vulnerable to changes in climate.

**Ecological Sustainability Score:** The ecological sustainability score for the spruce-fir ecozone is currently ranked as ‘good’ and would maintain the rating over time under all alternatives. All alternatives improve in score with a greater value within the ‘good’ rating after 50 years. This improvement is because balsam woolly adelgid is staying active and creating pockets of young forest, while other portions of the forest are aging to old growth conditions, thus moving toward a more diverse forest age class. Based on the ecological sustainability scores, plant and animal species associated with spruce-fir forests would persist and potentially expand due to increased suitable habitat following multiple planning cycles under all alternatives.

Indicator Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Percent of ecosystem exhibiting old growth conditions																			
Percent of ecosystem exhibiting young forest conditions																			
Percent of the ecosystem dominated by the ecologically characteristic canopy																			
Percent of the ecosystem impacted by balsam woolly adelgid																			
Total open road density within the spruce-fir forest ecosystem																			
Spruce Fir COMPOSITE SCORE																			

Figure 36. NPESE element ecological sustainability score, by alternative, for the spruce-fir forest ecosystem  
Red- poor, yellow- fair, light green- good, dark green- very good

### Northern Hardwood Forest

The northern hardwood ecozone typically occurs between 4,000 feet and 5,500 feet in elevation. The northern hardwood forest ecozone includes two broad types that occur under separate environmental conditions. Northern hardwood coves (separated by rich and acidic subtypes) occur on protected moist toe slopes and narrow to broad concave drainages (Simon 2011). In comparison, the northern hardwood typic subtype occurs on steep slopes that are often convex in shape. Soil moisture is generally not limiting within this ecozone, although it can be variable across subtypes, given the different landscape positions. Soil acidity can be variable, as low as 3.7 with low base content, to much higher in areas influenced by mafic rock, where the richer subtype tends to occur (Carolina Vegetation Survey 2019,

NatureServe 2021). Low temperatures, hoar frost, and ice storms are important natural disturbance events influencing the northern hardwood forest ecozone.

This ecozone ranges from southern West Virginia and south-central Virginia mountains to Western North Carolina and eastern Tennessee and occurs in a small area in northern Georgia (NatureServe 2021). All three subtypes are considered globally vulnerable, either with a G3 or a G3G4 rank (NatureServe 2021). This high elevation ecozone covers approximately 5.1%, or 53,500 acres, of the Nantahala and Pisgah NFs. Across the 18-county area identified for this plan revision, the northern hardwood forest ecozone covers approximately 2.9% of the total land base.

### **Composition**

The northern hardwood ecozone is dominated by yellow birch (*Betula allegheniensis*), sugar maple (*Acer saccharum*), yellow buckeye (*Aesculus flava*), and beech (*Fagus grandifolia*) with variable shrub density, most open on rich sites and high shrub density on acidic sites. Herbaceous diversity varies from 80+ species in the rich subtype to 14 species in the acidic subtype (Ulrey 1999, Carolina Vegetation Survey 2019). Similar to spruce-fir forest, there is high diversity of epiphytic bryophytes, mosses and liverworts, within the most mesic portions of this ecozone.

Yellow birch, red maple and fire cherry communities may represent post-logging and fire successional stages that will become increasingly dominated by beech and sugar maple (Ramseur 1960; White and Cogbill 1992). Yellow birch dominated communities still contain a lot of beech, supporting the theory that these communities transition to shade tolerant species over time. Though the contribution of beech to mature forest structure is in question due to the presence of the beech bark disease complex, it is suspected that many sites dominated by birch species were once spruce-fir forest that succumbed to logging and/or intense fire (Ramseur 1960; Schafale and Weakley 1990; Newell and Peet 1995) and may become more rich in structure and composition as spruce regains a foothold (Busing and Pauley 1994; NCWRC 2005; Morin and Widmann 2010; Nowacki et al. 2010).

Under passive management, the northern hardwood ecozone would likely have less mature, canopy-sized American beech due to beech bark disease and lower ash species abundance as the emerald ash borer continues to spread across Western North Carolina. Within the northern hardwood ecozone, progression would be similar to rich cove forests, with herbaceous diversity increasing in small-scale (e.g. single tree fall gaps) disturbance areas. Under active management, planting red spruce and Fraser fir would be used to recover the compositional diversity within these ecological zones. This is particularly true with the loss of evergreen cover from hemlock wooly adelgid impacting the eastern hemlock component. Thinning and release, various uneven-aged, and limited even-aged treatments will be beneficial to the structural development as well as creating more diverse habitat conditions for endangered species and species of conservation concern such as the Carolina northern flying squirrel and golden-winged warbler. These treatments may also provide the opportunity to enhance the composition of longer-lived, shade tolerant hardwood species like sugar maple, yellow birch, and yellow buckeye on northern hardwood sites (Webster et al. 2018 where past land management and wildfire has led to an abundance of shorter-lived sweet birch and fire cherry. Considering the limited canopy manipulations, herbaceous diversity and nonvascular diversity should be similar to that which occurs under passive management. The greatest risk for non-native invasive plant species would be where rare communities such as grassy balds or manipulated openings, such as maintained meadows occur. Northern hardwood forests would have the greatest risk of persistent nonnative invasive species such as oriental bittersweet, Japanese Spiraea, and garlic mustard.

### **Wildlife habitat**

Northern hardwood forests provide habitat for numerous wildlife species that also rely heavily on neighboring spruce-fir forests. Because of the spatial relationship between ecozones, and the fact that

they share many ecological components and plant species, northern hardwood forests are critical to maintaining many species of birds and mammals that are dependent upon spruce-fir habitats (reference spruce-fir section of this document). Additionally, northern hardwood plant species may be critical components of spruce-fir habitats even in their sub-dominant role. For example, many spruce-fir associated wildlife species are cavity nesters. Yellow birch, beech, sugar maple, buckeye, and other northern hardwood tree species often provide more natural cavities and decaying wood than spruce or fir, which is critical for species such as Carolina northern flying squirrels, yellow-bellied sapsuckers, black-capped chickadees, and northern saw-whet owls (NCWAP 2015).

Additionally, northern hardwood forests provide essential habitat for several animal species found nowhere else in North Carolina, including the federally endangered Carolina northern flying squirrel (*Glaucomys sabrinus coloratus*) (CNFS) and a suite of high-elevation associated terrestrial salamanders (Appendix C).

### Associated species

One hundred thirty-seven plant and animal species are associated with northern hardwood forests in the Ecological Sustainability Evaluation, including eight federally listed species, forty-nine Species of Conservation concern, and twenty-one focal species. Species associations are identified in Appendix C. Species associations are not meant to be all-inclusive, but rather a broad enough representation to assess potential effects at the coarse filter (i.e. ecozone) level.

### Environmental Consequences

Environmental consequences for each alternative considered in detail were estimated for five indicators of northern hardwood forest ecosystem health and resilience using the Ecological Sustainability Evaluation (ESE Tool): (1) canopy composition as measures of forest species' composition, (2) total road density as a measure of forest fragmentation and connectedness, (3) percent young forest, (4) percent old forest structural class, and (5) percent affected non-native invasive species. Ecological sustainability scores were generated to reflect overall effects of each alternative on the health and resilience of the northern hardwood forest ecosystem. Appendix C provides a list of these indicators and values.

The northern hardwood forest ecozone acres are distributed across the MA groups in the following way:

**Table 52. Distribution of Northern Hardwood Forest Ecozones Across Management Area Groups**

Management Area Group	Alt B	Alt C	Alt D	Alt E
MA Group 1	13,751	9,703	12,988	12,393
MA Group 2	11,208	14,533	13,323	9,351
MA Group 3	9,670	18,574	10,374	19,928
MA Group 4	18,935	10,753	16,879	11,883

See Management Area Plan Components Section above for a description of which management areas fall within each management area group.

Alternatives B, D and E may have a higher potential to increase the pace and scale of restoration because they include more acres in MA Group 1 compared to Alternative C. With a lower amount of MA Group 4, Alternative E may provide slightly higher opportunities for restoration, compared to Alternatives B and D. An example of a restoration opportunity could be the use of uneven-aged silvicultural practices to increase abundance of more shade tolerant species that are characteristic of this ecozone.

**Composition:** The estimated portion of this ecozone with characteristic vegetation is expected to follow forestwide trends which are maintained at current levels over 10 years and improve over 50 years under



all alternatives. Under Tier 2 objectives, the estimated proportion with characteristic vegetation would be higher across all alternatives when compared to Tier 1 objectives.

**Structure:** The amount of young forest would follow forestwide trends of increasing over 10 years to 50 years for all action alternatives. Tier 2 objectives would create slightly more young forests under alternatives B, C, and D. In Tier 1 Alternative E was estimated with the highest harvest rates resulting in young forest during the first 10 years. This resulted in over twice the density of young forest for any other alternative regardless of Tier 1 or Tier 2 objectives. After 50 years, young forest density was similar to the other action alternatives. In comparison, Alternative E estimated very low harvest rates under Tier 2 objectives resulting after 50 years in the lowest young forest density of all the active alternatives. The initial 10 year harvest rate is not reflective of the 50 or 100 year harvest average. As a result, the initial model estimates for Tier 1 is an anomaly with the model and probably will not be reflective of structural conditions during the actual first 10 years of plan implementation.

The amount of old forest structural class would likely increase over 10 to 50 years with Tier 1 objectives. Compared to Tier 1 objectives, Tier 2 objectives would result in a slower rate of increase in the old forest structural class for alternatives B, C, and D. Alternative E estimated greater harvest under a Tier 1 scenario compared to Tier 2. As a result, under Tier 2 objectives for alternative E, there will be a faster rate of increase for the older forest structural compared to Tier 1.

**Threats:** The percent of this ecozone occupied by non-native invasive species is not likely to differ from existing conditions over 10 years and would decrease under all alternatives with Tier 1 objectives. Tier 2 objectives of all action alternatives would likely result in an increase in non-native invasive species over 10 years and decrease in 50 years for all the action alternatives. For Alternative E, the risk is higher under Tier 1 compared to Tier 2 given the higher rates of harvest. Open road density is approximately 3.37 mi/mi<sup>2</sup> in the northern hardwood ecozone. The risk of invasive species spread from open roads is relatively high in northern hardwoods because there is a higher road density in the northern hardwood ecozone compared to other ecozones.

Other threats to this ecozone include beech bark disease and emerald ash borer and are addressed in the Forest Health section of the EIS.

**Ecological Sustainability Score:** The ecological sustainability score for the northern hardwood ecozone is currently ranked as 'poor' because its structural classes are departed from the natural range of variation. Scores improve to "fair" after 10 years under most alternatives, except Alternatives D and E (Tier 1) and Alternative B (Tier 2). Alternative A is slightly higher in its ecological sustainability score after 10 years compared to all the action alternatives since it has slightly less regeneration harvest and therefore increases the old forest structural class faster. Under most alternatives, after 50 years, the ranking improves with the majority changing to 'good' as a result of more balanced young and old growth forest, as well as long-term invasive plant species control work. Only Alternative E under Tier 2 objectives does not change in its rating after 50 years. This is a result of less young forest compared to the other action alternatives.

All alternatives, except Alternative B Tier 2, project improvements in northern hardwood forest conditions in the first 10 years and approach or exceed "good" ratings after 50 years. Based on this analysis, plant and animal species associated with northern hardwood forests would continue to persist following multiple planning cycles into the future under all alternatives.

Indicator Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Percent of ecosystem dominated by the ecologically characteristic canopy species																			
Percent of ecosystem exhibiting old growth conditions																			
Percent of ecosystem exhibiting young forest conditions																			
Percent of ecosystem NOT occupied by invasive species																			
Total open road density within the northern hardwood forest ecosystem																			
Northern Hardwood COMPOSITE SCORE																			

Figure 37. NPESE element ecological sustainability score, by alternative, for the Northern Hardwood Forest ecosystem  
Red- poor, yellow- fair, light green- good, dark green- very good

## Montane Oak Forests

Montane oak forests include four ecozones: high elevation red oak, mesic oak, dry-mesic oak, and dry oak, and represent more than 35% of the Nantahala and Pisgah NFs today. The majority of the oak forests have developed because of historical land use practices and disturbance events, including loss of the American chestnut, resulting in the current composition and structure influenced by humans (Clatterbuck 1991; Abrams 2003; Nowacki and Abrams 2008; Johnson et al. 2009; Lorimer 2001; Shifley and Thompson III 2011). There is debate about the degree and scale that the historical practices or disturbance events have exerted their influence on these communities. There is limited information about the structure and composition of pre-European settlement forests (Lorimer and White 2003; Thomas-Van Gundy and Strager 2011), but it is likely that the Southern Appalachian forests of today do not resemble past forests (pre-European settlement) in terms of species composition or structure (Nesbitt 1941; Oak 2002; Abrams 2003).

Human-induced processes that have developed the forest of today include, but are not limited to, widespread burning by native Americans and early colonial settlers, exploitive logging followed by destructive wildfires, widespread farming and animal grazing, land abandonment, loss of American chestnut, and fire suppression.

Currently, the overall structure of forests in the oak ecozones is generally described as mature, oak-dominated overstories, but it also includes many other upland tree species. Representation of other species within the main canopy varies with aspect, topographic position, local moisture gradients, site productivity, and past disturbances. The midstory and understory may be open or closed depending on the overstory structure and density, site productivity, and species present. Open overstories are

commonly associated with dense midstories and understories, except for those forests with recurrent wildfires or prescribed burns.

Due to land use history, many southern Appalachian oak-dominated forests are presumed to be more even-aged than their pre-settlement conditions (Lorimer 2001). After the series of events described above, oak species were able to take advantage of their relatively high abundance as advanced regeneration in the understory resulting from large-scale burning by Native Americans and early settlers (Clatterbuck 1991; Abrams 2003; Lorimer and White 2003; Fralish 2004; Nowacki and Abrams 2008). As the structure of these disturbed forests was developing, a primary component, American chestnut, was removed by chestnut blight (*Cryphonectria parasitica*) allowing then-abundant oak species to fill the void (Muzika et al. 1999; Oak 2002). The majority of oak ecozones on the Nantahala and Pisgah NFs are 80 to 120 years old, having been harvested in the early 1900's as land clearing progressed from east to west across the Appalachians and into the Ohio Valley (Shifley and Thompson III 2011).

Lack of disturbance in oak forests over the last 70 to 90 years has resulted in stands with a relatively dense midstory compared to historical conditions (Nesbitt 1941; Arthur et al. 2012). Herbaceous cover varies widely between the oak types based on moisture, soil nutrients, and fire. Species composition varies from 28 species in a closed canopy, fire suppressed, dry oak forest, to greater than 115 species in a basic mesic oak forest. The understory development begins as mortality and disturbance result in canopy gaps. Additions of light to the ground stimulate development of an understory including advance regeneration (Johnson 2004) and development of increased vertical structure. Oak decline occurring on more mesic sites that represent the extremes for oak dominance (Oak 2002; Arthur et al. 2012) yield stands with a high proportion of oaks and poplar in the overstory and a high proportion of maples, white pine, or tulip poplar in the understory as saplings and seedlings (Muzika et al. 1999, Abella and Selburne 2003). Pre-historic and historic fire use is considered the disturbance that suppressed the development of a dense mesic midstory on sites that are currently experiencing oak regeneration development problems due to fire suppression (Nowacki and Abrams 2008; Arthur et al. 2012; Brose et al. 2012, Lafron et al. 2017).

### **High Elevation Red Oak Forest**

This ecozone occurs on most major mountain ranges, generally at elevations ranging from 3,500 to 5,900 feet, across broad primary ridges and steeper secondary and tertiary ridges (NatureServe 2019, Schafale and Weakley 1990). Delapp (1978) recorded this ecozone across most slope aspects, but more commonly on southern and southeastern exposures. Low temperatures, high winds, ice storms, and occasional wildfires are important natural disturbance events influencing high elevation red oak forests.

Five subtypes have been delineated in this ecozone, primarily differing by structure or vegetation: typic herb, rich herb, heath, orchard, and stunted woodland (NatureServe 2019, Schafale 2019). These high elevation red oak forest subtypes occur across the southern Appalachian Mountains from southern Virginia and West Virginia to northern Georgia and (possibly) northern South Carolina (NatureServe 2019). The rich herb subtype is the rarest of the five, known only from three North Carolina mountain ranges with amphibolite substrate. It is globally ranked as G2 (imperiled), as are the orchard forest and the stunted woodland subtypes. The typic herb and heath subtypes are relatively abundant and globally ranked as G4. The high elevation red oak forest ecozone covers slightly more than 40,000 acres (3.9%) of the Nantahala and Pisgah NFs. Across the 18-county planning area, the high elevation red oak ecozone is less than half as abundant, covering about 1.3% of all ownerships.

### **Composition**

All five subtypes are dominated by tree canopies consisting of more than 50% red oak (*Quercus rubra*), often up to 75%, with lesser amounts of various tree species depending on subtype. Three of the subtypes, heath, orchard, and woodland, have dense evergreen or deciduous shrub layers, whereas the

other two are more open. Herb diversity is greatest within these open shrub types, typical herb and rich herb. Species richness varies greatly across subtypes within this ecozone, from a low of 14 in the shrub-dominated subtypes to greater than 85 for the rich subtypes (Ulrey 1999, Carolina Vegetation Survey 2019).

Under passive management the oak-dominated ecozones would likely experience an increased abundance of mesic tree species, such as red maple and white pine, and oaks greater than 100 years old (Nowacki and Abrams 2008, Butler et al 2018, Deyer and Hutchinson 2019). The high elevation red oak ecozone is likely to develop dense understories including beech, yellow birch, and maple that eventually advance into the main canopy and replace red oaks.

Advanced reproduction of oak in the understory is a prime consideration of restoration of all oak dominated ecozones (Dey et al. 2010). Since oak reproduction requires disturbance of the canopy to allow for light to penetrate to the forest floor, combinations of management actions would be used to enhance different phases of oak's life-cycle, such as prescribed fire with thinning and irregular shelterwood treatments. Controlling or reducing undesirable species in the midstory (red maple, tulip poplar) is necessary to give oak regeneration a competitive advantage for continued growth. In the high elevation red oak ecozone, prescribed fire would play a greater role, compared to harvesting, with the reduction in mesic species dependent on fire frequency during the restoration phase.

Shrub diversity will vary based on the oak ecozone and subtypes, as well as management activities. Canopy manipulation may enhance certain shrub species. For instance, deciduous azaleas and other deciduous shrubs respond to thinning. Frequent burning will reduce ericaceous shrubs, such as bear huckleberry, mountain laurel, and deciduous and evergreen rhododendron species.

### **Wildlife habitat**

High elevation red oak forests provide habitat for numerous wildlife species that also rely heavily on neighboring spruce-fir and northern hardwood forests. Because of the spatial relationship between them, and the fact that they share many ecological components and plant species, high elevation red oak forests are critical to maintaining many species of birds and mammals dependent upon other higher elevation habitats (reference spruce-fir and northern hardwood sections of this document).

Additionally, high elevation red oak plant species may be critical components of spruce-fir and northern hardwood habitats, even in their sub-dominant role. For example, high elevation hardwood tree species often provide more natural cavities and decaying wood than spruce or fir, which is critical for species such as Carolina northern flying squirrels, yellow-bellied sapsuckers, black-capped chickadees, and northern saw-whet owls (NCWAP 2015). High elevation red oak forests also support hard mast production critical to many species, but especially to wild turkey, black bear, and white-tailed deer. Creating and maintaining structural diversity within these ecozones is critical for almost all wildlife species, but especially so for species such as ruffed grouse and golden-winged warbler.

### **Associated species**

Seventy-eight plant and animal species are associated with high elevation red oak forests in the Ecological Sustainability Evaluation, including six federally listed species, twenty-six Species of Conservation concern, and sixteen focal species. Species associations are identified in Appendix C. Species associations are not meant to be all-inclusive, but rather a broad enough representation to assess potential effects at the coarse filter (i.e. ecozone) level.

### **Environmental Consequences**

Environmental consequences for each alternative considered in detail were estimated for five indicators of High Elevation Red Oak Forest ecosystem health and resilience using the Ecological Sustainability Evaluation (ESE Tool): (1) canopy composition as measures of forest species' composition, (2) total road

density as a measure of forest fragmentation and connectedness, and (3) percent young, (4) old forest, and (5) woodlands as measures of structural diversity. Ecological Sustainability scores were generated to reflect overall effects of each alternative on the health and resilience of the High Elevation Red oak forest ecosystem. Appendix C provides a list of these indicators and values.

The high elevation red oak ecozone acres are distributed across the MA groups in the following way:

**Table 53. Distribution of High Elevation Red Oak Forest Ecozones Across Management Area Groups**

Management Area Group	Alternative B	Alternative C	Alternative D	Alternative E
MA Group 1	16,325	10,518	15,135	13,727
MA Group 2	7,246	10,879	10,010	6,406
MA Group 3	4,796	10,848	4,437	10,876
MA Group 4	11,818	7,940	10,604	9,171

See Management Area Plan Components Section above for a description of which management areas fall within each management area group.

High elevation red oak ecozone restoration is not incumbent on activities occurring in a particular MA group. Woodland improvement would be possible in management groups 1-3 about equally under all alternatives. Young forest creation would be accomplished through mechanical treatments in MA Group 1 and prescribed fire in MA Group 3. An example of a restoration opportunity is removing some canopy and shrub cover to allow light for encouraging advanced regeneration of oak in the understory in order to sustain the red oak component that is characteristic of this ecozone. Therefore, one alternative's allocation is not better than another for achieving restoration objectives in this ecozone.

**Composition:** Vegetative composition is estimated to improve in the high elevation red oak forest ecozone over time. The estimated proportion of this ecozone with characteristic vegetation follows forestwide trends under Tier 1 objectives and increases slightly in 50 years. Estimates for improvement in composition assume that a reasonable rate of active restoration would be applied in this ecozone and that advanced oak regeneration would be present in the understory when creating young forest.

**Structure:** The high elevation red oak ecozone will follow forestwide trends for increasing levels of young, old forest, and open woodland classes under all alternatives.

As a result of more young forest conditions being created under Tier 2 objectives, the old forest structural class increases slower when compared to Tier 1. For both Tier 1 and Tier 2 objectives, the old forest structural class exceeds desired conditions in 50 years, with 49-59% of the ecozone in the old forest structural class.

Woodland conditions would be created slowly over the next 10 years through active restoration and follow forestwide trends over 50 years. The amount of woodland condition is expected to increase at a faster rate under Tier 2 objectives in 50 years under all alternatives. With the doubling in burning under Tier 2 objectives with Alternative E, estimates would provide the greatest opportunity to restore and maintain woodlands after 50 years compared to all the action alternatives.

**Threats:** Open road density ranges from 0.79 to 0.80 mi/mi<sup>2</sup> in the High Elevation Red Oak ecozone for all alternatives (Tier 1 and Tier 2 objectives) and is not expected to increase over time in this ecozone. This is well below the average forest-wide open road density of 1.28 mi/mi<sup>2</sup>. As such, impacts from open roads is expected to be low in this ecozone.

Occasional outbreaks of spongy moth (*Lymantria dispar*) also impact this ecozone in localized areas.

**Ecological Sustainability Score:** The ecological sustainability score for high elevation red oak forests is currently ranked as ‘fair’. With the no-action and Tier 1 objectives for all action alternatives, this ecozone remains ‘fair’ in 10 years, and remains stable or decreases slightly in scoring while still maintaining the “fair” (Alternatives B and D) rating after 50 years. All action alternatives improve with Tier 2 objectives after 50 years because of young forest and more woodland creation. However, the ratings differ under alternative E with a “good” score because of greater prescribed burning. Based on this analysis, plant and animal species associated with high elevation red oak would persist under all alternatives, and potentially expand due to increased suitable habitat under Tier 2 of Alternative B, C, D, or E following multiple planning cycles into the future.

Indicator Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Percent of ecosystem dominated by the ecologically characteristic canopy species																			
Percent of ecosystem exhibiting old growth conditions																			
Percent of ecosystem exhibiting young forest conditions																			
Percent of ecosystem in open canopy condition																			
Total open road density within the high elevation red oak ecosystem																			
High Elevation Red Oak COMPOSITE SCORE																			

Figure 38. NPESE element Ecological Sustainability score, by alternative, for the Northern Hardwood Forest ecosystem  
Red- poor, yellow- fair, light green- good, dark green- very good

## Mesic Oak Forest

The mesic oak forest ecozone occurs from low- to mid-elevations (approximately 2,000-4500 feet), in generally deep soils at all exposures, on somewhat-protected to partially sheltered landforms that are convex in shape (Simon 2011). Two main plant community associations are included within this zone: an acidic subtype and a basic subtype (NatureServe 2019, Schafale 2019). This ecozone has a broad range and is widely distributed over the Southern Blue Ridge, the Blue Ridge/Piedmont transition, the higher ridges of the Cumberland Mountains and Ridge and Valley in southwest Virginia (NatureServe 2019). The ecozone covers more than 177,000 acres (approximately 17%) of the Nantahala and Pisgah NFs. Across other ownerships within the 18-county planning area, mesic oak forest is more abundant (approximately 23.5%), making it the most abundant ecozone in the planning area. The acidic subtype of mesic oak forests is much more common across the Forests and planning area than the basic subtype. The acidic subtype is considered globally secure, globally ranked as G4G5, while the basic subtype is considered more vulnerable, globally ranked as G3 (NatureServe 2021).

## Composition

This ecozone is dominated by white oak (*Quercus alba*), red oak (*Quercus rubra*), and chestnut oak (*Quercus montana*), with a varying amount of other hardwood species. Shrub density varies across the two subtypes. Shrub density is moderate to dense within the acidic subtype, and generally sparse in the basic subtype. Herb species are typically sparse in the acidic type, and much more diverse in the basic subtype, where it is similar to rich cove forest. A large range in plant species diversity (from 29 to 115 species) has been recorded within the subtypes for this ecozone (NatureServe 2021, Ulrey 1999, Carolina Vegetation Survey 2019).

Under passive management, the oak-dominated ecozones would likely experience an increased abundance of mesic tree species, such as red maple and white pine, and oaks greater than 100 years old (Nowacki and Abrams 2008, Butler et al 2018, Deyer and Hutchinson 2019). Mesic oak forests are likely to have the highest mesophication rates due to higher soil moisture and nutrient capacity where maple, white pine, and tulip poplar dominate the canopy (Dey et al. 2010).

Advanced reproduction of oak in the understory is a prime consideration of restoration of all oak dominated ecozones, especially in mesic oak forests (Dey et al. 2010). Since oak reproduction requires disturbance of the canopy to allow for light to penetrate to the forest floor, combinations of management actions would be used to enhance different phases of oak's life-cycle, such as prescribed fire with thinning and irregular shelterwood treatments. Controlling or reducing undesirable species in the midstory (red maple, tulip poplar) is necessary to give oak regeneration a competitive advantage for continued growth. Restoration would occur more in mesic and dry mesic oak ecozones because they are more accessible and less costly. As a result, the reduction of mesic species such as red maple, white pine as well as increasing advanced oak regeneration would be greater in mesic and dry-mesic oak ecozones compared to other oak ecozones.

Shrub diversity will vary based on the oak ecozone and subtypes, as well as management activities. Canopy manipulation may enhance certain shrub species. For instance, deciduous azaleas and other deciduous shrubs respond to thinning. Herbaceous response to canopy manipulation and/or burning in mesic oak types across the southern Appalachians is limited and more anecdotal, however common herbaceous species persist with or without disturbance. Non-native invasive plant species will present the greatest risk of invasion within mesic and dry-mesic oak ecozones following canopy harvest or prescribed burn.

## Wildlife habitat

Largely because of the production of hard mast such as acorns and hickory nuts, and a variety of soft mast, the value of this habitat to wildlife is immense. In addition, different wildlife species are associated with different understory structures and compositions, including successional stages, of this ecozone. When compositional and structural diversity are combined with the amount of this habitat available across the southern Appalachian landscape, mesic oak forests provide one of the most valuable wildlife habitats in the region. Increasing structural diversity across the landscape through appropriate seral stage distribution is necessary to conserve wildlife diversity.

## Associated species

One hundred thirteen plant and animal species are associated with mesic oak forests in the Ecological Sustainability Evaluation, including six federally listed species, forty-four Species of Conservation concern, and twenty-one focal species. Species associations are identified in Appendix C. Species associations are not meant to be all-inclusive, but rather a broad enough representation to assess potential effects at the coarse filter (i.e. ecozone) level.

## Environmental Consequences

Environmental consequences for each alternative considered in detail were estimated for six indicators of mesic oak ecozone health and resilience using the Ecological Sustainability Evaluation (ESE Tool): (1) canopy composition as a measure of forest species' composition, (2) total road density as a measure of forest fragmentation and connectedness, and (3) percent young, (4) old growth, and (5) woodlands as measures of structural diversity and (6) occupancy by invasive species. Ecological Sustainability scores were generated to reflect overall effects of each alternative on the health and resilience of the mesic oak ecozone. Appendix C provides a list of these indicators and values.

The mesic oak ecozone acres are distributed across the MA groups in the following way:

**Table 54. Distribution of Mesic Oak Forest Ecozones Across Management Area Groups**

	Alt B	Alt C	Alt D	Alt E
MA Group 1	105,970	86,144	105,445	103,462
MA Group 2	18,476	36,205	24,602	20,745
MA Group 3	19,498	41,678	24,337	33,340
MA Group 4	33,322	13,234	22,882	19,638

See Management Area Plan Components Section above for a description of which management areas fall within each management area group.

All action alternatives have opportunities to increase the pace and scale of restoration in this ecozone. Alternatives B, D and E may have higher potential to increase the pace and scale of restoration because they have more acres in MA Group 1 compared to Alternative C. With high amounts of MA Groups 1 and 2, along with a lower amount of MA Group 4, Alternative E may provide slightly higher restoration opportunities compared to Alternative B or D. Alternative C, however, has more MA Group 3 and a low amount of MA Group 4, and if large landscape prescribed fire is feasible, then this alternative has opportunities for maintaining large acreages after successful restoration, followed next by Alternative E. An example of a restoration opportunity is thinning to open the canopy and provide conditions for advanced oak regeneration.

**Composition:** The mesic oak forest ecozone will follow forestwide trends of improving composition under all alternatives. More than two-thirds of this ecozone are in active restoration management area groups (MA Groups 1 and 2), with Alternative D having the most acres of the ecozone (approximately 73%) in active restoration MAs. Estimates for improvement in composition assume that reasonable rate of active restoration with advanced oak regeneration present in the understory.

**Structure:** The mesic oak forest ecozone will follow forestwide trends for increasing levels of young, old, and woodlands under all alternatives. Under Tier 2 objectives, young forest in the mesic oak forest ecozone temporarily exceeds desired conditions after 50 years. As a result, ESE tool scores are “fair,” or “poor” as opposed to “good” or “very good” under Tier 1 objectives after 50 years.

In Spectrum modeling for Alternative E under Tier 2 objectives, there was a constraint for lower rates of regeneration in cove forest types. The estimated model outputs did not realistically spread-out regeneration harvest in other types. As a result, the 50-year average for mesic oak is not reflective of the 100 or 200- year harvest average. The model estimate for Tier 2 is an anomaly in mesic oak and probably will not be reflective of structural conditions during the actual first 50 years of plan implementation for that ecozone.

For all alternatives, the old forest structural class would follow forestwide trends of increasing over the next 10 to 50 years under Tier 1 objectives. For Tier 2 objectives, the rate of increase in the old growth



structural class is almost the same as Tier 1 after 10 years but increases at a slower rate between 10 and 50 years.

Under all alternatives, creation of woodland conditions would increase after 50 years with a much greater amount under Tier 2 objectives for Alternative E. Compared to other fire adapted dry oak and pine ecozones, there would be a lower percentage of this ecozone in woodland restoration.

**Threats:** Impacts from invasive species will decrease slightly from an estimated 12% to 9% coverage (Tier 1 objectives) in 10 years and to 7-10% in 50 years. However, under Tier 2 objectives, impacts from invasive species would increase to 15% over 10 years because of increased amounts of active management with slightly higher estimated levels within Alternative E due to higher prescribed burning acreage. Open road density in the mesic oak ecozone averages about 1 mi/mi<sup>2</sup> and is not expected to increase over time in this ecozone. This is below the average open road density of 1.28 mi/mi<sup>2</sup>; therefore, impacts from open roads is expected to be low.

Occasional outbreaks of spongy moth (*Lymantria dispar*) also impact this ecozone in localized areas.

**Ecological Sustainability Score:** The ecological sustainability score for the mesic oak forest ecozone is currently ranked as 'poor' and would improve over time under all alternatives (Figure 39). The rate of improvement is lowest for Alternative E. This ecozone scored from "fair" in Alternatives B, C, D, and E under Tier 1 objectives, and improves to a condition of "good" over 50 years. Tier 2 objectives result in lower scores than Tier 1 objectives, although all alternatives are scored as "fair" except for Alternative E with a score of "poor." Relatively short-term declines under Tier 2 objectives are due to greater impacts from invasive species and the young forest structural class temporarily exceeding the amount of desired young forest in mesic oak. However, all alternatives improve to higher scores after 50 years due to greater amounts of woodlands and an increase in the older forest structural class. Based on this analysis, plant and animal species associated with mesic oak forests would continue to persist under all alternatives.

Indicator Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Percent of ecosystem dominated by the ecologically characteristic canopy species																			
Percent of ecosystem exhibiting old growth conditions																			
Percent of ecosystem exhibiting young forest conditions																			
Percent of ecosystem in open canopy condition																			
Percent of ecosystem NOT occupied by invasive species																			
Total open road density within the mesic oak forest ecosystem																			
Mesic Oak COMPOSITE SCORE																			

Figure 39. NPESE element ecological sustainability score, by alternative, for the Mesic Oak Forest ecosystem  
Red- poor, yellow- fair, light green- good, dark green- very good

### Dry-Mesic Oak Ecozone

The dry-mesic ecozone occurs across lower- to mid-elevation (approximately 2,000-4,000 feet) along ridges, concave upper slopes, and, occasionally, narrow dry coves (Simon 2011). In general, this ecozone can occur in locations similar to mesic oak forest, however the soils are more acidic and less fertile. Three separate communities have been distinguished within this zone: low montane red oak, and two montane oak-hickory subtypes: white pine and low dry (Schafale 2019). This ecozone has a broad range and is widely distributed over the Southern Blue Ridge, the Blue Ridge/Piedmont transition, and the higher ridges of the Cumberland Mountains and Ridge and Valley in southern Kentucky and southwest Virginia (NatureServe 2021). The ecozone covers approximately 103,000 acres (9.9%) of the Nantahala and Pisgah NFs. Across other ownerships within the 18-county planning area, dry-mesic oak forest abundance is similar (approximately 10%). This ecozone is more common in the Blue Ridge Escarpment and low elevation forests in Cherokee, Graham, Haywood, and Madison Counties. The white pine subtype for this zone is ranked G3G4, while the low dry is considered more vulnerable, ranked globally as G2G3 (NatureServe 2019). In comparison, the low montane red oak forest is globally ranked as G4, being much more common in other states than North Carolina.

### Composition

Red oak (*Quercus rubra*) dominates in low montane, while chestnut oak (*Quercus montana*) and white pine (*Pinus strobus*) in the white pine and low dry subtypes. A heath shrub layer is often present, often greater than 50%. Herb diversity is highly variable across the three communities and dependent on the shrub density. Typically, herb diversity is sparse to moderate, but can be relatively high. Vascular plant

counts within the communities in this ecozone have varied from a low of 33 to a high of 103 (Ulrey 1999, Carolina Vegetation Survey 2019).

Under passive management, the oak-dominated ecozones would likely experience an increased abundance of mesic tree species, such as red maple and white pine, and oaks greater than 100 years old (Nowacki and Abrams 2008, Butler et al 2018, Deyer and Hutchinson 2019). Of the oak types, dry-mesic oak ecozones may experience the greatest increase in white pine considering the abundance of white pine along the escarpment, particularly surrounding the Highlands and Cashiers areas (Abella and Shelburne 2003, Carter et al. 2000). Any southern pine component present would follow similar patterns described below in the pine ecozones. Herbaceous diversity, particularly grasses and legumes, would be less than what would occur with active restoration which includes frequent prescribed burns. In the absence of fire, shrub densities would be greater, particularly bear huckleberry.

Advanced reproduction of oak in the understory is a prime consideration of restoration of all oak dominated ecozones, especially in mesic oak forests (Dey et al. 2010). Since oak reproduction requires disturbance of the canopy to allow for light to penetrate to the forest floor, combinations of management actions would be used to enhance different phases of oak's life-cycle, such as prescribed fire with thinning and irregular shelterwood treatments. Controlling or reducing undesirable species in the midstory (red maple, tulip poplar) is necessary to give oak regeneration a competitive advantage for continued growth. Restoration would occur more in mesic and dry mesic oak ecozones because they are more accessible and less costly. As a result, the reduction of mesic species such as red maple, white pine as well as increasing advanced oak regeneration would be greater in mesic and dry-mesic oak ecozones compared to other oak ecozones.

Shrub diversity will vary based on the oak ecozone and subtypes, as well as management activities. Canopy manipulation may enhance certain shrub species. For instance, deciduous azaleas and other deciduous shrubs respond to thinning. Frequent burning will reduce ericaceous shrubs, such as bear huckleberry, mountain laurel, and deciduous and evergreen rhododendron species, and increase herbaceous diversity in dry oak and dry-mesic oak ecozones. Non-native invasive plant species will present the greatest risk of invasion within mesic and dry-mesic oak ecozones following canopy harvest or prescribed burn.

### **Wildlife habitat**

Largely because of the production of hard mast such as acorns and hickory nuts, and a variety of soft mast, the value of this habitat to wildlife is immense. In addition, different wildlife species are associated with different understory structures and compositions, including successional stages, of this forest type. When compositional and structural diversity are combined with the amount of this habitat available across the southern Appalachian landscape, montane oak forests become one of the most valuable wildlife habitats in the region. Increasing structural diversity through appropriate seral stage distribution is necessary to conserve wildlife diversity.

### **Associated species**

Seventy-six plant and animal species are associated with dry-mesic oak forests in the Ecological Sustainability Evaluation, including seven federally listed species, twenty-eight Species of Conservation concern, and nineteen focal species. Species associations are identified in Appendix C. Species associations are not meant to be all-inclusive, but rather a broad enough representation to assess potential effects at the coarse filter (i.e. ecozone) level.

### **Environmental Consequences**

Environmental consequences for each alternative considered in detail were estimated for six indicators of dry-mesic oak forest ecosystem health and resilience using the Ecological Sustainability Evaluation

(ESE Tool): (1) canopy composition as measures of forest species' composition, (2) total road density as a measure of forest fragmentation and connectedness, and (3) percent young, (4) old forest, and (5) woodlands as measures of structural diversity and (6) occupancy by invasive species. Ecological Sustainability scores were generated to reflect overall effects of each alternative on the health and resilience of the dry-mesic oak forest ecosystem. Appendix C lists these indicators and values.

The dry-mesic oak ecozone acres are distributed across the MA groups in the following way:

**Table 55. Distribution of Dry-Mesic Oak Forest Ecozones Across Management Area Groups**

Management Area Group	Alternative B	Alternative C	Alternative D	Alternative E
MA Group 1	74,159	58,895	73,494	74,237
MA Group 2	7,556	17,102	10,616	8,582
MA Group 3	10,223	21,490	12,279	13,344
MA Group 4	11,238	5,689	6,788	7,005

See Management Area Plan Components Section above for a description of which management areas fall within each management area group.

All action alternatives have opportunities for increasing the pace and scale of restoration in this ecozone. More than two-thirds of this ecozone are in active restoration management area groups (MA Groups 1 and 2). There are more opportunities for mechanical treatments within Alternatives B, D and E, while slightly greater opportunity for prescribed fire in Alternative C. Because the mesic oak ecozone has similar MA Group distribution across alternatives, opportunities to increase the pace and scale of restoration do not vary much across action alternatives.

**Composition:** Characteristic vegetation composition in the dry-mesic oak forest ecozone will improve under all alternatives. The estimated proportion of this ecozone with characteristic vegetation ranges from 83% in Alternative A, to 90% in Alternative D (Tier 1 objectives after 10 years). This assumes successful advanced regeneration of oak in the understory and reduction of more mesic species (e.g., red maple, white pine) in the mid-story and canopy.

**Structure:** The dry-mesic oak forest ecozone will follow forestwide trends for increasing levels of young, old forest, and woodlands under all alternatives. For Tier 1 objectives, the estimated proportion of young forests would increase from current levels in all four action alternatives over ten years. Under Tier 2 objectives, Alternatives B and D after 50 years would temporarily exceed the amount of desired young forest.

In contrast, Tier 2 objectives of Alternatives C and E creates less young forest. However the score for both is “very good” since it is within the range of the desired amount. Under all alternatives with Tier 1 objectives, the old forest structural class increases over the next 10 years and makes a more dramatic increase after 50 years. Alternative E has a much larger increase since it has lower estimates for young forest creation. Under all action alternatives, the old growth structural class increases at a slower rate with Tier 2 objectives.

Under all alternatives, creation of woodland conditions would increase after 50 years with a much greater amount under Tier 2 objectives for Alternative E. Compared to other fire adapted dry oak and pine ecozones, there would be a lower percentage of this ecozone in woodland restoration.

**Threats:** With increased treatment of nonnative invasive species infestations, impacts from invasive species would decrease slightly with Alternatives B, C, and D in 10 years with Tier 1 objectives. Alternative E increase slightly due to the higher risk with more burning. With Tier 2 objectives, impacts

from invasive species would likely increase over the next 10 years, due to increased amounts of activity. The greatest increase is with Alternative E due to the potential doubling in prescribe burning. Open road density averages about 1.2 mi/mi<sup>2</sup> in the dry-mesic ecozone and is not expected to increase over time. This is approximately the average forest-wide open road density of 1.28 mi/mi<sup>2</sup>, therefore, impacts from open roads is expected to be average. Occasional outbreaks of spongy moth (*Lymantria dispar*) also impact this ecozone in localized areas.

**Ecological Sustainability Score:** Considering all indicators, associations, and species in the ESE, the condition of the dry-mesic oak forest ecozone would improve over time under all alternatives (Figure 40). Under alternative A, this ecozone improves from between 10 and 50 years but has the least improvement of any alternative. Under Tier 1 objectives, alternative C improves the greatest after 10 years; however, all four action alternatives improve over 50 years. Alternatives B,C, and D all improve to a “good” rating. With Tier 2 objectives, Alternatives C and E score better, “good,” than Alternatives B and D, “fair,” after 10 and 50 years. With Tier 2 objectives, Alternative C scores better, “good,” than Alternatives B and D, “fair,” after 10 and 50 years. While Alternatives B and D in Tier 2 at 50 years temporarily exceed the amount of desired young forest, late and old structural classes are recruited more quickly than young forest created. Based on this analysis, plant and animal species associated with mesic oak forests would persist under all alternatives.

Indicator Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Percent of ecosystem dominated by the ecologically characteristic canopy species																			
Percent of ecosystem exhibiting old growth conditions																			
Percent of ecosystem exhibiting young forest conditions																			
Percent of ecosystem in open canopy condition																			
Percent of ecosystem NOT occupied by invasive species																			
Total open road density within the dry-mesic oak forest ecosystem																			
Dry-Mesic Oak COMPOSITE SCORE																			

Figure 40. NPSE element ecological sustainability score, by alternative, for the Dy-mesic Oak forest ecosystem  
Red- poor, yellow- fair, light green- good, dark green- very good

## **Dry Oak Forest**

The dry oak ecozone occurs on plateaus, ridges, and steep slopes from low- to mid- elevations (1,000-4000 feet) (NatureServe 2019). It occurs within rocky, acidic, infertile upland soils with low levels of calcium, magnesium, and total base saturation, along with moderately high iron and aluminum (Fleming and Patterson 2009). In general, this ecozone occurs on partially exposed landforms that are typically convex in shape (Simon 2011). Soil moisture is a limiting factor for this oak forest types. Wind, ice storms, and fire are all important natural disturbances influencing this ecozone.

Three chestnut oak subtypes have been identified within this ecozone: dry heath, herb, and white pine. In total, this ecozone has a broad range from West Virginia and Kentucky south to Georgia and South Carolina, distributed over the Southern Blue Ridge, the Blue Ridge/Piedmont transition, the Cumberland Mountains, and the Ridge and Valley (NatureServe 2021). Across the Nantahala and Pisgah NFs, this ecozone covers approximately 49,000 acres (4.7%). Across other ownerships within the 18-county planning area, dry oak forest is slightly more abundant (5.6%). The dry heath subtype for this zone is more common across the Nantahala and Pisgah NFs, as well as other lands within the planning area. This subtype is considered globally secure, ranked G5. The herb subtype is less common in the planning area than the dry heath, but is abundant across its range, globally ranked as G4. The white pine subtype is the least common of the three, although there is debate on the global rank between G3 and G4 (NatureServe 2021, Schafale 2019).

### **Composition**

This ecozone is dominated by chestnut oak (*Quercus montana*) and scarlet oak (*Quercus coccinea*) with varying amounts of dry hardwood species and yellow pines (Schafale 2019, Simon 2011). Ericaceous shrubs dominate this xeric community, with their density being dependent on the frequency and intensity of wildland fires. Herbaceous diversity is quite sparse across the dry heath and white pine subtypes. Within the herb subtype, shrub density is typically less than 20%, allowing for a greater diversity of herb species, becoming more similar to dry-mesic oak types. Species richness varies across the dry oak ecozone, from a low of 28 to over 65 species (Ulrey 1999).

Under passive management, the oak-dominated ecozones would likely experience an increased abundance of mesic tree species, such as red maple and white pine, and oaks greater than 100 years old (Nowacki and Abrams 2008, Butler et al 2018, Deyer and Hutchinson 2019). Dry Oak would likely have lower mesophication rates (the exception being red maple) due to lower site productivity but would likely have a higher component of ericaceous shrubs that would limit both canopy development and herbaceous plant species. Any southern pine component present would follow similar patterns described below in the pine ecozones. Herbaceous diversity, particularly grasses and legumes, would be less than what would occur with active restoration which includes frequent prescribed burns. In the absence of fire, shrub densities would be greater, particularly mountain laurel.

Advanced reproduction of oak in the understory is a prime consideration of restoration of all oak dominated ecozones. Since oak reproduction requires disturbance of the canopy to allow for light to penetrate to the forest floor, combinations of management actions would be used to enhance different phases of oak's life-cycle, such as prescribed fire with thinning and irregular shelterwood treatments. Controlling or reducing undesirable species in the midstory (red maple, tulip poplar) is necessary to give oak regeneration a competitive advantage for continued growth. In the dry oak ecozone, oaks are likely to persist through all canopy positions including seedlings, because xeric site conditions (thin soils and more extreme exposure) limit competitive mesic species and allow drought tolerant oaks to regenerate and persist into the canopy.

Shrub diversity will vary based on the oak ecozone and subtypes, as well as management activities. Canopy manipulation may enhance certain shrub species. Frequent burning will reduce ericaceous

shrubs, such as bear huckleberry, mountain laurel, and deciduous and evergreen rhododendron species, and increase herbaceous diversity in dry oak and dry-mesic oak ecozones.

### **Wildlife habitat**

Largely because of the production of hard mast such as acorns and hickory nuts, and a variety of soft mast, the value of this habitat to wildlife is immense. In addition, different wildlife species are associated with different understory structures and compositions, including successional stages, of this forest type. When compositional and structural diversity are combined with the amount of this habitat available across the southern Appalachian landscape, montane oak forests become one of the most valuable wildlife habitats in the region. Increasing structural diversity through appropriate seral stage distribution is necessary to conserve wildlife diversity.

### **Associated species**

Seventy-six plant and animal species are associated with dry oak forests in the Ecological Sustainability Evaluation, including five federally listed species, twenty-one Species of Conservation concern, and nineteen focal species. Species associations are identified in Appendix C. Species associations are not meant to be all-inclusive, but rather a broad enough representation to assess potential effects at the coarse filter (i.e. ecozone) level.

### **Environmental Consequences**

Environmental consequences for each alternative considered in detail were estimated for six indicators of dry oak forest ecozone health and resilience using the Ecological Sustainability Evaluation (ESE Tool): (1) canopy composition as measures of forest species' composition, (2) total road density as a measure of forest fragmentation and connectedness, and (3) percent young, (4) old forest, and (5) woodlands as measures of structural diversity and (6) occupancy by invasive species. Ecological Sustainability scores were generated to reflect overall effects of each alternative on the health and resilience of the dry oak forest ecosystem. Appendix C lists these indicators and values.

The dry oak ecozone acres are distributed across the MA groups in the following way:

**Table 56. Distribution of Dry Oak Forest Ecozones Across Management Area Groups**

<b>Management Area Group</b>	<b>Alternative B</b>	<b>Alternative C</b>	<b>Alternative D</b>	<b>Alternative E</b>
MA Group 1	30,056	24,235	29,163	29,189
MA Group 2	5,131	8,057	6,967	4,843
MA Group 3	5,842	11,007	6,338	8,585
MA Group 4	8,229	5,956	6,791	6,613

See Management Area Plan Components Section above for a description of which management areas fall within each management area group.

More than two-thirds of this ecozone are in active restoration management area groups (MA Groups 1 and 2).

The amount of MA Groups 1 and 2 is similar across all action alternatives; however, with a higher amount of MA Group 3 and lower amount of MA Group 4, Alternatives C and E have more potential to increase the scale of restoration, assuming that larger landscape prescribed fire is applied. The dry oak ecozone requires frequent fire for restoration and maintenance. Since the size and quality of tree species in this ecozone generally precludes commercial timber harvest, Alternatives C and E have advantages for restoration potential over Alternatives B and D, assuming landscape level prescribe fire is feasible.

**Composition:** Vegetative composition is estimated to improve in this ecozone over time. The action alternatives improve composition to a greater extent compared to alternative A. This improvement assumes that uncharacteristic vegetation is removed, such as dense stands of red maple and white pine and includes supplemental planting and frequent fire to keep mesic species from encroaching.

**Structure:** The dry oak ecozone follows forestwide trends for increases in young forest, old growth forest, and woodlands over time. The estimated proportion of young forests would increase from current levels under Alternative A, and slightly higher under action alternatives, with Tier 1 objectives. Over 50 years, young forest conditions would continue to increase under all alternatives. While higher than Alternative A, Alternative E has the slowest increase for the 50-year period for Tier 1 objectives. For Alternative E, the Spectrum model was constrained with less young forest as a response to public comments from the DEIS. Tier 2 objectives for all alternatives would provide young forest conditions at a higher rate compared to Tier 1 objectives. All the action alternatives are estimated with a “good” score after 50 years.

Older forest trends for dry oak meet forestwide trends within 50 years. For all action alternatives, the older forest structural class would increase to 44-46% under Tier 1 objectives in 10 years, and to about 60% in 50 years for Alternatives B, C, and D while increasing higher to 75% with Alternative E. Due to the creation of more young forest conditions under Tier 2 objectives, the old growth structural class increases at a slower rate from 10 to 50 years and is still greater with Alternative E.

With Tier 1 objectives, woodland conditions would be slowly created over the next 10 years through active restoration. For Alternatives B, C, and D, approximately 8% of this ecozone is estimated to be in woodland conditions within 50 years. Under Tier 2 objectives, woodland conditions would more than double over 50 years. In contrast Alternative has a much higher estimate of woodland restoration, particularly under Tier2 objectives where it would potentially quadruple the amount in other 3 action alternatives after 50 years.

**Threats:** Invasive species are estimated to impact about 4-6% of this ecozone over the next 10 years for all alternatives and reduce slightly in 50 years. Under Tier 2 objectives, impacts from invasive species would likely increase slightly over the next 10 years because of a higher amount of activity. The greatest increase is estimated for Alternative E due to much greater burning acreage. Open road density averages about 0.83 mi/mi<sup>2</sup> for dry oak forest ecozone and is not expected to increase over time in this ecozone. This is below the average forest-wide open road density of 1.28 mi/mi<sup>2</sup>, therefore impacts from open roads are expected to be low.

Occasional outbreaks of spongy moth (*Lymantria dispar*) also impact this ecozone in localized areas.

**Ecological Sustainability Score:** Considering all indicators, associations, and species in the ESE tool, the condition of the dry oak ecozone would improve over time in all alternatives (Figure 41). This ecozone scored “fair” in alternative A and “good” for the four action alternatives after 10 years with the Tier 1 objectives. Alternative A improves to “good” in 50 years and the action alternatives have an upward trend and remain “good”. Tier 2 objectives result in improving trends over the 10- and 50-year period for Alternatives C and D. In contrast, Alternative B has a slight downward trend from 10 to 50 years while Alternative E improves the greatest with a score or “very good”. Based on this analysis, plant and animal species associated with dry oak forests would persist under all alternatives.



Indicator Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Percent of ecosystem dominated by the ecologically characteristic canopy species																			
Percent of ecosystem exhibiting old growth conditions																			
Percent of ecosystem exhibiting young forest conditions																			
Percent of ecosystem in open canopy condition																			
Percent of ecosystem NOT occupied by invasive species																			
Total open road density within the dry oak forest ecosystem																			
Dry Oak Forest COMPOSITE SCORE																			

Figure 41. NPESE element ecological sustainability score, by alternative, for the Dry Oak Forest ecosystem  
Red- poor, yellow- fair, light green- good, dark green- very good

## Cove Forests

Cove forests include acidic cove and rich cove ecozones and occupy about 44% of the forests today. As with the other ecozones on the Nantahala and Pisgah NFs, rich and acidic cove forests have a widely distributed, even-aged structure, with stand ages typically between 70 and 100 years old (Van Lear et al. 2002). Due to the age of second growth forests on the Nantahala and Pisgah NFs, many cove forests exhibit mature forest conditions, with small canopy gaps resulting from individual tree mortality and tree regeneration in the understory (Oliver 1997). Over the next 50 to 100 years, cove forests will increase in structural complexity because a patchwork of canopy gaps will increase structural elements such as understory plants, young trees, forest layers, foraging opportunities, and potential nest sites (Oliver 1997, Guyon et al. 2003).

Distinguishing factors between acidic cove and rich cove ecozones are the presence of rhododendron in the understory and midstory of acidic coves, and differences in soil fertility (Ulrey 2002). More than half of the acidic cove ecozone has shrub cover greater than 50%. Modern-day rhododendron densities within cove forests may have developed after the exploitive logging and chestnut blight, giving it the opportunity to expand under the era of fire exclusion (Baker and Van Lear 1998; Vandermaast and Van Lear 2002; Van Lear et al. 2002), although there is uncertainty on pre-European evergreen shrub densities and may be tied to local environmental variability (Newell et al 1997).

Historically, eastern hemlock was an abundant and a dominant component of acidic cove forests but has been severely impacted by hemlock woolly adelgid across the Nantahala and Pisgah NFs in recent years. In many cases, mature hemlock have been reduced to standing dead stems, drastically altering the overstory structure and adding large quantities of snags to the ecozone. In the presence of dense

rhododendron, these structural changes may become permanent, as newly created canopy gaps are overwhelmed by rhododendron where it could become the climax species (Baker and Van Lear 1998; Vandermast and Van Lear 2002; Van Lear et al. 2002).

Many second-growth cove forest overstories are dominated (in basal area) by tulip poplar (Clebsch and Busing 1989; Vandermast and Van Lear 2002; Guyon et al. 2003). Clebsch and Busing (1989) and Runkle (1998) noted that large natural disturbances (tornadoes) as well as human disturbances (agriculture, overstory harvest) have resulted in cove forests that are dominated by tulip poplar. Tulip poplar is also known to regenerate in small tree fall gaps in old-growth or virgin forest (Clebsch and Busing 1989, Lorimer 1980, Buckner and McCracken 1978). American chestnut was likely more important in some subtypes of coves. Within these subtypes it represented 6-40% of the pre-blight cove forests (Lorimer 1980; Newell 1997, Vandermast and Van Lear 2002; Van Lear et al. 2002) and may have had a greater presence in the cove ecozones than previously thought (Wang et al. 2013). With the loss of American chestnut, shade-intolerant species such as tulip poplar and black birch were able to become established.

Rich cove forests have a denser and more diverse herbaceous layer compared to acidic cove forests (Ulrey 2002). Many herbaceous species in rich cove forests are slow-growing, long-lived, and have variable or limited seed production and dispersal. Species density increases in mature and old growth forests as structural diversity increases through multiple and single tree fall gaps (Tuttle and White 2018).

### **Acidic Cove Ecozone**

The acidic cove ecozone occurs on protected slopes, sheltered steep gorges or ravines, and gentle sloping valleys (Pittillo et. al. 1998, Schafale and Weakley 1990). Moist soil conditions are frequently prevalent given the occurrence on north-facing slopes, the occurrence in protected concave slopes associated with streams, or the occurrence within the high rainfall belt along the Blue Ridge Escarpment. Soil nutrients and low pH are often limiting factors within these sites as (McLeod 1988, Newell and Peet 1995). In total distribution, there are five subtypes occurring across the southern Appalachians from southern Kentucky and West Virginia to northern Georgia and South Carolina (NatureServe 2021). They extend over this broad range over the Southern Appalachians and the southern Central Appalachians, in the Blue Ridge/Piedmont transition, and the Cumberland Mountains of eastern Kentucky and Tennessee Ridge and Valley in southwest Virginia. The silverbell acidic cove subtype is the rarest of the five; the typic subtype the most common. The range in global rank for the subtypes is from G2 to G5. In North Carolina this zone is most abundant at mid elevations, from 2500-4000 feet, however it can occur from the lowest elevations within the region to almost 5000 feet (Schafale 2019, Simon 2011). Of the 11 ecozones, acidic cove is the most abundant, covering approximately 24% of the Nantahala and Pisgah NFs. Within other lands in the surrounding 18 county area the type is also quite abundant covering about 21.4% of the area.

The most abundant cove subtype within the Nantahala and Pisgah NFs is the typic acidic cove. The next most abundant subtype is the typic eastern hemlock forest, however considering the current impacts from the adelgid and massive loss of hemlock death over the last decade, this community may eventually not be distinguishable from the typic acidic cove subtype (Schafale 2012). The eastern hemlock, white pine subtype is more abundant in gorges, in particular on the Blue Ridge Escarpment. This habitat may eventually be dominated by white pines and may eventually be a white pine acidic cove subtype. The chestnut oak rhododendron subtype is evenly dispersed across the Nantahala and Pisgah NFs, about as abundant as the typic eastern hemlock subtype. As previously mentioned the silverbell subtype is restricted to Joyce Kilmer Wilderness within the USFS, although these sites have also been heavily impacted by the loss of hemlock.

## Composition

Yellow poplar (*Liriodendron tulipifera*), black birch (*Betula lenta*), and eastern hemlock (*Tsuga canadensis*) dominate the more protected portions of typical acidic cove forest overstory (Schafale 2019). Typical eastern hemlock subtype is dominated by eastern hemlock, although with the impact of hemlock woolly adelgid, the overstory may resemble typical acidic cove with a lower tree canopy density. The white pine eastern hemlock subtype is dominated by eastern hemlock and white pine (*Pinus strobus*). The silverbell subtype is dominated by silverbell (*Halesia tetraptera*) and eastern hemlock (NatureServe 2021). Red oak (*Quercus rubra*) and chestnut oak (*Quercus montana*) are dominant on steeper north-facing slopes and comprise the chestnut oak Rhododendron subtype. Great laurel (*Rhododendron maximum*) is by far the most common component of this layer in portions consisting of a 10 to 15 foot tall thicket. However, some sites can have a more open shrub density.

Few herbaceous species are present within this community, particularly where a dense shrub component occurs. Occurrences tend to be widely scattered. Bryophyte diversity, particularly near streams and in steep gorges, is very high within this ecozone. Vascular species richness varies greatly across the subtypes within this zone from a low of seven for dense Rhododendron-dominated types to greater than 100 species for the more open examples, where grading into the acidic cove ecological zone (Ulrey 1999, Peet et al. 2013). Those subtypes dominated by eastern hemlock have the lowest species diversity of the five subtypes.

Acidic coves, which exist on more protected portions of the landscape, are generally stable, and subject to smaller-scale natural disturbances. Gap-phase dynamics would likely favor the increased abundance of shade tolerant tree species over time (e.g. maples and birches), however, tulip poplar tends to compete for occupancy where canopy gaps are created. Rhododendron and white pine are likely to increase in acidic coves due to the loss of eastern hemlock.

A desired condition is to increase the diversity of mesic tree species in cove hardwood forest, including acidic cove ecozones. Prior land-use management and more recent eastern hemlock decline from hemlock woolly adelgid has resulted in greater densities of such as tulip poplar, white pine, red maple, oaks and black birch (Schafale 2019). To reduce these species dominance would require a full range of management options. Examples may include harvest of variable gap sizes (in space and time) and/or thinning to allow a variety of sunlight intensities to reach the forest floor (Raymond et al. 2009, Webster et al. 2018, Kern et al. 2016). Establishing diverse woody and herbaceous plants. In addition, some reduction of selected great laurel layers may be implemented in streamside zones to enhance stream productivity.

## Wildlife habitat

Appalachian cove hardwood forests represent some of the most diverse ecosystems in the world outside of tropical zones (Hunter et al. 1999). High vegetative diversity, combined with topographic, microclimatic, and soil characteristics combine to provide an extremely productive habitat for numerous mammals, amphibians, and birds. High numbers of endemic salamanders are present (Petranka 1998), and population densities of these animals in cove forests make these extremely important habitats. Additionally, Appalachian cove forests support very high densities of breeding birds, especially mature forest-dependent neotropical migrants (Hunter et al. 1999).

## Associated species

One hundred eighty-four plant and animal species are associated with acidic cove forests in the Ecological Sustainability Evaluation, including five federally listed species, eighteen Species of Conservation concern, and twenty-two species. Species associations are identified in Appendix C. Species associations are not meant to be all-inclusive, but rather a broad enough representation to assess potential effects at the coarse filter (i.e. ecozone) level.

## Environmental Consequences

Environmental consequences for each alternative considered in detail were estimated for five indicators of acidic cove oak forest ecosystem health and resilience using the Ecological Sustainability Evaluation (ESE Tool): (1) canopy composition as measures of forest species' composition, (2) total road density as a measure of forest fragmentation and connectedness, and (3) percent young, (4) old forest, and (5) occupancy by invasive species. Ecological Sustainability scores were generated to reflect overall effects of each alternative on the health and resilience of the acidic cove forest ecosystem. Appendix C lists these indicators and values.

The acidic cove ecozone acres are distributed across the MA groups in the following way:

**Table 57. Distribution of Acidic Cove Ecozones Across Management Area Groups**

Management Area Group	Alternative B	Alternative C	Alternative D	Alternative E
MA Group 1	150,822	121,416	148,688	148,789
MA Group 2	24,086	42,189	32,389	27,950
MA Group 3	30,528	60,898	33,621	43,397
MA Group 4	43,824	24,735	34,561	28,957

See Management Area Plan Components Section above for a description of which management areas fall within each management area group.

Alternatives B, D and E may have higher potentials to increase the pace and scale of restoration compared to alternative C because they include more MA Group 1. With more acres in MA Groups 1 and 2, along with a lower amount in MA Group 4, Alternative E may provide higher opportunities for restoration compared to Alternatives B and D. Since this ecozone is not considered to be fire-adapted, the advantages of Alternative C to facilitate larger landscape prescribed fire would not be needed. An example of a restoration opportunity would be to reduce the encroachment of white pine where abundance has increased substantially more than desired as a component of this ecozone.

**Composition:** Small improvements in vegetative composition within the acidic cove ecozone are anticipated over time. Vegetation management of the tree canopy, with retention of desirable hardwoods and augmenting or planting desirable species would restore characteristic vegetation in this ecozone by reducing the density of competitive species (e.g. red maple, white pine, and tulip poplar). The restoration of canopy composition would be at a slower pace compared to pine and oak dominated ecozones because less is known about the silvics and reestablishment of mesic hardwoods compared to pines and dry oaks. Another factor in acidic coves is the loss of eastern hemlock, where rhododendron in the understory and midstory prevents establishment of regenerating tree species.

**Structure:** Increases in the structural classes of young and old forests would occur over time. The estimated proportion of young forests would increase slightly over 10 years and continue to increase over 50 years with the least amount in Alternative E compared to the other three action alternatives. For all Alternatives B, C and D, Tier 2 objectives would provide about 8 percent of young forest over the next 10 to 50 years which exceeds the desired conditions for young forest in the acidic cove ecozone. In contrast, Alternative E would not exceed the desired conditions for young forests after the first 10 years but gradually increase to 8% after 50 years.

Within MA group 1, where even-aged regeneration harvests occur, the influence of natural disturbance patterns prevalent in this ecozone may be subdued for approximately 50 to 60 years within that even-aged regeneration opening. Within the acidic cove, this impact may be highest in Tier 2 and in Alternatives B, E, D and C respectively.

Consistent with forestwide trends, the old forest structural class would increase slowly over the next 10 years under all alternatives. There is a more than six-fold increase in old forest after 50 years under all alternatives. The old growth structural class increases slower with Tier 2 objectives.

**Threats:** For all alternatives, impacts from invasive species under Tier 1 objectives would likely remain the same as the current level of impact over 10 years, and decrease slightly after 50 years of control work. However, due to a substantially higher amount of activity with Tier 2 objectives, impacts from invasive species would likely increase in the short term, then decrease in 50 years. Open road density averages about 1.57 mi/sq-mi in the acidic cove ecozone and would increase in Tier 2 up to 1.60 mi/sq-mi.

**Ecological Sustainability Score:** The condition of the acidic cove forest ecozone would improve over time under all the alternatives. Under Tier 1 objectives, Alternatives B, C, and D result in a score of “fair” and improve to “good” over 50 years. Under Tier 2 objectives, scores improve over 50 years, but not as quickly as under Tier 1 objectives. Alternative E is similar although the score does not improve over 50 years. For all alternatives the slower change is likely due to young forest temporarily exceeding the amount of desired young forest and the greater risk from invasive plants. Even so, late and old structural classes are recruited more quickly than young forest is created. Based on this analysis, plant and animal species associated with acidic cove forests would continue to persist under all alternatives.

Indicator Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Percent of ecosystem dominated by characteristic canopy species																			
Percent of ecosystem exhibiting old growth conditions																			
Percent of ecosystem exhibiting young forest conditions																			
Percent of ecosystem occupied by nonnative invasive plant species																			
Total open road density within the acidic cove forest ecosystem																			
Acidic Cove COMPOSITE SCORE																			

Figure 42. NPESE element ecological sustainability score, by alternative, for the Acidic Cove Forest.  
Red- poor, yellow- fair, light green- good, dark green- very good

## Rich Cove Ecozone

This ecozone occurs on protected slopes, sheltered steep gorges or ravines, and gentle sloping valleys (Pittillo et. al. 1998, Schafale and Weakley 1990). Sites can be quite rocky; particularly for the boulderfield subtype (Schafale 2019). Four of the main subtypes, the montane intermediate, the montane rich, the boulderfield, and the red oak occur at elevations from 2000 to 4500 feet (Schafale 2012). The two foothills subtypes occur at elevations below 2000 feet. Moist soil conditions are frequently prevalent given the occurrence on north and east facing slopes and often associated with streams. Except for the boulderfield type soils are deep, dark and fertile with varying amounts of bases such as calcium or magnesium, which are greater in the montane and foothills rich subtypes (NatureServe 2021). Soil pH averages from 5.0 to 5.5, with the higher readings in the foothills sub types (Peet et. al 2013). In total distribution, the six subtypes of this zone occur across the southern Appalachians and foothills from southern Virginia to northern Alabama, Georgia and South Carolina (NatureServe 2021). They extend in this relatively broad range over the Southern Appalachians and Central Appalachians, the foothills escarpment region, and peripherally to the Cumberland Mountains and Ridge and Valley of southwest Virginia. The foothills rich subtype is the rarest of the six, with a global rank G2G3 respectively. Also restricted are the boulderfield and red oak subtypes. They are globally ranked as G3. The other three subtypes are more common, globally ranked from G3G4 to G4.

The ecozone covers approximately 199,000 acres, or 19.2% of the Nantahala and Pisgah NFs. Within other lands in the surrounding 18 county area the type is slightly less abundant covering less than 16% of the area. The most abundant subtype within the Nantahala and Pisgah NFs is the montane intermediate rich cove. It is distributed across both forests with a greater extent across the Nantahala NF. Less is known about the abundance of the three other montane subtypes although the rich intermediate is more evenly dispersed in comparison to the boulderfield and red oak subtypes. The rich intermediate subtype is disproportionate across the two forests with more occurrences within the Appalachian and Nantahala Ranger Districts, with slightly less on the Cheoah Ranger Districts. Both foothills subtypes are limited across the Nantahala and Pisgah NFs and in particular the rich subtype.

## Composition

Hardwood tree diversity is the highest within this ecological zone. Common species include tulip poplar (*Liriodendron tulipifera*), yellow buckeye (*Aesculus flava*), basswood (*Tilia americana*), white ash (*Fraxinus americana*), cucumber tree (*Magnolia acuminata*), silverbell (*Halesia tetraptera*), black cherry (*Prunus serotina*), and black birch. Sugar maple, black maple (*Acer nigrum*), and yellow wood (*Cladrastis kentuckea*) can be prevalent within the montane rich subtype (Schafale 2019). Within the open understory a diverse number of deciduous shrubs can occur (Schafale 2019). Herbaceous diversity typically is higher within this ecozone in comparison to any other ecozone across western NC. In the richer habitats the vascular species diversity can reach 135 (Ulrey 1999, Peet et al. 2013). Epiphytic bryophytes, mosses and liverworts, and lichen diversity is high within this ecozone, particularly on mature to older trees. In older forests, moss and liverwort covered downed woody debris is abundant.

Rich coves, which exist on more protected portions of the landscape, are generally stable, and subject to smaller-scale natural disturbances. Gap-phase dynamics would likely favor the increased abundance of shade tolerant tree species over time (e.g., maples and birches), however, tulip poplar tends to compete for occupancy where canopy gaps are created, and also increases in abundance in rich coves. Due to the emerald ash borer (EAB), white ash would continue to decline in rich cove forests. Herbaceous diversity should increase within rich coves with small scale natural disturbances (e.g. single tree fall gaps).

A desired condition is to increase the diversity of mesic tree species in cove hardwood forest, in particular the rich cove ecozone. Where pure stands of tulip poplar occur in this ecozone, active management would strive to increase species diversity (Webster et al. 2018, Kern et al. 2016). To reduce white pine or tulip poplar dominance would require a full range of management options. Examples may

include harvest of variable gap sizes (in space and time) (Raymond et al. 2009) and/or thinning to allow a variety of sunlight intensities to reach the forest floor establishing diverse woody and herbaceous plants. In certain cases, second growth cove ecozones are currently carrying a higher composition of oak species compared to historical conditions. These sites would also be considered for management to return to a more appropriate and diverse cove hardwood species mix.

Herbaceous response to canopy manipulation in rich cove types across the Southern Appalachians is controversial and inconclusive (Duffy and Meir 1992, Johnson et al. 1993, Elliott et al. 1997, Roberts and Gilliam 1995). Species persist after logging based on their individual light capabilities; inflexible sun, inflexible shade herbs, or light-flexible (Collins et al. 1985, Reader and Bricker 1992). As a result some species with narrower habitat condition requirements either persist in low densities or take a long time to recover following a harvest (Gilliam 2007). Following canopy manipulation, cove sites are the most vulnerable ecozones to invasion of non-native invasive plant species. It is anticipated that the greater amount of canopy manipulation would result in a greater risk of invasive plant species introduction.

### **Wildlife habitat**

Appalachian cove hardwood forests represent some of the most diverse ecosystems in the world outside of tropical zones (Hunter et al. 1999). High vegetative diversity, combined with topographic, microclimatic, and soil characteristics combine to provide an extremely productive habitat for numerous mammals, amphibians, and birds. High numbers of endemic salamanders are present (Petranka 1998), and population densities of these animals in cove forests make these extremely important habitats. Additionally, Appalachian cove forests support very high densities of breeding birds, especially mature forest-dependent neotropical migrants (Hunter et al. 1999).

### **Associated species**

One hundred eighty-three plant and animal species are associated with rich cove forests in the Ecological Sustainability Evaluation, including five federally listed species, fifty-seven Species of Conservation concern, and twenty-three focal species. Species associations are identified in Appendix C. Species associations are not meant to be all-inclusive, but rather a broad enough representation to assess potential effects at the coarse filter (i.e. ecozone) level.

### **Environmental Consequences**

Environmental consequences for each alternative considered in detail were estimated for six indicators of rich cove forest ecosystem health and resilience using the Ecological Sustainability Evaluation (ESE Tool): (1) canopy composition as measures of forest species' composition, (2) total road density as a measure of forest fragmentation and connectedness, and (3) percent young, (4) old growth, and (5) mature forest conditions as measures of structural diversity and (6) occupancy by invasive species. Ecological Sustainability scores were generated to reflect overall effects of each alternative on the health and resilience of the rich cove forest ecosystem. Appendix C lists these indicators and values.

The rich cove ecozone acres are distributed across the MA groups in the following way:

**Table 58. Distribution of Rich Cove Ecozones Across Management Area Groups**

<b>Management Area Group</b>	<b>Alternative B</b>	<b>Alternative C</b>	<b>Alternative D</b>	<b>Alternative E</b>
MA Group 1	128,169	98,484	125,937	123,016
MA Group 2	17,485	37,374	25,019	21,386
MA Group 3	21,550	52,531	26,501	36,876
MA Group 4	32,280	11,094	22,027	18,175

See Management Area Plan Components Section above for a description of which management areas fall within each management area group.

Alternatives B, D and E may have higher potentials to increase the pace and scale of restoration because they include higher amounts of MA Group 1 compared to Alternative C. With higher amounts of MA Groups 1 and 2, and a lower amount of MA Group 4, Alternative E may provide slightly higher opportunities for restoration compared to Alternatives B and D. Since this ecozone is not considered to be fire-adapted, the advantages of Alternative C to facilitate larger landscape prescribed fire is not present. An example of a restoration opportunity in this ecozone is the reduction of high densities of tulip poplar where it dominates the ecozone and introduction of other mesic species such as sugar maple and black cherry.

**Composition:** Vegetative composition is estimated to improve in this ecozone over time under Tier 1 and Tier 2 objectives. Vegetation management of the tree canopy, with retention of desirable hardwoods, and augmenting or planting other desirable species would restore characteristic vegetation in this ecozone by reducing the density of competitive species (e.g. red maple, white pine, and tulip poplar). Restoration of canopy composition would be at a slower pace compared to pine- and oak- dominated ecozones because less is known about the silvics and reestablishment of mesic hardwoods compared to pines and oaks.

**Structure:** Increases in the structural classes of young and old growth forests would occur over time. The estimated proportion of young forests would increase slightly over 10 years and continue to increase over 50 years. For all action alternatives, Tier 2 objectives would provide 8-10 percent of young forest over the next 10 to 50 years which exceeds the desired conditions for young forest in the rich cove ecozone.

Within MA group 1, where even-aged regeneration harvests occur, the influence of natural disturbance patterns prevalent in this ecozone may be subdued for approximately 50 to 60 years within that even-aged regeneration opening. Within the rich cove, this impact may be highest in Tier 2 and in Alternatives B, D, E and C respectively.

Consistent with forestwide trends, the old forest structural class would increase slowly over the next 10 years with Tier 1 objectives (all alternatives). For Alternatives B, C, and D there is greater than a six-fold increase in old forest after 50 years while slightly less, a five-fold increase, under Alternative E. The old forest structural class increases slower with Tier 2 objectives. Mature forested conditions would increase over time. Currently, about 33% of this ecozone is mature forests. Under Tier 1 objectives, this increases to 50% in 10 years for all alternatives, and up to 80% after 50 years. Tier 2 objectives would increase at a slower rate, from 46% to 68% for all action alternatives.

**Threats:** Impacts from invasive species in all alternatives would decrease slightly with increased control efforts over 50 years under alternative A and the action alternatives under Tier 1 objectives. However, under Tier 2 objectives, impacts from invasive species would likely increase the first 10 years and then slowly decrease after 50 years of control work under all action alternatives. Open road density averages about 1.13 mi/sq-mi in the rich cove ecozone and would increase with Tier 2 objectives, up to 1.15 mi/sq-mi. Emerald Ash Borer is also active now.

**Ecological Sustainability Score:** The condition of the rich cove ecozone would improve over time (50 years) under all alternatives. Ecological sustainability scores would improve over 10 years and 50 years with Tier 1 and Tier 2 objectives. Under Tier 1 objectives, Alternatives B, C and D are estimated with the greatest increases improving to a “good” score. Tier 2 objective scores are similar to Tier 1 over 10 years for the action alternatives, but slightly lower in 50 years with no change in the ratings. These lower scores are probably a result of greater invasive plant infestations and young forest structural class creation that exceeds desired conditions.



Based on this analysis, plant and animal species associated with rich cove forests would continue to persist under all alternatives. Alternatives, B (Tier 1), and D (Tier 1) show the greatest potential for improved species diversity and density over 50 years.

Indicator Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Percent of ecosystem dominated by the ecologically characteristic canopy species																			
Percent of ecosystem exhibiting mature forest characteristics																			
Percent of ecosystem exhibiting old growth conditions																			
Percent of ecosystem exhibiting young forest conditions																			
Percent of ecosystem occupied by invasive species																			
Total open road density within the rich cove forest ecosystem																			
Rich Cove COMPOSITE SCORE																			

Figure 43. NPESE ecological sustainability score, by alternative, for the Rich Cove Forest  
Red- poor, yellow- fair, light green- good, dark green- very good

## Pine Forests

Shortleaf pine and pine-oak heath ecozones have a major component of southern pines in the canopy and occur primarily on lower elevations (shortleaf pine), with the exception of pine-oak heath which also occurs at mid-elevations. Together, these ecozones comprise approximately 150,000 acres, or about 14 percent of the Nantahala and Pisgah NFs. These ecozones are fire-adapted and require the most frequent periodic fire than any other ecozones.

### Pine-Oak/Heath Ecozone

Pine-oak/heath comprises about 104,000 acres on the Nantahala and Pisgah NFs. The pine oak/heath ecozone occurs on highly exposed ridgetops, and steep, spur slopes from low to mid elevations, 2000-4500 feet (NatureServe 2021, Landfire 2009). It is often on southerly and westerly exposures in acidic, thin, infertile soils (Newell and Peet 1995). Moisture content is very limiting as the soils are excessively drained. Three pine-oak subtypes have been identified within this ecozone: typic forest, high elevation, and low elevation mixed pine woodland. This community ranges from southwestern Virginia and southeastern Kentucky, south through Western North Carolina and eastern Tennessee, into northeastern

Georgia and northwestern South Carolina (NatureServe 2021). Across the Nantahala and Pisgah NFs, the zone covers about 104,000 acres, about 10%. It is unevenly distributed across both forests with much greater abundance within the Grandfather Ranger District and within Madison, Clay, and Transylvania Counties. Within other lands in the surrounding 18 county area, the distribution the type is less abundant, covering about 5.6% of the area. The typic forest subtype for this zone is more common across the Nantahala and Pisgah NFs as well as for those other lands within the surrounding 18 county area. This subtype is globally ranked G3. The low elevation mixed pine woodland subtype is less common in the planning area than the typic but is slightly more abundant across its range compared to the typic, globally ranked as G3G4 (NatureServe 2021). The high elevation pine subtype is the least common of the three, is only known from North Carolina, and is ranked globally as G2 (NatureServe 2021).

The desired fire return interval for maintenance of this ecozone is 4-6 years. Current stand structure is a result of fire suppression, allowing oaks to expand their prevalence and traditionally fire-intolerant pines to occupy greater proportions of the overstory community (Waldrop et al 2003). Red maple (and other mesic species) started to invade after disturbances at turn of the 19th century, but before mountain laurel was in control of the understory (Brose et al. 2012). Though mesic species (pine and hardwoods) are not highly competitive on the driest sites to date, they are present in the understory and midstory.

Recovery of the composition of pine forests has been slow over the last 80 to 100 years. Factors contributing to this slow recovery include 1) the lack of fire which aids in seed bed preparation, control of the ericaceous shrub layer and control of encroaching mesic hardwood and white pine and, 2) southern pine beetle infestations.

### Composition

This ecozone is dominated by pitch pine (*Pinus rigida*), a combination of pitch pine and Table Mountain pine (*Pinus pungens*), or a mix with shortleaf pine (*Pinus echinata*) at low elevations. Varying amounts of oaks, other hardwoods, and white pine can dominate in the absence of fire (Schafale 2012, NatureServe 2021) and under the influence of southern pine beetle. Ericaceous shrubs dominate this xeric community, particularly those sites without periodic wildfires. Mountain laurel (*Kalmia latifolia*) is the dominant shrub in the typic subtype with lesser amounts of flame azalea and bear huckleberry. Hillside blueberry (*Vaccinium pallidum*) is dominant with mountain laurel at low elevation sites. Catawba rhododendron is dominant within the high elevation subtype. Herbaceous diversity can be quite sparse within the denser shrub thickets. For those more open examples herbs and grasses can dominate. In the low elevation subtype, little bluestem (*Schizachyrium scoparium*), is dominant (NatureServe 2021). Species richness varies across the zone from quite low counts of ten in fire suppressed examples to over 55 species in sites with recurrent fire and a more open structure (Ulrey 1999).

Under passive management, over time, shortleaf pine, and the other southern pine species, such as Table Mountain pine, pitch pine, and, to a lesser degree, Virginia pine, would decrease in abundance due to increasing age, impacts of the southern pine beetle, and infrequent wildfires. These effects are similar across both the pine-oak heath and shortleaf pine-oak ecozones. Both of these systems would slowly convert to the dry oak ecozone. In the absence of frequent fire, mountain laurel would dominate the shrub layer in both these types, thereby excluding the development of a diverse grass and herb layer.

Compositional restoration of these ecozones would emphasize the removal of white pine and mesic tree species to favor southern pines. Management techniques would include a range of intensities from regeneration harvests to intermediate treatments. Thinning and prescribed burning of dense pockets of shortleaf and pitch pine to create open understory and woodland conditions would increase their resiliency to southern pine beetle outbreaks. Planting and managing for Table Mountain and pitch pines on appropriate sites would be used to restore these ecozones. Managing xeric oak species, such as southern red, black, and scarlet oak, a common associate of southern pines within these communities would also play a part in management efforts. Harvest activities may be more concentrated within

shortleaf pine ecozone due to accessibility and a greater economic return. As with the oak ecozones, prescribed burning would occur across both pine ecozones, however it would be limited by capacity and suitable burning days. The two pine ecozones are the most fire-adapted ecozones and would require frequent burning. A greater proportion of the shortleaf pine ecozone would be restored compared to the pine oak/heath due to its accessibility and smaller extent on the forests.

Compared to other ecozones, non-native invasive plant species are less likely to invade because they are the driest sites; however, both princess tree and Chinese silvergrass frequently invade these sites following wildfire or prescribed burning.

### **Wildlife habitat**

Largely because of the production of hard mast such as pine cones, and a variety of soft mast, the value of this habitat to wildlife is immense. In addition, different wildlife species are associated with different understory structures and compositions, including successional stages, of this forest type. When compositional and structural diversity are combined with the amount of this habitat available across the southern Appalachian landscape, montane oak forests and mixed pine-oak types such as shortleaf pine forests, become one of the most valuable wildlife habitats in the region. Increasing structural diversity through appropriate seral stage distribution is necessary to conserve wildlife diversity.

### **Associated species**

Sixty-seven-six plant and animal species are associated with pine-oak/heath forests in the Ecological Sustainability Evaluation, including three federally listed species, ten Species of Conservation Concern, and eleven focal species. Species associations are identified in Appendix C. Species associations are not meant to be all-inclusive, but rather a broad enough representation to assess potential effects at the coarse filter (i.e. ecozone) level.

### **Environmental Consequences**

Environmental consequences for each alternative considered in detail were estimated for six indicators of pine-oak/heath forest ecosystem health and resilience using the Ecological Sustainability Evaluation (ESE Tool): (1) canopy composition as measures of forest species' composition, (2) total road density as a measure of forest fragmentation and connectedness, and (3) percent young, (4) old forest, and (5) woodlands as measures of structural diversity and (6) occupancy by invasive species. Ecological Sustainability scores were generated to reflect overall effects of each alternative on the health and resilience of the pine-oak/heath forest ecozone. Appendix C lists these indicators and values.

The pine-oak/heath ecozone acres are distributed across the MA groups in the following way:

**Table 59. Distribution of Pine-Oak/Heath Ecozones Across Management Area Groups**

<b>Management Area Group</b>	<b>Alternative B</b>	<b>Alternative C</b>	<b>Alternative D</b>	<b>Alternative E</b>
MA Group 1	57,961	44,850	58,265	58,061
MA Group 2	7,313	13,275	10,497	9,703
MA Group 3	16,291	35,639	19,899	21,750
MA Group 4	22,273	10,074	15,179	14,213

See Management Area Plan Components Section above for a description of which management areas fall within each management area group.

All action alternatives have advantages for increasing the pace and scale of restoration in this ecozone. Alternative C, followed by Alternative E have more MA Group 3 and a low amount of MA Group 4, thus greater opportunity for restoring or maintaining large acreages of woodlands, although priority areas can

be burned in all MA Groups. Alternatives B, D, and E may have higher potential for thin and burn activities because they include more MA Group 1 compared to Alternative C because of greater access.

**Composition:** Vegetative composition is estimated to improve slightly in this ecozone under Tier 1 objectives, with more improvement under Tier 2 objectives over 10 and 50 years. This assumes that uncharacteristic vegetation is removed, such as pure stands of white pine, and that variable density thinning, supplemental planting of yellow pine, and frequent fire are used to keep mesic species from invading this system.

**Structure:** Consistent with forestwide trends, the structural classes of young, old, and open woodlands would increase over time. Tier 2 objectives would result in greater amounts of young forests over the next 10 to 50 years with slightly greater amounts estimated under Tier 1 objectives in Alternative E.

Areas of passive management would contribute to old forest structural class development over the next 10 years. For the action alternatives under Tier 1 objectives, less active management across this ecozone would result in a score of “good” or “very good” after 10 years. Within 50 years all the alternatives would exceed old forest desired conditions, resulting in lower scores. The old growth structural class increases at a slightly slower rate under Tier 2 objectives but still exceeds desired conditions in 50 years.

Woodland conditions would be slowly created over the next 10 years through active restoration but would take many decades to accomplish. Woodlands would expand under Tier 2 objectives after 50 years with Alternative E having the greatest change under both Tier 1 and Tier 2 objectives. This alternative is the only one with a higher score rating of “fair” versus “poor.”

**Threats:** Invasive species are estimated to impact about four to six percent of this ecozone over the next 10 years for all action alternatives, with a slight reduction over 50 years. This is slightly lower than current conditions under Alternative A due to less burning and higher under Alternative E with the most burning. Due to a higher amount of activity under Tier 2 objectives, impacts from invasive species would likely increase over the next 10 years. While recurrent fire is a natural disturbance mechanism, non-native invasive plants can dominate these subtypes in areas where a high-intensity, high-severity wildfire completely consumes the duff layer and removes the overstory canopy (Kuppinger and White 2007). Initially, there would be greater invasive species outbreaks which would take time to control, (greater than 10 years). As such, Alternative E would have the greatest risk of invasives for 50 years under Tier 2 objectives. Gradually, control would reduce some outbreaks, but it is assumed it would never get back to the existing condition. Open road density averages about 0.80 mi/sq-mi in the pine-oak/heath ecozone and is not expected to increase over time in this ecozone.

**Ecological Sustainability Score:** The existing condition of the pine-oak/heath ecozone is in relatively “poor to fair” condition. This is due to long term fire suppression in what is the forests’ most fire-adapted ecozone. All alternatives show little change or a slight improvement in scores over 50 years due to increased prescribed burning and repeated burns in the same locations. Tier 2 objectives would result in slightly improved scores after 10 years compared to Tier 1 objectives, and would continue to improve after 50 years, because of the objective to increase woodland conditions in this ecozone. While not varying in the rating, Alternative E would have slightly higher scores with the much greater burning while being balanced with the greater risk in non-native invasive plants.

Conditions are improving over time under all alternatives, but not as much as other ecosystems. Overall, species associated with pine-oak/heath may be maintained, but not to desired diversity and density. Given the severely departed current condition, plan implementation should emphasize actively managing in this ecosystem to enhance wildlife habitat and diversity.

Indicator Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Percent of ecosystem dominated by the ecologically characteristic canopy species																			
Percent of ecosystem exhibiting old growth conditions																			
Percent of ecosystem exhibiting young forest conditions																			
Percent of ecosystem in open canopy condition																			
Percent of ecosystem occupied by invasive species																			
Total open road density within the pine oak-heath ecosystem																			
Pine-Oak/Heath COMPOSITE SCORE																			

Figure 44. NPESE ecological sustainability score, by alternative, for the Pine-Oak /Heath Forest  
Red- poor, yellow- fair, light green- good, dark green- very good

### Shortleaf Pine Ecozone

Shortleaf pine ecozone comprises about 46,000 acres on the Nantahala and Pisgah NFs. The shortleaf pine ecological zone is present only at low elevations, typically below 2,400' elevation (NatureServe 2021). It occurs on exposed slopes, low hills, and ridges. Soils are typically acidic (pH 4.1 to 4.3) (Peet 2013, NatureServe 2021). The lower elevation sites that this ecozone occupies are generally gentler in topography and were more accessible to early settlers to develop as pasture and farmland.

Unfortunately, these sites typically have lower soil productivity and could not sustain settlers in the area, which resulted in rapid abandonment. Many low-elevation shortleaf pine-hardwood stands of today likely resulted from abandoned agricultural land, in the presence of a frequent low intensity fire regime in the early 1900s (Vose et al. 1997). The desired fire return interval to restore this ecozone is every 1 to 3 years.

This zone occurs in the southern-most extent of the Southern Blue Ridge across South Carolina, Georgia, North Carolina, and Tennessee, extending into the southern Ridge and Valley and Cumberland Plateau of Tennessee and Kentucky, and possibly into the upper Piedmont (NatureServe 2013). Three or four subtypes have been distinguished based on composition and a more open canopy. All subtypes are limited with a global rank of G3 or G3G4 (NatureServe 2021).

In Western North Carolina, this habitat is very restricted to low elevation areas in the Hiwassee River, Little Tennessee River, French Broad River, Catawba River, and Broad River valleys. The shortleaf pine ecozone covers about 46,500 acres or 4.5% of the Nantahala and Pisgah NFs. Within other lands in the surrounding 18-county area, the ecozone is twice as abundant, covering about 8.9% of the land base.

### **Composition**

The shortleaf pine ecozone is dominated by shortleaf pine (*Pinus echinata*) with less amounts of southern red oak (*Quercus falcata*), pitch pine (*Pinus rigida*), and a variety of other oak and hickory species (Schafale 2012, Simon 1996). Shortleaf pine is not dominant within the montane and mixed pine-oak subtypes, rather co-dominant with pitch pine in the former and with numerous oaks in the latter. Many sites with these subtypes, particularly those with no recent fire occurrences, have a dense shrub layer, typically dominated by ericaceous species. The abundance of shortleaf pine is lower in many sub-types due to lack of fire-supported overstory pine recruitment and impacts from southern pine beetle. Scattered herbs occur within the more closed shrub layer; however, under more frequent prescribed burn management, the shrub layer can be open with a diverse herb layer dominated by grasses and forbs. Herbaceous diversity can be sparse under the densest shrub layer and can account for sites recorded with 20 vascular plant species (Ulrey 1999). A more open fire-maintained habitat can have as many as 70 plant species (G. Kauffman, pers. obs.)

Under passive management, over time, shortleaf pine, and the other southern pine species, such as Table Mountain pine, pitch pine, and, to a lesser degree, Virginia pine, would decrease in abundance due to increasing age, impacts of the southern pine beetle, and infrequent wildfires. These effects are similar across both the pine-oak heath and shortleaf pine-oak ecozones. Both of these systems would slowly convert to the dry oak ecozone. In the absence of frequent fire, mountain laurel would dominate the shrub layer in both these types, thereby excluding the development of a diverse grass and herb layer.

Compositional restoration of these ecozones would emphasize the removal of white pine and mesic tree species to favor southern pines. Management techniques would include a range of intensities from regeneration harvests to intermediate treatments. Thinning and prescribed burning of dense pockets of shortleaf and pitch pine to create open understory and woodland conditions would increase their resiliency to southern pine beetle outbreaks. Planting and managing for Table Mountain and pitch pines on appropriate sites would be used to restore these ecozones. Managing xeric oak species, such as southern red, black, and scarlet oak, a common associate of southern pines within these communities would also play a part in management efforts. Harvest activities may be more concentrated within shortleaf pine ecozone due to accessibility and a greater economic return. As with the oak ecozones, prescribed burning would occur across both pine ecozones, however it would be limited by capacity and suitable burning days. The two pine ecozones are the most fire-adapted ecozones and would require frequent burning. A greater proportion of the shortleaf pine ecozone would be restored compared to the pine oak/heath due to its accessibility and smaller extent on the forests.

Compared to other ecozones, non-native invasive plant species are less likely to invade because they are the driest sites; however, both princess tree and Chinese silvergrass frequently invade these sites following wildfire or prescribed burning.

### **Wildlife habitat**

The value of mountain yellow pine habitat for vulnerable birds, other than early successional species, is poorly understood, as few studies have been conducted in these areas. Bartlett (1995) found that mature yellow and mixed pine-hardwood stands were less diverse and supported fewer migrant and resident bird species than other deciduous upland forest types in the mountains of Tennessee. However, some mature yellow pine forests, especially those mixed with hardwoods or containing a dense shrub

layer, provide optimal breeding habitat for several vulnerable species that occur in other mature forests, including ovenbird, eastern wood-pewee, and several woodpecker species.

Additionally, recently harvested pine stands, (along with young oak regeneration) provide essential habitat for many priority early successional species, including the prairie warbler, as well as locally important populations of ruffed grouse, northern bobwhite, and wild turkey. Local subspecies of red crossbill may depend on stands dominated by yellow pines at middle elevations during some years, but more information is needed on whether these forests are equivalent to hemlock, white pine, and spruce as important food sources (Groth 1988).

Shortleaf pine forests may provide important winter habitat for several high priority resident and short distance migrant species. Hamel (1992) identified late successional mixed-pine hardwoods as optimal habitat for yellow-bellied sapsucker, brown creeper, red-breasted nuthatch and golden-crowned kinglet. Mature Virginia pine stands were also identified as optimal habitats for red-breasted nuthatch and golden-crowned kinglet. However, it is unclear if these forest types are important to these species in the southern blue ridge specifically. Studies addressing the use of yellow pine forests by these, and other species during the winter months would help clarify the importance of pine ecosystems to the overall bird community.

#### **Associated species**

Eighty-two plant and animal species are associated with shortleaf pine forests in the Ecological Sustainability Evaluation, including two federally listed species, nine Species of Conservation Concern, and ten focal species. Species associations are identified in Appendix C. Species associations are not meant to be all-inclusive, but rather a broad enough representation to assess potential effects at the coarse filter (i.e. ecozone) level.

#### **Environmental Consequences**

Environmental consequences for each alternative considered in detail were estimated for six indicators of shortleaf pine forest ecosystem health and resilience using the Ecological Sustainability Evaluation (ESE Tool): (1) canopy composition as measures of forest species' composition, (2) total road density as a measure of forest fragmentation and connectedness, (3) percent young forest, (4) percent old forest, and (5) percent of woodlands as measures of structural diversity, and (6) presence of invasive species. Ecological Sustainability scores were generated to reflect overall effects of each alternative on the health and resilience of the shortleaf pine forest ecosystem. Appendix C lists these indicators and values.

The shortleaf pine ecozone acres are distributed across the MA groups in the following way:

**Table 60. Distribution of Shortleaf Pine Ecozones Across Management Area Groups**

<b>Management Area Group</b>	<b>Alternative B</b>	<b>Alternative C</b>	<b>Alternative D</b>	<b>Alternative E</b>
MA Group 1	39,332	37,605	40,717	40,709
MA Group 2	2,391	5,134	2,808	2,741
MA Group 3	1,532	3,210	2,288	2,270
MA Group 4	3,217	524	659	749

See Management Area Plan Components Section above for a description of which management areas fall within each management area group.

Opportunities to increase the pace and scale of restoration in shortleaf pine are similar for all action alternatives. Alternatives D and E would provide the highest potentials to increase the pace of restoration, with the high amounts of MA Group 1 and low amount of MA Group 4. Alternative C would

provide more opportunity than alternative B because it supports higher amounts of MA Groups 1 and 2, and less MA Group 4. An example of a restoration opportunity in shortleaf pine is the use of frequent fire necessary to restore and maintain this fire-adapted ecozone.

Most of this ecozone occurs in active restoration management area groups (MA Groups 1 and 2) with alternative D having the most in active restoration and alternative C having the least. In all alternatives, 20 to 25 percent of this ecozone occurs in passive management MA groups (MA Groups 3 and 4).

**Composition:** Vegetative composition is estimated to improve slightly in this ecozone under Tier 1 objectives, with more improvement under Tier 2, over 10 and 50 years. There is a greater amount of compositional change in the shortleaf pine ecozone compared to the pine-oak/heath because of accessibility, collaborative initiatives, and opportunities to burn in shortleaf pine ecozones. Compositional and structural restoration are closely linked within the shortleaf pine ecozone. Typical treatments to adjust the composition will lead to variable density stand structural conditions and open conditions over time in the presence of prescribed fire.

**Structure:** Increases in the structural classes of young, old, and open woodlands would occur over time. The estimated proportion of young forests would increase after 10 years under Tier 1 objectives. All action alternatives are stable or improving over 50 years with the greatest increase with Alternative E. Young forest conditions under Tier 2 objectives would initially be higher than Tier 1 but then would stabilize to Tier 1 outputs at 50 years for Alternatives B, C, and D. For Alternative E, young forest proportions would stay high during the 50 year period and have a score of “very good.” Areas of passive management would contribute to the old structural class development slowly over the next 10 years.

For the action alternatives under either Tier 1 or Tier 2 objectives, all would exceed the old forest structural class after 50 years even though the old forest structural class increases at a slower rate under Tier 2 objectives. As a result the ratings are lower after 50 years, “fair”, compared to 10 years, which vary from “good” to “very good” (Alternative E).

Woodland conditions would slowly be created over the next 10 years through active restoration and would greatly expand under Tier 2 objectives, up from 3 percent in 10 years to 14-18% for Alternatives B, C, or D in 50 years. Alternative E has the greatest proportion of woodlands after 50 years under both Tier 1 and Tier 2 objectives.

**Threats:** Invasive species are estimated to impact about 5% of this ecozone over the next 10 years for all alternatives, and slightly less over 50 years. Due to a higher amount of activity in Tier 2 objectives, impacts from invasive species would likely increase over the next 10 years, but reduce in 50 years for all action alternatives. Slightly greater amounts are estimated to be present with Alternative E given the doubling in burning. Open road density is approximately 1.5 mi/square mile in the shortleaf pine ecozone. Because road density is higher than average in the shortleaf pine ecozone, this ecozone is expected to be more susceptible to the spread of invasive species.

Southern pine beetle outbreaks may also impact this ecozone and are discussed in the Forest Health section of the EIS.

**Ecological Sustainability Score:** The existing condition of the shortleaf pine ecozone is in relatively “fair” condition and remains “fair” under all alternatives over 10 years. Under Alternatives B, C, and D, scores improve slightly after 50 years due to increased prescribed burning and repeated burns in the same locations. In contrast under Alternative E the scores are stable for 50 years with little change, probably due to the greater increase in risk from invasive plants.

Conditions are improving over time under all alternatives, but not as much as other ecosystems. Overall, species associated with shortleaf pine may be maintained, but not to desired diversity and density. Given



the severely departed current condition, the plan implementation should emphasize the importance of actively managing in this ecosystem to enhance wildlife habitat and diversity.

Indicator Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Percent of ecosystem dominated by the ecologically characteristic canopy species																			
Percent of ecosystem exhibiting old growth conditions																			
Percent of ecosystem exhibiting young forest conditions																			
Percent of ecosystem in open canopy condition																			
Percent of ecosystem occupied by invasive species																			
Total open road density within the shortleaf pine ecosystem																			
Shortleaf Pine Forest COMPOSITE SCORE																			

Figure 45. NPESE ecological sustainability score, by alternative, for the Shortleaf Pine Forest  
Red- poor, yellow- fair, light green- good, dark green- very good

### Floodplain Forest Ecozone

The floodplain ecozone occurs in small and large flat floodplains occurring at the lowest mountain elevation to 3,000 feet, although seldom occurs above 2,600 feet (NatureServe 2021). The large floodplain system only occurs at lower elevations, more often below 2,000 feet, along large rivers and can have many fluvial features such as river terraces or islands, point bars, or oxbows (Simon 2011, NatureServe 2021). It is influenced by frequent flooding, typically for a low duration within the small river subtype, with scoured riverbanks. Soils typically are sandy, silty, and acidic with low base saturation (Peet et al, Carolina Vegetation Survey web database 2019). The large river subtype is documented from the Southern Blue Ridge in southwestern Virginia, south to northern Georgia, and west into the Cumberland Mountains of Western North Carolina, northern South Carolina, eastern Tennessee, and possible northern Georgia (NatureServe 2021). In comparison the small river subtype extends from the southern and western extend of the Blue Ridge Province in Georgia to the heart of the Blue Ridge in North Carolina, South Carolina, and Tennessee and possibly in the Ridge and Valley in Virginia. This large river subtype is the least common of the two subtypes with a global rank of G2?. In contrast the small river subtype is globally ranked at G3 (NatureServe 2021).

This ecozone covers slightly less than 2,400 acres, approximately 0.2% of the Nantahala and Pisgah NFs. It is the least represented of all the 11 ecozones. Within other lands in the surrounding 18 county area the type is ten times more abundant, covering about 4.1% of the land base. Canopy composition is varied but often includes sycamore (*Platanus occidentalis*), tulip poplar (*Liriodendron tulipifera*), red maple (*Acer rubrum*), black birch (*Betula lenta*), eastern hemlock (*Tsuga canadensis*), and white pine (*Pinus strobus*). Within both subtypes the shrub layer can be dense to more scattered. Herbaceous species composition varies from site to site, and herbaceous strata can be quite patchy on the rocky substrate. The herbaceous layer is dominated by many rich cove mesic loving species that are floodplain adaptive. Vascular plant counts vary widely, from 13 to 123 across sites within this ecozone. The low diversity sites are dominated by evergreen shrubs.

Floodplain forests represent some of the most dynamic ecosystems in the southern Appalachians. High vegetative diversity, combined with topographic, microclimatic, and soil characteristics combine to provide an extremely productive habitat for numerous mammals, amphibians, and birds. High numbers of endemic salamanders are present, and population densities of these animals in floodplain forests make these extremely important habitats. Additionally, floodplain forests support high densities of breeding birds (Hunter et al. 1999).

Sixty-eight plant and animal species are associated with floodplain forests in the Ecological Sustainability Evaluation, including six federally listed species, twenty-five Species of Conservation concern, and ten focal species. Species associations are identified in Appendix C. Species associations are not meant to be all-inclusive, but rather a broad enough representation to assess potential effects at the coarse filter (i.e. ecozone) level.

### Environmental Consequences

Environmental consequences for each alternative considered in detail were estimated for five indicators of floodplain forest ecosystem health and resilience using the Ecological Sustainability Evaluation (ESE Tool): (1) canopy composition as measures of forest species' composition, (2) total road density as a measure of forest fragmentation and connectedness, and (3) percent young, (4) percent old forest structural class, and (5) occupancy by invasive species. Ecological Sustainability scores were generated to reflect overall effects of each alternative on the health and resilience of the floodplain forest ecosystem. Appendix C lists these indicators and values.

The floodplain ecozone acres are distributed across the MA groups in the following way:

**Table 61. Distribution of Floodplain Ecozones Across Management Area Groups**

Management Area Groups	Alternative B	Alternative C	Alternative D	Alternative E
MA Group 1	1,408	1,352	1,380	1,369
MA Group 2	334	388	379	355
MA Group 3	394	444	414	455
MA Group 4	206	157	169	161

See Management Area Plan Components Section above for a description of which management areas fall within each management area group.

All action alternatives may have the same potential to increase the pace and scale of restoration in this ecozone because the distribution of MA Groups are similar across alternatives. The greatest opportunity for harvest is within Group 1 and less in Group 2.

**Composition:** Vegetation management of the tree canopy, either by commercial or noncommercial harvests, with retention of desirable hardwoods, and augmenting or planting other desirable species would increase the potential for restoring this ecozone. It would reduce the density of competitors such as red maple, white pine, and tulip poplar. For all action alternatives, Tier 2 objectives have greater potential for canopy composition restoration compared to Tier 1 objectives. The silvics and reestablishment of mesic hardwoods is less well-known compared to pines and xeric oaks. Therefore, canopy composition restoration would be at a slower pace compared to pine and oak dominated ecozones. Vegetative composition is estimated to remain relatively stable in this ecozone over time. The estimated proportion of this ecozone with characteristic vegetation has little variation after 10 years with Tier 1 objectives. Under all alternatives, Tier 2 objectives increase the amount of characteristic vegetation over 10 to 50 years.

**Structure:** The floodplain forest ecozone will follow forestwide trends for increasing levels of young, old, and woodlands under all alternatives.

The estimated proportion of young forests would increase under Tier 1 objectives over 10 years with minimal change after 50 years. Tier 2 objectives would increase these amounts after 10 years, followed by a decrease over the next 50 years. During the first 10 years, both Alternatives B and D would have the greatest percent of young forest with a rating of “very good” compared to “good” or “fair” for the other action alternatives.

For the no action and the three action alternatives with Tier 1 objectives, the old forest structural class increases slowly over the next 10 to 50 years. With greater harvesting under Tier 2 objectives, there is slightly less old forest compared to Tier 1 objectives.

**Threats:** Invasive species are estimated to impact about 16 percent of this ecozone over the next 10 years for all action alternatives under Tier 1 objectives. Over 50 years, impacts from invasive species are expected to decrease. Under Tier 2 objectives, impacts from invasive species would increase over 10 years because of higher amounts of activity but be reduced after 50 years of control under all action alternatives. The overall reduction would be less for Alternative E, thereby resulting in the only “poor” rating by action alternatives. Open road density is approximately 4.73 mi/mi<sup>2</sup> in the floodplain ecozone. This is higher than the 1.28 mi/mi<sup>2</sup> forestwide average. Because this ecozone has a relatively high density of roads, it would likely be impacted by a high level of public access.

**Ecological Sustainability Score:** Floodplain forests are dynamic systems that are in a constant state of change so it is not surprising that scores do not exceed “fair”. The existing condition of the floodplain forests ecozone is in relatively “poor” condition due to heavy invasive species and prior land use history and would likely have small incremental improvement over time to “fair” condition over 50 years for all the action alternatives except Alternative E. There is a slight increase for Alternatives B, C, and D compared to Alternatives A and E. Alternative E scores lower due to the greater risk of non-native invasive plant species. Species that are adapted to the dynamic nature of the floodplain ecozone would continue to persist and potentially expand due to increased suitable habitat under these conditions.

	Existing Condition	Alt A	Alt A	Alt B	Alt B	Alt B	Alt B	Alt C	Alt C	Alt C	Alt C	Alt D	Alt D	Alt D	Alt D	Alt E	Alt E	Alt E	Alt E
		Alt A	Alt A	Alt B	Alt B	Alt B	Alt B	Alt C	Alt C	Alt C	Alt C	Alt D	Alt D	Alt D	Alt D	Alt E	Alt E	Alt E	Alt E
Indicator Name		10 yrs	50 yrs	T1	T1	T2	T2	T1	T1	T2	T2	T1	T1	T2	T2	T1	T1	T2	T2
Percent of ecosystem dominated by the ecologically characteristic canopy species																			
Percent of ecosystem exhibiting old growth conditions																			
Percent of ecosystem exhibiting young forest conditions																			
Percent of ecosystem NOT occupied by invasive species																			
Total open road density within the floodplain forest ecosystem																			
Floodplain Forest COMPOSITE SCORE																			

Figure 46. NPESE ecological sustainability score, by alternative, for the Floodplain Forest  
Red- poor, yellow- fair, light green- good, dark green- very good

### 3.3.2.4 Forest Species Groups

#### Closed Canopy Associates

##### Affected Environment

This species group includes closed overstories excluding young forest, partial forest canopies (woodlands), and wildlife openings, and balds. Species within this group are more closely associated with mesic, shade-dominated ecozones than with dry ecozones. These species are not necessarily dependent on mid- or old-age classes; however, diversity tends to be greater when the canopy is well-developed and has variable shade densities. Currently, more than 97% of the Forests are in closed canopy conditions, which exceeds the desired condition for this structural condition providing sufficient habitat for many plant and animal species in this group across the Forests. Long-term (multiple planning cycles) desired conditions are to have 50 to 62 percent of the forest in closed conditions, while the rest of the forest is open woodlands.

While suitable habitat may be abundant for species associated with closed canopy conditions, many species are experiencing declines across their range for reasons outside of the control of Forest Service management (e.g. loss or degradation of wintering habitat for cerulean warbler). For example, the cerulean warbler is declining at a rate of 3% annually (Sauer et al. 2013), and current population estimates represent a >75% decline since 1966 (Buehler et al. 2008). It is suspected that this decrease is due, at least in part, to the loss of large, unfragmented forest blocks across the landscape (AMJV 2019),

This species is very uncommon across the Nantahala and Pisgah NFs, despite an abundance of closed canopy forest conditions, although at the landscape and regional scales, connectivity and condition of mature forests in the Appalachians has also changed drastically over the last century, as a result of invasive species, a reduction in natural disturbance regimes, and an increase in urban and energy development (AMJV 2019). Conversely, wood thrush populations are also declining across most of their range (2% annually, with a recent decline of over 70%) (Sauer et al. 2013), due largely to habitat fragmentation associated with changing land use patterns. Unlike cerulean warbler, wood thrush is common on the Nantahala and Pisgah NFs and exhibit increasing population trends. This reinforces the need to maintain and improve closed canopy forest conditions into the future.

### Associated Species

One hundred thirty-eight plant and animal species are associated with closed canopy forests in the Ecological Sustainability Evaluation, including four federally listed species and seventy-four Species of Conservation Concern. Species associations are identified in Appendix C. Species associations are not meant to be all-inclusive, but rather a broad enough representation to assess potential effects at the coarse filter (i.e., species group) level.

### Environmental Consequences

While there is an abundance of closed canopy habitat on the Forests, the amount is currently departed from the natural range of variation. However, species associated with closed canopy forests have sufficient habitat at present and will continue to in the future.

All alternatives would continue to directly and indirectly provide habitat for species associated with closed canopy forests, and the ecological sustainability ranking for this group is expected to remain “very good” over the next 10 to 50 years. Similarly, species associated with closed canopy forests, including shaded rock outcrops, would have improved conditions under all the action alternatives for both Tier 1 and Tier 2 objectives. As such, these species may increase population sizes, continue to persist and potentially expand due to increased suitable habitat under all alternatives. These habitats are especially important to species such as green salamander (*Aneides aeneus*), a Species of Conservation Concern, a suite of other salamanders and bats, and a suite of epiphytic bryophytes and lichens.

Element Name	Existing Condition	Alt A		Alt B		Alt C		Alt D		Alt E		Alt F		Alt G		Alt H		Alt I		Alt J	
		10 yrs	50 yrs	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2
Closed Canopy Associates																					

Figure 47. NPESE ecological sustainability composite score, by alternative, for the Closed Canopy Forest Associates  
Red- poor, yellow- fair, light green- good, dark green- very good

## Forest Edge and Transition Associates

### Affected Environment

Ecotones, or transitional habitats between different forest types and/or successional classes, provide some of the most diverse wildlife habitats, and also support high species diversity. Edge and transition habitats are important for foraging, reproduction, and/or shelter for all or part of the life history of almost every wildlife species on the Nantahala and Pisgah NFs.

Forest edge and transition habitats are particularly important to species such as wild turkey, black bear, white-tailed deer, golden-winged warblers, and many bats. When considering forest edge habitat, it is important to also consider threats such as predation and nest parasitism, as well as introduction and spread of nonnative invasive plant species, that occurs at a higher rate in edge habitats.

Given current successional class diversity, this habitat type is well represented throughout the Nantahala and Pisgah NFs. Active management and natural disturbance patterns ensure that some edge and transitional forest conditions are always present on the landscape.

### Associated Species

Ninety-two plant and animal species are associated with forest edge and transition habitats in the Ecological Sustainability Evaluation, including five federally listed species and twenty-eight Species of Conservation Concern. Species associations are identified in Appendix C. Species associations are not meant to be all-inclusive, but rather a broad enough representation to assess potential effects at the coarse filter (i.e. species group) level.

### Environmental Consequences

Alternative A addresses forest edge and transition habitat with a primary focus on ensuring that interior habitat is maintained with minimal impacts from edge-forming disturbances (MAs 2a, 2c, and 4a). Reference to edge habitat as a desired habitat feature is minimal in the current forest plan.

Within Alternatives B, C, and D include desired conditions for edge habitat at the forest-wide level and within the Matrix MA. The presence and development of edge habitats is also indirectly supported by forest plan objectives that call for creation of open and young forest conditions across the Nantahala and Pisgah NFs, with most management anticipated to occur in the Matrix MA.

Analysis indicates that forestwide trends across all alternatives would result in stable to slightly increasing amounts of edge forest habitat under all alternatives (more information can be found in the project record).

Element Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Forest Edge and Transition Associates																			

**Figure 48. NPESE ecological sustainability composite score, by alternative, for Forest Edge and Transition Associates species group. These scores reflect forest edge habitat provided in the Matrix, and do not reflect edge forest habitat provided by Backcountry and other low- to no-active management portions of the landscape (see above).**

Red- poor, yellow- fair, light green- good, dark green- very good

The differences between alternatives for forest edge and transition associates at this forestwide scale is hard to identify. Therefore, the analysis looked exclusively at the Matrix Management Area, the management area that will be most impacted by active management, in order to display differences by alternative.

Within Matrix, all alternatives would continue to directly and indirectly provide habitat for Forest Edge and Transition associates over the next 10 to 50 years. The ecological sustainability ranking for Alternative C drops from a 'very good' rank to a ranking of 'good' because Alternative C includes fewer acres in the Matrix MA, where most active management is expected to occur, compared to Alternatives B and D.

## **Interior Forest Associates**

### **Affected Environment**

Unfragmented interior forests are generally free of anthropogenic disturbance, and relatively unaffected by edge and ecotone conditions. Interior forest conditions are found across the Nantahala and Pisgah NFs, within all forest types and successional classes, in patches of various size and shape. They provide essential habitat for foraging, reproduction, and shelter for all or part of the life history of almost every wildlife species occurring on the Forests.

### **Associated Species**

Seventy-four plant and animal species are associated with interior forest habitats in the Ecological Sustainability Evaluation, including two federally listed species and twenty-six Species of Conservation Concern. Species associations are identified in Appendix C. Species associations are not meant to be all-inclusive, but rather a broad enough representation to assess potential effects at the coarse filter (i.e. species group) level.

### **Environmental Consequences**

Alternative A includes forest wide direction for maintaining interior forest through the establishment of old growth patches and 38 interior forest bird patches across the Nantahala and Pisgah NFs. The ecological sustainability ranking for this group is "good" under Alternative A for 10 to 50 years.

Alternatives B, C and D include desired conditions for old growth forest and other interior habitat conditions. Additionally, Backcountry, Wilderness, Wilderness Study Areas, and Recommended Wilderness MAs all provide interior forest conditions. Forest plan objectives include old growth management thresholds and the terrestrial ecosystems section identifies proportions of structural classes for old growth by ecozone. It should be noted the threshold is the minimum age and does not necessarily mean the area has existing old growth. There are other characteristics besides age that denote high quality old growth. An analysis of potential impacts to the designated old growth network is disclosed in a later section of this FEIS.

The proposed plan does not designate forest interior bird patches, but instead relies on the development of interior conditions as portions of the forest age and remain relatively free of disturbance.

Analysis indicates that forestwide trends across all alternatives would result in large amounts of interior forest habitat, stable to slightly decreasing over time. However, this analysis does not consider loss of ephemeral edge habitat, and growth of interior forest as managed treatments age. The rate that edge forest is lost due to forest aging exceeds the rate at which new edge forest is created.

	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
<b>Indicator Name</b>																			
Acres of interior forest habitat																			
Edge to interior forest ratio																			
Percent of forest with canopy cover $\geq 60\%$																			
Interior Forest Associated Composite Score																			

Figure 49. NPSE ecological sustainability scores for the Interior Forest Associates species group.

**Note:** These scores do not reflect interior forest habitat provided by backcountry and other low- to no-active management portions of the landscape. Red- poor, yellow- fair, light green- good, dark green- very good

The differences between alternatives for interior forest associates is difficult to identify a forestwide analysis. Therefore, the analysis looked exclusively at the Matrix Management Area, the management area that will be most impacted by active management, in order to display differences by alternative.

Within Matrix, Ecological sustainability rankings for Alternatives B and D remain ‘very good’ under Tier 1 objectives for 10 to 50 years. Interior Forest Associates remain ‘very good’ under all alternatives.

## Road Density Sensitive Species

### Affected Environment

For species sensitive to disturbance, minimizing road density is vital to reducing disruption of basic life history. However, roads are also migration and dispersal barriers for some species with limited mobility and home range. Even open unpaved forest roads can be barriers to movement for species such as salamanders, turtles, snakes, and small mammals. These movement barriers make roadkill a real threat to many species. Open forest roads occur across the Nantahala and Pisgah National Forests, within all forest types.

This species group is addressed through the establishment of plan components to improve road density through limited construction of new, and increased decommissioning of old forest roads. In this sense, open forest road density is especially important to species with limited mobility and dispersal, such as those mentioned above.

Data analysis and summarization done in preparation for the Ecological Sustainability Evaluation of the Nantahala and Pisgah Forest Plan revision demonstrates that total open road density in the Matrix is on average 1.289 miles of alternative, across all alternatives and Tiers, over the next 50 years.

### Associated Species

Forty-eight plant and animal species are associated with road density sensitivities in the Ecological Sustainability Evaluation, including one federally listed species and eighteen Species of Conservation



Concern. Species associations are identified in Appendix C. Species associations are not meant to be all-inclusive, but rather a broad enough representation to assess potential effects at the coarse filter (i.e. species group) level.

### Environmental Consequences

All of the proposed alternatives provide protection and management of this species group in the same way. Ecological Sustainability Evaluation modeling for the Nantahala and Pisgah Forest Plan Revision predicts that conditions for the Road Density Sensitive species group would remain 'good' in the next 50 years under Alternatives B, C, D and E. Implementation of Alternative A would improve road density to 'very good' in 50 years (Figure 50).

Based on this analysis, it is concluded that species sensitive to disturbance or with limited home range and dispersal ability (increasing roadkill potential) (Figure 50), would continue to persist under any of the proposed alternatives.

Element Name	Existing Condition	Alt A	Alt A	Alt B	Alt B	Alt B	Alt C	Alt C	Alt C	Alt C	Alt D	Alt D	Alt D	Alt D	Alt E	Alt E	Alt E
		10 yrs	50 yrs	T1	T1	T2	T1	T1	T2	T2	T1	T1	T2	T2	T1	T2	T2
Road Density Sensitive Species																	

Figure 50. NPESE ecological sustainability composite scores (light green) for the Road Density Sensitive species group.  
Red- poor, yellow- fair, light green- good, dark green- very good

## Bark and Leaf Epiphytes

### Affected Environment

This species group includes non-vascular bryophytes and lichens that adhere to bark or leaf substrates. These species typically occur within mesic portions of the landscape and are primarily associated with mature or old growth spruce-fir, northern hardwood, acidic cove, rich cove, and floodplain ecozones.

### Associated Species

Thirty-four plant species are associated with the bark and leaf epiphyte species group in the Ecological Sustainability Evaluation, including twenty-six Species of Conservation Concern. Species associations are identified in Appendix C. Species associations are not meant to be all-inclusive, but rather a broad enough representation to assess potential effects at the coarse filter (i.e. species group) level.

### Environmental Consequences

Because all alternatives would continue to directly and indirectly provide habitat for species in this group, the ecological sustainability ranking for Bark and Leaf Epiphytes is expected to maintain its 'good' rating during the next 10 to 50 years for all alternatives except Alternative E after 50 years (Tier 2 objectives). The decline for Alternative E is due to slightly less mature habitat for the mesic ecozones.

Element Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Bark and Leaf Epiphytes																			

Figure 51. NPESE ecological sustainability composite scores (good and fair) for the Bark/Leaf Epiphytes species group. Red- poor, yellow- fair, light green- good, dark green- very good.

## Coarse Woody Debris and Downed Wood Associates

### Affected Environment

Coarse woody debris consists of broken branches, tree boles, and root wads in varying states of decay across the forest floor. These habitats are important for reproduction, shelter, and/or hibernation for many species. Woody debris serves as cover for songbirds and small mammals, provides dark and moist conditions for salamanders and insects, as well as drumming areas for ruffed grouse.

Given the mature and late successional stage of most of the forest, this habitat type is well represented throughout the Nantahala and Pisgah NFs. Additionally, Forest Vegetation Simulation (FVS) (Keyser and Rodrigue 2014) modeling predicts that coarse woody debris and downed wood would meet the minimum requirements following management activities and continue to increase as managed stands age.

### Associated Species

Forty-one plant and animal species are associated with coarse woody debris and downed wood in the Ecological Sustainability Evaluation, including nine Species of Conservation Concern. Species associations are identified in Appendix C. Species associations are not meant to be all-inclusive, but rather a broad enough representation to assess potential effects at the coarse filter (i.e., species group) level.

## Environmental Consequences

The ecological sustainability ranking for the coarse woody debris and downed wood associates species group is “good” after 10 years under Tier 1 objectives and continues to increase after 50 years with a “very good” rating because, generally speaking, disturbance (both natural and anthropogenic) results in an influx of coarse woody debris immediately post-disturbance.

Alternatives B, C, D and E all provide habitat for this species group through the establishment of plan components that protect and enhance coarse woody debris amount and distribution when management activities would remove trees.

Implementing Tier 2 objectives would allow ecological sustainability rankings for this species group to remain “good” over the next 50 years, largely because of increased vegetation management. This trend makes sense when addressed in context with the landscape’s natural increase in coarse woody debris production as a forest ages (Figure 52, Natural Aging). What this analysis does not consider are the effects of localized forest floor drying that occurs immediately following forest management activities such as timber harvest and prescribed fire. However, this species group is linked to mature and old forest structural classes across all ecozones and represents general trends in coarse woody debris and downed woody debris trends across the Forests.

Element Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B	Alt B	Alt B	Alt B	Alt C	Alt C	Alt C	Alt C	Alt D	Alt D	Alt D	Alt D	Alt E	Alt E	Alt E
				T1 10 yrs	T1 50 yrs	T2 10 yrs	T2 50 yrs	T1 10 yrs	T1 50 yrs	T2 10 yrs	T2 50 yrs	T1 10 yrs	T1 50 yrs	T2 10 yrs	T2 50 yrs	T1 10 yrs	T1 50 yrs	T2 10 yrs
CWD and Downed Wood Associates																		

Figure 52. NPESE ecological sustainability composite scores for the Coarse Woody Debris/Downed Wood Associates species group. Red- poor, yellow- fair, light green- good, dark green- very good

## Hard and Soft Mast Associates

### Affected Environment

Mast-dependent species need a mixture of hard and soft mast to survive. Habitat associated with these species can be found in all ecological systems; however, it is most common in oak forests and forest woodlands. Maintaining oak ecosystems, enhancing woodland conditions, and balancing edge to interior forest needs will satisfy most of the needs of this species group.

Given the mature and late successional stage of most of the forest, hard mast potential is well represented across the Nantahala and Pisgah NFs. Soft mast production is closely related to the amount and type of openings, and their associated edge habitat. Additionally, USFS canopy gap analysis (Lewis et. al 2017) and U.S. Geological Survey land cover analysis (USGS 2018) aid in the quantification of quality edge habitats. This analysis predicts that soft mast production would gradually increase over time as forest edges are created or maintained.

### Associated Species

Ten animal species are associated with hard and soft mast availability in the Ecological Sustainability Evaluation, including one Species of Conservation Concern. Species associations are identified in

Appendix C. Species associations are not meant to be all-inclusive, but rather a broad enough representation to assess potential effects at the coarse filter (i.e. species group) level.

### Environmental Consequences

Alternative A includes direction to enhance and maintain mast production through a standard to encourage hard and soft mast producing species within young forests and direction to retain hard mast producing species in management areas 2 and 4.

Alternatives B, C, D and E include desired conditions that identify the importance of hard and soft mast to a variety of animal species. Standards and guidelines identify the need to retain hard and soft mast during vegetation management activities.

Indicators used to analyze the effects to this species group include total acorn production, based on FVS modeling, and miles of forest edge (as a surrogate for soft mast potential). Because all alternatives would continue to directly and indirectly provide habitat for species in this group, the ecological sustainability ranking for this group is expected to improve in scoring while maintaining a “good” rating for the majority of the alternatives during the next 10 to 50 years. For Alternatives D and E (Tier 2 objectives), there is increase in the rating to “very good” due to greater miles of forest edge which would potentially enhance soft mast production.

Element Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Hard/Soft Mast Dependent Species																			

Figure 53. NPESE ecological sustainability composite scores for the Hard and Soft Mast Dependent Species group. Red- poor, yellow- fair, light green- good, dark green- very good

### Snag and Den Tree Associates

#### Affected Environment

Snags are dead trees or live trees with dead limbs or tops that provide sloughing bark, perches, and food sources for a variety of animals. Cavity and den trees are live or dead trees with openings or broken tops that provide habitat for reproduction, shelter, and/or hibernation. These habitats and associated species can be found throughout the Nantahala and Pisgah NFs.

Snags and den trees are especially important to cavity-dependent species such as squirrels, woodpeckers, roosting bats, and denning species such as black bear and flying squirrels. Given the mature and late successional stage of most of the Forests, this habitat type is well represented throughout the Nantahala and Pisgah NFs.

#### Associated Species

Twenty-two animal species are associated with snags and den trees in the Ecological Sustainability Evaluation, including three federally listed species and eight Species of Conservation Concern. Species associations are identified in Appendix C. Species associations are not meant to be all-inclusive, but

rather a broad enough representation to assess potential effects at the coarse filter (i.e., species group) level.

### Environmental Consequences

**Plan direction for the establishment and protection of snags and den trees is primarily consistent** between Alternative A and the action alternatives. Proposed plan components for Indiana bat are consistent with the current plan (as amended) and the rate of snags retained during management activities increases from two per acre to four per acre.

Because all alternatives would continue to directly and indirectly provide habitat for species in this group, the ecological sustainability ranking for this group is expected to remain in the “good” category during the next 10 to 50 years.

Element Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Snag and Den Tree Associates																			

Figure 54.NPESE ecological sustainability composite scores (good) for the Snag and Den Tree Associates species group. Red-poor, yellow- fair, light green- good, dark green- very good

## Fire-Intolerant Associates

### Affected Environment

This species group includes species that are generally intolerant of fire. Typically, habitats occupied by these species are moist or have discontinuous fuels, which limits the spread of fire. Species within this group avoid impacts from fire and occur in the most mesic portions of the landscape, primarily in spruce-fir, northern hardwood, acidic cove, rich cove, and floodplain ecozones, or occur in thin soils associated with rock outcrops. Some are non-vascular bryophytes and lichens either adhering to bark or leaf substrates or are terrestrial mollusks and other animals with limited dispersal ability that are sensitive to the effects of fire (Appendix C). Several species of tree-roosting bats are also sensitive to the effects of fire, primarily to smoke intensity during burning, and timing of the burns, rather than the fire itself.

As a whole, the complex topography and ecozone patterns within Western North Carolina result in a mosaic of habitat conditions for fire-intolerant and fire-tolerant species across the landscape. Coincidentally, many landscape prescribed burn units contain less than 40% mesic habitats, mixed with fire-adapted ecozones. Typically, fire activity and fire intensity are minimal within these mesic habitats during a prescribed burn.

### Associated Species

One hundred sixty-seven plant and animal species are associated with fire-intolerant life histories in the Ecological Sustainability Evaluation, including seven federally listed species and one hundred twelve Species of Conservation Concern. Species associations are identified in Appendix C. Species associations are not meant to be all-inclusive, but rather a broad enough representation to assess potential effects at the coarse filter (i.e. species group) level.

### Environmental Consequences

The ecological sustainability score for the fire-intolerant species group is currently ‘very good’ and would remain ‘very good’ under all Alternatives A, B, C and D regardless of Tier 1 or Tier 2 objectives. Under Tier 2 objectives for Alternative E, resulting in more than doubling the prescribed fire activity, there would be a decline in the rating to “good.” Therefore, a slightly greater impact to habitat for fire-intolerant species is anticipated under Tier 2 objectives but ecological sustainability scores remain good over 10 and 50 years. The limited change in rating for the majority of the alternatives and the reduction in Ecological Sustainability scores for the fire-intolerant species group for Alternative E (Tier 2) are not expected to result in a substantial change in habitat quality for species in this group. Therefore, fire-intolerant species would continue to persist across the Forests.

Element Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B	Alt B	Alt B	Alt B	Alt C	Alt C	Alt C	Alt C	Alt D	Alt D	Alt D	Alt D	Alt E	Alt E	Alt E
				T1 10 yrs	T1 50 yrs	T2 10 yrs	T2 50 yrs	T1 10 yrs	T1 50 yrs	T2 10 yrs	T2 50 yrs	T1 10 yrs	T1 50 yrs	T2 10 yrs	T2 50 yrs	T1 10 yrs	T2 10 yrs	T2 50 yrs
Fire-intolerant Species																		

Figure 55. NPSE ecological sustainability composite scores for the Fire-Intolerant species group.  
Red- poor, yellow- fair, light green- good, dark green- very good

## Fire-Adapted Associates

### Associated Species

Fifty-nine plant and animal species are associated with fire-adapted life histories in the Ecological Sustainability Evaluation, including two federally listed species and fifty-one Species of Conservation Concern. Species associations are identified in Appendix C. Species associations are not meant to be all-inclusive, but rather a broad enough representation to assess potential effects at the coarse filter (i.e. species group) level.

### Environmental Consequences

The ecological sustainability score for the Fire-adapted species group is currently ‘poor’ and is expected to improve to ‘fair under tier 1 objectives for all alternatives. Except for Alternative E, it remains with a “fair” rating after 50 years although individuals scores improve. Alternative E improves to “good” due to higher rates of burning compared to the other action alternatives. Under Tier 2 objectives, ecological sustainability scores maintain a ‘fair’ rating over time because the proposed amount of prescribed burns doubles. After 50 years of burning across unique habitats, the ratings for Alternatives B, C, and D improves to “good.” The higher ecological sustainability score under Alternative E is purely the large increase in burning under Tier 2 objectives.

Ensuring persistence of fire-adapted species on the forests will require decades of repeated burning. An ecological fire prioritization model has been developed to analyze the role of and need for fire on different parts of the landscape. The model incorporates rare species, weighted differently based on their rarity, as well as fire adapted ecozones. Provided rare habitats or rare fire adapted species are burned on a repeated schedule, suitable habitat for these species would improve under all alternatives. Over time, the Ecological Sustainability scores for the rare fire adapted species would improve, ensuring their continued persistence on the Forests. However, other more common fire adapted species would not receive the necessary burning to maintain all their populations or restore all their surrounding habitats. Obstacles to maintain all fire adapted habitats include capacity, logistic difficulty within remote locations, burning in wilderness or wilderness study areas, smoke management, and safety concerns. Tier 2 objectives would increase the likelihood of improving fire adapted species compared to Tier 1 objectives; however, they would not be enough to restore all the forest wide fire adapted habitats or species.

When comparing the need forest wide for burning to restore and maintain open woodland conditions, only Alternative E after 50 years is estimated to result in a change from the current “poor” rating to “fair”.

	Existing Condition	Alt A	Alt A	Alt B	Alt B	Alt B	Alt B	Alt C	Alt C	Alt C	Alt C	Alt D	Alt D	Alt D	Alt D	Alt E	Alt E	Alt E
				T1	T1	T2	T2	T1	T1	T2	T2	T1	T1	T2	T2	T1	T2	T2
Element Name		10 yrs	50 yrs	10 yrs	50 yrs	10 yrs	50 yrs	10 yrs	50 yrs	10 yrs	50 yrs	10 yrs	50 yrs	10 yrs	50 yrs	10 yrs	50 yrs	50 yrs
Fire-Adapted Species																		

Figure 56. NPSE ecological sustainability composite scores for the Fire-adapted species group. Red- poor, yellow- fair, light green- good, dark green- very good

## **Species Groups Related to Forest Structure**

Three species groups were developed to address key structural conditions as they contribute to wildlife habitat: young forest associates, old growth forest associates, and open (woodland) forest associates. Appendix C summarizes species associated with these coarse filter elements. The forest wide analysis focuses on the changes that are expected in these most limited structural classes on the forest (see Forest Structure section above). Additionally, analysis presented in the Ecozone and Species Group, Old Growth, Species of Conservation Concern, and Demand Species sections discuss these topics and potential effects on wildlife habitat in detail.

### **Young Forest Associates**

Generally speaking, the amount of young forest conditions, despite being in relatively poor condition at the present, improves over time across the Forests under all alternatives. The Forest Structure section (see above) discusses this in detail. This habitat condition is spread across all ecozones in appropriate amounts, based on natural range of variation and disturbance conditions discussed throughout this analysis.

Open (woodland) forest conditions contribute similar wildlife habitat characteristics, such as increased herbaceous understory, which is important for many species (e.g. deer, turkey, pollinators). Additionally, permanent openings (i.e., wildlife openings and linear wildlife openings) and balds also contribute similar conditions, although in a very limited capacity given their size and configuration. These areas may be important locally, but do not contribute significantly to the amount of young forest conditions at the landscape scale.

Overall, Tier 2 of Alternatives B, C, D, and E provide the best opportunity to improve wildlife habitat in terms of young forest conditions over time. It is important to note that these habitats are ephemeral and occur across the landscape in different spatial arrangements over time.

### **Old Forest Associates**

Generally speaking, the amount of potential old growth forest, here called old forest, conditions increase over time under all alternatives. The Forest Structure section (see above) discusses this in detail, as well as species group discussions such as Coarse Woody Debris and Downed Wood Associates and Closed Canopy Forest Associates. The old growth network analysis also discusses potential effects by alternative.

It is difficult to assess which alternative provides better habitat conditions for old forest associated species, as all alternatives improve over time. This analysis only determines the amount of the oldest forest component, which does not necessarily denote old growth quality, such as presence of large trees, abundant snags, downed woody debris in all sizes, etc. Given that overall, the forest is aging at a faster rate than active management is restoring young forest conditions, and that most young forest conditions are ephemeral across the landscape, all alternatives provide good opportunity to improve wildlife habitat in terms of old forest conditions over time.

### **Open (Woodland) Forest Associates**

The amount of woodland habitat conditions across the Forests is primarily related to the amount of active forest management, specifically the amount of prescribed burning, proposed under each alternative. The Forest Structure section (see above) discusses this in detail, as well as species group discussions such as Fire-adapted Species and Forest Edge and Transition Associates, and the Demand Species section. It should be noted woodland development typically takes multiple burns thus increases in amounts require multiple decades, particularly for the common fire adapted ecozones. With an



emphasis on burning within the fire adapted unique habitats, it is anticipated they will be restored at a faster rate than those common habitats, particularly under Tier2 objectives.

Open (woodland) forest conditions provide habitat characteristics, such as increased herbaceous understory, which is important for many species (e.g. deer, turkey, pollinators). In this sense, Alternative E provides the best opportunity for improved wildlife habitat for species requiring open forest conditions, although Alternatives B, C, and D also address restoring these conditions. Alternative A provides the least direction for improving open forest conditions, and therefore contributes the least to improving wildlife habitat in terms of structural diversity.

### 3.3.2.5 Unique Habitats

#### Background

Unique or rare habitats are defined as those natural communities that are rare on the Nantahala and Pisgah NFs or rare in the southern Appalachians with a global rank of G3, G#T3 or less. The number of unique habitat sites across the forest was determined from the Biotics database as maintained by the NC Natural Heritage Program (delineated by separate element occurrence numbers) and new location information from cooperators and/or forest biologists. The exact number of sites fluctuates as new locations are identified. Each site may have multiple mapped polygons of an individual unique habitat. The rarest habitat groups that occur on the Forests are grassy balds, serpentine barrens, upland vernal pools, calcareous oak-walnut forest, shale slope woodlands and various subtypes of high and low elevation rocky summits.

Most of the unique habitats support an assemblage of associated rare species, including several rare animals. High elevation rocky summits have the greatest concentration of federally listed plant species, followed by low elevation rock outcrops and montane cliffs. More mesic habitats, such as southern Appalachian bogs, seeps, and spray cliffs, support the highest plant diversity among unique habitats. Several unique habitats have few or no documented rare species, such as white pine forests, Carolina hemlock bluffs, and floodplain pools. However, these habitats have unique assemblages of plants and animals, unique geology and provide unique ecosystem functions.

**Table 62. Unique Habitats on the Nantahala and Pisgah NFs**

Unique Habitat	Number of Sites on the Nantahala and Pisgah NFs <sup>27</sup>	Number of Threatened and Endangered Species		Number of Species of Conservation Concern	
		Plants	Animals	Plants	Animals
Low Elevation Glade	16	0	3	25	5
Serpentine Woodland	1	0	2	17	4
Shale Slope	8	0	1	14	4
Montane Red Cedar Hardwood Woodland	8	0	2	11	5

<sup>27</sup> These are known locations on the Nantahala and Pisgah NFs.

Unique Habitat	Number of Sites on the Nantahala and Pisgah NFs <sup>27</sup>	Number of Threatened and Endangered Species		Number of Species of Conservation Concern	
		Plants	Animals	Plants	Animals
High Elevation Rocky Summit	20	4	3	10	6
Low Elevation Rocky Summit	13	2	2	13	6
High Elevation Granitic Dome	29	1	0	11	2
Low Elevation Granitic Dome	5	0	0	5	2
Montane Cliff (acidic and calcareous)	65	1	0	27	2
Southern Appalachian Bog	17	4	3	33	5
Swamp Forest Bog Complex	17	2	2	13	4
Seeps	69	0	2	24	2
Spray Cliff	60	1	0	26	1
Upland Vernal Pool	3	0	2	1	5
Floodplain Pool	2	0	2	1	8
Rocky Bar and Shore	13	1	3	1	10
Calcareous Oak Walnut	1	0	3	7	15
White Pine Forest	6	0	2	1	4
Beech Gaps/Boulderfields	11/16	0	3	11	9
Hemlock Bluffs/Forests	46	0	3	1	6
Heath Bald	16	0	4	2	8
Grassy Bald	7	1	4	8	6
Caves and Mines	15*	0	4	0	5

\*Fifteen biologically significant caves and abandoned mines (i.e. those that are known to support bat populations) are currently documented on the Forests; however, inventory is incomplete. This number could increase as survey intensity increases over the life of the plan.

### Plan direction

Current forest plan direction (Alternative A) is to protect unique habitats when they are encountered and identifies caves and the following rare plant communities: bogs, rock cliffs, granitic domes, high elevation rocky summits, barrens and glades, balds, boulder field forests, and seeps. While active management is

generally avoided in unique habitats, management activities such as controlling shrubs and trees in grassy balds, controlling woody invasion in bogs, controlling invasive plants, periodic prescribed burning in the serpentine barrens, and treatment of hemlock woolly adelgids do occur during implementation of the current forest plan.

The current forest plan identifies some of the most exceptional examples of unique habitats within the Special Interest Area Management Area. However, because unique habitats range in size from less than an acre up to approximately 100 acres and occur throughout the forest, many are not mapped and occur within multiple management areas.

Alternatives B, C, and D include desired conditions for the unique habitats listed in Table 62 above, with specific forest plan objectives for glades and barrens, Carolina hemlock bluffs, balds, and bogs, and standards for caves and mines and rocky habitats in the Plan and Animal Diversity section of the plan. Additionally, goals for unique habitats are throughout the Geographic Area chapter.

The proposed plan continues to identify Special Interest Areas as a management area, but the size and configuration of the management area is larger in all action alternatives compared to the current plan. During the forest plan revision, the Forest reviewed an updated list of NC Natural Heritage Program Natural Areas. These Natural Heritage Natural Areas are identified by the state of North Carolina as part of a systematic inventory of elements of natural diversity that exemplify the state's natural heritage. The state recognizes these areas for their special biodiversity significance, due to the presence of either terrestrial or aquatic rare species, exemplary natural communities, important animal assemblages, or other ecological features. All Natural Areas do not possess the same degree of unique ecological characteristics and range on a scale from general to exceptional. The Forest Service reviewed the exceptional Natural Heritage Natural Areas that are within the boundary of the Nantahala and Pisgah NFs and identified areas to include in the Special Interest Area management area. As a result of this review, action alternatives B, C and D delineate approximately 103,000 acres that are recognized for their distinctive characteristics including unique plant and animal habitats, compared to approximately 51,000 acres that are identified in Alternative A. Between draft and final, the Forest Service coordinated further with new NC Natural Heritage Program and district resource specialists. As a result of this review, Alternative E adjusted area boundaries and added new areas, totaling approximately 118,000 acres.

In the action alternatives, just as in the current plan, Natural Heritage Natural Areas that are not recognized as Special Interest Areas by the National Forest will be part of the management area in which they occur. However, the proposed plan includes plan direction to increase coordination between the US Forest Service and NC Natural Heritage Program when proposing work in Natural Heritage Natural Areas. The action alternatives include an objective to work with the NC Natural Heritage Program annually to identify Natural Heritage Natural Areas in potential project areas (PAD-O-05). Coordination with the NC Natural Heritage Program includes discussing unique values that are present in the area and opportunities to enhance and maintain resiliency of rare plant communities through site-specific management (i.e., prescribed fire in fire adapted habitats, treatment of encroaching woody vegetation), as well as reviewing and updating boundary information. The objective clarifies the intent to engage with the Natural Heritage Program prior to initiating projects. The Tier 2 objective encourages additional coordination with the NC Natural Heritage Program and review of all state Natural Heritage Natural Areas.

### **Analysis Methods**

Under all alternatives, when unique habitats are identified in a project level analysis, project design will maintain and, where possible, enhance desired conditions for those unique values. Therefore, this analysis assumes unique habitats are sustained under all alternatives, regardless of tiered objectives, when such actions are within Forest Service authority.

When unique habitats fall within management areas that are likely to have an increased amount of active management (MA Group 1), active management may either slightly improve the habitat conditions (such as increasing prescribed fire acres in habitats that depend on fire), or slightly increase the risk that the habitat could be negatively impacted, such as increasing the spread of nonnative species. Additionally, when unique habitats are within management areas that are likely to see heavy visitor use, trampling and impacts from recreation may increase.

Potential risks to unique habitats are analyzed below by considering drivers and threats that affect the habitat. Threats consistent across most unique habitats include nonnative invasive species and recreational trampling. Drivers such as fire and hydrologic regime are also used to analyze potential effects to some unique habitats. Specific threats and drivers used as indicators for analyzing risk to each unique habitat, as well as associated species, are listed in Appendix C of the EIS and described in the following section.

Since non-native invasive plant (NNIS) densities or cover information is incomplete for the unique habitats across the Nantahala & Pisgah NFs, the current condition is based on staff experience working in these communities and reflective of the risk relative to each other as well as an assessment on the quality rating, Element Occurrence rank, from the NC Natural Heritage Program (NCNHP). For the Element Occurrence rank it was assumed habitats with a rank of A (excellent) or B (good) would not be impacted by NNIS. The assessment by alternatives, both Tier 1 and Tier 2, is based on the intensity of potential activities within management area groups, which are reflective of active management and associated road building. A unique habitat site assessment by alternative was completed across the four MA groups. The greatest potential for road construction would occur within MA Group 1, less in MA Group 2, even less in MA Group 3, and no construction in MA Group 4. The risk of NNIS spread is highest for unique habitats in MA Group 1 and is the least for MA Group 4.

Recreational traffic data and associated impacts are not available for all unique community sites. As a result, a surrogate distance of 100 meters from roads and trails was used to determine the risk or likelihood of visitation to these sites. MA Groups were used to inform the amount of use and access from the existing and potential road system with MA Group 1 having the most road use and MA Group 4 having the least road use. In addition, known impacts were factored for those sites with recent information. For those unique habitats with steeper slopes and little climbing activity, such as montane cliffs, potential risks were reduced.

Opportunities for ecological restoration within fire-adapted unique habitats using prescribed fire vary among the alternatives. The existing condition, with appropriate open woodland conditions, is either based on recent observations or how frequently these sites were burned during the last 12 years. The analysis for action alternative assumes the development of new burn units. In general, there would be greater opportunity to burn dispersed unique habitats in MA Group 1, with the least flexibility to burn in MA Group 4. For MA Group 4, there is an exception for low elevation rocky summits because Linville Gorge Wilderness has a critical need to burn for federally threatened mountain golden heather, where 80% of its worldwide population occurs.

The effects of alternatives are considered in two tiers. More active management including timber harvest, prescribed burning, and road building would occur under Tier 2 objectives. In some unique habitats (described below), there would be a corresponding greater risk of non-native invasive species spread under Tier 2 objectives as a result of a greater amount of disturbance in the area surrounding the unique habitat. The indicators and their values for each unique habitat are presented in Appendix C.

The discussion of impacts to unique habitats is organized by grouping similar unique habitats together. Groups of unique habitats addressed in this analysis include 1) Woodlands, 2) Rock Outcrops, 3) Wet, 4) Forested, and 5) Balds. Caves and mines are a unique habitat this is discussed separately.

Information in these charts has a different style than the ecozone section above. The ecological sustainability rankings are a summary of the ESE outputs for the individual ecozones, unique habitats and species groups that are relevant for each unique habitat.

## **Woodland (Open Canopy) Unique Habitats**

### **Affected Environment**

Unique woodland habitats include Low Elevation Glades, Serpentine Woodlands, Shale Slopes, and Red Cedar Hardwood Woodlands. In addition to invasive species and recreational trampling, the role of fire is analyzed for serpentine woodlands, glades and shale slopes. Rock harvesting (digging holes and removing rocks) is also an indicator for analyzing the effects to serpentine barrens.

Woodland habitats are important to many wildlife species, but particularly species that require open forest conditions, such as foraging habitat for bats, including the federally listed Indiana and northern long-eared bats (*Myotis sodalis* and *M. septentrionalis*, respectively) and several bat Species of Conservation Concern, as well as nectaring habitat for many pollinators, including the federally listed rusty-patched bumblebee (*Bombus affinis*) and two insect Species of Conservation Concern.

Alternatives B, C, and D include an objective to restore and maintain 11-23 glades and barrens to an open woodlands structural class.

#### **Low Elevation Glades**

Low elevation glades are gently to moderately sloping rock outcrops with a mixture of graminoids (herbaceous plants with grass-like morphology), shrubs, and open trees (Schafale 2012, NatureServe 2021). Three glade subtypes are distinguished within the planning area by geology and dominant vegetation: basic grass, acidic grass, and acidic Biltmore sedge, and vary in global rank from G1G2 (acidic grass), G2 (basic), to G2G3 (acidic Biltmore sedge) (NatureServe 2021).

Risk factors associated with low elevation glades include non-native invasive plants, recreational trampling and lack of fire.

#### **Serpentine Woodlands**

This ecosystem is described as a patchwork of forest, dense grass patches, and partially open woodland that occurs over serpentine geology. Serpentinized dunite and olivine geology influence the vegetation present on these sites (Hadley 1949). Soil characteristics reveal higher base saturation, cation exchange capacity, pH, and magnesium relative to surrounding sites (Mansberg and Wentworth 1984). Given the unique geology, various rare species are associated with this ecosystem, including three endemic plants, Rhiannon's aster (*Symphyotrichum rhiannon*), Buck Creek ragwort (*Packera serpenticola*), and Buck Creek heartleaf (*Asarum vannerorum*) (Kauffman et al. 2004, Boufford 2014, A. Weakley pers. comm 2019). This ecosystem has a global rank of G1 (NatureServe 2021). Serpentine woodlands occur at one site on the Tusquitee Ranger District and occurs within a Special Interest Area.

Risk factors associated with serpentine woodlands include non-native invasive plants, recreational trampling, rock harvesting, and lack of fire.

#### **Shale Slopes**

Shale slopes are distinguished by small openings or woodlands with outcrops of larger bedrock or looser gravel-size shale. Canopy and other species composition is influenced by two dominant geologies (acidic or basic), each delineated as a separate subtype (Schafale 2012, NatureServe 2021). The two subtypes vary in global rank from G2? For the acidic subtype to G2with the basic

subtype (NatureServe 2021). This community is characterized by shallow soil and abundant shale, and may be maintained by periodic fires (NatureServe 2021).

Risk factors associated with shale slopes include non-native invasive plants, recreational trampling, and to a lesser extent, the lack of fire.

#### Montane Red Cedar-Hardwood Woodlands

Montane red cedar-hardwood woodlands occur on steep slopes, typically south- to west-facing, with a complex of rock outcrops, woodlands and denser grasslands (Small and Wentworth 1998). This community has a global rank of G2. It is uncertain what the natural disturbance regime is within this rare ecosystem. Some associated plants, both common and rare species, are fire-adapted, and may benefit from periodic burning. However red cedars are not adapted to fire and may be eliminated with moderate- to high-intensity burns (Curtis 1959). Given the uncertainty of periodic fire, no analysis was completed for fire frequency.

Risk factors associated with montane red cedar-hardwood woodlands include non-native invasive plants and recreational trampling.

### Environmental Consequences

**Table 63. Ecological Sustainability Rankings for Woodland Unique Habitats**

	Existing Condition	Alt A	Alt A	Alt B	Alt B	Alt B	Alt B	Alt C	Alt C	Alt C	Alt C	Alt D	Alt D	Alt D	Alt D	Alt E	Alt E	Alt E	Alt E
Element Name		10 yrs	50 yrs	T1	T1	T2	T2	T1	T1	T2	T2	T1	T1	T2	T2	T1	T2	T2	T2
Low Elevation Glades																			
Montane Red Cedar Hdwd Woodlands																			
Serpentine Woodlands																			
Woodlands and Shale Slopes																			

\*Table legend: Existing Condition, Alternatives: A, B, C, D, numbers 1 and 2 after alternatives indicate Tier 1/Tier 2 objectives. Red = poor; yellow = fair; light green = good; dark green = very good Please see Appendix C for NPESE details.

Low elevation glades are currently in “poor” condition on the Forests because of the high density of non-native invasive plants and the absence of fire across all known sites. Under Alternatives B and D, the ecological sustainability score for this habitat improves to “fair,” and under Alternatives C and E it improves to “good.” This improvement is based on the objective that increases the amount of prescribed fire under Tier 2 objectives and the assumption that prescribed fire would be prioritized in this unique fire adapted habitat. Since prescribed fire objectives are higher under Tier 1 conditions in Alternative E, it also improves to “good” after 50 years.

Montane red cedar-hardwood woodlands are currently in “very good” condition on the Forests. Under Tier 2 objectives, Alternatives B, C and E decline to “good” in the initial 10-year period, recovering to existing condition in 50 years. Lower scores for Alternative D are the result of more occurrences of this ecosystem in MA Group 1, therefore assuming more management activities and a greater risk of non-native invasive plant infestations and recreational impacts.

Serpentine woodlands are currently in ‘good’ condition and the ecological sustainability score improves to ‘very good’ after 50 years, under all alternatives. Currently, serpentine woodlands are maintained and burned more frequently than any other rare habitat across the Nantahala and Pisgah NFs. Objectives to increase burning and a standard to manage noncommercial mineral collection in special interest areas to protect unique values, would improve the condition of serpentine barrens over the long term.

Shale slopes are currently in ‘good’ condition. Under Tier 1 objectives, the ratings do not vary even with the slightly higher risk from nonnative invasive plant infestations and recreational trampling in the action alternatives. They do improve in higher individual scores after 50 years as a result of long-term burning across this unique habitat. However, with the higher risk from invasive plants under Tier 2 objectives, ecological sustainability score declines to their lowest number while still remaining ‘good’ after ten years but then improve to high ‘good’ scores after 50 years. This rebound in 50 years reflects the assumption there will be a long-term commitment to controlling nonnative invasive plant infestations within the few sites with this unique habitat. Alternative E improves under because of the increased emphasis of burning, compared to Alternatives B, C and D.

## **Rock Outcrops Unique Habitats**

### **Affected Environment**

Rock outcrops include High Elevation Rocky Summits, High Elevation Granitic Domes, Low Elevation Rocky Summits, Low Elevation Granitic Domes, Montane Acidic Cliffs, and Montane Calcareous Cliffs. The risk from invasive species and recreational trampling, including rock climbing impacts, are risk factors associated with rock outcrop unique habitats. Additionally, the lack of fire is also analyzed as a risk factor impacting low elevation rocky summits.

A diversity of plant and animal species, including vascular and nonvascular plants, as well as amphibians, mammals, reptiles, and invertebrates are dependent on rock outcrops to thrive and reproduce. These unique habitats are important for peregrine falcon (*Falco peregrinus*) nesting.

The current Forest Plan provides general direction for protection of rock outcrops. Eagle Cliff and Roan High Bluff are identified within the Roan Mountain Massif MA 9, with general management area direction and a standard to restrict public access. Portions of low elevation rocky summit have restricted access in Linville Gorge Wilderness. In addition to Eagle Cliff, several cliffs and summits are identified within the Special Interest Area section of Chapter 3, including Bonas Defeat Gorge cliff, clifftop vista in Cullasaja gorge, and Whiteside Mountain.

The proposed plan offers a higher degree of detail regarding unique habitats throughout the document. Embedded unique habitats, including rock outcrop unique habitats, are identified in each of the ecozones described in the terrestrial ecosystems section. Within the geographic areas chapter of the plan, rock outcrops are described as they occur across each geographic area. For example, rare cliffs are identified in nine of the 11 ecozones and mentioned in the geographic area descriptions for nine of the 12 geographic areas.

In addition to descriptive content, the proposed plan includes desired conditions and standards related to rock outcrops. The forest wide desired condition in the Plant and Animal Diversity section provides a description of desired conditions specific to rock outcrops. A forest wide standard affords similar levels

of protection to rock outcrops as the existing forest plan while another standard is added in the forest wide recreation section restricting new trails and climbing routes from traversing these ecosystems.

#### **High Elevation Rocky Summit**

High elevation rock outcrops occur on scattered summits and bluffs, generally above 4,000 feet (Wiser et al. 1996, Schafale and Weakley 1990, Schafale 2012). High elevation rocky summits have an extensive vertical component of exposed rock and are typically dominated by herbaceous vegetation with scattered lichens, mosses, and liverworts. High elevation rocky summits are restricted in range, occurring only in Tennessee and North Carolina (NatureServe 2021). Three subtypes are known to occur on the Pisgah and Nantahala NFs: typic, high peak, and dry lichen (NatureServe 2021, Schafale 2012). The typic and lichen subtypes are globally ranked G2, while the high peak type subtype is G1 (NatureServe 2021).

High elevation rocky summit habitat is important to many wildlife species (Appendix C), but particularly to species such as Allegheny woodrat (*Neotoma magister*) and eastern small-footed bat (*Myotis leibii*), both identified as Species of Conservation Concern, and timber rattlesnake (*Crotalus horridus*).

#### **High Elevation Granitic Dome**

High elevation granitic domes are characterized by large expanses of smooth granite with exfoliation surfaces that prevent soil development, and thereby inhibit most woody species. Generally they occur above 3,000 feet (Schafale 2012). Large mats of twisted-hair spikemoss (*Bryodesma tortipilum*) characterize this habitat, along with various herbaceous plants, lichens, and mosses. High elevation granitic domes have a global rank of G2G3 (NatureServe 2021) and largely occur on the Blue Ridge escarpment on the Pisgah and Nantahala Ranger Districts. These areas are especially important for peregrine falcon (*Falco peregrinus*) nesting.

#### **Low Elevation Rocky Summit**

Low elevation rocky summits occur on low- to mid-elevation, generally below 4,000', sloping rock outcrops or summits (Schafale and Weakley 1990, Schafale 2012). Three subtypes are distinguished by rock substrate: basic, acidic, and quartzite (NatureServe 2021, Schafale 2012), which are all dominated by herbs or low growing shrubs preferring either higher pH, acidic substrates, or quartzite. The quartzite subtype is known from the Linville Gorge area, and harbors fire-adapted species such as the federally endangered mountain golden-heather (*Hudsonia montana*) (Newell and Peet 2005). Global ranks for these three subtypes vary from G3? for the acidic type to G1 for the two other subtypes (NatureServe 2021). The majority of delineated sites on the Forests occur on the Grandfather Ranger District in the Linville Gorge Wilderness.

Low elevation rocky summit habitat is important to many wildlife species (Appendix C), but particularly to species such as Allegheny woodrat (*Neotoma magister*) and eastern small-footed bat (*Myotis leibii*) (both identified as Species of Conservation Concern), and timber rattlesnake (*Crotalus horridus*).

#### **Low Elevation Granitic Dome**

Low elevation granitic domes are distinguished by smooth exfoliating rock surfaces with an absence of crevices. They occur at lower elevations (below 3,000') compared to high elevation granitic domes and have vegetation mats dominated by rock spikemoss (*Bryodesma rupestre*) (Schafale 2012). This unique habitat has a global rank of G2. Within the planning area, low elevation granitic domes occur within the Blue Ridge escarpment in Macon, Jackson, Transylvania, Henderson, Caldwell and McDowell Counties (NatureServe 2021).



**Montane Cliffs: Acidic and Calcareous**

Only one subtype of montane acidic cliffs, acidic herb, occurs on the Nantahala and Pisgah NFs. This subtype is dominated by bare felsic rock, consisting of 90% of the area, with a mix of mosses, lichens and vascular plants and has a global rank of G3G4 (NatureServe 2021). Of all the rock outcrop types, montane acidic cliffs are the most widely dispersed.

Montane calcareous cliffs are similar to montane acidic cliffs, only differing in geology and associated plant species. There are two subtypes which differ by rock substrate, mafic and calcareous. Within the planning area the calcareous subtype is much less common than the mafic subtype. The mafic subtype has a global rank of G3 and the calcareous subtype has a global rank of G3G4.

**Environmental Consequences****Table 64. Ecological Sustainability Rankings for Rock Outcrops Unique Habitat**

Element Name	Existing	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
High Elevation Granitic Domes	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair	Fair	Good	Good	Fair	Fair	Good	Good	Fair	Fair
High Elevation Rocky Summits	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair
Low Elevation Granitic Domes	Fair	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good	Good
Low Elevation Rocky Summits	Poor	Poor	Poor	Poor	Poor	Poor	Fair	Poor	Poor	Poor	Fair	Poor	Poor	Poor	Fair	Poor	Fair	Poor	Fair
Montane Calcareous Cliffs	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair
Montane Cliffs	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good

\*Table legend: Existing Condition, Alternatives: A, B, C, D, numbers 1 and 2 after alternatives indicate Tier 1/Tier 2 objectives. Red = poor; yellow = fair; light green = good; dark green = very good. Please see Appendix C for NPESE details.

High elevation granitic domes are currently in 'good' condition on the Forests and remain 'good' under Tier 1 for all alternatives. Ecological sustainability scores decline to 'fair' under Tier 2 objectives because of impacts from non-native invasive species and trampling.

High elevation rocky summits are currently in ‘fair’ condition on the Forests and are expected to remain ‘fair’ under all alternatives. Recreational trampling is and will continue to be the greatest threat to this habitat. Impacts have been reduced during the last 20 years with restricted access to select sites. The scoring reflects the level of risk to this habitat as well as the disproportionate number of federally listed species associated with the unique habitat.

Low elevation granitic domes are currently in ‘good’ condition on the Forests and remain ‘good’ under Tier 1 objectives for all alternatives. Under Tier 2 objectives, Alternatives B, D and E decline to ‘fair’ due to the increased threat from nonnative invasive species in MA Group 1.

Low elevation rocky summits currently have an ecological sustainability ranking of ‘poor’ because of the high density of non-native invasive plants and the lack of recurrent fire. Except for Alternative E, this habitat remains ‘poor’ under Tier 1 objectives. With the increased burning under Tier 1 objectives in Alternative E, habitat is improved in 50 years. All alternatives improve to ‘fair’ under Tier 2 objectives due to the increased potential for prescribed burning. This slow improvement will only be evident after 50 years within this habitat since it will require multiple burns over many years. Given these results, there is a need to prioritize prescribed fire in Linville Gorge Wilderness to maintain the presence of *Hudsonia montana*.

As a result of this analysis, a plan component will be added into the final Plan to ensure the persistence of *Hudsonia montana* and *Liatis helleri* that emphasizes reducing cover from competing shrubs and impacts from nonnative invasive species and recreational trampling.

Montane cliffs are currently in ‘good’ condition on the Forests and remain ‘good’ under all alternatives. Nonnative invasive species and recreational trampling do not play as important a role in this unique habitat because of the steepness of these sites.

Montane Calcareous Cliffs are currently in ‘fair’ condition on the Forests and remain ‘fair’ under all alternatives. Both nonnative invasive species infestations are more of a risk as well as recreational trampling, in comparison to montane acidic cliffs. As a result, the rating remains fairly constant across all alternatives.

## **Wet Unique Habitats**

### **Affected Environment**

Wet unique habitats are dependent on moisture to maintain their associated species and include Southern Appalachian Bog, Swamp Forest-Bog Complex, Spray Cliff, Seep, Upland Vernal Pool, Floodplain Pool, and Rocky Bar and Shore. Most of these habitats are associated in some way with streams or rivers. Upland vernal pools are separate from streamside zones and derive moisture from ambient precipitation.

Considering the wet nature of these habitats, nonnative invasive threat is greater than in most other unique habitats across the Nantahala and Pisgah NFs. Recreational trampling is an indicator for spray cliffs and southern Appalachian bogs but not the other wet unique habitats. The maintenance of natural hydrologic regimes (flooding and scouring) is an indicator for floodplain pools and rocky bar and shores and the proximity to fish bearing water is used as an indicator of impacts to upland vernal pools.

A variety of plant and animal species, including vascular and nonvascular plants, amphibians, mammals, reptiles, and invertebrates, are dependent on the wet conditions within these unique habitats to thrive and reproduce. Many amphibians, including more than a dozen salamander species are associated with one or more of these unique habitats. Several of these species are identified as Species of Conservation Concern, including the incredibly rare dwarf black-bellied salamander (*Desmognathus folkertsii*).

The current forest plan includes general direction to protect bogs and seeps as unique communities when they are encountered. In addition to desired conditions for unique habitats, the proposed plan (Alternatives B, C, and D) also includes an objective to restore and/or maintain at least 12 Southern Appalachian bogs by reducing woody plant production.

### **Southern Appalachian Bogs**

Mountain bogs occur in flat or gently sloping portions of the landscape with poorly drained and saturated soils (Schafale and Weakley 1990). Although usually hydrologically connected to streams or rivers, they are generally not subject to flooding. While technically fens, since they are groundwater influenced, southern Appalachian bogs are floristically more similar to low nutrient, low pH bogs from the northeastern United States. Two southern Appalachian bog subtypes, low elevation and typic, occur on the Nantahala and Pisgah NFs, and differ primarily by elevation and the presence of southern or northern wetland species (Schafale 2012). The two subtypes have a global rank of G1G2 (NatureServe 2021).

### **Swamp Forest-Bog Complex**

Swamp forest bog complexes occur in flat or gently sloping portions of the landscape with poorly drained and saturated soils (Schafale and Weakley 1990), and are often associated with southern Appalachian bogs. There are two swamp forest bog complex subtypes: spruce and typic. Both subtypes have a dense shrub layer, typically *Rhododendron maximum*, with small boggy openings dominated by moss (*Sphagnum* sp.). Both subtypes have a closed to partially open canopy with the spruce subtype occurring at higher elevations. The two subtypes have a global rank of G2, with the spruce subtype having a G2? status (NatureServe 2021).

Swamp forest-bog complexes provide important habitat for many salamander species and contribute to maintaining the persistence of the bog turtle (*Glyptemys muhlenbergii*) on the Forests.

### **Spray Cliffs**

Spray cliff are rock outcrops associated with waterfalls and various flora, both vascular and nonvascular species. As such, they have high moisture and low annual temperature fluctuations (Billings and Anderson 1966). This habitat and associated community is primarily restricted to the Carolinas, Georgia, and Tennessee, and is best developed on the steep slopes of the Blue Ridge Escarpment (Zartman and Pittillo 1998). The vegetative community is primarily herbaceous and nonvascular plants, with occasional shrubs. The global rank is G2 due to the small number of occurrences but is not consistent with the number of occurrences documented during the past 10 years (NatureServe 2021). Spray cliffs are particularly sensitive to recreational trampling as waterfalls are a popular attraction for forest visitors.

### **Seeps**

Seeps represent a very diverse group of small habitats, ranging from low to high elevations, and occurring in headwater streams, floodplains, or over bedrock (NatureServe 2021, Schafale 2012). Two mid- to high-elevation subtypes occur in stream headwaters: high elevation boggy seep and rich montane seep. High elevation boggy seeps are dominated by sedges and grasses with a sphagnum moss component, while rich montane seeps are dominated by broadleaf herbaceous species. Both types are small and surrounded by either spruce-fir, northern hardwood, or rich cove forests. Four subtypes have been described for low elevation seeps, differing in associated species or landform: typic, montane, bedrock, and floodplain.

The range and rarity of seep communities varies. The global rank for high elevation boggy seeps is G2, and G3 for rich montane seeps (NatureServe 2021). Of the low elevation seep subtypes, typic is ranked as G3?, montane is G2G3, bedrock is G1, and floodplain seeps are G4.

In addition to providing important habitat for many amphibians, reptiles, invertebrates and plants, healthy high elevation seeps are vital to the persistence of the federally endangered spruce-for moss spider (*Microhexura montivaga*) and Yancey sideswimmer (*Stygobromus carolinensis*), a very rare crustacean and Species of Conservation Concern.

### **Upland Vernal Pools**

Upland vernal pools are small depressions occurring on flat portions of broad ridges. An impermeable soil layer inhibits or prevents drainage that pools water all winter and most of the cooler spring and fall months (NatureServe 2021, Newell and Peet 1995). While upland pools can completely dry out in the summer, the seasonal pooling inhibits tree and shrub invasion. This unique habitat is particularly susceptible to the effects of climate change.

Upland vernal pools are small (less than ½ acre), are dominated by wetland herbs and mats of sphagnum moss and provide important breeding grounds for amphibians such as members of the genus *Desmognathus*, many of which are rare, and several of which are Species of Conservation Concern (dwarf black-bellied salamander, *Desmognathus folkertsii*, and northern pygmy salamander, *D. organi*).

Upland vernal pools are exceedingly rare. Existing information limits this habitat to western NC with a global rank of G1. The three documented occurrences within western NC, occur on the Grandfather Ranger District (Pisgah NF), in fire-adapted ecozones.

In addition to the risk from non-native invasive plants, the presence of fish in upland vernal pools also poses a risk to species that naturally occur in this unique habitat. Fish introduced into an upland pool from adjacent fish-bearing waters (e.g., by predators losing live prey) pose a direct threat to species associated with vernal pools, especially from predation of amphibian eggs.

### **Floodplain Pools**

Floodplain pools are transitional habitat between aquatic and wetland systems (NatureServe 2021). They occur in narrow sloughs or rounded depressions of floodplains (Schafale 2012). Water is supplied by flooding and rainfall. Sparse emergent aquatic vegetation is present in shallow areas. The small habitats are typically shaded by floodplain forests. Two variants are known: those that contain water year-round and those that occasionally dry between floods (Schafale 2012). While vegetation is consistent among the variants, aquatic animal species differ depending on the hydroperiod and flood frequency. The global rank is G3 due to the scattered small occurrences (NatureServe 2021).

Floodplains are ecotones between aquatic and terrestrial habitats, and especially important to many reptiles and amphibians, including several *Desmognathus* and *Eurycea* salamanders, three of which are Species of Conservation Concern.

### **Rocky Bar and Shore**

Rocky bar and shore habitats occur in sand or gravel bars in or along small rivers and streams (Schafale and Weakley 1990). Structural and vegetation dynamics and sediment input are determined by the frequency of flooding. Severe flooding may damage some rocky bar habitats, while also creating new bars in other portions of the drainage. Three rocky bar and shore subtypes are known to occur on the Nantahala and Pisgah NFs, differing by their dominant

vegetation: alder-yellowroot and twisted sedge subtypes, or river bar woodland subtype that is surrounded by a partially open canopy. The woodland subtype is believed to be slightly more common across its range, with a G4 rank, while the other two are ranked G3G4 (NatureServe 2021).

### Environmental Consequences

**Table 65. Ecological Sustainability Rankings for Wet Unique Habitats**

Element Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Floodplain pools																			
Rocky Bars and Shore																			
Seeps																			
Southern Appalachian Balds																			
Spray Cliffs																			
Swamp Forest-Bog Complex																			
Vernal Pools																			

\*Table legend: Existing Condition, Alternatives: A, B, C, D, numbers 1 and 2 after alternatives indicate Tier 1/Tier 2 objectives. Red = poor; yellow = fair; light green = good; dark green = very good. Please see Appendix C for NPESE details.

Southern Appalachian Bogs are currently in ‘good’ condition on the Forests and improve under Tier 1 objectives for all alternatives because of the objective to restore and/or maintain 12 bogs by reducing woody plant encroachment. Under Tier 2 objectives, the ecological sustainability ranking under Alternatives B and D declines to ‘fair’ due to the greater risk of non-native plant infestations and recreational trampling. With the emphasis on treating non-native infestations, both of these alternatives improve to “good” in 50 years.

Swamp forest-bog complexes are currently in ‘good’ condition on the Forests and remain ‘good’ under all alternatives. This unique habitat is not as susceptible to nonnative invasive plant infestations and trampling compared to southern Appalachian bogs, which often co-occur, since they have scattered to dense *Rhododendron* thickets.

Spray Cliffs are currently in ‘good’ condition on the Forests and remain ‘good’ under Tier 1 objectives for all alternatives. Under tier 2 objectives, the ecological sustainability ranking under Alternatives B, C, D, and E declines to ‘fair’ in 10 years due to the greater risk of non-native plant infestations and recreational trampling. This rating improves to “good” after 50 years with a greater emphasis on treating non-natives, which requires time to control.

Seeps are currently in ‘fair’ condition on the Forests and remain ‘fair’ under all alternatives. There is no difference between alternatives since there is only a slight variation in the number of seeps occurring in the four MA Groups. All the seeps remain with a fair rating since nonnative invasive plant risks are present across all the alternatives.

Upland vernal pools are currently in ‘good’ condition on the Forests and remain ‘good’ or improve to ‘very good’ under all alternatives. As a result of the increase in burning and a greater threat from non-native plant infestations under Tier 2 objectives, this habitat remains “good” after 50 years compared to a “very good” rating under Tier 1 objectives.

Floodplain pools are currently in ‘very good’ condition on the Forests and remain ‘very good’ under all alternatives since implementation of any of the proposed plan alternatives will not affect the hydrology of known natural floodplain pools.

Rocky bars and shores are currently in ‘very good’ condition on the Forests and remain ‘very good’ under all alternatives. Past flooding and scouring events across all eight stream and river systems with rocky bar and shore occurrences have been frequent enough to ensure open high-quality habitats. Implementation of any of the alternatives will not change these dynamic periodic events.

## **Forested Unique Habitats**

### **Affected Environment**

Forested unique habitats include calcareous oak-walnut forest, white pine forest, beech gap and boulderfields, and Carolina hemlock bluffs and forests. These unique habitats all have a forested canopy but differ in elevation, the amount of embedded rock, and in landscape position. Non-native invasive plants pose a threat to these unique habitats and hemlock woolly adelgid is an additional risk to Carolina hemlock bluffs and forests. In addition, appropriate canopy composition is threatened within beech gaps from beech bark disease. Calcareous oak-walnut forests are threatened by lack of advanced oak regeneration.

#### **Calcareous Oak-Walnut Forest**

This low elevation forest occurs within sheltered gorge slopes or bottoms influenced by calcareous rocks such as dolomite. Higher calcium content and greater pH provide substrate for this forest that is dominated by chinquapin oak (*Quercus muhlenbergia*) and red oak, with lesser amounts of black walnut (*Juglans nigra*). Herb diversity is higher than typical dry-mesic sites that occur on felsic rock substrate. With more sheltered mesic slopes and the presence of rock outcrops, fire is probably less important than in most montane oak forests (Schafale 2019). This community is currently restricted to North Carolina and may be more similar to Ridge and Valley calcareous forests (NatureServe 2021). The global rank is G1Q and the only documented site on the Forests is on the Grandfather Ranger District.

#### **White Pine Forest**

This community is a naturally-occurring white pine-dominated forest that primarily occurs on steep slopes. Given prior land use history of planting or favoring white pine, as well as fire suppression, it can be difficult to distinguish a natural occurrence from planted white pine or off-site white pine. However, on steep gorges within inaccessible sites, the forests are presumed to be of natural origin (NC Biotics 2019). It occurs on upper slopes and steep ridges protected by higher landforms. It can occur in thin soils and is often associated with various size rock outcrops. Other canopy species are primarily xeric pines and hardwoods. Typically, there is a dense shrub layer with sparse herbaceous composition. Disturbance dynamics are wind and

possibly fire at infrequent frequencies, although the latter is undocumented. The global rank is G2G3 (NatureServe 2021).

### Beech Gap/Boulderfields

Beech gap/boulderfield forest habitats are typically found above 4,000 feet elevation and occur up to 5,800 feet elevation. Beech gaps are within concave slopes at high elevation gaps (NatureServe 2021). As such, they tend to be strongly affected by high winds often resulting in dwarfed or gnarled trees. Low temperatures and high rainfall within these sites ensure mesic conditions (NatureServe 2021). In comparison, boulderfields are located on slightly more mesic and steeper slopes with large boulders, which can have seepage underneath (Schafale and Weakley 1992, Chafin and Jones 1989). Wind swept American beech is the dominant tree within beech gaps with little shrub development and variable herbaceous diversity depending on soil moisture. Boulderfields have a more open tree canopy of yellow birch, yellow buckeye, and black birch. Shrubs, particularly gooseberries, and vines are abundant as are bryophytes covering the boulders (Schafale and Weakley 1990). Herbaceous cover is relatively sparse given the limited pockets of soil. Both beech gaps and boulderfields appear stable and are maintained by the extreme cold or wind at high elevations.

Beech gaps have a limited distribution from Tennessee and North Carolina global rank of G1. In contrast boulderfield forest has a broader distribution with a global rank of G3.

### Carolina Hemlock Bluffs/Forests

There are three subtypes of Carolina hemlock (*Tsuga caroliniana*) forest or bluffs. Carolina hemlock bluffs, either a typic or pine subtype, occur in shallow rocky soils on exposed ridges or steep slopes (NatureServe 2021). In contrast, mesic Carolina hemlock forests occur within streamside bottoms or sheltered slopes and are less susceptible to hemlock woolly adelgid than eastern hemlock.

Besides Carolina hemlock, oak is a minor component for the typic subtype with a dense ericaceous shrub layer and sparse herbs. The pine subtype is co-dominated with a xeric pine component (NatureServe 2021). A patchy to open shrub layer occurs within the pine subtype with a greater herb layer, which can include grasses and lichens. Both subtypes have a global rank of G2. The mesic subtype co-occurs with eastern hemlock and more closely resembles a hemlock hardwood forest. Great laurel and dog hobble are often very dense within the shrub layer with a very sparse herbaceous component. This represents the rarest subtype with the global rank is G1G2.

## Environmental Consequences

**Table 66. Ecological Sustainability Rankings for Forested Unique Habitats**

Element Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Beech Gap/ Boulderfield Forest																			

Element Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Calcareous Oak-walnut Forest																			
Carolina Hemlock Forest																			
White Pine																			

\*Table legend: Existing Condition, Alternatives: A, B, C, D, numbers 1 and 2 after alternatives indicate Tier 1/Tier 2 objectives. Red = poor; yellow = fair; light green = good; dark green = very good. Please see Appendix C for NPES details.

Calcareous Oak-Walnut unique habitats are currently in a ‘good’ condition and are expected to remain ‘good’ under all action alternatives. Under Alternative C Tier 1 and Tier 2 objectives, there is improvement to a “very good” condition, due to the lower risk of nonnative plant infestations

White Pine Forests are currently in a ‘very good’ condition and are expected to remain in this rating under all alternatives with either Tier 1 or Tier 2 objectives. Higher scores are estimated after 50 years for Alternatives A, C, D, and E (Tier 1 objectives) due to lower risks from non-native invasive species and long-term control.

Beech gaps and boulderfields are currently in a ‘very good’ condition and are expected to decline to ‘good’ under all alternatives. This decline can be attributed to beech bark disease, which is expected to degrade beech gaps over the long term, showing more impact after 50 years regardless of action or no-action alternatives.

Carolina Hemlock Bluffs and Forests are currently in a ‘good’ condition and improve to ‘very good’ under all action alternatives except within 10 years for Alternatives D and E (Tier 1 objectives). For these two alternatives, there is a greater risk from non-native plant infestations. The improvement can be attributed to the addition of plan direction to maintain all Carolina hemlock bluff sites to ensure Carolina hemlocks are reproducing with minimal impact from hemlock woolly adelgid.

## Balds Unique Habitats

### Affected Environment

Balds unique habitats include grassy balds and shrub balds. Both primarily occur at high elevations, although they differ in soil depth and moisture. The threat of canopy tree and blackberry invasion impacting species composition is an indicator for both bald habitats and for grassy balds, impacts from recreational trampling and infestation of non-native invasive plants are also indicators impacting the habitats.

A variety of plant and animal species, including vascular and nonvascular plants as well amphibians, mammals, reptiles, and others are dependent on the conditions within these habitats to thrive and reproduce. High elevation open areas are especially important to a suite of pollinators, including the federally listed rusty-patch bumblebee (*Bombus affinis*), several bats that use the openings for foraging,



including three species of conservation concern: tricolored bat (*Perimyotis subflavus*), eastern small-footed bat (*Myotis leibii*), and little brown bat (*M. lucifugus*), and two federally listed species: Indiana bat (*M. sodalis*) and northern long-eared bat (*M. septentrionalis*), as well as ruffed grouse (*Bonasa umbellus*), elk (*Cervus elaphus*) and other rare species such as the golden-winged warbler (*Vermivora chrysoptera*) and southern Appalachian cottontail (*Sylvilagus obscurus*).

The current Forest Plan provides direction for managing balds primarily in the Roan Mountain management area. The proposed plan includes similar direction in the Roan Mountain management area with an objective to restore and maintain an additional 10 to 20 acres of grassy and heath balds over the life of the plan.

### **Grassy Balds**

Grassy balds occur at high elevations, typically above 5,000 feet elevation, on ridgetops, knobs and gentle slopes (Newell and Peet 1995, NatureServe 2021). Soils are generally moist due to low temperatures and frequent moisture from rain or snowstorms and fog deposition (Schafale and Weakley 1990). Three subtypes are delineated: grass, sedge, and alder (Schafale 2019). All three subtypes have a global rank of G1. The green alder subtype is the most restricted, only occurring at Roan Mountain in North Carolina and Tennessee (NatureServe 2021). The sedge subtype is also quite restricted, known from Roan Mountain and one other peak in North Carolina. The grass subtype is also known from Virginia, primarily Whitetop Mountain.

There is uncertainty on the historical extent of grassy balds, as well as their origin (Wells 1937). Theories on creation and maintenance have been hypothesized about megaherbivore grazing, trampling, clearing by early settlers, Native American prescribed burning or natural wildfires, historical climatic change, and/or insect damage (Lindsay and Bratton 1976, McLeod 1988, DeSelm, H. R., and N. Murdock. 1993, Wiegand & Knowles 1999, Schafale & Weakley 1990, NatureServe 2021). All have experienced grazing, periodic woody plant invasion, and management activities. It is fairly certain they are not presently being created (Landfire 2009). The analysis here does not include what are thought to be anthropogenic derived balds. This analysis includes the balds on Roan Mt, Big Bald, and Middle Prong Wilderness. There are at least another 20 balds, such as Max Patch, Huckleberry, Goat, or Siler Bald, on the Nantahala and Pisgah NFs which are a result of prior land use conversion, probably of high elevation red oak forest. Soil phytolith analysis at several of these sites did not indicate a difference between adjacent reference forest soils and the existing opening (Knoepp et al 1998).

In Western North Carolina, grassy balds are disproportionately concentrated in federal ownership, including the Nantahala and Pisgah NFs, Blue Ridge Parkway, and the Great Smoky Mountains National Park. The majority of the forestwide grassy balds, including all three subtypes, occur at Roan Mountain.

### **Shrub Balds**

Shrub balds are treeless areas on exposed steep slopes and ridges or flatter thin soil areas bordering rock outcrops (Risk 1993, Schafale 2019). Shrub balds are generally restricted to high elevation, above 4,800 feet, except for a single low elevation subtype, which has been located at less than 4,000 feet elevation (Schafale 2019). Three other subtypes are distinguished by one of their primary shrub dominants, either Catawba rhododendron, Carolina rhododendron, or mountain fetterbush (*Pieris floribunda*). The four subtypes in the national forest vary in global rank from G1 (southern mixed), to G2 (Carolina and Catawba Rhododendron subtypes), and G2G3 (low elevation).

Of the delineated subtypes in western NC, all the known Carolina rhododendron occurrences are on USFS lands, 50% of the low elevation subtype occur on USFS, and about 30% of the site for both southern mixed and Catawba rhododendron subtypes occur on either the Pisgah or Nantahala NFs.

## Environmental Consequences

**Table 67. Ecological Sustainability Rankings for Balds Unique Habitat**

Element Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Grassy Balds																			
Shrub Balds																			

\*Table legend: Existing Condition, Alternatives: A, B, C, D, numbers 1 and 2 after alternatives indicate Tier 1/Tier 2 objectives. Red = poor; yellow = fair; light green = good; dark green = very good. Please see Appendix C for NPESE details.

Grassy balds currently have an ecological sustainability score that ranks as ‘fair’. Grassy balds improve under all alternatives because of the objectives to treat non-native invasive plants and reduce recreational impacts. All action alternatives also include an objective to restore additional acres of grassy balds.

Shrub balds are currently “good” and remain ‘good’ under all alternatives since the current condition of tree invasion, which is scattered and minimal, is not expected to increase over time.

## Caves and Abandoned Mines

### Affected Environment

This group includes both natural caves and abandoned mines. Two types of natural caves are present within the planning area, differing mainly by how they are formed: solution caves and fissure caves. Additionally, rock shelters provide some cave-like characteristics and habitat.

Solution caves are formed by water slowly dissolving underlying rock to form tunnels that gradually enlarge. These types typically form in limestone geology, and are known from the Nantahala Gorge, North Fork Catawba River, and Linville Mountain within the planning area. Fissure caves are formed by Earth’s movement creating cracks in the rock and can vary in size and configuration. In North Carolina, the area of greatest concentration of fissure caves is adjacent to the planning area, along the southern border of Henderson and Rutherford Counties in the Hickory Nut Gorge.

Rock shelters, or boulder caves, are formed by a number of factors, including erosion, extreme weather, and earth movement, all of can create spaces underneath or behind surface rock. Rock shelters are the most common type of cave within the planning area and across North Carolina. In addition, abandoned mines have created various-sized subterranean cavities which can mimic natural caves in terms of habitat.

Temperature, humidity, water quantity and quality, and level of human disturbance are important components of cave, abandoned mine, rock shelter, and grotto habitats. Habitat needs of the species

(mostly bats) in these groups are directly tied to these conditions. Most known, caves and abandoned mines are identified as unique habitats across the Nantahala and Pisgah NFs by the Forest Service and North Carolina Natural Heritage Program. All caves known to support bats, salamanders, or other animal life on the Nantahala and Pisgah NFs have been identified by the Forest Service as Biologically Significant under the Federal Cave Resources Protection Act of 1988 (16 USC 63:4301-4310).

While bats, and a few salamanders and invertebrates, are found occasionally, these resources do not support the biological diversity of the same ecosystems in karst geology. The presence and spread of white-nose syndrome are the greatest threat to the persistence of cave-associated species on the Forests. White-nose syndrome was first found in the northeast in 2006, rapidly spread southward, and is now moving west. Cave-associated bat populations in North Carolina have been reduced by as much as 90% in some locations (NCWRC 2017).

Partially open rock shelters can provide habitat for lichens, bryophytes, and ferns; however, most completely dark habitats would have limited to no plant diversity. No cave obligate plant species are known in Western North Carolina.

This ecosystem and related species groups are addressed through the establishment of plan components to protect caves, and abandoned mines —especially by limiting human access to these resources (PAD-DC-05, PAD-S-09, PAD-S-10, PAD-S-11). Recreational traffic has been identified as one of the largest vectors of the spread of white-nose syndrome, which has decimated cave-associated bat populations in the eastern United States. Environmental conditions such as temperature, humidity, and water quantity and quality are, perhaps, more affected by climate change than anthropogenic disturbance given protections in place for these resources.

#### Environmental Consequences

Element Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Caves and Abandoned Mines																			

\*Table legend: Existing Condition, Alternatives: A, B, C, D, numbers 1 and 2 after alternatives indicate Tier 1/Tier 2 objectives. Red = poor; yellow = fair; light green = good; dark green = very good. Please see Appendix C for NPESE details.

All of the proposed alternatives provide protection and management of caves and abandoned mines, including associated species. With the exception of the presence of white-nose syndrome within known caves and abandoned mines, which is expected to remain 'poor,' conditions within this unique habitat are currently 'good' and improve to 'very good,' largely due to the commitment to protect all caves and abandoned mines, including installing gates to prohibit human access when appropriate.

### 3.3.3. Federally Endangered or Threatened Plant Species

In the initial planning revision assessment, the Nantahala and Pisgah NFs was tracking 14 federally threatened or endangered plant species. Based on discussions with the Asheville field office of the U.S. Fish and Wildlife Service, three of those species, *Hexastylis naniflora*, *Sarracenia oreophila*, and *Sisyrinchium dichotomum* were dropped from further review because it was determined the Nantahala and Pisgah NFs have no suitable habitat or the species habitat has been lost due to long-term land use conversion. Of the remaining 11, nine have known populations on the Forest. Both *Sagittaria fasciculata* and *Sarracenia rubra ssp. jonesii* have suitable habitat on the Pisgah NF as well as nearby occurrences on other lands. Since the assessment, one other species, *Platanthera integrilabia*, was listed in 2016. While there is an historical occurrence in Cherokee County near the Tusquitee Ranger District, it has not been relocated. *Platanthera integrilabia* is also documented from Henderson County but has not been located recently. For those reasons the USWS considers the species historical in North Carolina and did not recommend consultation. The species was analyzed as potential suitable habitat in bogs for the ESE.

**Table 68. Federally Listed Plant Species Analyzed for the Nantahala and Pisgah NFs Land Management Plan Review**

Common Name	Scientific Name	Federal Status	G-Rank	Presence
Spreading Avens	<i>Geum radiatum</i>	Endangered	G2	yes
Rock Gnome Lichen	<i>Gymnoderma lineare</i>	Endangered	G3	yes
Swamp Pink	<i>Helonias bullata</i>	Threatened	G3	yes
Roan Mountain Bluet	<i>Hedyotis purpurea</i> <i>var. montana</i>	Endangered	G5T2	yes
Mountain Golden-heather	<i>Hudsonia montana</i>	Threatened	G1	yes
Small Whorled Pogonia	<i>Isotria medeoloides</i>	Threatened	G2G3	yes
Heller's Blazing Star	<i>Liatris helleri</i>	Threatened	G2Q	yes
Blue Ridge Goldenrod	<i>Solidago spithamea</i>	Threatened	G2	yes
Virginia Spiraea	<i>Spiraea virginiana</i>	Threatened	G2	yes
Bunched Arrowhead	<i>Sagittaria fasciculata</i>	Endangered	G2	no
Mountain Sweet Pitcher Plant	<i>Sarracenia rubra ssp. jonesii</i>	Endangered	G2	no

Nine federally listed threatened and endangered (T&E) plant species have been documented across the Nantahala and Pisgah NFs. Fifty-five populations and two hundred twenty discrete T&E plant subpopulations have been documented for these nine species (Table 68). For this analysis, a “population” is defined as any grouping of sites located within one kilometer of each other, provided that they occur within the same drainage or local watershed, or a dispersal barrier separates closer occurrences. As expected of the rarest species, the nine federally listed plants are unevenly distributed across the two forests. All nine species are currently documented on the Pisgah NF and three species on the Nantahala NF. Four of the nine species only have one or two extant populations; however, the number of extant subpopulations is greater and ranges from one subpopulation of the orchid *Isotria medeloides* to 83 subpopulations of *Gymnoderma lineare* (Table 69).

**Table 69. Distribution of Extant Federally Listed Threatened and Endangered (T&E) Plant Species Across the Nantahala and Pisgah NFs**

Species	Populations (Subpopulations)	Forest	Districts
<i>Gymnoderma lineare</i>	38(83)	Pisgah, Nantahala	Cheoah, Nantahala, Tusquitee, Pisgah, Appalachian, Grandfather
<i>Spiraea virginiana</i>	3 (39)	Pisgah, Nantahala	Cheoah, Nantahala, Appalachian
<i>Hudsonia montana</i>	5 (34)	Pisgah	Grandfather
<i>Geum radiatum</i>	2 (20)	Pisgah	Appalachian
<i>Helonias bullata</i>	2 (26)	Pisgah, Nantahala	Pisgah, Nantahala
<i>Hedyotis purpurea</i> <i>var. montana</i>	4 (18)	Pisgah	Appalachian
<i>Solidago spithamea</i>	1 (6)	Pisgah	Appalachian
<i>Liatris helleri</i>	6(17)	Pisgah	Grandfather
<i>Isotria medeloides</i>	1 (1)	Pisgah	Pisgah
<i>Sagittaria fasciculata</i>	0	Potential Pisgah	No known occurrences
<i>Sarracenia rubra</i> ssp. <i>jonesii</i>	0	Potential Pisgah	No known occurrences

The majority of federally listed species only occur within unique habitats, rock outcrops, bogs, or adjacent to streams (Table 70). One species, *Isotria medeloides*, occurs in multiple forested habitats. Species that occur in similar habitats are often impacted by similar environmental and social threats. Therefore, the effects to federally listed plants is organized by plant community type.

**Table 70. Habitat for the Listed Threatened and Endangered (T&E) Plant Species Across the Nantahala and Pisgah NFs**

Species	Habitat Type	Plant Community
<i>Geum radiatum</i>	Rare Community	High Elevation Rocky Summit
<i>Solidago spithamea</i>	Rare Community	High Elevation Rocky Summit
<i>Hedyotis purpurea</i> <i>var. montana</i>	Rare Community	High Elevation Rocky Summit, Grassy Bald
<i>Hudsonia montana</i>	Rare Community	Low Elevation Rocky Summit
<i>Liatris helleri</i>	Rare Community	Low Elevation Rocky Summit
<i>Helonias bullata</i>	Rare Community	Southern Appalachian Bog, Swamp Forest Bog Complex
<i>Sagittaria fasciculata</i>	Rare Community	Southern Appalachian Bog
<i>Sarracenia rubra</i> ssp. <i>jonesii</i>	Rare Community	Southern Appalachian Bog
<i>Spiraea virginiana</i>	Rare and General	Rocky Bar and Shore, Streamside
<i>Gymnoderma lineare</i>	Rare and General	Shaded Rock Outcrops, Streamside or Stream Boulders
<i>Isotria medeloides</i>	General Forest	Dry-Mesic Oak, Mesic Oak, Acidic Cove, Rich Cove

### 3.3.3.1 High Elevation Rocky Summits

The three federally listed species associated with high elevation rocky summit habitats are *Geum radiatum*, *Solidago spithamea*, and *Hedyotis purpurea var. montana*.

#### Spreading avens (*Geum radiatum*)

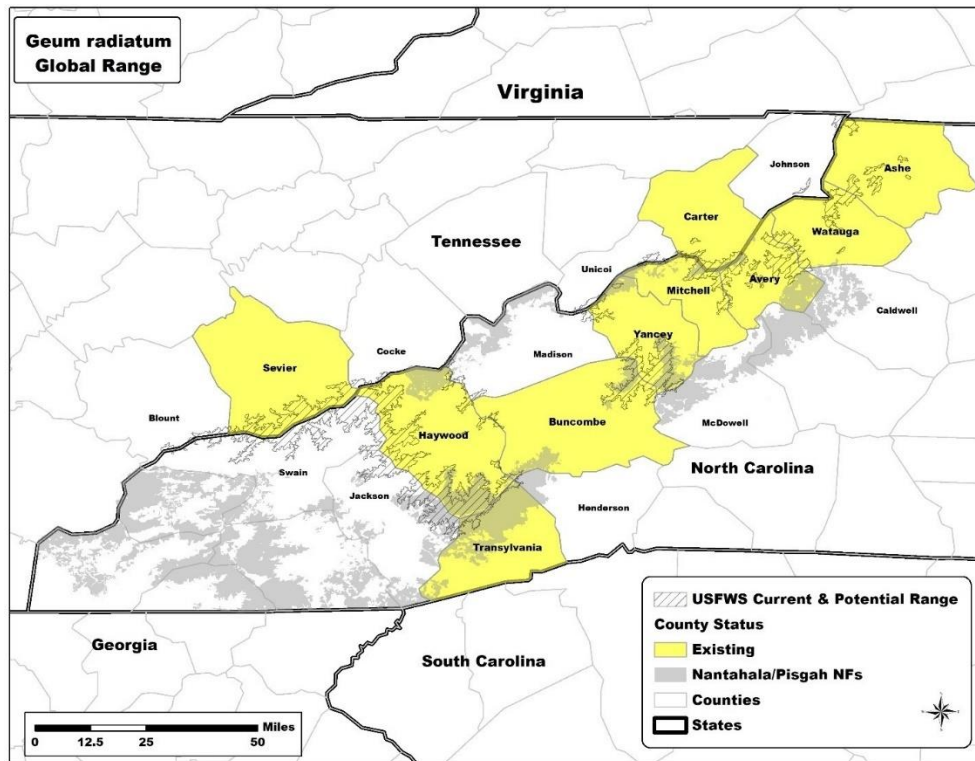
##### Affected Environment



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unties in North

**Figure 57).** In Tennessee, spreading avens is restricted to two sites and counties, within the Great Smoky Mountains and on Roan Mountain, where it occurs with the other clusters of NC Roan Mountain populations. In 2021, the USFWS modeled potential habitat across higher elevation sites in NC and TN. This includes the upper elevations of six additional NC counties and four TN counties (Figure 58). Spreading avens has a global rank of G2 and was listed as endangered under the Endangered Species Act on April 5, 1990 (U.S. Fish and Wildlife Service 1990). There is no designated critical habitat for spreading avens.

There are fifteen spreading avens populations and 49 subpopulations that occur across its range in North Carolina and Tennessee. On the Nantahala and Pisgah NFs, there are two known populations with 20 subpopulations, both occurring at Roan Mountain on the Appalachian Ranger District of the Pisgah NF. Combined with two additional subpopulations on the Cherokee NF at Roan Mountain, this represents the largest concentration of this species across its range, therefore the Pisgah NF has a large role in maintaining this federally listed species.



**Figure 57. Documented current and potential county-wide global range map of spreading avens (NatureServe 2021, USFWS 2021, NC Biotics 2021)**

Threats to spreading avens include habitat loss (natural succession with invasion by woody plants and/or taller herbs, and development), recreation (trampling, rock climbing), rockslides, possibly acid deposition, and poor seedling recruitment (NatureServe 2021, Prince and Morse 1985, USFWS 2013, Ulrey et al. 2016). Similar to other high elevation rocky summit species, spreading avens is thought to persist on small high elevation “islands” where the climate still remains cool and moist. Recent analysis of climate change with long-term demographic population dynamics indicates the need to augment populations as temperatures warm (Ulrey et. al. 2016).

In order to address the impact of recreational trampling on Roan Mountain, closure orders were issued in 1996 to protect subpopulations of spreading avens at Roan High Bluff and Eagle Cliff. Monitoring data from 2005 to 2013 indicate that subpopulations have recovered (Donaldson 1999a, 1999b, 2002b; David Danley, Pisgah NF botanist, personal communication).

Variable monitoring intensity has been implemented across the 20 subpopulations. All 20 subpopulations have been visited at least once during the last 10 years, and most have been visited two to three times. With incorporation in a demographic study administered by Dr. Chris Ulrey, ecologist for the Blue Ridge Parkway, portions of five subpopulations have been tracked for the last 17 to 19 years. Four of the five sites do not vary greatly in the number of clumps from year to year. Some declines have been recorded but is primarily a result of two previously separate clumps merging into a single clump or from yearling deaths. One site has a decline, representing less than 10% of the recorded clumps, which is probably a result of impacts from freeze and thawing which dislodged fragmented rocks with adhering *Geum radiatum* clumps off the cliff face during the winter. Rosette numbers tend to be more variable from year to year but did not vary in total by more than 5-10% from the total numbers recorded across the five sites.

Evidence of both sexual and asexual reproduction is present at sites on Roan Mountain; however, sexually reproduced seedlings are rarely encountered across the five sites.

### Environmental Consequences

Plan components addressing conditions for unique habitat conditions discussed above encompass requirements for spreading avens and are described in other parts of this analysis. Appendix C summarizes key characteristics and indicators of the following habitats and species groups in the Ecological Sustainability Evaluation (ESE) that include spreading avens:

- High Elevation Rocky Summit (Unique Habitat)
- Grassy Balds (Unique Habitat)
- Fire Intolerant Species (Species Group)

Environmental consequences were estimated for indicators of the two unique habitats and single species group by alternative and are displayed in Appendix C. These indicators include the risk of non-native invasive plant infestations, recreational impacts, open habitat, and fire severity.

Table 71 displays the assessment of the proposed planning framework (i.e., mitigation and management constraints, as well as habitat enhancement and restoration) on habitats or species groups that affect spreading avens, by alternative. Specifically, this table reflects its estimated health and resilience on Forest Service land. All of the alternatives include plan components to directly or indirectly maintain, enhance, and/or restore habitat for federally listed species, including spreading avens, on the Nantahala and Pisgah NFs (Appendix C).

**Table 71. Ecological Sustainability Scores for Ecosystems and Species Groups Relevant to Spreading Avens (NPSE 2021)**

	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
High Elev. Rocky Summit																			
Grassy Balds																			
Fire-intolerant Species																			

\*Table legend: E: Existing Condition, Alternatives: A, B, C, D, numbers 1 and 2 after alternatives indicate Tier 1/Tier 2 objectives. Red = poor; yellow = fair; light green = good; dark green = very good.

Ecological Sustainability Evaluation modeling for the Nantahala and Pisgah Forest Plan Revision shows that conditions for spreading avens within the two habitats and associated species group are variable. Existing conditions in high elevation rocky summits would be under all alternatives. One of the factors affecting the rating for high elevation rocky summits in the ESE modeling was the risk or known occurrence of non-native invasive plant infestations. While NNIS infestations are a high risk for many sites within this unique community, this is not evident at Roan Mountain. In comparison, conditions in grassy balds improve under all alternatives because of an objective to maintain or restore 10-20 acres of



existing grassy balds across the Forests (PAD-O-04). Conditions for fire intolerant species potentially decline under Tier 2 objectives which doubles the amount of prescribed burning. The likelihood of fire within a high elevation rocky summit is almost non-existent but could be initiated within grassy balds to control invading woody vegetation. However, the likelihood of a prescribed burn at the two locations it in which it occurs in grassy balds is very unlikely, as the is the potential for a wildfire. During the past 35 years, only a single wildfire occurred within grassy balds at Roan Mountain, on Jane Bald. The species is typically associated with high elevation rocky summits and maintaining a “fair” trend across all alternatives may not be indicative of the current health of spreading avens on the Pisgah NF. It does however, reflect the risk from recreational trampling, which is the greatest threat to this species and its suitable habitat. Impacts have been reduced during the last 20 years with restricted access to the larger population sites where spreading avens occurs.

The ESE Tool provides coarse assessment across all habitats and conditions. In additional analysis was included in the FEIS analysis which considers the spatial distribution of existing spreading avens occurrences. This analysis describes how plan components affecting vegetation management, native vegetation encroachment, non-native invasive species, recreation management, and climate change impact spreading avens by alternative.

### **Plan direction**

The Forest Plan includes a desired condition that habitats are consistent with recovery plans and Biological Opinions for federally listed and proposed species in order to contribute to recovery of these species (PAD-DC-01). Specific to spreading avens, the Nantahala and Pisgah NFs would contribute to the recovery by minimizing any impact from human uses and woody encroachment at or near two known *Geum radiatum* populations and subpopulations and continue to document population change in long-term demographic plots. These action alternative items are more specific than Alternative A which only indicates to manage recreational impacts to spreading avens.

Spreading avens occurs within two unique habitats, primarily high elevation rocky summits and to a lesser extent grassy balds. Fifteen subpopulations occur on rocky summits, two on grassy balds, and three at the interface of the two unique habitats. Plan desired conditions for unique habitats are to maintain natural disturbance patterns, restore conditions, if necessary, support associated wildlife and plant species, reduce recreational impacts and maintain resilience (PAD-DC-02 and 03). For the action alternatives, specific direction for high elevation rocky summits is to keep canopy cover less than 10% , shrub cover under 20% density and provide habitat for a diversity of herbaceous species (PAD-DC-06). For grassy balds, the subtype with occasional spreading avens, desired, conditions are to keep tree and shrub cover less than 25% and blackberry (*Rubus canadensis*) cover less than 15% cover (PAD-DC-06).

Twenty-five of the subpopulations occur within unique rock habitats adjacent to forested habitats. All action alternatives include a standard that requires maintenance of habitat characteristics for plant and animal species occupying boulderfields, low and high elevation rocky summits, granitic domes, glades, or cliffs during project design and implementation (PAD-S-07).

### **Management Areas**

Management Area designations determine the type of management activities across the forest. Special Interest Areas (SIAs) are designated to maintain, restore, or enhance the special features within the area. All spreading avens subpopulations occur in the Roan Mountain SIA which does not vary by alternative. Both spreading avens occurrences and the two habitats in which they occur are special features within the Roan Mountain SIA; therefore, all alternatives would maintain or enhance the habitat for spreading avens.

### **Recreational Impacts**

The ESE tool rating by alternatives for unique habitats, including high elevation rocky summits and grassy balds, assessed recreational impacts based on accessibility to sites. Sites within 100 meters of roads or trails were determined to have a higher potential for visitation by recreationists and therefore potentially greater impacts to associated species. Spreading avens is susceptible to trampling from climbers, fishermen, and hikers. Currently 65% of spreading avens occurrences are within 100 meters of existing roads and/or trails. This percent is higher than the ESE tool analysis for all high elevation rocky summits across the forest but under for grassy balds. This highlights the susceptibility of this species to potential recreational impacts. Fortunately, five of the subpopulations, including the largest one and three within 100 meters of a trail, are included within closure areas on Roan Mountain. While closure areas are disregarded by a portion of the recreating public, observations by David Danley, former Pisgah NF botanist, indicates recovery in the chute at Roan High Bluff a few years following the closure. Plants are now established in previously heavily trampled areas and old fire rings. The recreational impacts to these areas will continue to be monitored. While closure areas and other recreation mitigation have been implemented with the current plan, all action alternatives include a standard to mitigate recreational impacts to sensitive areas (REC-S-08).

### **Climate Change**

Spreading avens occurs in high elevation sites where climate changes effects could be more drastic. Climate change modeling scenarios were completed for spreading avens with use of long-term demographic data (Ulrey et al 2016). The modeling determined that augmentation of individuals may be necessary to ensure viability of this federally endangered species, which would be supported by revised plan direction. As detailed above, this highlights the need to maintain the demographic study to detect changes in populations. Monitoring questions included in the revised plan will ensure that monitoring for spreading avens and its habitat is implemented (MQ 4-3-T1 and MQ 6-7-T2).

### **Cumulative Effects**

Cumulative effects include state, tribal, local, or private actions that are reasonably certain to occur in the 18-counties of Western North Carolina.

The majority of *Geum radiatum* occurrences, 10, are present on state or private lands. Of these, all except two are managed for conservation, either in state, land trust, or other private ownership (USFWS 2020). These occurrences are subject to most of the same threats that are present on federal lands, although recreational impacts may vary. Access is limited for one of the state parks, the two land trusts, and those in private ownership. The two occurrences that are not managed for conservation could be subject to development in the future.

A recent potential threat across state lands is the proposed Northern Peaks State Trail, a 40-mile trail linking Watauga and Ashe Counties in the northeastern most portion of spreading avens' range. This trail could provide greater access to three or four populations.

The majority of the range-wide populations are included within a long term demographic study that will help to detect changes (Ulrey et al. 2016). If negative impacts occur, the two populations on the Pisgah NF at Roan Mountain could provide maintenance and enhancement of populations on federal lands and therefore have a larger role in the recovery of this species. Based on habitat and known populations, the Nantahala and Pisgah NFs have a large role in the recovery of this species. This illustrates the need to closely monitor populations to mitigate any increasing recreational impacts. Threats from climate change will likely affect spreading avens in the future and may be mitigated by adding individuals to existing populations (Ulrey et.al.).

## Conclusions

Ecologically, spreading avens has a long life-cycle, with infrequent successful reproduction, and slow spread and recovery. This analysis indicates the species should continue to persist, maintaining itself across Forest Service lands; however, long-term maintenance and recovery of the species may require augmentation of populations.

### Blue Ridge goldenrod (*Solidago spithamea*)

#### Affected Environment

Blue Ridge goldenrod, *Solidago spithamea*, is a small (less than 1 foot in height) perennial herbaceous plant in the aster family that occurs in high elevation rocky summits in the southern Appalachians and is restricted to North Carolina and Tennessee (Weakley 2020). Three populations have been documented by the NC Natural Heritage Program, with another two with obscure records. One population is known to occur in Tennessee at Roan Mountain; all the remaining existing populations are present in North Carolina at Roan Mountain, Grandfather Mountain, and Hanging Rock Mountain (Figure 58). One obscure population was previously documented but possibly misidentified in the Craggy Mountains, but has not been verified there since the original determination in 1990 (Dr. Chris Ulrey, Plant Ecologist, Blue Ridge Parkway, personal communication). Another obscure population at The Peak in Ashe County has not been adequately verified regarding its identification and was not located during a field review in 2016 (USFWS 2019, G. Kauffman, personal observation). In 2021, the USFWS modeled Blue Ridge goldenrod potential habitat across higher elevation sites in NC and TN. This includes the upper elevations of eight additional NC counties and two TN counties (Figure 58). Blue Ridge goldenrod has a global rank of G2 and was listed as threatened under the Endangered Species Act on March 28, 1985 (NatureServe 2021, USFWS 1985). There is no designated critical habitat for Blue Ridge goldenrod (USFWS 1985).

Seven subpopulations of this unique goldenrod were historically documented on the Pisgah NF, all on Roan Mountain. Six subpopulations are known to be currently extant, clustered either at Roan High Bluff or Eagle Cliff. It is uncertain why the extirpated subpopulation died or if it was a misidentification since the habitat seems questionable and all the existing information on its extent is obscure.

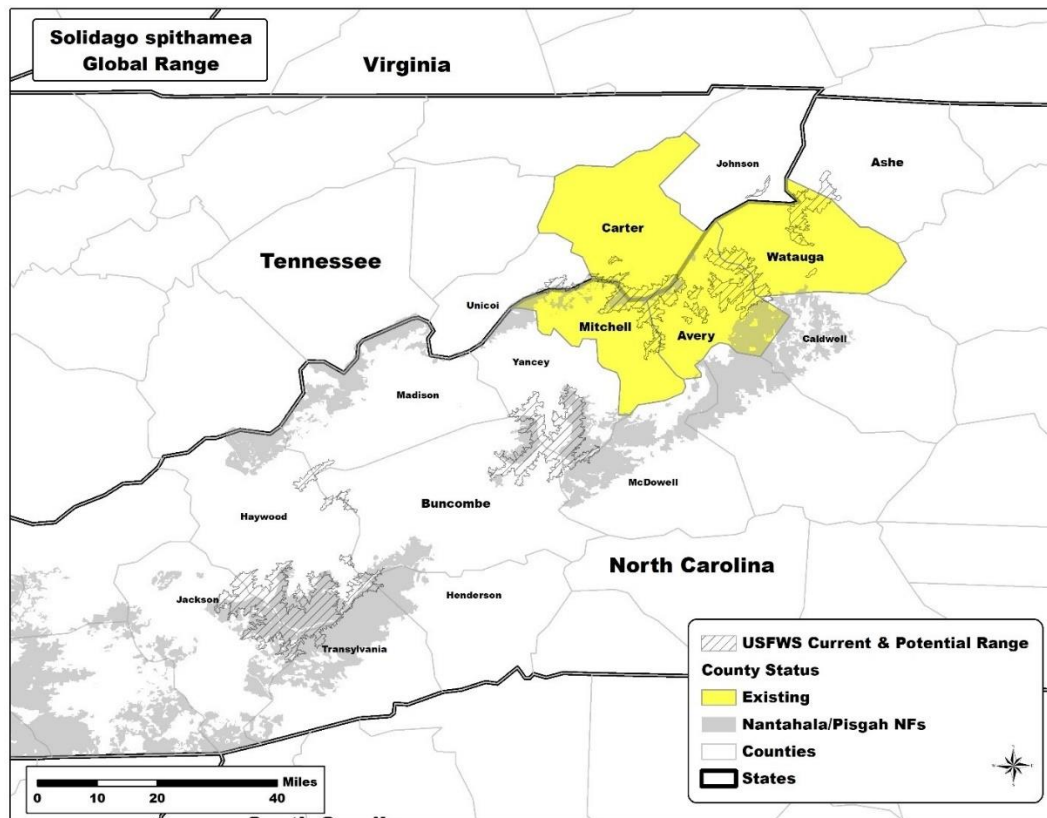


Figure 58. Documented current and potential county-wide global range of Blue Ridge goldenrod (2021)

Primary threats to the species include trampling from recreational activity, woody encroachment, and potentially trampling while monitoring associated *Geum radiatum* individuals (USFWS 2012, USFWS 2019). Similar to other high elevation rocky summit species, Blue Ridge goldenrod is thought to persist on small high elevation “islands”, where the climate still remains cool and moist. It is uncertain what the impacts from climate change will be on this species.

In order to address the impact of recreational trampling at Roan Mountain, closure orders were issued in 1996 to protect subpopulations of Blue Ridge goldenrod at Roan High Bluff and Eagle Cliff. Monitoring and observational data from 2005 to 2013 indicates that subpopulations have recovered (Donaldson 1999a, 1999b, 2002b; David Danley, Pisgah NF botanist, personal communication). This does not imply that some impacts are not continuing within the closure areas since some trampling was noted by Thompson during monitoring. All six of the extant subpopulations occur within areas with closure orders and within the Roan Mountain special interest area.

Increased searches for the species in the mid 2000’s located two new Roan Mountain subpopulations of Blue Ridge goldenrod within the Eagle Cliff area, with a total of more than 50 clumps. Given the difficulty of inventorying suitable habitat for this species, it may be possible to locate more subpopulations via rappel lines or with remote drones on very steep rock outcrops. Monitoring has been limited across the subpopulations since juvenile individuals of a co-occurring species, skunk goldenrod (*Solidago glomerata*), are difficult to distinguish from mature Blue Ridge goldenrod, which is a much shorter species relative to skunk goldenrod. Thompson developed a monitoring protocol and collected baseline data across the majority of the range in 2016 and 2017, documenting number of patches within each population. Grandfather Mountain had the majority of the counted individuals representing four times as many as on Forest Service land at Roan Mountain. Observations in 2016, 2017, 2018, and 2021 at all

of the USFS sites indicate the persistence of all six subpopulations on the Pisgah NF, although the data is not detailed enough to accurately determine population trends.

### Environmental Consequences

Plan components addressing conditions discussed above encompass requirements for Blue Ridge goldenrod and are described in other parts of this analysis. Appendix C summarizes key characteristics and indicators of the following habitat within the Ecological Sustainability Evaluation (ESE) that includes Blue Ridge goldenrod:

- High Elevation Rocky Summit

While Blue Ridge goldenrod is believed to be a fire intolerant species, that species group was not included since this species is only known on USFS lands where adjacent lands would not be proposed for a prescribed burn nor would a wildfire be likely. Therefore, environmental consequences were estimated for the indicators of high elevation rocky summits by alternative, and are displayed in Appendix C. Indicators for high elevation rocky summits include the risk of non-native invasive plant infestations and recreational impacts. While woody plant succession is known to be a threat for some high elevation rocky summits, such as those present on Roan Mountain within occupied Blue Ridge goldenrod habitat, it was not assessed as an indicator within the ESE because of limited forestwide data.

Table 72 displays the assessment of the proposed planning framework (i.e. mitigation and management constraints, as well as habitat enhancement and restoration) on the single unique habitat that affects Blue Ridge goldenrod, by alternative. Specifically, this table reflects its estimated health and resilience on Forest Service land. All alternatives include plan components to directly or indirectly maintain, enhance, and/or restore habitat for federally listed species, including Blue Ridge goldenrod, on the Nantahala and Pisgah NFs (Appendix C).

**Table 72. Ecological Sustainability Scores for Ecosystems and Species Groups Relevant to Blue Ridge Goldenrod (NPESE 2021)**

	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
High Elev. Rocky Summit																			

\*Table legend: E: Existing Condition, Alternatives: A, B, C, D, numbers 1 and 2 after alternatives indicate Tier 1/Tier 2 objectives. Red = poor; yellow = fair; light green = good; dark green = very good.

Ecological Sustainability Evaluation modeling for the Nantahala and Pisgah Forest Plan Revision shows that conditions for Blue Ridge goldenrod within high elevation rocky summits maintain existing conditions of “fair”, under all alternatives. Since there is incomplete long-term monitoring on the species, it is uncertain if the species population numbers improved like spreading avens after site closures in response to recreational trampling. Maintaining a “fair” rating during the life of the plan reflects the risk of recreational trampling within high elevation rocky summits which is the greatest threat to this species, and the potential for increasing suitable habitat. This rating is not reflective of the current USFS occupied habitat for Blue Ridge goldenrod since all the occurrences are within closure areas. As such the rating for this species is at least “good” and does not vary among alternatives.

The ESE Tool provides an assessment of habitat conditions. In addition, the final EIS considers the spatial distribution of existing Blue Ridge goldenrod occurrences by alternative. This analysis describes how vegetation management, recreation management, and climate change impact Blue Ridge goldenrod.

### **Plan Direction**

The action alternatives include desired conditions to reduce woody encroachment and impacts from recreational use around some of the subpopulations within the two populations of Blue Ridge goldenrod in order to increase individuals. In addition, the plan includes a desired condition to introduce one new population on a suitable site approximately two miles from the existing population in order to increase redundancy (PAD-DC-01). The plan also includes a guideline to maintain habitat characteristics during project design and implementation (PAD-G-01). These action alternative plan components are more specific than Alternative A which indicates to monitor and protect the species from recreational impacts.

### **Management Areas**

Management area designations determine the type of management activities across the forest. All the Blue Ridge goldenrod subpopulations occur in the Roan Mountain SIA which does not vary by alternative. With designation of this SIA, both Blue Ridge goldenrod and its associated habitat will be enhanced.

### **Recreational Impacts**

An accessibility analysis was completed for known Blue Ridge goldenrod occurrences. Currently, 33% of Blue Ridge goldenrod occurrences are within 100 meters of existing roads or trails. This percent is lower than the ESE tool analysis for rocky summits. All six subpopulations are protected by closure areas on Roan Mountain. However, the documentation of impacts during Thompson's study within the closure areas indicates a need for recurrent monitoring to more completely assess recreational impacts for this species.

### **Woody Encroachment**

Site specific population monitoring by Thompson noted some woody plant encroachment at 14 of 15 subpopulations (USFWS 2019). Even though cutting back competing woody plant vegetation has been completed within some subpopulations, it is a recurring threat. Both the recurrent monitoring question to assess threats and the desired condition to reduce woody encroachment will help to address this threat under all action alternatives.

### **Climate Change**

The climate change analysis completed for spreading avens occurrences could also apply for Blue Ridge goldenrod based on where they occur, both geographically and within the same unique habitat on the forest.

While it is uncertain whether augmentation would be needed for Blue Ridge goldenrod, it is clear that habitat conditions could change within occupied high elevation rocky summits. Recurrent monitoring to more adequately detect trends will be necessary to determine any management needs for this species; addressed in monitoring questions MQ -3-T1 and MQ 6-7-T2.

### **Cumulative Effects**

Cumulative effects include state, tribal, local, or private actions that are reasonably certain to occur in the 18-counties of Western North Carolina. Two other populations occur besides the Roan Mountain site; one large population at Grandfather Mountain state park, the other smaller one is in private ownership. These occurrences are subject to most of the same threats as present on federal lands, although recreational impacts may vary. Of the 10 park subpopulations present, four have been noted to

have varying impacts from trampling (USFWS 2019). In contrast, the single population on private ownership is remote and rarely visited. Woody plant encroachment was observed across both ownerships in the 2019 monitoring study. These similar impacts indicate the importance of managing any impacts on Roan Mountain and enhancing the existing population.

### Conclusions

All the subpopulations are located within two forest closure areas which does not eliminate but helps to reduce recreational impacts. More careful monitoring of the populations and the habitat will encourage adaptive changes, if needed. This analysis indicates that Blue Ridge goldenrod should continue to persist, maintaining itself across Forest Service lands.

### Roan Mountain bluet (*Hedyotis purpurea* var. *montana*)

#### Affected Environment

Roan Mountain bluet (*Hedyotis purpurea* var. *montana*) is a short clumped perennial herbaceous plant in the bedstraw family that occurs on high elevation rocky summits and grassy balds with thin, gravelly soils or embedded rocks (Weakley 2012). It is endemic to the southern Appalachians with primary occurrences in North Carolina and one occurrence in Tennessee on Roan Mountain. A new population was recently located in southern Virginia, extending the range to the north (Virginia Botanical Associates 2014, Figure 59). In 2021, the USFWS modeled Roan Mountain bluet potential habitat which is displayed in the range map below, at high elevation sites in from the southern Virginia boundary and eastern Tennessee boundary to the central counties in western North Carolina. Roan mountain bluet has a global rank of G5T2 (NatureServe 2021, Wichmann 2021) and was listed as endangered under the Endangered Species Act on April 5, 1990. A recovery plan was approved for the species in 1996 (USFWS). There is no designated critical habitat for Roan Mountain bluet. Specific tasks to the Pisgah NF included searching for additional populations and monitoring existing subpopulations.

There are 17 populations of Roan Mountain bluet known across its range according to the USFWS 5-year review in 2017, although one occurrence in Yancey County is not documented in the NC Natural Heritage database (NC Biotics 2021). Depending on the spatial scale of subpopulation separations, there are 45-75 known across its range (USFWS 2017, NC Biotics). Roan Mountain bluet is known across three separate areas on the Pisgah NF on Roan Mountain and one area in Yancey County. The four populations vary significantly in the number of subpopulations and numbers of individuals. Subpopulation numbers and overall population size increase from east to west on Roan Mountain. Only a single subpopulation occurs at the Yancey County location. Recent genetic work completed on this population indicated the plants represent a stable hybrid between *H. purpurea* var. *montana* and the more common species, *H. purpurea* (Glennon et al 2011, Church and Taylor 2005). In total, 21 subpopulations have been documented in the Pisgah NF, only 18 of which are extant. The three extirpated populations were located adjacent to the upper Roan Mountain road or picnic areas and were obscure records. One was introduced on the loop road in the 1970s by J.D. Yelton (G. Kauffman, personal observation).

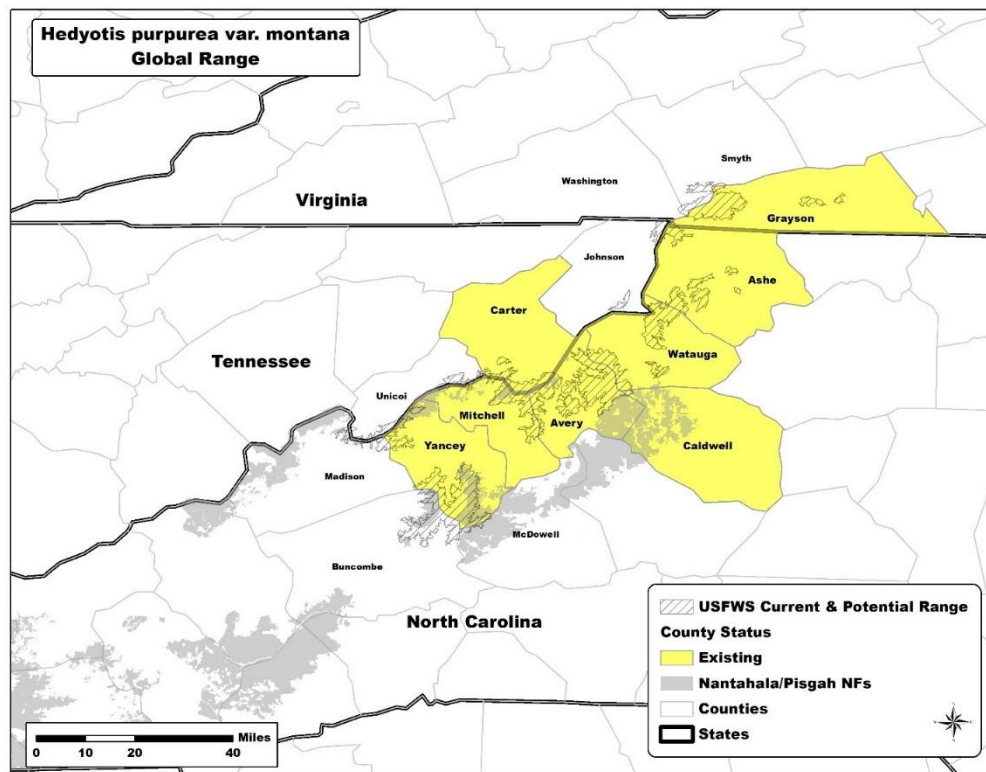


Figure 59. Documented current and potential county-wide global range of Roan Mountain bluet (2021)

Threats to *Hedyotis purpurea* var. *montana* on the Pisgah NF include recreational activities (primarily trampling), woody plant encroachment, hybridization with the more common congener, *Hedyotis purpurea* var. *purpurea*, and trampling while monitoring associated spreading avens individuals. Similar to spreading avens and Blue Ridge goldenrod, Roan Mountain bluet is restricted to scattered high elevation sites and could be impacted by global warming in the future.

To address the impact of recreational trampling on Roan Mountain, closure orders were issued in 1996 to protect subpopulations of Roan Mountain bluet at Roan High Bluff and Eagle Cliff. Monitoring and observational data from 2005 to 2013 indicates that subpopulations have recovered and maintained their abundance at Roan High Bluff (Donaldson 1999a, 1999b, 2002b; David Danley, Pisgah NF botanist, personal communication). The largest population on the Pisgah NF occurs within a closure area, which probably includes 60-75% of all individuals known on the forest. Three of the 18 subpopulations are within closure areas. This does not imply that some impacts from trampling are still occurring at the site, but it is clear that plants have become established in previously bare areas.

Monitoring has been variable across the 18 extant subpopulations. All have been visited at least once or searched for during the last 10 years. In addition to the 18, three small subpopulations may no longer be present, probably due to woody plant encroachment. The other 18 subpopulations are present although the majority do not have recurrent monitoring. The largest one on Roan Mountain at Roan High Bluff has been visited every year for the past 18 years and anecdotally appears quite robust, although trampling impacts are still evident. As previously mentioned it includes over 60% of those individuals observed on the Pisgah NF. In contrast, the larger population on Grassy Ridge has been visited every year and showed decline in the late 2000's. Habitat surrounding the two subpopulations differs from a high elevation summit at Roan High Bluff to a grassy bald with thin soil on Grassy Ridge. Woody plants and tall herb



encroachment is occurring at the Grassy Ridge site but the population was still observed to be in decline after cutting back the encroaching plants in 2008.

Two subpopulations on Roan Mountain have been intensely monitored. Neither of these sites are in closure areas and are threatened by herbaceous and woody plant competition. The population trends within the two subpopulations have varied but both are in sharp decline since the monitoring started (Figure 60).

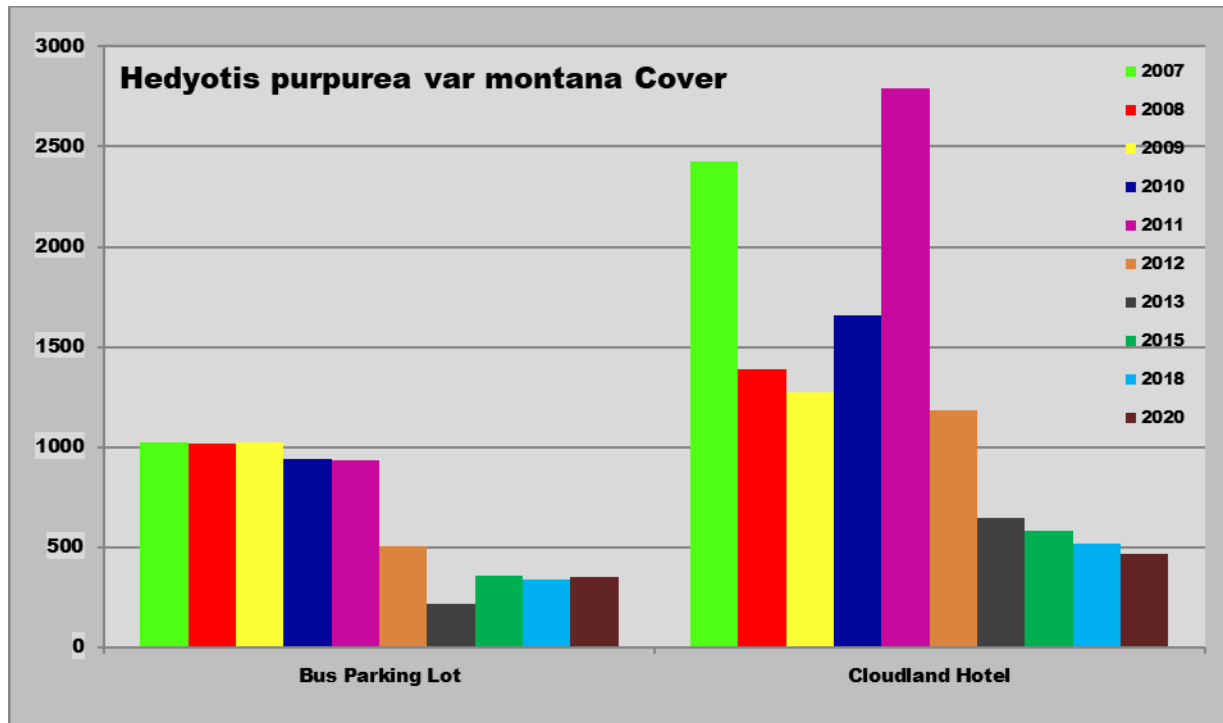


Figure 60. Change in area coverage (centimeters square) from 2007-2020 for *Hedyotis purpurea var. montana* within two subpopulations on Roan Mountain.

Observations in 2018, 2019, and 2020 at both sites indicate smaller declines at both locations. In 2019, removal of overtopping vegetation on half of the parking lot site was completed and was monitored to determine population changes. Individuals were more robust where the competing vegetation was reduced. While these sites are interesting, it should be noted that the parking lot area represents an extreme variation on a rock outcrop or rocky summit with the gravel bed. However, the cloudland hotel site might indicate the more tenuous persistence within grassy bald sites with deeper soils compared to high elevation rocky summits.

### Environmental Consequences

Plan components addressing conditions for unique habitat conditions discussed above encompass requirements for Roan Mountain bluet and are described in other parts of this analysis. Appendix C summarizes key characteristics and indicators of the following habitats, and species group within the Ecological Sustainability Evaluation (ESE) that include Roan Mountain bluet:

- High Elevation Rocky Summit (Unique Habitat)
- Grassy Bald (Unique Habitat)
- Fire Intolerant Species (Species Group)

Environmental consequences were estimated for indicators of the two unique habitats or single species group by alternative, and are displayed in Appendix C. These indicators included the risk of non-native invasive plant infestations, recreational impacts, open habitat, and fire severity.

Table 73 displays the assessment of the proposed planning framework (i.e., mitigation and management constraints, as well as habitat enhancement and restoration) on habitats or species groups that affect Roan Mountain bluet, by alternative. Specifically, this table reflects its estimated health and resilience on Forest Service land. All alternatives include plan components to directly or indirectly maintain, enhance, and/or restore habitat for federally listed species, including Roan Mountain bluet, on the Nantahala and Pisgah NFs (Appendix C).

**Table 73. Ecological Sustainability Scores for Ecosystems and Species Groups Relevant to Roan Mountain Bluet (NPESE 2021)**

	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
High Elev Rocky Summit																			
Grass Balds																			
Fire-intolerant Forest																			

\*Table legend: E: Existing Condition, Alternatives: A, B, C, D, numbers 1 and 2 after alternatives indicate Tier 1/Tier 2 objectives. Red = poor; yellow = fair; light green = good; dark green = very good.

Ecological Sustainability Evaluation modeling for the Nantahala and Pisgah Forest Plan Revision shows that conditions for Roan Mountain bluet within the two habitats and species group are variable. High elevation rocky summits maintain existing conditions under all alternatives. In comparison, grassy balds improve under all alternatives because of the objectives to treat non-native invasive plants and reduce recreational impacts. While grassy balds improvements are indicated as a result of emphasis on non-native invasive plant control, it should be noted that the specific areas where the bluet occurs within this unique habitat are not threatened by non-native infestations. Conditions for fire intolerant species potentially decline under Tier 2 objectives which doubles the amount of prescribed burning. The likelihood of fire within a high elevation rocky summit is almost non-existent but could be initiated within grassy balds to control invading woody vegetation. However, the likelihood of prescribed fire or wildfire is low at these two sites. Based on available monitoring and observations, Roan Mountain bluet appears to be more stable within high elevation rocky summits compared to grassy balds, primarily since it is not overtopped by adjacent vegetation. Both larger subpopulations of this species occur within high elevation rocky summit habitat on Roan Mountain and have benefitted from restricted public access. Maintaining a “fair” trend across all alternatives may be indicative of the current health of Roan Mountain bluet on the Pisgah NF, but it does not reflect the potential for increasing existing populations in grassy bald habitat. In order to maintain or increase these populations, more active management to control competing vegetation will need to be done.

The ESE Tool provides a coarse assessment of the habitats and conditions across the Nantahala and Pisgah NFs. In addition, the Final EIS includes an analysis that looks at the spatial distribution of existing Roan Mountain bluet occurrences. This analysis describes how vegetation management, vegetation change, recreation management, and climate change impact Roan Mountain bluet by alternative.

### **Plan Direction**

The action alternatives include desired conditions to maintain structurally open habitat in high elevation rocky summits at and near the four existing populations of Roan Mountain bluet, and to reduce impacts from recreational use and consider augmentation at one site. This plan direction is more specific than Alternative A which only indicates to manage recreational impacts.

Roan Mountain bluet occurs within two unique habitats, high elevation rocky summits and grassy balds. Fourteen Roan Mountain bluet subpopulations occur on rocky summits while the other four are in grassy balds with rocky soils. The proposed plan includes desired conditions for high elevation rocky summits and grassy balds.

### **Management Areas**

Management Area designations determine the type of management activities within that portion of the forest. Special Interest Areas are designated to maintain, restore, or enhance the special features within a designated area. All four populations of Roan Mountain bluet occur within two SIAs, which do not vary by alternative. Roan Mountain bluet and the two unique habitats in which they occur are within SIAs under all alternatives; therefore, management area direction should enhance Roan Mountain bluet.

### **Vegetation Change**

Existing monitoring indicates population declines from encroaching vegetation, particularly where the species occurs on grassy balds with rocky soils or in one instance a gravel parking lot. It will be important to control competing vegetation and carefully monitor the subpopulations, although as previously stated, the parking lot site represents an unnatural community.

### **Recreational Impacts**

An accessibility analysis was completed for known Roan Mountain bluet occurrences. Currently 39% of Roan Mountain bluet occurrences are within 100 meters of existing roads and/or trails. This percent is lower than the ESE tool analysis for rocky summits. The largest subpopulation that is accessible is protected by a closure area on Roan Mountain; therefore, the need for additional monitoring to assess recreational impacts is not needed for this species.

### **Genetic introgression**

Glennon et al. (2011) researched hybridization and found hybrids at two sites, the USFS one in Yancey County on the southeastern edge of its range and another in Ashe County near the northern edge of its range. Previous field reviews of the easternmost Roan Mountain site near Big Hump may have also had introgression. Hybrids have not been located within any other sites. It is uncertain how much of a threat introgression is since *Hedyotis purpurea* var. *purpurea* is very infrequent at higher elevations.

### **Climate Change**

The climate change analysis completed for spreading avens could also apply to Roan Mountain bluet based on the habitat where they occur on the forest (Ulrey et al. 2016). If microclimatic conditions change, such as higher average temperatures, and lower relative humidity, resulting in lower individual persistence or increase in competing vegetation, conservation measures may need to be implemented to ensure the species persistence. The forest plan addresses this need to closely monitor populations through the inclusion of monitoring questions MQ 4-3-T1 and MQ 6-7-T2.

### **Cumulative Effects**

Cumulative effects include state, tribal, local, or private actions that are reasonable certain to occur in the 18-counties of Western North Carolina. Of the 17 Roan Mountain bluet range-wide populations, five occur in North Carolina or Virginia state owned lands, one is managed by a land trust, and eight are in private ownership. Of these, the majority of the individuals are known from Grandfather Mountain State Parks. Just as on federal land, the accessible portions are threatened by recreational trampling and visitation is increasing. While the other state park occurrences are less accessible, two other populations potentially could be more at risk after the Northern Peaks State Trail is constructed. Occurrences on privately owned lands are not at risk from recreational visitation, although development pressure could occur on those lands not managed for conservation. Threats from climate change could affect Roan Mountain bluet populations on all state and private owned lands. Based on these threats on other populations, the narrow range of the species, and the number of subpopulations on federal land at Roan Mountain, the Pisgah NF has a large role in the recovery of this species.

### **Conclusions**

This analysis indicates that Roan Mountain bluet should continue to persist, maintaining itself across Forest Service lands for all action alternatives as well as the no-action alternative. The Forest Service should continue to control competing vegetation at grassy bald and parking lot sites to ensure species persistence.

### **3.3.3.2 Low Elevation Rocky Summit T&E Plants**

The two federally listed plants that are associated with low elevation rocky summits are Mountain golden-heather and Heller's blazing-star.

#### **Mountain golden-heather (*Hudsonia montana*)**

##### **Affected Environment**

Mountain golden-heather is a very short shrub, up to 6 inches in height, in the rock-rose family that occurs in low elevation rocky summits. *Hudsonia montana* is a narrow endemic North Carolina species, restricted to Linville Gorge Wilderness and Woods Mountain on the Grandfather Ranger District (Figure 61, NatureServe 2021). In 2021, the USFWS modeled potential habitat across mid elevation sites with steep slopes and potential outcrops. The model further refines the potential habitat with the two counties where the species occurs. Mountain golden-heather has a global rank of G1 and was listed as threatened under the Endangered Species Act on October 20, 1980 and a species recovery plan was approved in 1983 (USFWS 1980, USFWS 1983). Critical habitat across 952 acres has been designated for *Hudsonia montana* (USFWS 1980).

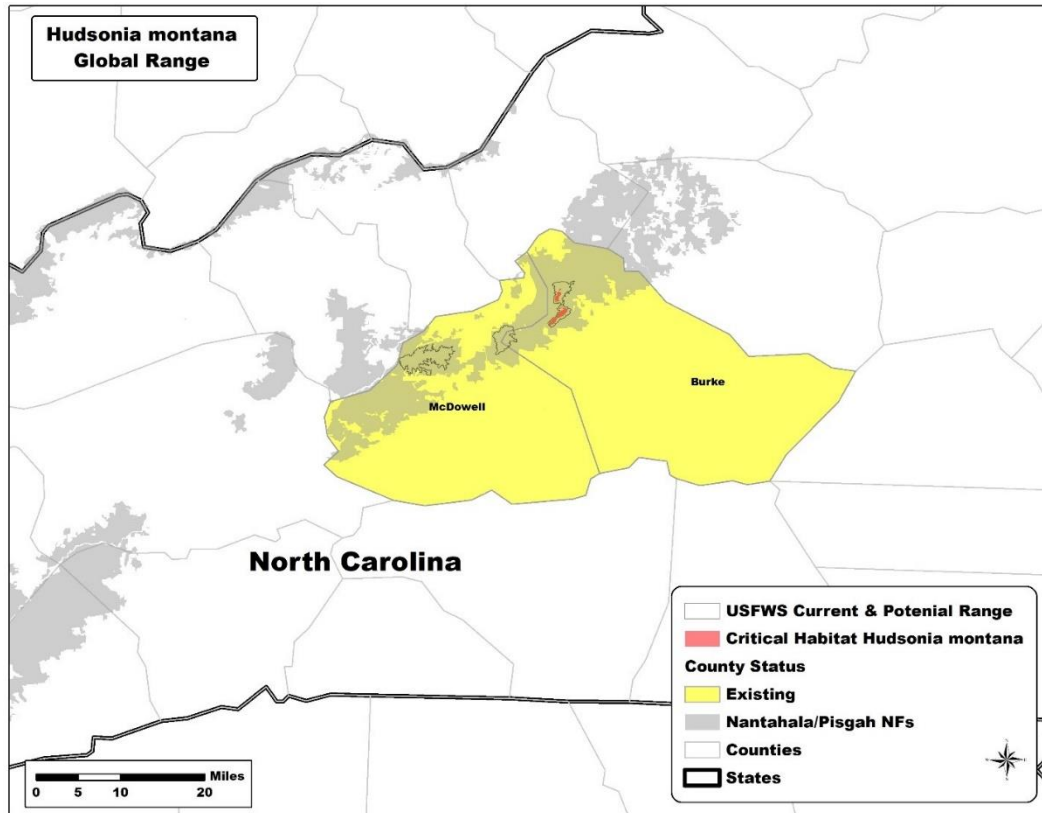


Figure 61. Documented current and potential county-wide global range of mountain golden-heather (NatureServe 2021, USFWS 2021). Critical Habitat for mountain golden heather is also highlighted in red.

Thirty-seven subpopulations, representing five to six populations of mountain golden-heather have been documented on the Grandfather Ranger District. The USFWS recognizes six populations while this analysis recognizes five based on a 1 kilometer separation distance (USFWS 2019). Under all action alternatives, all 37 of the subpopulations occur within two special interest areas. All but four subpopulations, representing over 80-90% of all known individuals, occur within Linville Gorge Wilderness.

A complete census of the subpopulations has been completed approximately every 10 years since 1982 and some previously delineated subpopulations have not been relocated in more recent years (Donaldson 2004). Five of the 37 subpopulations are historical since they have not been documented for almost 40 years. This may be due to previously spatially discrete subpopulations merging or as a result of woody plant encroachment and/or recreational trampling on subpopulations.

Threats to the species include recreational trampling, non-native invasive plant infestations, and fire suppression which allows woody shrub encroachment and does not promote seedling recruitment (USFWS 2012). A five-year experimental management study determined that fire, at a frequency from 5-15 years, was most effective in reducing competing shrubs and exposing mineral soil to encourage seedling establishment (Frost 1990). The fire frequency was further refined to a 5-8 year interval with use of long-term demographic data and experimental burn results within either a deterministic or a stochastic model (Gross et al. 1998). Population growth was also dependent on control of recreational trampling. Without reduction in trampling, prescribed burns alone did not result in population stability.

The latest update to the periodic census was completed in 2017 and 2018 on Shortoff Mountain to document changes one year after a large variable intensity and severity, duff-burning, lightning-set fire.

A total of 15 subpopulations were surveyed and similar to 2008, no individuals were detected in two small subpopulations. The 2007 Shortoff Mountain wildfire increased suitable habitat and more than doubled the number of individuals across the subpopulations, primarily due to the increase in seedlings. The more recent counts of the 13 subpopulations indicate a decline in numbers across eight subpopulations.

Most of the remaining *Hudsonia montana* subpopulations were also inventoried in 2015-2018. This includes 13 extant subpopulations on the Chimneys, a single subpopulation on Table Rock, and the three subpopulations at Woods Mountain. This data shows there has been a short term increase in *Hudsonia montana* clumps in the subpopulations surrounding the Chimneys and Chimney Gap in Linville Gorge Wilderness since the last monitoring. While many of the subpopulations are small in size, most are stable. A wildfire occurred throughout this area in the fall of 2014, with varying fire intensity.

A dramatic decline in abundance (191 individuals to 1 individual over twenty years) was recorded at Table Rock, while a steady decline (from 689 to 473 clumps) occurring at Woods Mountain. The Table Rock subpopulation has not had a prescribed burn for at least seven years, and some for more than 10 years. In 2012 a prescribed burn was conducted across the Woods Mountain subpopulations; however, the plant recount later that year did not result in an increase in individuals from the previous counts. To improve suitable habitat for *Hudsonia montana*, treatments to clear vegetation and expose mineral soil were completed also. However, a recount in 2021 indicated a 33% reduction in individuals even after a recent prescribe burn there. Several shrubs and trees were noted overtopping extant individuals.

In the mid 1990's, a closure order was issued in the vicinity of the Chimney subpopulations to reduce recreational trampling. Despite the closure, these subpopulations have continued to decline. Since the closure, recreational usage has continued to increase across Linville Gorge Wilderness, which highlights that visitors are not consistently abiding by the closure areas. One subpopulation appears to be still experiencing some impacts from campfires. In addition, wildfires have not been frequent or intense enough to effectively reduce overtopping vegetation across all subpopulations.

### **Environmental Consequences**

Plan components addressing conditions for unique habitat conditions discussed above encompass requirements for mountain golden heather and are described in other parts of this analysis. Appendix C summarizes key characteristics and indicators of the following habitat and species group within the Ecological Sustainability Evaluation (ESE) that include mountain golden heather:

- Low Elevation Rocky Summit
- Fire Adapted Species Associates

Environmental consequences were estimated for indicators of the unique habitat and single species group by alternative, and are displayed in Appendix C. These indicators included the risk of non-native invasive plant infestations, recreational impacts, and appropriate fire frequency.

Table 74 displays the assessment of the proposed planning framework (i.e. mitigation and management constraints, as well as habitat enhancement and restoration) on the habitat and species group that affect mountain golden-heather, by alternative. Specifically, this table reflects its estimated health and resilience on Forest Service land. All alternatives include plan components to directly or indirectly maintain, enhance, and/or restore habitat for federally listed species, including mountain golden-heather, on the Nantahala and Pisgah NFs (Appendix C).

**Table 74. Ecological sustainability scores for ecosystems and species groups relevant to mountain golden-heather (NPESE 2021).**

	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Low Elev Rocky Summit																			
Fire-adapted Species																			

\*Table legend: E: Existing Condition, Alternatives: A, B, C, D, numbers 1 and 2 after alternatives indicate Tier 1/Tier 2 objectives. Red = poor; yellow = fair; light green = good; dark green = very good.

Ecological Sustainability Evaluation modeling for the Nantahala and Pisgah Forest Plan Revision shows conditions for mountain golden-heather within low elevation rocky summits do not vary much across alternatives. For fire adapted species associates, there is an improvement to “fair” with increased emphasis on burning under Tier 2 objectives which do not vary across alternatives (Table 74). They remain poor across all alternatives because of the high density of non-native invasive plants, recreational trampling, and the lack of recurrent fire. Habitat conditions only improve after 50 years to ‘fair’ under tier two objectives due to the increased potential for burning under all action alternatives. Given these results, there is a need to prioritize control of overtopping vegetation, which may include wildfires and prescribed fire in Linville Gorge Wilderness to maintain the presence of mountain golden-heather, as well as the control of non-native plants. While the species may continue to persist, in the absence of additional focused management for the species, populations may decrease in size, and some subpopulations may be lost. As a result of this analysis, an objective to control competing vegetation was added in the final Plan to ensure the persistence of mountain golden heather (PAD-O-05).

The ESE Tool provides a coarse assessment across all habitats and conditions associated with mountain golden-heather. In addition, in the Final EIS, an analysis was added looking at the spatial distribution of existing mountain golden-heather occurrences. This analysis describes how vegetation management (including wildfires and non-native invasive plant control), and recreation management impact mountain golden-heather by alternative.

### Plan Direction

All action alternatives include desired conditions for *Hudsonia montana* to provide open habitat conditions on rock outcrops and restrict impacts from recreational use and non-native plant infestations.

*Hudsonia montana* occurs within low elevation rocky summits. Desired conditions for this unique habitat provide for open habitats with widely dispersed trees providing less than 10% canopy cover. In addition, the desired condition specifies that shrubs greater than 1 meter in height shall not exceed 20% cover, and habitat for a diversity of low growing subshrubs and herbaceous species should be present.

### Management Areas

An analysis was completed for all management areas by alternative surrounding the 37 subpopulations. Under the action alternatives, all of the subpopulations occur within special interest areas. In comparison, in Alternative A two of the subpopulations occur in the Backcountry MA as opposed to an SIA. Therefore, none of the occupied habitat occurs within MA Group under any alternative.

### **Vegetation change**

Existing monitoring indicates population declines from invading vegetation, either overtopping native shrubs or non-native invasive trees, grasses, and herbs. Alternative E includes an objective that is specific to *Hudsonia montana* and *Liatris helleri* which requires management and restoration of populations to ensure competing woody plants do not overtop and impact either species (PAD-O-05).

*Hudsonia montana* occurs in the most xeric portion of the landscape. While it is known that the drier landscape within Linville Gorge Wilderness is fire adapted, recurrent wildfires since 2000 have increased infestations of two invasive, wind dispersed species, *Paulownia tomentosa* and *Miscanthus sinensis*. Several *Hudsonia montana* subpopulations are threatened and all are at risk by these two non-native species. An amendment to the current plan and an objective for all action alternatives emphasizes more non-native invasive plant inventory and control work (FHL-O-02). A management approach for this activity would include prioritizing treatment sites with unique habitats required for threatened or endangered species as well as key characteristics of ecozones that provide habitat requirements for threatened and endangered species (FHL-DC-02). An important action needed for control of infestations within the wilderness is to complete an environmental assessment for those actions within Linville Gorge Wilderness, which would require approval by the Regional Forester.

In the last 21 years, there have been four wildfires, the Chimneys in 2000, Shortoff in 2007, Table Rock in 2013, and White Creek in 2017, that have reduced overtopping vegetation for a portion of the *Hudsonia montana* subpopulations. While the emphasis of the wildfire control was suppression, it was implemented to ensure firefighter safety. As a result, the wildfires were large and impacted vegetation around many subpopulations. The proposed forest plan includes a standard within designated wilderness to continue to enhance competing vegetation around species occurrences in the event of additional wildfires. It also allows for the use of prescribed fire to reduce a buildup of fuels or to decrease the risks and consequences of wildland fire escaping from the area (CDW-S-23). The use of natural fire breaks such as streams, roads, and bare areas is encouraged to minimize fire line construction. In addition, a desired condition in designated wilderness promotes the use of natural processes such as wildfires, to shape the landscape including promoting threatened and endangered species (CDW-DC-03). An additional site-specific analysis would be required in order to conduct prescribe burns within the wilderness.

Two specific goals for the Eastern Escarpment geographic area are to emphasize treatment of non-native invasive plant in and around Linville Gorge Wilderness and reduce or eliminate impacts to threatened and endangered species such as Heller's Blazing Star and mountain golden-heather at Linville Gorge (EE-GLS-11).

### **Recreational Impacts**

As completed for the other federally listed species, an accessibility analysis was completed for known *Hudsonia montana* occurrences. Currently 85% of the *Hudsonia montana* occurrences are within 100 meters of existing roads and/or trails. The USFWS also completed an analysis within 500 feet of mapped trails, including social trails, across Linville Gorge Wilderness (USFWS 2019). All of the occurrences are within 500 feet of these trails. Both analyses indicate accessibility is a potential visitor use problem. A plan standard for Alternative E addresses this concern by requiring management of recreational impacts to *Hudsonia montana* and *Liatris helleri* within Linville Gorge Wilderness to protect the species (PAD-S-01).

Furthermore, in the recreation section of the Forest Plan, a standard indicates that if unacceptable damage to natural or cultural resources is occurring or safety issues are identified on a trail, temporarily mitigate impacts or close the trail (or trail segment) until planning and implementation can occur to correct issues, relocate, or decommission the trail (REC-S-19). Currently there are specific closure orders



for robust trailside subpopulations, however signage has been illegally removed by visitors. One of the tools to address recreational impacts is with closure orders. It will be important to resign and educate the public about the importance of protecting these closure areas. If needed, the recreation standard would require flexibility to expand closure areas or develop other tools to reduce impacts. Some of the potential solutions may include mitigation to augment populations with propagated individuals after impacts are addressed.

### Effects Analysis for Critical Habitat

As previously mentioned, 952 acres were designated as critical habitat for *Hudsonia montana*. Among the action alternatives, there is little variation within potential management based on management areas. Six hundred and eighty-eight acres of critical habitat occur within designated Wilderness, the remaining 220 or 221 acres in Backcountry, 20 acres in the Linville Special Interest Area that extends beyond the Wilderness, and 22 to 23 acres in Interface MA. Within the Interface MA, Alternatives C and E include all of the area except for 5 acres in the Designated Old Growth Network, compared to 7 and 15 acres not in the network for Alternatives D and B, respectively. Given this designation, as well as the remote area, the likelihood of any active vegetation management within the interface acres is minimal, probably only where accessible to the winding Table Rock parking lot road. In reality, this narrow area does not appear to have any suitable habitat for *Hudsonia montana* (personal observation, G. Kauffman).

For the designated critical habitat, Alternative A differs by including all the acreage outside the wilderness in Management Area 4C, which has an emphasis on more remote wildlife management. During the last 20 years, the only activity across this 4C area has been several wildfires and control of non-native invasive plant species. While there is potential for active management in MA 4C under Alternative A, the likelihood of any activity is minimal given its inaccessibility.

### Cumulative Effects

Cumulative effects include state, tribal, local, or private actions that are reasonably certain to occur in the 18-counties of Western North Carolina. All occurrences of this narrow endemic species are within the Grandfather Ranger District of the Pisgah NF. A potential scenario on private property that could influence *Hudsonia montana* would be a dramatic increase in xeric non-native invasive plant infestations. Currently, both *Paulownia tomentosa* and *Miscanthus sinensis* are evident across private lands. However, all the known *Hudsonia montana* occurrences are 1.3 to 2 aerial miles from any private land. As such, the risk of increased spread of NNIS is low and there are no anticipated cumulative effects from private lands on *Hudsonia montana*.

### Conclusions

This analysis indicates that habitat conditions will not improve for this species unless more active management (including fire) occurs, recreational impacts are diminished, and non-native invasive plant control is implemented within the Linville Gorge Wilderness populations, which contains 80-90% of extant individuals as well as the only designated critical habitat. Plan standards for Alternative E include language to manage populations to maintain open conditions, to address recreational impacts in Linville Gorge Wilderness, and to increase control of non-native invasive plant infestations prioritizing where infestations are impacting T&E species and unique habitats. As a result, Alternative E will provide the best opportunity to restore and maintain this federally listed species. Given the uncertainty in timing of completing a site-specific analysis for prescribed fire in Linville Gorge Wilderness, the use of prescribe burns to maintain open conditions is not assumed.

## Heller's blazing-star (*Liatris helleri*)

### Affected Environment

Heller's blazing-star is a medium height perennial herbaceous plant in the aster family with narrow lily-like leaves. It occurs on low and high elevation rocky summits and montane acidic cliffs (Biotics 2021). *Liatris helleri* is a southern Appalachian endemic that is only known to occur within North Carolina and was formally listed as threatened on November 19, 1987 (U.S. Fish and Wildlife Service 1989). There is no designated critical habitat for Heller's blazing-star.

In an herbarium study of this species and a similar species, *Liatris turgida*, Guy Nesom has questioned the validity of both species and recommended combining them into a single taxon, *L. helleri* (Nesom 2005). Doing so would substantially increase the range of *L. helleri* and thereby undermine the need to maintain it as a federally listed species; however, there is scientific disagreement on whether the two species should be combined. In 2019, Clarke determined genetically distinct *Liatris helleri* and *Liatris turgida*. He further distinguished two other clades of *Liatris helleri-turgida* which may be other diverging taxa, although what these genetic separations mean is still being determined (Dr. Matt Estep, personal communication). Field determination of these groupings, while primarily geographic, is not possible based on taxonomic characters currently used. For the analysis here, all the historically denoted *L. helleri* populations will be assessed as if the taxonomy is not uncertain.

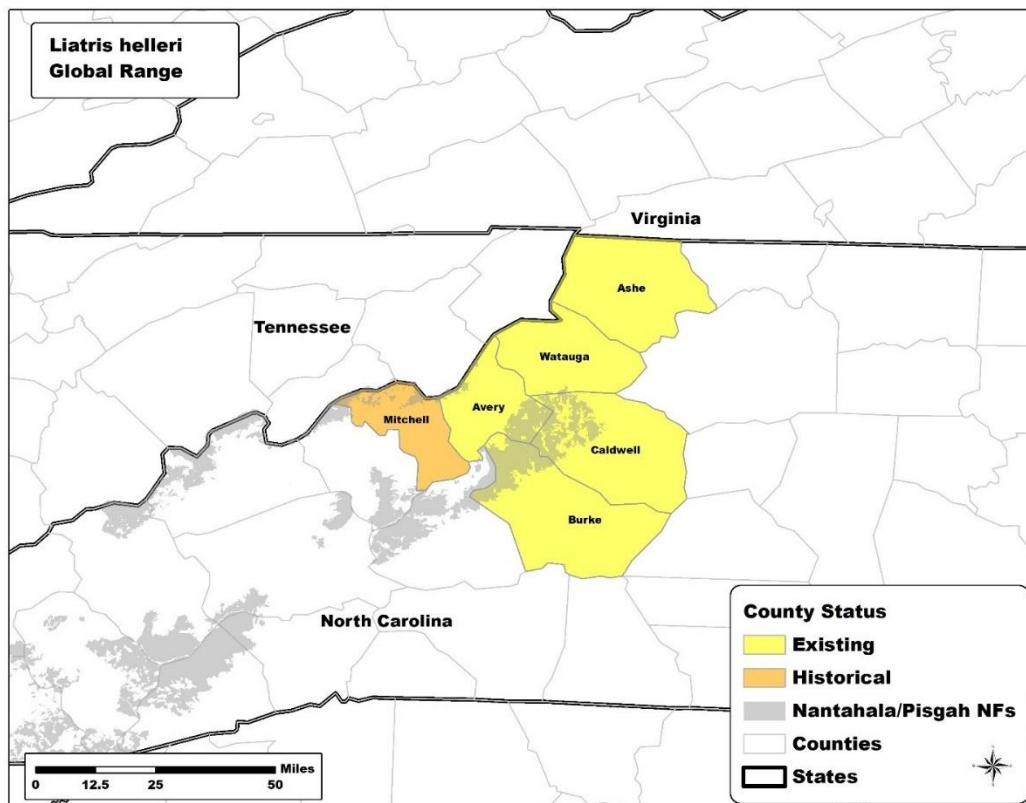


Figure 62. Documented county-wide global range of Heller's blazing-star (2021). Range may be limited to Avery County with more recent genetic analysis

As currently recorded, there are 12 separate extant populations of *Liatris helleri* in NC, representing 45 subpopulations, with concentrations at Linville Gorge Wilderness, Grandfather Mountain, and in Ashe

County. Five populations are known to occur on USFS lands in NC, with 17 separate subpopulations. The five populations vary from a low of 67 individuals, distinguished by clumps, to more than 1,500. The last comprehensive survey of four of the populations was from 2016 to 2018. In 2020, a new population was validated on Big Lost Cove Cliff. In total, there are more than 2,000 clumps across these five populations. All of the populations have stable numbers although long-term data is not as robust as other documented threatened and endangered plant species on the Nantahala and Pisgah NFs.

Threats to this species include poaching for specialized native plant usage, shrub encroachment, and recreational trampling by hikers and rock climbers, invasive plant species, fire suppression or infrequent fire, and herbivory (USFWS 2020, NatureServe 2021). Separate subpopulations of four of the populations have been affected by various activities during the last 20 years. One subpopulation has been negatively impacted by poaching of mature plants. The three other populations have remained stable or tentatively improved as a result of periodic prescribed burning and/or wildfires, as well as augmentation of the population on Table Rock. The current population trend is tentative since the monitoring data across sites has not been consistent. There has been an increasing trend in recreational within Linville Gorge Wilderness as well as an increased spread of non-native invasive plants.

### Environmental Consequences

Plan components addressing conditions for unique habitat conditions discussed above encompass requirements for Heller's blazing star and are described in other parts of this analysis. Appendix C summarizes key characteristics and indicators of the following three habitats and species group within the Ecological Sustainability Evaluation (ESE) that include Heller's blazing star:

- Low Elevation Rocky Summit (Unique Habitat)
- High Elevation Rocky Summit (Unique Habitat)
- Montane Acidic Cliff (Unique Habitat)
- Fire Adapted Species Associates (Species Group)

Environmental consequences were estimated for indicators of the unique habitats and species group by alternative, and are displayed in Appendix C. These indicators included the risk of non-native invasive plant infestations, recreational trampling, and appropriate fire frequency.

Table 75 displays the assessment of the proposed planning framework (i.e. mitigation and management constraints, as well as habitat enhancement and restoration) on the habitat and species group that affect Heller's blazing star, by alternative. Specifically, this table reflects its estimated health and resilience on Forest Service land. All the alternatives include plan components to directly or indirectly maintain, enhance, and/or restore habitat for federally listed species, including Heller's blazing star, on the Nantahala and Pisgah NFs (Appendix C).

**Table 75. Ecological Sustainability Scores for Ecosystems and Species Groups Relevant to Heller's Blazing Star (NPESE 2021)**

	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Low Elev Rocky Summit																			

	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
High Elev Rocky Summit																			
Montane Cliffs																			
Fire-adapted Species																			

\*Table legend: E: Existing Condition, Alternatives: A, B, C, D, numbers 1 and 2 after alternatives indicate Tier 1/Tier 2 objectives. Red = poor; yellow = fair; light green = good; dark green = very good.

Ecological Sustainability Evaluation modeling for the Nantahala and Pisgah Forest Plan Revision shows conditions for Heller's blazing star within the three unique habitats and fire adapted species varies from mostly "poor" across alternatives for low elevation rocky summit to "fair" with high elevation rocky summits and fire adapted species, and "good" with montane acidic cliffs. Low elevation rocky summits are ranked poor because of the high density of non-native invasive plants, recreational trampling, and the lack of recurrent fire in these habitats. Recreational trampling is also influencing the rating for the other two unique habitats; however, with acidic cliffs there is less of a risk since they are not as frequently visited. For fire adapted species, there is an improvement to "fair" with increased emphasis on burning under Tier 2 objectives which do not vary across alternatives.

The ESE Tool provides an assessment across all habitats and conditions. In addition, in the Final EIS, an analysis was added looking at the spatial distribution of existing to Heller's blazing star occurrences. This analysis describes how vegetation management, vegetation change and recreation management impact to Heller's blazing star by alternative.

### Plan Direction

The action alternatives include specific *Liatris helleri* desired conditions to provide open habitat conditions on rock outcrops and restrict impacts from human uses.

The majority of *Liatris helleri* occurrences on the Pisgah NF are within low elevation rocky summits. Desired conditions for this unique habitat are detailed with the analysis above for *Hudsonia montana*. The species also includes two populations in a high elevation rocky summit at Big Lost Cove Cliff and Little Lost Cove Cliff, with desired conditions detailed above in the analysis for spreading avens. A small subpopulation also occurs on a montane acidic cliff in Linville Gorge Wilderness. Desired conditions for montane cliffs are to have canopy trees only on their periphery and to provide habitat for a diverse group of herbaceous, moss, liverwort, and lichen species based on the opening size (0.5-2 plus acres) and rock type.

The majority of the *Liatris helleri* populations occur in Linville Gorge Wilderness, primarily in the same habitat as *Hudsonia montana*. Alternative E includes a standard to manage recreational impacts within Linville Gorge Wilderness to protect the species (PAD-S-04).

Additionally, there is a need to prioritize management for more open habitat, which could include prescribed fire, in Linville Gorge Wilderness to maintain the presence of *Liatris helleri*, as well as to control non-native plants which are impacting populations. Presently all the Linville Gorge Wilderness wildland fires surrounding *Liatris helleri* occurrences have been a result of experimental burns in the

1990's or periodic wildfires between 2000 and 2017. As indicated with *Hudsonia montana*, prescribed burning in the wilderness will require a site specific environmental analysis. As a result of this analysis an objective was added between draft and final to Alternative E to manage and restore the species to ensure competing woody plants do not overtop and impact the species (PAD-O-05). This management may or may not include prescribed burning.

Outside of Linville Gorge Wilderness, there is a need to deter poaching and minimize recreational impacts. While there has been less long-term monitoring of Heller's blazing star compared to *Hudsonia montana*, recreational trampling and overtopping vegetation impacts, including non-native invasive species, have been noted. Between draft and final, REC-S-19 was modified to ensure that trails or climbing routes would not negatively impact unique habitats and that protective measures such as closures and relocations would be implemented when needed for resource protection.

### **Management Areas**

An analysis was completed for all management areas by alternatives surrounding the five populations and 17 subpopulations. All alternatives include three populations and 12 subpopulations within one existing SIA. The remaining two populations, including five subpopulations occur within two recommended wilderness areas.

### **Vegetation change**

Existing monitoring indicates some recent stability although some subpopulations have been lost and long-term monitoring is not as robust as some other federally listed species. Previous losses may have been a result of invading vegetation, either overtopping native shrubs or non-native invasive trees, grasses, and herbs. The analysis for *Hudsonia montana* above indicates specific proposed plan actions to address these concerns. All the proposed actions for *Hudsonia montana* are also be applicable to *Liatris helleri*.

### **Recreational Impacts**

As completed for the other federally listed species, an accessibility analysis was completed for known *Liatris helleri* occurrences. Seventy percent of the *Liatris helleri* occurrences are within 100 meters of existing roads and/or trails. This percent is slightly less than the *Hudsonia montana* occurrences but is just as much of a concern. In addition to trampling impacts, this showy species has also experienced poaching, presumably for the horticultural trade. The measures and plan components discussed above with *Hudsonia montana* are also applicable to address recreational concerns with *Liatris helleri*. One of the potential mitigation measures might be to augment populations with propagated individuals after impacts are mitigated. It should be noted that the population on Table Rock was previously augmented in the mid 1990's.

### **Cumulative Effects**

Cumulative effects include state, tribal, local, or private actions that are reasonably certain to occur in the 18-counties of Western North Carolina. Of the 12 populations documented for this species, over ½ occur in state, land trust, or other private ownership (NC Biotics 2021). Grandfather Mountains State Park has the largest concentration of subpopulations and individuals, with at least 55% of all the individuals known, although the later is difficult to assess with inconsistency in monitoring (NC Biotics 2021, USFWS 2020). The accessible subpopulations have been impacted by trampling and one subpopulation has possibly been poached (USFWS 2020). Two other populations on state lands are potentially threatened by the Northern Peaks State Trail, previously discussed in the cumulative effects for *Geum radiatum* and *Hedyotis purpurea* var. *montana*. Based on these threats on other populations, the narrow range of the species, and the number of subpopulations on USFS lands, the Pisgah NF has a large role in the recovery of this species.

## Conclusions

This analysis indicates habitat conditions on the NF, restricted to the Grandfather Ranger District will not improve for this species unless open habitat is consistently maintained, recreational impacts are diminished, and non-native invasive plant control is implemented within the Linville Gorge Wilderness populations. Plan standards for Alternative E include language to manage populations to maintain open conditions, to address recreational impacts in Linville Gorge Wilderness, and to increase control of non-native invasive plant infestations prioritizing where infestations are impacting T&E species and/or unique habitats. As a result, Alternative E provides the best opportunity to restore and maintain *Liatis helleri*.

### 3.3.3.3 Southern Appalachian Bog T&E Plants

The three federally listed plants on the Nantahala and Pisgah NFs that are associated with Southern Appalachian Bogs are swamp pink, bunched arrowhead, and mountain sweet pitcher plant.

#### Swamp pink (*Helonias bullata*)

##### Affected Environment

Swamp pink is a perennial herb with a basal rosette of evergreen leaves and dense, showy pink flowers in early spring. The species occurs within acidic seeps, seepage swamps, bogs, and swamp forest-bog complexes (Weakley, Ludwig, and Townsend 2013, Weakley 2020).

Swamp pink is known from the Coastal Plain of New Jersey, Delaware, Maryland, and Virginia (formerly also Staten Island, NY, where now extirpated), as well as from higher elevations in northern New Jersey, Virginia, North Carolina, South Carolina, and Georgia (NatureServe 2021, Weakley 2020). Considering the broad range of this species, it has a global rank of G3 and was formally listed as a threatened species in 1988 (U.S. Fish and Wildlife Service 1989). A recovery plan was approved for the species in 1991 (USFWS). There is no designated critical habitat for swamp pink.

In North Carolina, swamp pink is restricted to five counties (Wichmann 2021). Twenty-five discreet subpopulations of swamp pink have been documented across the Pink Beds on the Pisgah Ranger District and an additional seven subpopulations were historically delineated within the same area in the 1970s. Since the historic data was collected prior to GPS instruments, the resolution may be too coarse to precisely relocate and reconcile with currently known subpopulations. In the last ten years, biologists have searched for all historical subpopulations and slightly fewer than half were relocated. Those that were relocated include the currently delineated twenty-five subpopulations. One additional subpopulation was located within North Carolina in 2019 on the Nantahala Ranger District, representing part of a population on private land also. There are an additional 17 element occurrences within North Carolina, which are separated into 12 individual populations based on localities (NC Biotics 2021). Of these, one may be extirpated, another has not been located in recent searches, and another is an introduced population. None of these are as robust as the two sites with swamp pink on USFS lands. The Pink Beds subpopulations represent the largest concentration of the species within North Carolina and probably the southern portion of its range.

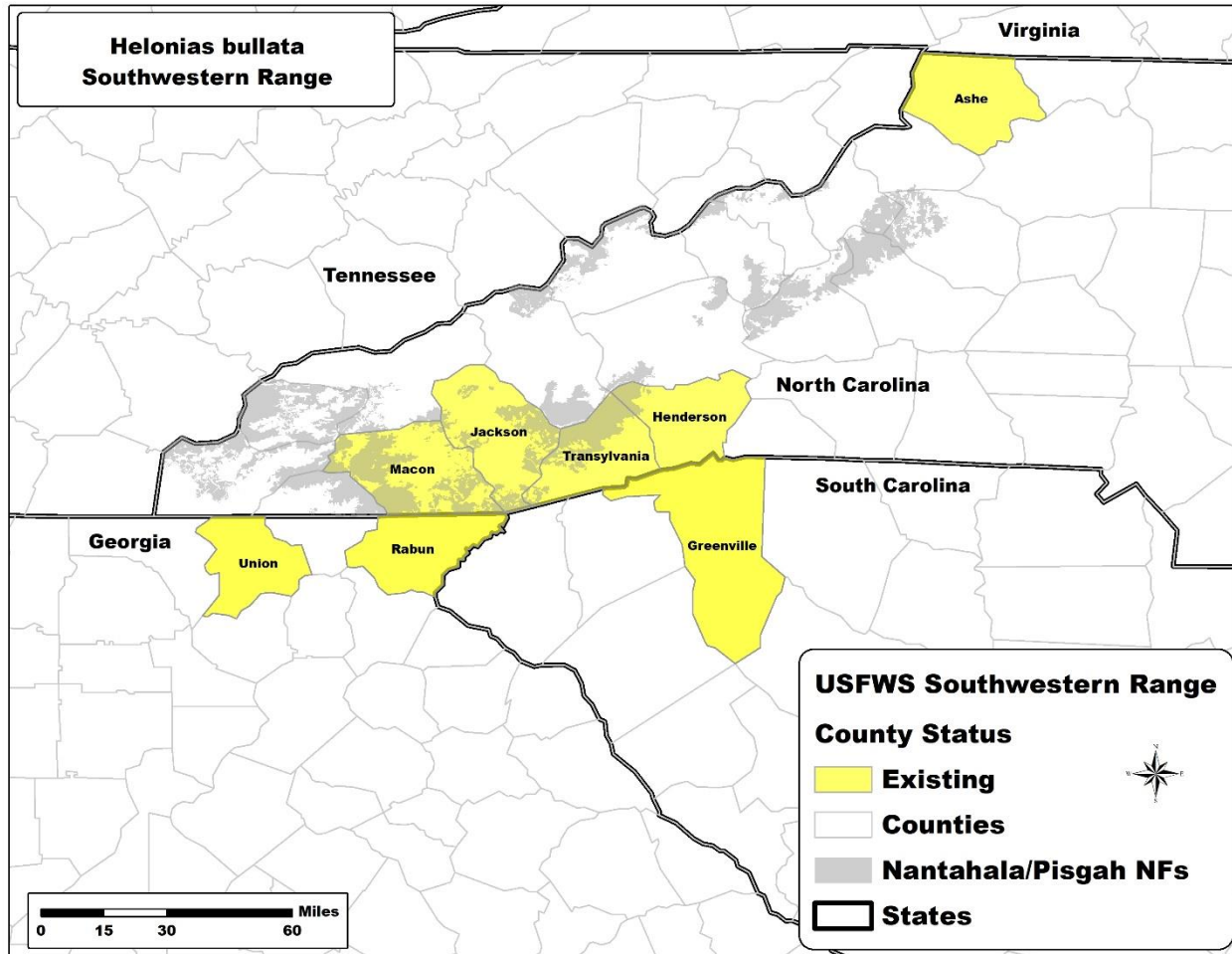


Figure 63. Documented county-wide southwestern range of swamp pink (2021)

Threats to swamp pink include degradation of habitat primarily by hydrological regime changes, nonnative invasive plant infestations, woody plant encroachment, all-terrain vehicles, deer herbivory, recreational trampling, horticultural collections, and flooding from beaver activity. The limited seed dispersal and poor seedling establishment also present difficulties with population growth. Dense shade may also pose a threat, as some shady sites have been observed as having very low flowering (Dr. Chris Ulrey, NPS plant ecologist, pers. comm.)

Monitoring every three to five years has been completed for all existing Pink Beds subpopulations. All the subpopulations were last visited in 2019-2020 and vary in size from precise count of five individuals to a conservative estimate of one with more than 100,000 individuals.

Intensive monitoring has been completed to document potential construction impacts to one subpopulation located downslope of the Cradle of Forestry amphitheater which was constructed in 2006. Rosette counts have been periodically estimated along 50-meter lengths within the larger drain downslope of the amphitheater since 1991. The rosette number estimates have varied from the first count of 4,025 in 1991 to 3,800 in 2020. In contrast, flowering has been more variable. After the first count there was sub-watershed flood that impacted the subpopulation resulting in dislodging and burning of numerous rosettes (Nora Murdock, NPS biologist, former USFWS biologist, pers. comm.). Since that time the subpopulation has slowly recovered and data suggests that the subpopulation in the vicinity of the amphitheater construction is stable.



In addition, two macroplots were established in 2008. All rosettes were numbered and tagged and the number of leaves and flowering stems were recorded. The total number of patches (rosettes) monitored from 2008 to 2012 slowly increased (17%) with the largest count in 2012 (Figure 64). Data from the five sampling dates indicates an increasing trend and indicates no adverse trends from the amphitheater construction and the more recent, 2010, construction of a roof overtopping a portion of the amphitheater. While the number of leaves have varied more than the rosettes there has also been an increase in numbers with the latest counts in 2012. While the number of flowering stems varies from year to year, this may be indicative of the limitations of the species or weather patterns for any single year since other researchers have also noted an increase in number of flowering stems in 2009 (Dr. Chris Ulrey, pers. comm.).

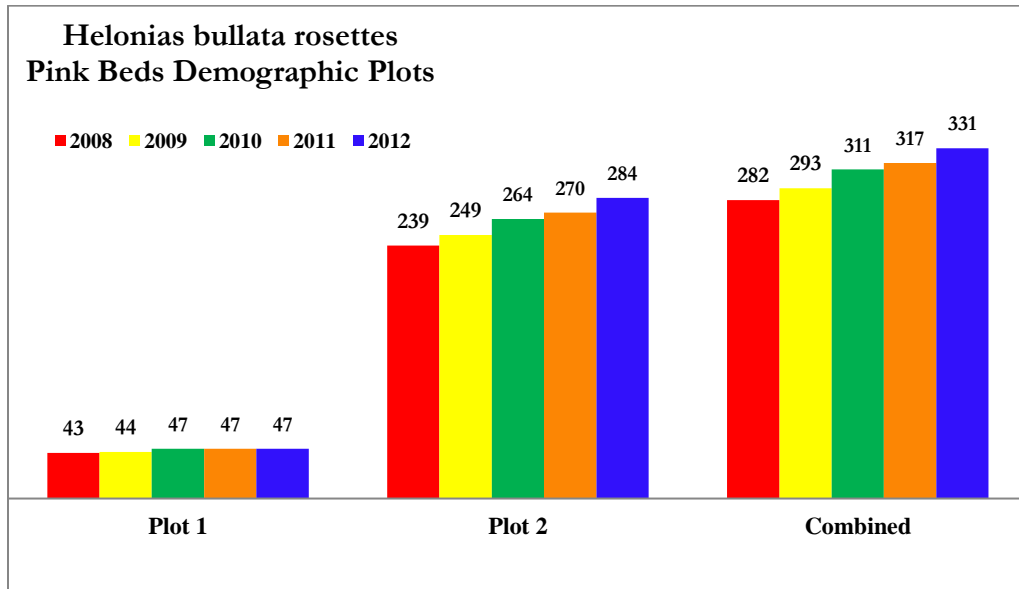


Figure 64. Change from 2008 to 2012 in *Helonias bullata* in rosette numbers in two macro plots in the Pink Beds

### Environmental Consequences

Plan components addressing unique habitat conditions discussed above encompass requirements for swamp pink and are described in other parts of this analysis. Appendix C summarizes key characteristics and indicators of the following unique habitats within the Ecological Sustainability Evaluation (ESE) that include swamp pink:

- Southern Appalachian Bogs
- Swamp Forest-Bog Complexes

Environmental consequences were estimated for indicators of the three unique habitats by alternative, and are displayed in Appendix C. These indicators included the risk of non-native invasive plant infestations, recreational trampling, and open habitat conditions.

Table 76 displays the assessment of the proposed planning framework (i.e., mitigation and management constraints, as well as habitat enhancement and restoration) on the habitats that affect swamp pink, by alternative. Specifically, this table reflects its estimated health and resilience on Forest Service land. All alternatives include plan components to directly or indirectly maintain, enhance, and/or restore habitat for federally listed species, including swamp pink, on the Nantahala and Pisgah NFs (Appendix C).



**Table 76. Ecological Sustainability Scores for Ecosystems and Species Groups Relevant to Swamp Pink (NPESE 2021).**

	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Southern App Bogs																			
Swamp Forest Bog Comp																			

\*Table legend: E: Existing Condition, Alternatives: A, B, C, D, numbers 1 and 2 after alternatives indicate Tier 1/Tier 2 objectives. Red = poor; yellow = fair; light green = good; dark green = very good.

Ecological Sustainability Evaluation modeling for the Nantahala and Pisgah Forest Plan Revision shows habitat conditions primarily being influenced by treatment of non-native invasive plant infestations and woody plant reductions. Swamp forest-bog complexes are consistently “good” across all alternatives, and have lower potential risk from invasive species due to a typically dense *Rhododendron maximum* layer. Southern Appalachian Bogs are currently in ‘good’ condition on the Forests and improve under tier one objectives for all alternatives because of the objective to restore and/or maintain 12 bogs by reducing woody plant encroachment and controlling invasive plants. Under tier 2 objectives, the ecological sustainability ranking under alternatives B and D declines to ‘fair’ due to the greater risk of non-native plant infestations but improves in the long-term with the greater attention within this habitat for non-native invasive plant infestation control and woody plant encroachment. These results indicate that this species would persist under all alternatives with potentially greater suitable habitat and population sizes with more concentrated non-native invasive control work.

The ESE Tool provides a coarse assessment for habitats and conditions. An additional analysis considers the spatial distribution of existing swamp pink occurrences on the Forests. This analysis describes how plan components associated with vegetation management, recreation management, and nonnative invasive species management impact swamp pink by alternative.

### Plan Direction

All alternatives include desired conditions to control non-native invasive plant species, reduce woody encroachment, and maintain hydrologic flows of bogs and swamp forest bog complexes.

The desired condition for swamp forest bog complex is for a mostly closed canopy coverage with an opening up to ¼ acre in size including 50% coverage of grasses, sedges, and Sphagnum moss. Southern Appalachian Bog desired conditions are to have less than 20% canopy cover and at least 25% cover that includes suitable habitat for associated herbaceous and woody plant species, as well as abundant Sphagnum moss (PAD-DC-06).

The action alternatives include an objective to restore or maintain at least 12 Southern Appalachian bogs during the life of the plan (PAD-O-03) which could enhance occupied swamp pink habitat. This restoration could include vegetation management such as reducing native and non-native woody plant encroachment, if needed. The Highlands Dome Geographic Area has a goal (HD-GLS-14) within occupied swamp pink habitat to reduce woody plant encroachment and non-native invasive plants on Southern Appalachian bogs and swamp forest bog complexes, improving habitat for bog turtles, swamp pink, and other rare species in Panthertown Valley and Dulany Bog. The action alternatives also include a

monitoring question for Southern Appalachian bogs regarding what percent have been restored to proper composition, structure, and hydrology (MQ 4-2-T1).

### **Management Areas**

Management Area designations determine the type of management activities across the forest. The Special Interest Areas MA is designed to maintain, restore, or enhance the special features within a designated area. In the action alternatives, all except two swamp pink subpopulations are distributed across two SIAs. In comparison, Alternative A does not include one of those Special Interest Areas, so this alternative includes one fewer swamp pink population and 12 fewer subpopulations within SIAs.

Both subpopulations occur in the Cradle of Forestry management area, where the desired condition is to ensure ecological values of the Southern Appalachian bog and swamp forest bog complex habitats are protected and interpreted (CFL-DC-11). In Alternative A, more of the swamp pink subpopulations would be in the Cradle of Forestry MA, and one population is in an area that was acquired after the 1994 amendment and has not been assigned MA direction.

### **Impacts from Non-native invasive Plants**

Many of the swamp pink subpopulations have known non-native plant infestations or are at risk from non-native invasive species. Seventy percent of the swamp pink occurrences are within 100 meters of a road or trail. NNIS control has been done in the past and is continuing. An amendment to the current plan and an objective for all action alternatives emphasizes more non-native invasive plant inventory and control work. A management approach for this activity is to prioritize treatment sites with unique habitats required for threatened or endangered species as well as key characteristics of ecozones that provide habitat requirements for threatened and endangered species. A streamside zone guideline mitigates potential impacts to swamp pink occurrences from herbicide activity. It prohibits aerial application within 200 horizontal feet and ground-applied applications within 30 horizontal feet of perennial streams, intermittent springs and streams, wetlands, or open bodies of water without specific advice from the appropriate resource specialists (AQS-G-02).

### **Recreational Impacts**

Trampling from recreational usage is known to be a threat to swamp pink. All except eight subpopulations are within 100 meters of existing trails or roads. The greatest trampling risk would be within the Pink Beds subpopulations. Current monitoring, including interacting with larger groups such as mushroom foray participants, has not detected trampling impacts, although visitation continues to increase. Alternative E includes a specific standard that does not allow trails or relocations in Southern Appalachian bogs (REC-S-20), which would apply to trails in the Pink Beds. In addition, if trail impacts are noted, mitigations such as temporary closures, would be applied to ensure impacts would not continue (REC-S-08). With these measures as well as recurrent monitoring to detect population changes or threats, the risk from recreational usage would be minimized.

### **Cumulative Effects**

Cumulative effects include state, tribal, local, or private actions that are reasonably certain to occur in the 18-counties of Western North Carolina. Swamp pink has a global range from Delaware and New Jersey south to Georgia and South Carolina (USFWS 2021). Within NC, the majority of the non-federal ownership occurrences are in private ownership, although the majority of documented individuals besides those in the Pink Beds are under state ownership. The Dulany Bog population occurs both on private and USFS ownership, although the bog is jointly managed by the two and the NC Plant Protection Program, which owns adjacent land also incorporating the southern Appalachian bog. Threats including encroaching vegetation and non-native invasive infestations across most of the populations managed under state or private ownership. Two private sites are partly managed by two land trusts and

another site may eventually be under a land trust conservation easement. Half of the sites are working to manage threats to swamp pink. Considering the active restoration management within many of the occupied sites and the cooperative management with USFS, private foundation, and state within the Dulany Bog site, there are no anticipated cumulative effects to this species.

## Conclusions

This analysis indicates habitat conditions will improve for this species with control of non-native invasive plant infestations and management to reduce woody plant encroachment. While current Forest Plan direction for Alternative A would maintain or improve this species across the Forest, the action alternatives provide a greater emphasis on management of Southern Appalachian bogs through plan direction that provides for protection and potential restoration.

The following two species all occur in similar wetland habitat and do not occur on the Nantahala or Pisgah NFs.

### Bunched arrowhead (*Sagittaria fasciculata*)

Bunched arrowhead, *Sagittaria fasciculata*, is an aquatic perennial herbaceous plant that occurs in continuously flowing seepage areas with cool, clear water (NatureServe 2021, Newberry 1991). It occurs in bogs, ditches adjacent to drained bogs, and wooded seepage areas (Weakley 2020). The presence of the continuous slow flowing seepage is considered the most limiting environmental factor (NatureServe 2021). This species has a narrow range within two counties in North and South Carolina (Figure 65). Buncombe County is also displayed as historical range based on an herbarium record, although there is speculation it may have been collected in Henderson County (USFWS 1983). The species was listed in August of 1979 (USFWS 1979). No critical habitat has been designated for this species.

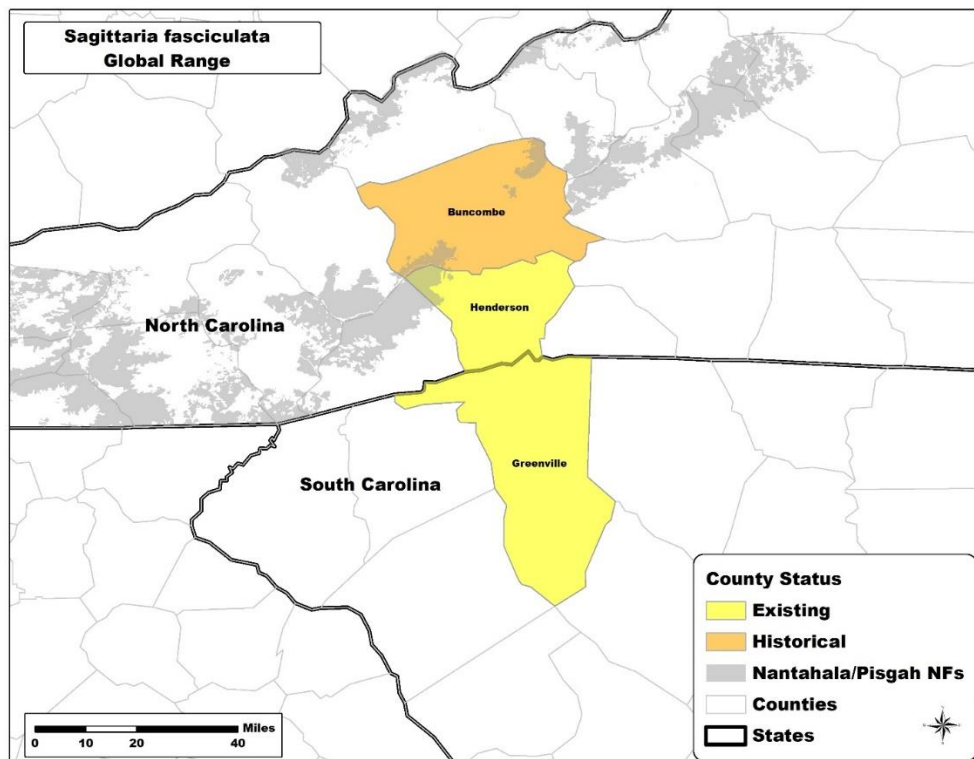


Figure 65. Documented county-wide range of bunched arrowhead (NatureServe 2021, USFWS 2021)

Thirteen populations, with 36 extant colonies, are currently known within the Carolinas. Six populations are present in North Carolina and seven in South Carolina, where the majority of the colonies occur (USFWS 2020). There are no known populations of this species on either the Nantahala or Pisgah NFs; however, the species has been located within similar bogs that occur on the Pisgah NF and could potentially occur on the forest in the future. A population has been documented less than 1 aerial mile from suitable habitat in the Pisgah NF. The greatest likelihood of occurrence on the forest would be in Henderson County at lower elevations, less than 2,400 feet, which represents fewer than 500 acres across this portion of the Pisgah Ranger District.

### **Mountain sweet pitcher plant (*Sarracenia rubra ssp jonesii*)**

Mountain sweet pitcher plant (*Sarracenia rubra ssp jonesii*) is a carnivorous plant in the pitcher plant family that grows in southern Appalachian bogs or cataract seeps (Weakley 2020). It differs from *S. rubra ssp. rubra* by scape heights, and orientation and size of the pitcher hood opening (Weakley 2020). Based on various taxonomic work, it has been accepted as *S. jonesii* versus a subspecies by various authorities, although the USFWS has not renamed the species via the Code of Federal Regulations. The species is a Carolina endemic, restricted to three counties in North Carolina and two South Carolina counties with a global rank of G2 (NatureServe 2021, USFS 2020). One additional North Carolina county has an introduced population (Wichmann 2021). Historically, there were 16 populations known across this area; 15 are presently known (USFWS 2013). Ten of the 15 extant populations are in North Carolina (USFWS 2020). The species was formally listed as endangered in 1988 (U.S. Fish and Wildlife Service 1989) and a recovery plan was approved on August 13, 1990 (USFWS). No critical habitat has been designated for this species.

There are no known populations of this species on either the Nantahala or Pisgah NFs. However, the species has been located within similar bogs that occur on the Pisgah NF and could potentially occur in the French Broad River drainage across a narrow portion of the forest, Henderson, Transylvania, or southern Buncombe County in the future. A recent five-year review of the species indicates only three of the known populations are stable; all the remaining ones are declining from baseline data collected in the 1990's (USFWS 2020). Threats to the species include hydrological disruptions, nutrient intake, non-natives invasive plant infestations, and illegal collections (NatureServe 2021, USFWS 2020).

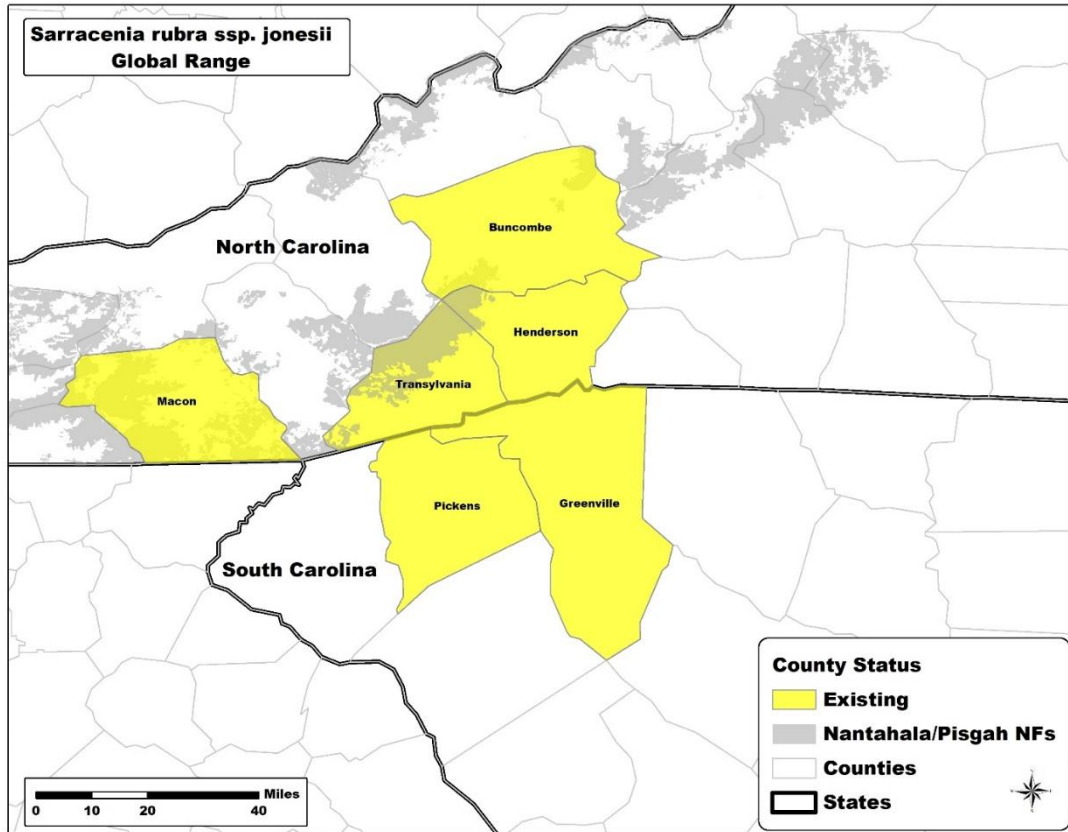


Figure 66. Documented county-wide range of mountain sweet pitcher plant (2021).

### Environmental Consequences

Plan components addressing unique habitat conditions discussed above encompass requirements for bunched arrowhead and mountain sweet pitcher plant. They are described in other parts of this analysis. Appendix C summarizes key characteristics and indicators of the following unique habitats within the Ecological Sustainability Evaluation (ESE) that include the three species:

- Southern Appalachian Bogs (Unique Habitat)
- Swamp Forest-Bog Complexes (Unique Habitat)

Environmental consequences were estimated for indicators of the two unique habitats by alternative, and are displayed in Appendix C. These indicators include the risk of non-native invasive plant infestations, recreational trampling, and open habitat conditions.

Table 77 displays the assessment of the proposed planning framework (i.e. mitigation and management constraints, as well as habitat enhancement and restoration) on the habitat and species group that affect bunched arrowhead and mountain sweet pitcher plant, by alternative. Specifically, this table reflects the estimated health and resilience on Forest Service land. All alternatives include plan components to directly or indirectly maintain, enhance, and/or restore habitat for federally listed species, including these two species, if located on the Forest (Appendix C).

**Table 77. Ecological sustainability scores for ecosystems and species groups relevant to bunched arrowhead and mountain sweet pitcher plant (NPESE 2021).**

	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Southern App Bogs																			
Swamp Forest Bog Comp																			

\*Table legend: E: Existing Condition, Alternatives: A, B, C, D, numbers 1 and 2 after alternatives indicate Tier 1/Tier 2 objectives. Red = poor; yellow = fair; light green = good; dark green = very good.

Ecological Sustainability Evaluation modeling for the Nantahala and Pisgah Forest Plan Revision shows conditions primarily being influenced by treatment of non-native invasive plant infestations and woody plant reductions. Swamp forest-bog complexes have a rating of “good” across all alternatives, and have lower potential risk from invasive species due to a typically dense *Rhododendron maximum* layer. Southern Appalachian Bogs are currently in ‘good’ condition on the Forests and improve under tier one objectives for all action alternatives because of the objective to restore and/or maintain 12 bogs by reducing woody plant encroachment and controlling invasive plants. Under tier 2 objectives, the ecological sustainability ranking under alternatives B and D declines to ‘fair’ due to the greater risk of non-native plant infestations but improves in the long-term with the greater attention in this habitat for non-native invasive plant infestation control. Therefore, suitable habitat should improve for these two wetland species. While no documented occurrences are currently known, the alternatives should not result in restrictions for potential populations. Since there currently are no occurrences, there are no cumulative effects.

### Conclusions

This analysis indicates that with control of non-native invasive plant infestations and reducing woody plant encroachment, habitat conditions will improve for bunched arrowhead and mountain sweet pitcher plant. These two species could potentially occur on the Nantahala and Pisgah NFs in the future. If either are found, recovery plan tasks, as updated in the most recent five-year review would be addressed.

### 3.3.3.4 Streambank T&E Plants

The one federally listed plant associated with streambanks is Virginia spiraea.

#### **Virginia spiraea (*Spiraea virginiana*)**

##### **Affected Environment**

Virginia spiraea (*Spiraea virginiana*) is a medium height perennial shrub in the rose family with showy yellow flowers in July and August (Weakley 2020, NatureServe 2021). It is typically located in disturbed areas along high gradient sections of rivers and streams or braided features of lower reaches and is occasionally located along road corridors. Virginia spiraea has been recently documented or relocated along the Appalachian Mountains from Ohio and West Virginia south to northwestern Georgia. It historically occurred in Pennsylvania but is thought to be extirpated (NatureServe 2021). Virginia Spiraea is known currently to occur in eight counties within three river basins (French Broad, New and Little Tennessee) in North Carolina (Wichman 2021, Figure 67). Virginia Spiraea has a global rank of G2 and was listed as a federally threatened species in 1990 (USFWS 1990). Critical habitat has not been designated for this species.

The shrub is known across 39 subpopulations on the Nantahala and Pisgah NFs, within the Nolichucky River Gorge, in the Cheoah River, and in Whiteoak Creek. All except eight of the subpopulations are within a proposed special interest area. Threats to the species include competition from surrounding vegetation including non-native invasive plants, inundation, beaver herbivory, and clearing vegetation in the riparian area including adjacent roadside edge (USFWS 2009, USFWS 2021). Non-native invasive plants are threatening all 39 subpopulations. Invasive plants have been treated across two of the occupied sites in the Nolichucky Gorge, the one site at Whiteoak Creek, and 20 sites along the Cheoah River.

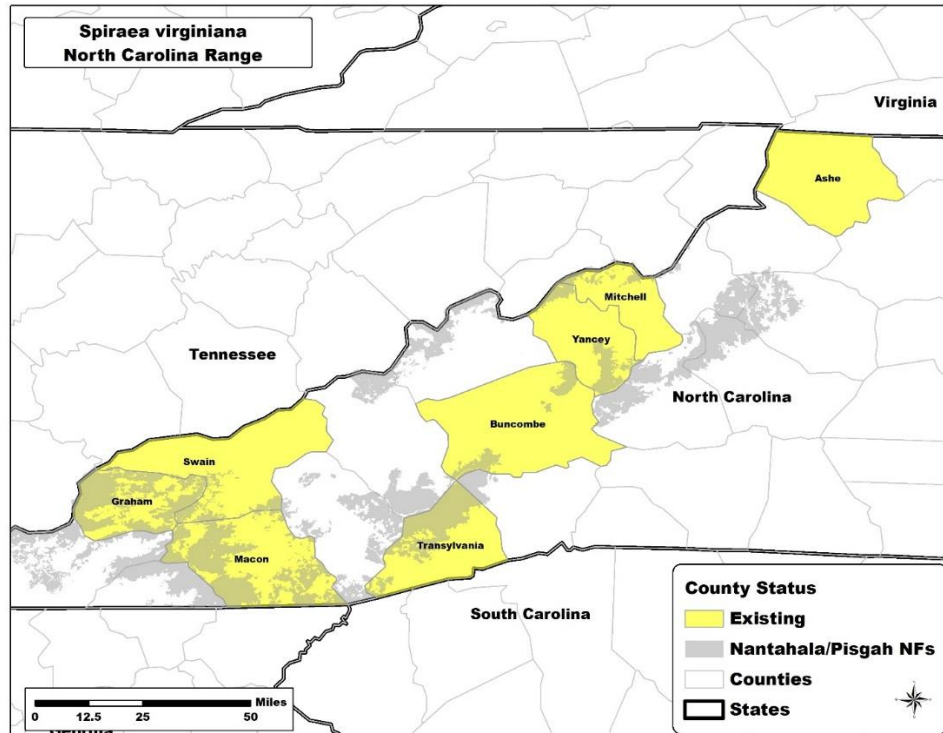


Figure 67. Documented county-wide North Carolina range of Virginia Spiraea (NC Biotics 2021)



In the Nolichucky River Gorge two of the three recently relocated subpopulations have been monitored. The two subpopulations were covering the same aerial extent as previously recorded. The same aerial extent was assessed within 29 of the subpopulations in 2020 along the Cheoah River. Of the 29 on USFS lands, three were not relocated, five declined, and the rest were primarily stable across their coarse aerial estimate. Nine new subpopulations were located in an updated survey conducted in 2021 along the entire nine-mile length from Santeetlah Dam to Lake Calderwood (Siripoonsup 2021). These changes are potentially the result of a more dynamic river system, with an increase in stream flow rates after 2005 following the federal energy regulatory commission (FERC) relicensing agreement for the Tapoco Hydroelectric Project (formerly with Alcoa, now with Brookfield Renewable Energy Group).

One remaining Virginia spiraea clump with one visible stem was recorded at the Whiteoak Creek site in spring of 2011. This population declined as a result of a Japanese knotweed infestation and from a heavy storm event in 2010 that scoured the streambank. Based on similar observations following invasive plant treatments near another Virginia Spiraea population along the Little Tennessee River (not on USFS lands), it is thought that the herbicide can translocate into Virginia Spiraea rhizomes that touch the targeted invasive plant roots.

### Environmental Consequences

Plan components addressing habitat conditions discussed above encompass requirements for Virginia spiraea and are described in other parts of this analysis. Appendix C summarizes key characteristics and indicators of the following terrestrial and aquatic ecosystems within the Ecological Sustainability Evaluation (ESE) that include Virginia Spiraea:

- Floodplain Forest (Ecozone)
- Aquatic habitats - Large, medium and small rivers, streams, and Rocky Bar and Shore

Environmental consequences were estimated for indicators for terrestrial and aquatic habitats by alternative and are displayed in Appendix C. Floodplain forest includes structural and age conditions tied to a balance in the natural range of variation while the other habitats include indicators of non-native invasive plant infestations and hydrological impacts.

Table 78 displays the assessment of the proposed planning framework (i.e. mitigation and management constraints, as well as habitat enhancement and restoration) on the habitats and species groups that affect Virginia spiraea, by alternative. Specifically, this table reflects its estimated health and resilience on Forest Service land. All the alternatives include plan components to directly or indirectly maintain, enhance, and/or restore habitat for federally listed species, including Virginia spiraea, on the Nantahala and Pisgah NFs (Appendix C).

**Table 78. Ecological Sustainability Scores for Ecosystems and Species Groups Relevant to Virginia Spiraea (NPESE 2021)**

	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Floodplain Forest																			
Rocky Bar and Shore																			



	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Streams																			
Small Rivers																			
Medium/Lg Rivers																			

\*Table legend: E: Existing Condition, Alternatives: A, B, C, D, numbers 1 and 2 after alternatives indicate Tier 1/Tier 2 objectives. Red = poor; yellow = fair; light green = good; dark green = very good.

Ecological Sustainability Evaluation modeling for the Nantahala and Pisgah Forest Plan Revision shows conditions within floodplain forest as “poor” and improving to “fair” after 50 years under Tier 1 objectives. Floodplain forest is not as important to the persistence of *Virginia spiraea* across the Forest as the aquatic habitats, which vary from “fair” to “very good” rating across all alternatives. These results indicate the persistence of this species under all alternatives and potentially greater suitable habitat and population sizes through reduction of non-native invasive plant infestations.

The ESE Tool provides a coarse assessment across all habitats and conditions associated with *Virginia spiraea*. An additional analysis considered the spatial distribution of existing to *Virginia Spiraea* occurrences on the Forests. This analysis describes how vegetation management, non-native invasive plants, and roadside maintenance impact *Virginia spiraea* by alternative.

### Plan Direction

Both the current plan and the action alternatives contain desired conditions supporting *Virginia spiraea* to control non-native invasive plant species and allow adjacent river streamside scour at and near the three existing populations in order to maintain open suitable habitat.

*Virginia Spiraea* occurs within one unique habitat, rocky bar and shore. In the action alternatives, plan desired conditions for unique habitats are to maintain natural disturbance patterns, restore conditions if necessary, support associated wildlife and plant species, reduce recreational impacts, and maintain resilience (PAD-DC-02 & 03). Specific plan direction for rocky bar and shore is to maintain a treeless area along a naturally functioning floodplain with variable densities of shrubs and herbs depending on disturbance frequencies (PAD-DC-06).

*Virginia spiraea* also occurs within streamside zones. All action alternatives include standards that limit vegetation management within streamside zones and the similar riparian zone for Alternative A. This includes no visible sedimentation reaching stream channels as well as management activities designed to minimize, avoid, or mitigate negative impacts on aquatic habitats with all the alternatives (WTR-S-01 & AQS-S-01). The action alternatives include an objective for maintenance and expansion of the occupied range of freshwater mussels and other aquatic species of conservation concern and federally listed species across the Forests that could enhance occupied *Virginia spiraea* habitat (AQS-O-01).

## **Management Areas**

Management Area designations determine type of management activities across the forest. Special Interest Areas are designated to maintain, restore, or enhance the special features within a designated area. Except for the three subpopulations within the Nolichucky River Gorge, all the action alternatives include the remaining subpopulations within two SIAs. In comparison, Alternative A does not include any of the subpopulations within an SIA. *Virginia spiraea* and the unique habitat in which it occurs, would be some of the special features within these two SIAs.

The remaining three subpopulations in the Nolichucky River Gorge are within the Backcountry MA designation. While limited timber management and road construction could occur within this management area, given the location of these three subpopulations in a steep gorge, the primary management surrounding the subpopulations would be management to restore *Virginia spiraea*, either through the reduction of woody plant competition or controlling non-native plants. In Alternative A, 35 of the 39 subpopulations occur within MAs 2a, 3b, or 4d, all of which allow for timber production and active vegetation management.

## **Impacts from Non-native invasive Plants**

All of the *Virginia spiraea* subpopulations have known impacts from non-native plant infestations. Control has been done in the past and is continuing. Given the nearby road occurrences, nonnative invasive spread will continue to be a problem. An amendment to the current plan and an objective for all action alternatives emphasizes more non-native invasive plant inventory and control work. A management approach for NNIS includes prioritizing treatment sites with unique habitats required for threatened or endangered species as well as key characteristics of ecozones that provide habitat requirements for threatened and endangered species. A streamside zone guideline mitigates potential impacts to *Virginia spiraea* occurrences from herbicide activity by prohibiting aerial application within 200 horizontal feet and ground-applied applications within 30 horizontal feet of perennial streams, intermittent springs and streams, wetlands, or open bodies of water without specific advice from the appropriate resource specialists (AQS-G-02). The Fontana Lake Geographic Area, which contains 90% of the *Virginia Spiraea* occurrences across the Nantahala and Pisgah NFs, includes a goal to ensure non-native invasive plants are not impacting *Virginia Spiraea* along the Cheoah River.

## **Impacts from Roadside Maintenance**

*Virginia Spiraea* populations have been impacted by roadside mowing and indiscriminate herbicide activity. More than 1/3 of the Forest subpopulations are adjacent to roads and could be impacted by roadside activities. The proposed plan includes a guideline that along trails and roads with existing populations of proposed endangered and threatened plant species, such as *Virginia spiraea*, ground disturbance activities that displace plants should be minimized. Maintenance activities such as mowing and/or herbicide applications should be timed when the rare plants are dormant, unless the disturbance is beneficial (TA-G-01).

## **Cumulative Effects**

Cumulative effects include state, tribal, local, or private actions that are reasonably certain to occur in the 18-counties of Western North Carolina. *Virginia spiraea* has a broad range across the Appalachians from Ohio to Georgia. In North Carolina, the species is distributed along the Little Tennessee River, the French Broad, the Toe River, the Cane River, the Nolichucky River, and the New River, and their tributaries. Within the Cheoah River drainage with the large USFS population there are a few subpopulations managed by Brookfield Renewable Energy Group (BREG). Just as on USFS lands, non-natives invasive plant infestations are present, specifically kudzu. Kudzu also occurs on the adjacent roadside edge managed by the NC Department of Transportation (NCDOT). Both NCDOT and BREG are cooperative and are in support of

controlling the infestation. In contrast, there is an adjacent landowner with a dense privet infestation impacting one subpopulation. There is no cooperation with this landowner and without control across the private land, this infestation may impact the subpopulation.

Many other sites across the 18-county area are in conservation agreements and while invasive plants are a concern they are being addressed. Six of the seven sites along the Little Tennessee River and its tributaries are being managed by state agencies or within conservation agencies. In contrast, 10 sites along the Toe River, Cane River or their tributaries are under private ownership with an uncertain dedication of conservation of Virginia spiraea. A few sites have non-native invasive plant infestations. While they are far removed from the downstream USFS Nolichucky River occurrences, they could increase invasive species, such as Japanese knotweed, which establishes new colonies via rhizome fragments spread by river scour. These potential cumulative effects illustrate the importance of controlling non-native invasive plants on all lands, to the extent possible.

### **Conclusions**

This analysis indicates that Virginia spiraea will persist, and habitat conditions could improve by minimizing non-native invasive plant impacts. While restoration and control of infestations is being done under the current plan, the action alternatives provide a better opportunity for improving habitat due to more targeted plan components and the inclusion of the majority of the occurrences within Special Interest Areas.

#### **3.3.3.5 Shaded Rock Outcrop or Stream Boulders T&E Plants**

The one federally listed plant associated with shaded rock outcrops or stream boulders is rock gnome lichen.

##### **Rock gnome lichen (*Gymnoderma lineare*)**

##### **Affected Environment**

For the purposes of this report, rock gnome lichen will still be referred to as *Gymnoderma lineare* as the US Fish and Wildlife Service still refer to it. A taxonomic revision of the genus including this species was completed in 2002, resulting in the change to *Cetradonia linearis* (Wei and Ahti 2002). Until the new binomial is changed in the integrated taxonomic information system, the USFWS will maintain the older binomial (USFWS 2013).

*Gymnoderma lineare* is a squamulose lichen with a narrow strap-shaped olive-grey thallus which grades to a blackened base (Evans 1947). Rock gnome lichen occurs in a narrow portion, 19 counties, of the Southern Appalachian, primarily occurring in the North Carolina mountains with small peripheral populations in the mountains of Tennessee, Georgia, South Carolina, and Virginia (Figure 68, NatureServe 2021, USFWS 2021). It was federally listed as endangered in the Federal Register in 1995 (USFWS 1995) and currently has a G3 global rank (NatureServe 2021). Critical habitat has not been designated for rock gnome lichen (USFWS 2001).

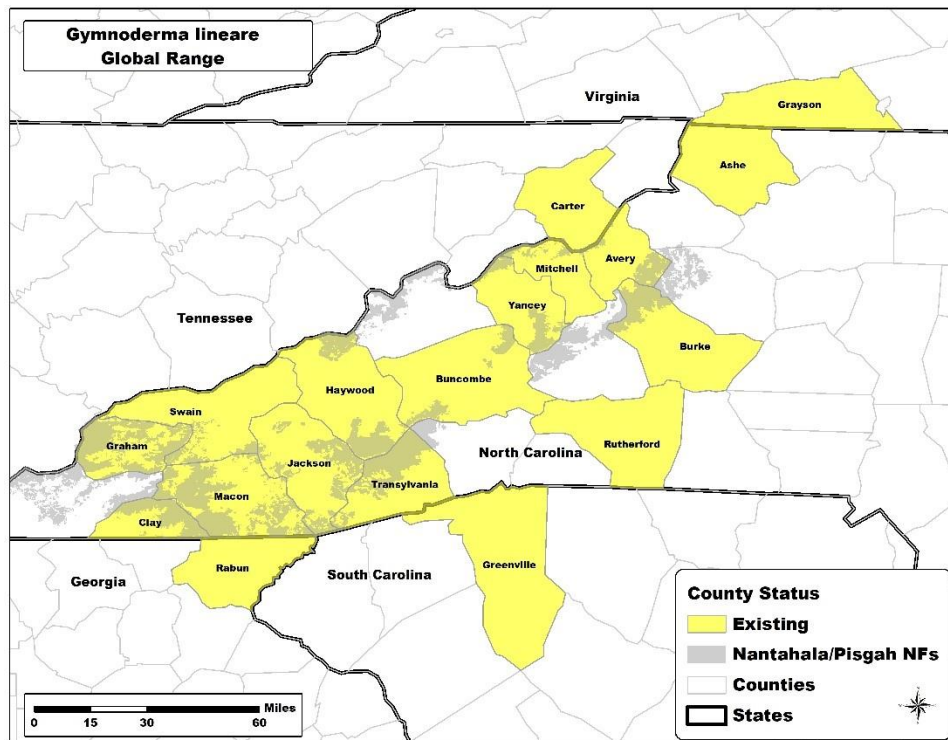


Figure 68. Documented county-wide global range of rock gnome lichen (NatureServe 2021, NC Biotics 2021, USFWS 2021).

Rock gnome lichen occurs on sloping to vertical rock faces with some seepage at higher elevations, generally above 4,000 feet. Typically it occurs on rock outcrops partially shaded by spruce-fir, northern hardwood, acidic cove forests and very occasionally floodplain forest. In portions of its range it occurs on partially shaded high elevation rocky summits or occasionally high elevation granitic domes. The species has also been located in riparian areas on boulders within and adjacent to streams. Streamside populations occur both within the headwaters, some occurring above 5,500 feet, as well as larger 5<sup>th</sup> to 6<sup>th</sup> order streams. Populations vary in density from tiny dispersed clumps, barely one centimeter square, to dense colonies, greater than four meters square in extent. Populations on Fowler Creek and the east bank of the Chattooga River on the Nantahala Ranger District represent the lowest elevation at which this species occurs across its range (approximately 2,240 feet). Of the 83 subpopulations on the Forests, 55 of those occur on boulders in streams, associated with spray cliffs, or rock features within 10 feet of a stream.

As previously indicated, the vast majority of the populations of rock gnome lichen occur within western NC. There is some uncertainty on the delineation of populations, these varying based on different criteria for separation distance or occurrence in separate subwatersheds. The 2020 five-year monitoring review denoted 68 populations, with 59 in North Carolina. It is uncertain how many of these populations were delineated on the Nantahala or Pisgah NFs. Currently there are 83 subpopulations known on the Nantahala and Pisgah NFs, which include all or portions of 38 populations. This represents at least 50% of the populations currently known across rock gnome lichen's range. As such, the populations on the Nantahala and Pisgah NFs are critical for the long-term restoration and maintenance of this lichen.

The current geographic range of *Gymnoderma lineare* has expanded since it was listed with the addition of three counties in North Carolina, one county in Tennessee, and single county and state occurrences in Virginia, Georgia, and South Carolina. Several populations are believed to have been extirpated or reduced in size during the last 25 years. It is not specifically known why certain populations of this lichen

have declined although recreational use, pathogens impacting canopy trees previously providing shade, road construction, and high sulfur levels have been documented in areas of decline (USFWS 1997, Martin and Noble 1996).

Intermittent monitoring has occurred within various rock gnome lichen subpopulations across the two forests. All except four of the occupied sites on the forests have been revisited at least once in the last 15 years, with cursory observations on presence and health recorded. Within these revisited sites, all except one population or subpopulation was relocated. The one un-relocated population, in Wright Creek in Graham County, is believed to have been adversely affected and potentially locally extirpated as a result of sedimentation associated with the construction of the Cherohala Skyway. Most subpopulations with more frequent visitation are relatively stable in their covered extent. However, three subpopulations have been impacted either by unsubstantiated events (potentially ozone damage) or by recent tree falls.

### **Environmental Consequences**

Plan components addressing habitat conditions discussed above encompass requirements for rock gnome lichen and are described in other parts of this analysis. Appendix C summarizes key characteristics and indicators of the following terrestrial and aquatic ecosystems, unique habitats, and species groups within the Ecological Sustainability Evaluation (ESE) that include rock gnome lichen:

- More common terrestrial- Spruce-fir Forest, Northern Hardwood Forest, Acidic Cove Forest, and Floodplain Forest
- Unique terrestrial – High Elevation Rocky Summit, High Elevation Granitic Dome, Montane Acidic Cliff, and Spray Cliffs
- Aquatic habitats - Large, medium, and small rivers and streams
- Species Groups – Interior Forest, Old Forest, and Closed Canopy Forest

Environmental consequences were estimated for indicators for the 14 separate habitats and species groups by alternative, and are displayed in Appendix C. These indicators include habitat structure and age based on the natural range of variation for ecozones. It includes threats such as non-native invasive plant infestations and recreational impacts in rock outcrop unique habitats, hydrological impacts in aquatic habitats, and shaded interior forests as determined with gap analysis from the 2017 LiDAR database.

Table 79 displays the assessment of the proposed planning framework (i.e. mitigation and management constraints, as well as habitat enhancement and restoration) on the habitat and species group that affect rock gnome lichen, by alternative. Specifically, this table reflects its estimated health and resilience on the Forest. All alternatives include plan components to directly or indirectly maintain, enhance, and/or restore habitat for federally listed species, including rock gnome lichen, on the Nantahala and Pisgah NFs (Appendix C).

**Table 79. Ecological Sustainability Scores for Ecosystems and Species Groups Relevant to Rock Gnome Lichen (NPESE 2021)**

	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Spruce-fir Forest																			
No. Hardwood Forest																			
Acidic Cove Forest																			
Floodplain Forest																			
Interior Forest																			
Closed Canopy Forest																			
High Elevation Granitic Dome																			
High Elevation Rock Summit																			
Montane Cliffs																			
Spray Cliffs																			
Streams																			
Small Rivers																			
Medium and Large Rivers																			

\*Table legend: E: Existing Condition, Alternatives: A, B, C, D, numbers 1 and 2 after alternatives indicate Tier 1/Tier 2 objectives. Red = poor; yellow = fair; light green = good; dark green = very good.

Ecological Sustainability Evaluation modeling for the Nantahala and Pisgah Forest Plan Revision shows conditions across the four ecozones influenced by the abundance or absence of young and older forest. While ratings vary widely across these ecozones, they are not as important to the persistence and health of rock gnome lichen as closed canopy forest, which is synonymous with shaded rock outcrops, old forest, and interior forest. These three species groups have a rating of r “very good”. Unique rock outcrop habitats vary from “fair” to “good”. Maintaining a “fair” rating during the life of the plan reflects the risk of recreational trampling, which is the greatest threat to the persistence of rock gnome lichen within these habitats. Aquatic habitats vary from a fair” to “good” rating across all alternatives. These results indicate the persistence of this species under all the alternatives and potentially greater suitable habitat and population sizes by minimizing any recreational impacts, primarily on high elevation rocky summits and granitic domes.

The ESE Tool provides a coarse assessment across all habitats and conditions applicable to rock gnome lichen. In addition, an analysis was added to consider the spatial distribution of existing rock gnome lichen occurrences on the Nantahala and Pisgah NFs. This analysis describes how plan components associated with vegetation management, recreation management, air pollution, and climate change impact rock gnome lichen by alternative.

### **Plan Direction**

All alternatives include desired conditions (PAD-DC-01) to manage human impacts and minimize them near rock gnome lichen population locations in high elevation rock outcrops, spray cliffs or streams, and to document population stability to help assess the need for endangered species status.

Rock Gnome lichens occur in a variety of habitats as discussed above. Nineteen of the 83 subpopulations occur surrounded by spruce-fir or northern hardwood forests. The action alternatives require a 100-foot buffer in appropriate habitat for spruce-fir moss spider and rock gnome lichen (PAD-S-02). The action alternatives also include an objective to restore 50 acres of spruce-fir ecozones annually to improve ecozone composition during the first 10 years of the planning cycle (ECO-O-07). This objective would potentially implement restoration activities within two areas, Roan Mountain and Flat Laurel Creek at Graveyard Fields, with occupied rock gnome lichen habitat. The action alternatives include a goal in the Pisgah Ledge Geographic Area to expand spruce restoration in the Flat Laurel Creek and Graveyard Fields Areas (PL-GLS-05), which would improve habitat for rock gnome lichen in the long term. The North Slope Geographic Area includes a goal to emphasize restoration of spruce-fir and northern hardwood forests for the northern flying squirrel and rock gnome lichen and maintain the health and resiliency of these critical forest types in the face of climate change (NS-GLS-03).

Twenty-five of the subpopulations occur within unique rock habitats adjacent to various forested habitats. All action alternatives include a standard that requires maintenance of habitat characteristics for plant and animal species occupying boulderfields, low and high elevation rocky summits, granitic domes, glades, or cliffs during project design and implementation (PAD-S-07).

Fifty-five of the 83 subpopulations across the Nantahala and Pisgah NFs are located within boulders on streams or on moist rock outcrops within 10 feet of a stream. Specific standards, guidelines, and objectives address these areas where occupied habitat could be affected. A standard included for all alternatives prevents visible sediment from reaching perennial and intermittent stream channel and perennial water bodies in accordance with North Carolina Forest Practice Guidelines Related to Water Quality (NC FPGs or latest) (WTR-S-01). Furthermore, another standard requires management activities to be designed to avoid, minimize, or mitigate negative impacts on aquatic habitats and species unless the management objective is to protect a native species from encroachment by a non-native species (AQS-S-01). A streamside guideline mitigates potential impacts to rock gnome occurrence from pesticide or herbicide activity. It prohibits aerial application within 200 horizontal feet and ground-applied applications within 30 horizontal feet of perennial streams, intermittent springs and streams, wetlands, or open bodies of water without specific advice from the appropriate resource specialists (AQS-G-02). The action alternatives include an objective for maintenance and expansion of the occupied range of freshwater mussels and other aquatic species of conservation concern and federally listed species across the Forests that could enhance rock gnome lichen habitat (AQS-O-01). In the action alternatives, two geographic areas goals would improve occupied habitat for rock gnome lichen. The Highlands Dome's goal is to improve watershed conditions and function in the five identified 6th level watersheds (HD-GLS-09). Another goal within the Panthertown Valley area emphasizes management that restores and protects rare communities such as southern Appalachian bog, swamp-forest bog complexes, and at-risk species such as rock gnome lichen (HD-GLS-14).

### **Management Areas**

Management Area designations determine the type of management activities across the forest. Special Interest Areas are designated to maintain, restore, or enhance the special features within a designated area. Rock gnome lichen subpopulations are a special feature. All the action alternatives include 72-73% of all subpopulations within SIAs. In comparison, only 31% of the subpopulations occur in existing SIAs with the current plan, Alternative A.

The locations with the greatest likelihood of vegetation management activities are those within MA Group 1. For the action alternatives, there are fewer *Gymnoderma lineare* occurrences in MA Group 1 than the other MA groups, where Alternatives B and D include 10% of the occurrences while Alternatives C and E have 6% and 5%, respectively. In contrast, Alternative A includes 13% of all the occurrences within either 3b or 4d MAs, MAs which emphasize active management. The locations with the least likelihood of vegetation management activities are those within MA Group 4. The number of occurrences vary within this group from 12-19% with the most in Alternatives B and D. In comparison, Alternative A has the least number of occurrences within either wilderness or wilderness study areas where passive management would be the predominate activity.

*Gymnoderma lineare* can occur within multi-aged forest, including old growth. Subpopulations of this species occurs within the designated old growth network for all alternatives. The greatest percentage is in Alternative E at 45%, Alternative C has with slightly fewer at 42%, while the other three alternatives vary from 33-35% of the occurrences.

### **Recreational Impacts**

Recreational impacts were based on accessibility to species sites. Sites within 100 meters of roads or trails were determined to have a higher potential for visitation by recreationists and therefore potentially greater impacts to associated species. Rock gnome lichen is susceptible to trampling from climbers, fishermen, and hikers. Currently 51% of rock gnome lichen occurrences across the Forest are within 100 meters of existing roads and/or trails. This percent is slightly higher than the average of the four unique habitats assessed for recreational impacts in the ESE tool. Subpopulations occurring in the Graveyard Fields, Panthertown Valley, and Roan Mountain area are more susceptible due to high visitation rates in those areas. These areas also have an abundance of undesignated “social” trails that increase the trampling risk. Several of the occurrences are protected by closure areas on Roan Mountain; however, the vast majority are not.

It is important to monitor these more susceptible areas to assess recreational impacts. While closure areas and other recreation mitigations have been implemented with the current plan, the action alternatives also include a standard to mitigate recreational impacts to sensitive areas.

### **Air Pollution**

When *Gymnoderma lineare* was originally listed, one of the primary threats was air pollution, specifically acid rain. Researchers in the mid-1990’s did not specifically determine nor eliminate impacts from air pollutants to rock gnome lichen. They did detect higher sulfur concentrations in desiccated or slimy squamules versus healthy subpopulations although it was inconclusive what the impacts were (Martin and Noble 1996). Observations have been noted of declining subpopulations, while a later observation during the same season or the following year did not observe any decline (personal observation, G. Kauffman). As noted, there has not been robust long-term data to effectively detect population changes (USFWS 2020, Woodward 2021).

### **Climate Change**

Climate change effects are thought to be more drastic within high elevation forests and unique habitats where many populations of this species occur. Allen and Lendemer (2016) modeled climate change effects to eight endemic Southern Appalachians high elevation lichens and predict declines of greater



than 90% within a century. While these impacts are outside the control of the US Forest Service, it highlights the need to more closely monitor and detect changes.

### **Cumulative Effects**

Cumulative effects include state, tribal, local, or private actions that are reasonably certain to occur in the 18-counties of Western North Carolina. Less than 1/3 of the occurrences for rock gnome lichen within the 18-county area occur outside of federal ownership. Of these, almost all sites are under conservation agreements or within state lands, either parks or the NC Wildlife Resources Commission. Fewer than five occurrences are on private ownership where there is less certainty as to conservation of rock gnome lichen. All the occurrences are subject to the same threats as on federal ownerships, although the majority have limited recreational impacts since access is either not allowed or the occurrences are mostly inaccessible. Two of the occurrences occur within municipality drinking water watersheds. Cumulative effects to rock gnome lichen from activities on nonfederal properties is not extensive.

### **Conclusions**

This analysis indicates that under the action alternatives, rock gnome lichen will persist and habitat conditions would improve, by minimizing recreational impacts on unique rock outcrops. Based on the greater amount of designated Special Interest Areas within occupied rock gnome lichen habitat, all the action alternatives would have a greater chance of persistence compared to Alternative A. In addition, more site-specific plan components for the action alternatives provide a better opportunity for improving habitat compared to the no-action alternative (Alternative A).

### **3.3.3.6 Forested Communities T&E Plants**

#### **Small whorled pogonia (*Isotria medeoloides*)**

##### **Affected Environment**

Small whorled pogonia is a short perennial herb in the orchid family that has solitary flowers (Von Oettingen 1992). Three distinct ranges occur for the species, the northern New England states and southeastern Ontario, the southern Appalachians, and the coastal plain and piedmont of Virginia, Delaware, and New Jersey (NatureServe 2021). Small whorled pogonia has not been located recently among previously documented sites in Ontario, New York, Maryland, and Missouri, and the species is believed to have been extirpated in Vermont and the District of Columbia. In the southern Appalachians, small whorled pogonia is known from Georgia, Tennessee, South Carolina, North Carolina, and southern Virginia (NatureServe 2019). Typically, these populations are small, often with fewer than 20 individuals. *Isotria medeoloides* was listed as federally endangered in 1982 (von Oettingen 1992). In 1994, it was reclassified to a federally threatened status as a result of more recently discovered populations and because 25% of the known populations were protected (USFWS 1994). No critical habitat has been designated for small-whorled pogonia.

In North Carolina, the status of small whorled pogonia is tenuous at best. Sixteen small whorled pogonia populations have previously been documented in 10 counties in Western North Carolina (Figure 69). Two of these populations are believed to be extirpated while eight others have not been relocated for over 15 years and may be extirpated. Only one of the six recently observed small whorled pogonia populations within North Carolina has been documented with more than 10 individuals. Four of these populations are in decline in terms of population size. This orchid was documented on the Pisgah Ranger District in 2016 and known historically across three populations on the Nantahala and Grandfather Ranger Districts. No plants of this species have been seen within these three subpopulations for over 10 years.

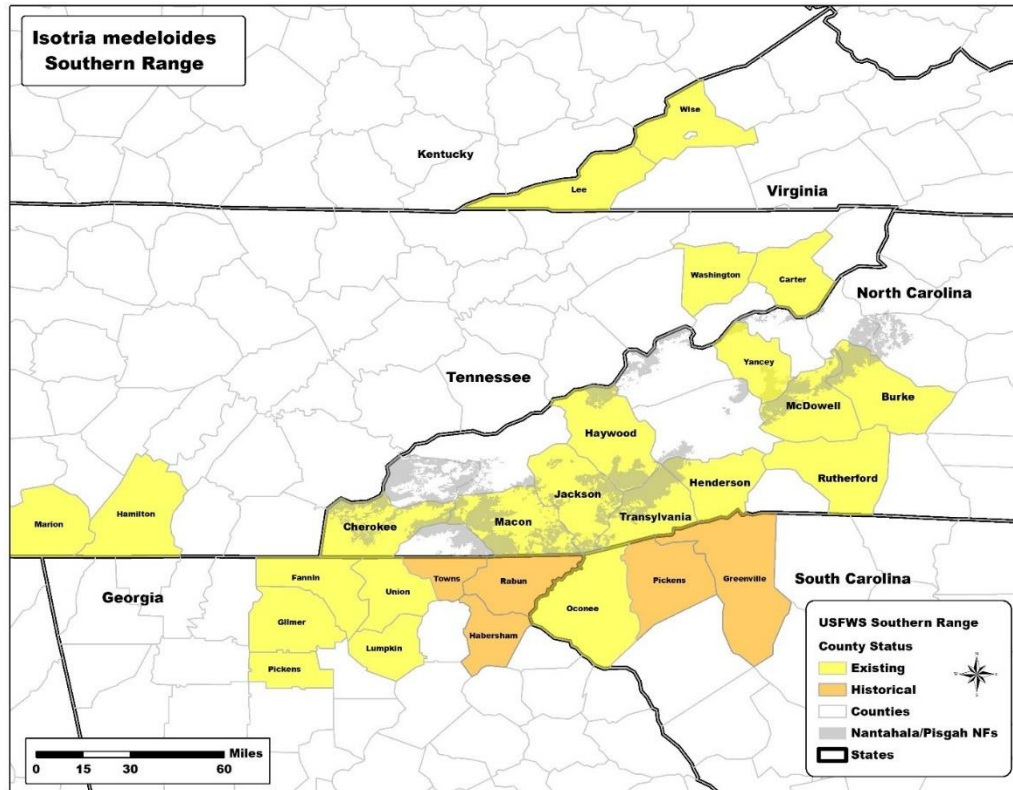


Figure 69. Documented county-wide North Carolina range of small-whorled pogonia (2019).

Recent experimental manipulation of the canopy in order to increase light levels to plants in the northeastern US has resulted in an increase in small whorled pogonia population numbers in other portions of its range (Brumback et al 2011, Dibble et. al. 2019). One-third to one quarter of the surrounding canopy and sub-canopy trees were felled across existing and historic subpopulations to increase light levels at the forest floor thereby improving suitable habitat. Increases in reproductive vigor and recruitment was noted across the thinned area compared to the un-thinned area. However, the researchers indicated more replicates should be completed. Some habitat manipulations, canopy or subcanopy reductions across two of the historical populations have not resulted in relocating individuals at these sites on the Pisgah or Nantahala NFs. Monitoring of the overstory canopy within the existing populations is proposed for potential reduction on the population periphery.

### Environmental Consequences

Plan components addressing habitat conditions discussed above encompass requirements for small whorled pogonia and are described in other parts of this analysis. Appendix C summarizes key characteristics and indicators of the following five terrestrial ecosystems and one species group within the Ecological Sustainability Evaluation (ESE) that include small whorled pogonia:

- More common terrestrial- Dry-Mesic Oak Forest, Mesic Oak Forest, Acidic Cove Forest, Rich Cove Forest, and Floodplain Forest
- Species Groups –Forest Edge and Transition

Environmental consequences were estimated for indicators for the six separate habitats and species groups by alternative, and are displayed in Appendix C. These indicators included habitat structure and age based on the natural range of variation for ecozones, and forest edge.

Table 80 displays the assessment of the proposed planning framework (i.e., mitigation and management constraints, as well as habitat enhancement and restoration) on the habitats and species groups that affect small whorled pogonia, by alternative. Specifically, this table reflects its estimated health and resilience on the Forest. All alternatives include plan components to directly or indirectly maintain, enhance, or restore habitat for federally listed species, including small whorled pogonia, on the Nantahala and Pisgah NFs (Appendix C).

**Table 80. Ecological Sustainability Scores for Ecosystems and Species Groups Relevant to Small Whorled Pogonia (NPESE 2019)**

	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Mesic Oak Forest																			
Dry-mesic Oak Forest																			
Acidic Cove Forest																			
Rich Cove Forest																			
Floodplain Forest																			
Forest Edge/ Transition																			

\*Table legend: E: Existing Condition, Alternatives: A, B, C, D, numbers 1 and 2 after alternatives indicate Tier 1/Tier 2 objectives. Red = poor; yellow = fair; light green = good; dark green = very good.

ESE Tool modeling for the Nantahala and Pisgah Forest Plan Revision shows conditions across the five ecozones where small whorled pogonia occurs, with a large area of the forest as potential habitat. However specific suitable habitats have not been identified. Populations are small and occupied habitat is only located with careful searches. Forest edge may be important for persistence, which is sustainable under all alternatives. Low light and low abundance of mycorrhizal fungi have been identified in dormant populations (McCormack et. al. 2014). The forest plan standard to conduct surveys for rare species (PAD-S-02) would ensure unknown populations would be identified during project planning.

The ESE Tool provides coarse assessment across all habitats and conditions. An additional analysis was completed for the single existing occurrence as well as the other potentially extirpated occurrences.

### Plan Direction

Small whorled pogonia desired conditions are to reduce mid-story and provide more open canopy conditions in mid-succession forests.

As previously mentioned, specific habitat is illusive and uncertain for this tiny orchid although it may prefer small light gaps (USFWS 2021). In the action alternatives, the single geographic area with occupied habitat, Pisgah Ledge, includes a goal to enhance structural diversity within the dry-mesic oak forest surrounding small whorled pogonia.

Primary threats to this species include habitat destruction and lack of seedling recruitment. In terms of habitat management, the response to recurrent prescribe fires is unknown. None of the historical or extant sites have had a recent prescribe burns. All the action alternatives include objectives to increase prescribe burning compared to Alternative A. Alternative E has the greatest amount of proposed burning to create greater amounts of woodlands within fire adapted plant communities. Small whorled pogonia has been located in dry-mesic and mesic oak forests, both of which are fire adapted and proposed for more prescribe burns compared to Alternative A.

### **Management Areas**

All action alternatives include the one population of small whorled pogonia within an SIA. Of the three historical occurrences, one is within an SIA under all alternatives.

The locations with the greatest likelihood of vegetation management activities are those within MA Group 1. All action alternatives include the single occurrence in an SIA, which includes more passive management and an emphasis on maintaining or enhancing unique features of the SIA. For Alternative A, the single extant occurrence within the Pisgah NF is in MA 4C which has a more remote wildlife emphasis. All action alternatives include the historical occurrences in MA Group 1. In comparison, Alternative A includes one in MA 2a, the other in MA 4C. The former has more emphasis on scenery with some timber production.

### **Cumulative Effects**

Cumulative effects include state, tribal, local, or private actions that are reasonably certain to occur in the 18-counties of Western North Carolina. Small whorled pogonia has a broad eastern US range but is restricted in NC. As previously indicated, there are 16 occurrences within 10 western NC counties. Of the nonfederal ownership occurrences, two are in state parks, one is in a municipal watershed, and eight are in private ownership. None of the sites with plants documented during the last 15 years have had management to increase light levels at the forest floor. As such it is uncertain on the long-term viability of these populations based on what has happened to other historical populations across the western NC mountains. Therefore, it is speculated there could be a potential decline in these populations. Given that the Pisgah National Forest occurrence has the greatest number of individuals currently known in NC, it is important the USFS manage this site to maintain or enhance the population.

## Conclusions

This analysis indicates that small whorled pogonia will persist on the Forest if light levels on the forest floor are enhanced at the occupied site. Surveys across the forest for project activities in potentially suitable habitat should be continued, and mitigations implemented to ensure persistence if the species is located.

### 3.3.4 Federally Endangered or Threatened Animal Species

Eleven federally endangered or threatened animal species are known to occur on or immediately adjacent to the Nantahala and Pisgah NFs. These include five small mammals (one squirrel and four bats), three terrestrial invertebrates, two freshwater mussels, and one freshwater fish (Table 81).

Three endangered species that historically occurred on or adjacent to the Forests, American burying beetle (*Nicrophorus americanus*), eastern cougar (*Puma concolor cougar*), and Tennessee (Cumberland) Bean (*Villosa trabalis*) are considered extirpated from North Carolina by the United States Fish and Wildlife Service (USFWS) and North Carolina Wildlife Resources Commission (NCWRC). Therefore, they will not be addressed further in this plan. If new, relevant information on these species becomes available, they will be incorporated through a forest plan amendment. Potential effects of the proposed plan revision on federally listed animals are described below.

Information in this section is taken largely from NatureServe (2019), North Carolina Natural Heritage Program (NCNHP) records (2019), the North Carolina Wildlife Action Plan (NCWAP) (NCWRC 2015), and all references within these sources. This section is meant to provide a general overview of the species' range, distribution, and habitat requirements. It is not intended to provide detailed species' accounts.

**Table 81. Federally listed animal species known to occur or that historically occurred on or immediately adjacent to the Nantahala and Pisgah NFs**

Common Name	Scientific Name	Federal Status
<b>Small Mammals</b>		
Carolina northern flying squirrel	<i>Glaucomys sabrinus coloratus</i>	Endangered
Virginia big-eared bat	<i>Corynorhinus townsendii virginianus</i>	Endangered
gray myotis (gray bat)	<i>Myotis grisescens</i>	Endangered
northern long-eared bat	<i>Myotis septentrionalis</i>	Threatened (4d)
Indiana bat	<i>Myotis sodalis</i>	Endangered
<b>Terrestrial Invertebrates</b>		
rusty-patched bumblebee	<i>Bombus affinis</i>	Endangered
spruce-fir moss spider	<i>Microhexura montivaga</i>	Endangered
noonday globe	<i>Patera clarki nantahala</i>	Threatened
<b>Freshwater Mussels</b>		
Appalachian elktoe	<i>Alasmodonta raveneliana</i>	Endangered
little-wing pearlymussel	<i>Pegias fabula</i>	Endangered
<b>Freshwater Fish</b>		
spotfin chub	<i>Erimonax monachus</i>	Threatened

Additionally, the USFWS is conducting review, analysis, and evaluation to list animal species known to occur on or immediately adjacent to the Forests (Table 82). It is possible that actions to list these species could take place within the life of this forest plan; therefore, these species are included in the Biological Assessment. Currently, these species are included as Species of Conservation Concern (SCC) and evaluated with their associated species groups in the aquatic and terrestrial ecosystem sections above.

**Table 82. Animal Species Currently Being Evaluated for Federal Listing by the USFWS that are Known to Occur or Historically Occurred on or Immediately Adjacent to the Nantahala and Pisgah NFs**

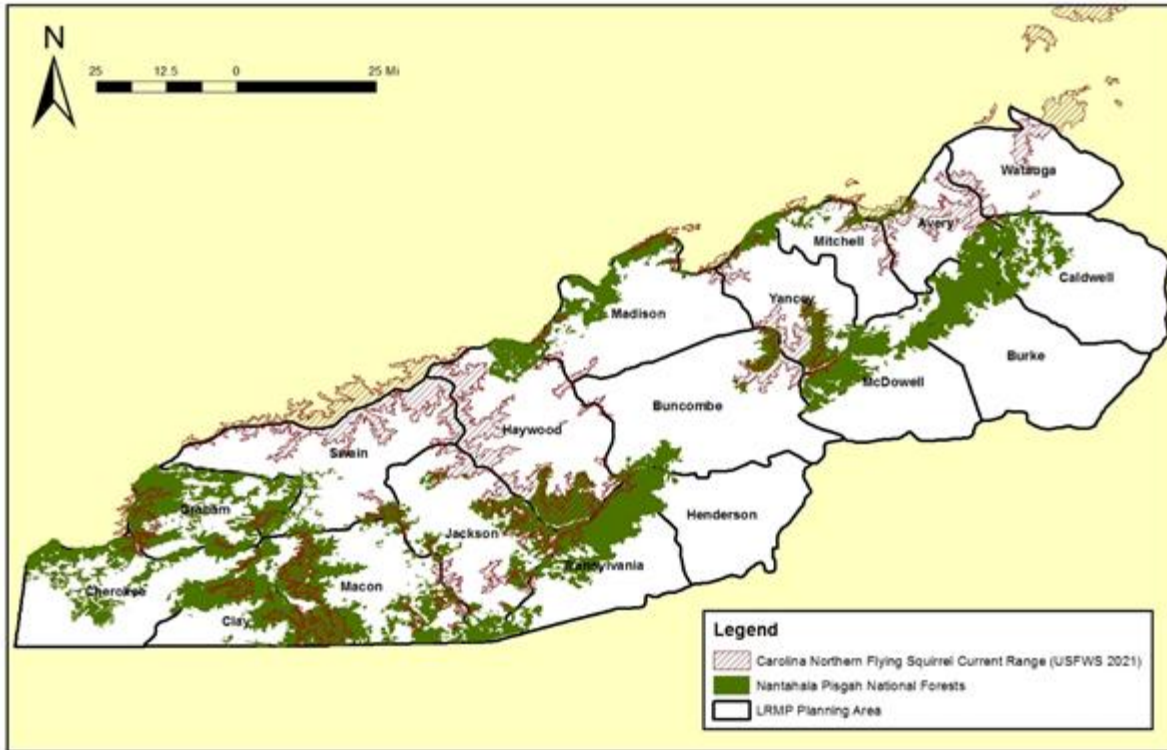
Common Name	Scientific Name	Species Group
tricolored bat	<i>Perimyotis subflavus</i>	Mammal
little brown bat	<i>Myotis lucifugus</i>	Mammal
longsolid	<i>Fusconaia subrotunda</i>	Freshwater Mussel

### 3.3.4.1 Carolina Northern Flying Squirrel (*Glaucomys sabrinus coloratus*)

#### Affected Environment

The northern flying squirrel, *Glaucomys sabrinus*, is a small, nocturnal, non-hibernating mammal that occurs in forested regions of North America. The range of the species is continuous across Canada, and includes disjunct populations in the southern Appalachian Mountains, southern Rocky Mountains, and Sierra Nevada Mountains. Two subspecies, *G. s. fuscus* and *G. s. coloratus* occur only at high elevations (i.e. above 4,000') in the Appalachian Mountains of North Carolina, Tennessee, Virginia and West Virginia. The Carolina northern flying squirrel, *Glaucomys sabrinus coloratus* (CNFS), is the subspecies relevant to this forest plan revision.

The species was listed as endangered in July 1985 (Federal Register 50: 26999-27002). There is no critical habitat designated for this species. In North Carolina, the Carolina northern flying squirrel is known from a handful of locations within the highest elevation spruce-fir and northern hardwood habitats, including parts of the Nantahala and Pisgah NFs (Figure 70). Increased knowledge about the species and its habitat requirements, combined with extensive inventory and monitoring efforts by the North Carolina Wildlife Resources Commission (NCWRC) and USFWS have expanded the known range of the species on the Forests. It is not known whether this represents true range expansion (recolonization) or is associated with the amount of effort spent studying the species. In April 2021, the North Carolina Natural Heritage Program (NCNHP) identified 597 element occurrences of the CNFS in North Carolina. Four hundred and three (68%) of these are from the Forests. These occurrences do not represent the number of populations, but rather the number of times the species has been detected.



**Figure 70. Estimated current range of the Carolina northern flying squirrel in western North Carolina, as summarized from USFWS (2021)**

In the southern Appalachian Mountains, Carolina northern flying squirrel habitat is represented by islands of high elevation spruce-fir and northern hardwood forests separated by lower elevation hardwood forest. Individuals in such relict populations are imperiled by isolated gene pools and limited dispersal ability, analogous to populations of mammals on islands in marine environments.

Carolina northern flying squirrels prefer high elevation coniferous and mixed forest but will utilize northern hardwood forests. Optimal habitat conditions include cool, moist, mature forest with abundant standing and downed snags. They occupy tree cavities, leaf and twig nests, and underground burrows but seem to prefer cavities in mature trees as den sites and will also use artificial nest boxes. Carolina northern flying squirrels' diet consists of both plant and animal material, including insects, nuts, lichens, fungi, buds, seeds, and fruit when available. They can also subsist on lichens and fungi for extended periods. The species spends considerable time foraging on the ground.

The limited and discontinuous range of Carolina northern flying squirrels in the southern Appalachians makes it vulnerable to several natural and human-related impacts. Human impacts far outweigh natural threats and include habitat loss and fragmentation, introduced exotic pests, recreational and residential development, and pollution (heavy metals and acid rain) (USFWS 2019).

The NCWRC, USFWS, and other partners (including the National Forests in North Carolina) have been monitoring Carolina northern flying squirrel populations in western North Carolina for decades. Although much has been learned about this species over the years, recent monitoring indicates that much more inventory effort is needed to fully document the species' range. Although extensive amounts of valuable data have been collected, it remains difficult to determine population status and trends largely because of the cryptic nature of this mammal.

Because most suitable habitat for Carolina northern flying squirrels within North Carolina is on the Nantahala and Pisgah NFs, maintaining persistence of the species within today's known (estimated)

occupied range where it overlaps the Forests is critical to species' persistence into the future. USFWS (2013) recognizes that the Forest Service attempts to balance forest management and recreation activities with habitat needs of the squirrel. Relevance of the proposed planning framework to these topics is addressed below. USFWS (2013) also introduces the need to restore or introduce spruce to certain areas where it was thought to have been historically, where pests continue to decimate the conifer component of the habitat, or where climate change and acidic deposition have affected forest health. Spruce restoration will help with population maintenance, and possibly expansion, in some areas. Relevance of the proposed planning framework to this topic is also addressed below. Implementation of sound forest management and the restoration of spruce forests in key areas will contribute to conditions that allow for expansion and connection of habitat for Carolina northern flying squirrels.

## Environmental Consequences

Plan components addressing larger ecosystem conditions discussed above (e.g., spruce-fir and northern hardwood forests, snags and den trees) encompass habitat requirements for Carolina northern flying squirrel and are described above and in the ecozone subsections. EIS Appendix C summarizes key characteristics and indicators of ecosystems, and species groups within the Ecological Sustainability Evaluation that include Carolina northern flying squirrel. These indicators include things such as canopy composition and density, young forest, mature forest, old growth forest, and open woodland condition, presence of snags and den trees, road density, and effects of balsam woolly adelgid.

Environmental consequences were estimated for each of these indicators, for each alternative, and are presented in EIS Appendix C. Within this larger analysis process, Carolina northern flying squirrel is associated with the following coarse filter elements (ecozones, unique habitats, and species groups) within the Ecological Sustainability Evaluation:

- Spruce-fir Forest (Ecozone),
- Northern Hardwood Forest (Ecozone),
- High Elevation Red Oak Forest (Ecozone),
- Beech Gaps/Boulderfield Forest (Unique Habitat), and
- Snag and Den Tree Associates (Species Group).

While snags and den trees are presented as a forestwide element in the EIS, this analysis focuses on this element as it relates to spruce-fir and northern hardwood forests. Similarly, beech gap/boulderfield Forest represents a unique habitat that is scattered across the Forests—this analysis addresses them as relevant to the Carolina northern flying squirrel, and not forest-wide. High elevation red oak forests are included in this analysis to encompass potential modeling or mapping errors.

EIS Appendix C summarizes plan components directly or indirectly related to the protection, enhancement, or restoration of habitat for terrestrial animal species, including federally listed species such as Carolina northern flying squirrel, via association with one or more of the coarse filter elements above. These plan components range from very broad direction applicable to the whole forest or ecozone to restore or enhance conditions on the landscape, to specific direction for habitat elements associated with Carolina northern flying squirrel. These efforts contribute to maintaining persistence and facilitating recovery of the species.

Appendix C, Table 2 identifies three hundred sixty-eight plan components directly or indirectly support healthy and resilient habitat conditions associated across the Forests in places and ecozones associated with the Carolina northern flying squirrel. In addition, thirteen of these components specifically address and prioritize habitat conditions for the species (Table 83). These plan components serve specifically as conservation measures for Carolina northern flying squirrel on the Forests. Restoring and maintaining healthy and resilient forests across the landscape is a primary goal of the revised forest plan.



**Table 83. Plan Components Specifically Addressing Habitat Conditions for and/or Persistence of Carolina Northern Flying Squirrel on the Nantahala and Pisgah NFs.**

Component	Language					
WLF-DC-06	<p>Habitat components at finer scales provide for wildlife occupancy, are present in sufficient amounts, and distributed across all ecozones. For example, snags provide roosting and nesting habitat for bats and cavity nesting birds, especially along the edge of openings, and foraging habitat for insectivores such as woodpeckers. Larger-diameter live or dead trees provide habitat for black bear and other species requiring cavity or denning conditions, while smaller live or dead trees with crevices provide critical nesting and roosting habitat for flying squirrels and bats. Coarse wood on the forest floor, in a variety of sizes and shapes, provides habitat for salamanders and other cover and moisture-associated wildlife, nesting areas for some migratory birds (e.g., black and white warbler), as well as drumming logs for ruffed grouse.</p> <p>These habitat components that are retained during young forest restoration perpetuate to later successional stage, either through natural succession or through forest stand improvement practices. Over time, they contribute to the development of old growth characteristics such as large, downed woody debris; abundant snags; variable gap sizes; and tip up mounds.</p> <p>Plan Figure 4 provides desired amounts of finer scale habitat components retained during young forest restoration.</p>					
	<p><b>Fine-Scale Habitat Desired Conditions for Young Forests</b></p>					
	<table><tr><th>Snags</th><th>Den Trees</th><th>Coarse Woody Debris</th></tr><tr><td>An average of at least 4 snags/ac greater than 9” DBH is present within young forest habitats across the forest, including naturally-occurring and those created incidentally or intentionally during restoration activities. In areas known to be or potentially occupied by federally listed bats, snag recruitment and retention should also include snags ≥ 3” DBH.</td><td>Trees greater than 9” DBH exhibiting crevices and other suitable denning characteristics are present across the landscape.</td><td>Density will vary by surrounding forest type and age, but some pieces of downed wood that are at least 10” in diameter and at least 10’ long are present on the forest floor across the landscape.</td></tr></table>	Snags	Den Trees	Coarse Woody Debris	An average of at least 4 snags/ac greater than 9” DBH is present within young forest habitats across the forest, including naturally-occurring and those created incidentally or intentionally during restoration activities. In areas known to be or potentially occupied by federally listed bats, snag recruitment and retention should also include snags ≥ 3” DBH.	Trees greater than 9” DBH exhibiting crevices and other suitable denning characteristics are present across the landscape.
Snags	Den Trees	Coarse Woody Debris				
An average of at least 4 snags/ac greater than 9” DBH is present within young forest habitats across the forest, including naturally-occurring and those created incidentally or intentionally during restoration activities. In areas known to be or potentially occupied by federally listed bats, snag recruitment and retention should also include snags ≥ 3” DBH.	Trees greater than 9” DBH exhibiting crevices and other suitable denning characteristics are present across the landscape.	Density will vary by surrounding forest type and age, but some pieces of downed wood that are at least 10” in diameter and at least 10’ long are present on the forest floor across the landscape.				
WLF-S-01	<p>When identifying wildlife habitat diversity elements for retention during vegetation management activities:</p> <ul style="list-style-type: none"><li>i. Maintain an average of four snags (≥ 9” DBH) per acre across the project area to contribute to landscape scale wildlife habitat diversity for species such as bats, woodpeckers, and other cavity nesting birds, except where such snags pose a threat to human health or safety. Retain snags exhibiting</li></ul>					

Component	Language
	<p>suitable wildlife habitat characteristics (e.g., exfoliating or sloughing bark, cavities, or crevices) along the edge of openings or combined with other leave trees to extend the life of ephemeral wildlife habitat elements in the project area and reduce threats to human health and safety during vegetation management activities. To minimize the risk of incidental take, in areas known to be or potentially occupied by federally listed bats, snag recruitment and retention should also include snags or live trees with more than 25% exfoliating bark <math>\geq 3</math>" DBH.</p> <p>ii. Emphasize hard and soft mast producing species, including mast-bearing trees, berries, and fruit trees, to enhance foraging opportunities for species such as white-tailed deer, wild turkey, ruffed grouse, black bear, songbirds, and small mammals.</p> <p>iii. Emphasize the following:</p> <ul style="list-style-type: none"> <li>• Native trees with exfoliating bark and natural crevices, including, but not limited to, shagbark hickory, white oaks, yellow pines, yellow birch, and black locust, to provide roosting and denning habitat for bats and Carolina northern flying squirrels. Consider current research, such as United States Fish and Wildlife Service (USFWS), NCWRC, North Carolina Bat Working Group (NCBWG), the USFS bat conservation strategy, or other relevant guidance to determine appropriate roost and den tree species and condition for retention during project implementation.</li> <li>• Whenever possible, snags susceptible to windthrow should be identified in clumps and/or buffered by live trees.</li> <li>• Standing live and dead trees <math>&gt; 9</math>" DBH that exhibit cavities and other denning conditions, except where human safety is of concern.</li> <li>• Live eastern hemlock where possible to preserve the gene pool and food source for birds and small mammals.</li> </ul> <p>iv. Emphasize retention of downed woody debris of various sizes should be emphasized for retention, where available, and include pieces that are at least 10" DBH and 10' long to provide habitat for salamanders and other cover- and moisture-associated wildlife and drumming logs for ruffed grouse. Consider leaving new logging slash.</p>
ECO-O-07	Restore 50 acres of spruce fir ecozones annually to improve ecozone composition.
OGN-DC-02	Old growth characteristics shift over time, and disturbances are a natural part of the system. High quality old growth characteristics, such as large, downed woody debris, abundant snags, variable gap sizes, tip-up mounds, and undisturbed soils, etc., develop over time and are present.

Component	Language
OGN-O-01	<p>Enhance or accelerate the development of old growth conditions over time, by actively managing 250 acres for each ten-year interval through activities.</p> <p><i>Management approaches:</i></p> <p>Methods for enhancing old growth condition could include increasing downed woody debris within all size classes by felling variable size trees, creating woodlands in appropriate ecozones by thinning and prescribe burning, enhancing the composition of native species, creating snags by girdling trees, and harvesting products as a side benefit of removing uncharacteristic vegetation.</p>
OGN-S-01	<p>In patches identified as part of the designated old growth network, allow vegetation manipulation, including thinning, woodland creation and prescribed burns and limited soil disturbance, for the following purposes and with project specific analysis:</p> <ul style="list-style-type: none"> <li>a. To enhance old growth values and characteristics, including: <ul style="list-style-type: none"> <li>i. Downed logs in all stages of decay;</li> <li>ii. Old trees;</li> <li>iii. Standing snags;</li> <li>iv. Uneven-aged structure of canopy species;</li> <li>v. Single and multiple tree-fall gaps;</li> <li>vi. Abundant fungal component;</li> <li>vii. Large trees;</li> <li>viii. Appropriate density and basal area of canopy trees;</li> <li>ix. Approximate composition of native forest species including trees, shrubs, and herbs.</li> </ul> </li> <li>b. To improve forest health or prevent the spread of disease when the integrity (including characteristics) of the old growth patch or adjacent lands are threatened from conditions within the patch.</li> </ul>
SB-DC-14	Habitat for the Carolina northern flying squirrel and associated red spruce communities is sustained or enhanced.
BAM-GLS-05	Emphasize restoration of spruce-fir habitat for the Carolina northern flying squirrel and spruce-fir moss spider and maintain the health and resiliency of this forest type in the face of climate change.
BLM-GLS-01	Emphasize restoration of spruce-fir habitat for the Carolina northern flying squirrel and spruce-fir moss spider and maintain the health and resiliency of this critical forest type in the face of climate change.
GB-GLS-01	Conserve and restore high elevation red oak forests, northern hardwood forests, spruce-fir forests, and mesic oak forests. Emphasize restoration of spruce-fir habitat for the Carolina northern flying squirrel and spruce-fir moss spider and maintain health and resiliency of this forest type in the face of climate change.
NS-GLS-03	Emphasize restoration of spruce-fir and northern hardwood forests for the northern flying squirrel, spruce-fir moss spider, and rock gnome lichen, and maintain health and resiliency of these critical forest types in the face of climate change.
UM-GLS-04	Maintaining and increasing the Carolina northern flying squirrel population through active restoration and habitat enhancement and planting red spruce in northern hardwood forests within the headwaters of Santeetlah creek and along the Cherohala skyway.
PL-GLS-05	Expand spruce restoration in the Flat Laurel Creek and Graveyard Fields Areas.

Upon completion of this assessment, it was determined that three additional conservation measures to protect and conserve CNFS on the Forests are included. These have been incorporated into the revised forest plan as management approaches, which makes them plan components.

- When removing trees within CNFS habitat (spruce-fir and northern hardwood ecozones), and where human health and safety will not be affected, consider the use of girdling or herbicides to recruit future potential den trees, especially trees  $\geq 8$ " dbh.
- Avoid tree felling during CNFS breeding season (approximately March to August).
- Avoid felling hemlock, spruce, and fir in CNFS habitat. Also avoid felling yellow birch in CNFS habitat where yellow birch is limited.

Table 84 displays the cumulative assessment of the proposed planning framework (i.e., mitigation and management constraints, as well as terrestrial habitat enhancement and restoration) on Carolina northern flying squirrel. Specifically, this table reflects species' estimated health and resilience on Forest Service land under each alternative.

**Table 84. Ecological Sustainability Scores for Indicators representing Forest Service Ownership Within Coarse Filter Elements Supporting Carolina Northern Flying Squirrel on the Nantahala and Pisgah NFs (NPESE 2021)**

Element Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Spruce-fir Forest																			
Northern Hardwood Forest																			
Beech Gap/ Boulderfield Forest																			
High Elevation Red Oak Forest																			
Snag and Den Tree Associates																			

*Red = poor, yellow = fair, light green = good, and dark green = very good.*

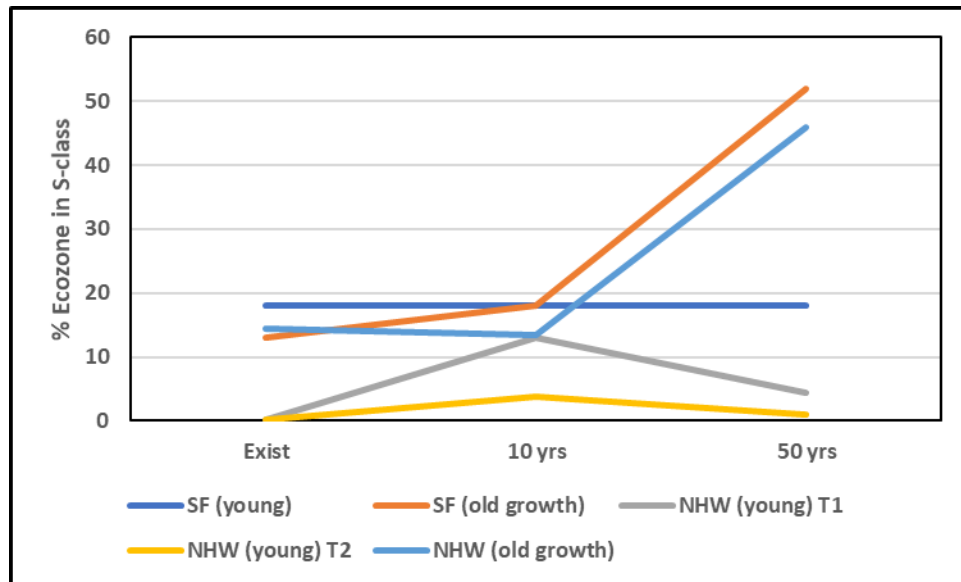
Ecological Sustainability Evaluation modeling for the Nantahala and Pisgah Forest Plan Revision shows that conditions for Carolina northern flying squirrel will be maintained or improve (slightly) over existing conditions under all alternatives. This species is most closely associated with spruce-fir forests, which is estimated to improve in the long term under all alternatives, and northern hardwood forests, which show even more improvement in overall health and resilience over time. Predicted trends in overall

condition of beech gaps and boulderfield forests decreases over time, from very good to good, largely due to the increased threat from non-native invasive plants on community health and resilience and the growing threat from beech bark disease. This generally improving trend in habitats associated with Carolina northern flying squirrel is an indication of the overall intent of the proposed planning framework to improve forest health and resiliency, therefore improving wildlife habitat across the Forests.

Carolina northern flying squirrel is strongly associated with spruce-fir and northern hardwood forests in general, requiring structural diversity within these ecozones. The species has also been associated with high elevation red oak forests, although peripherally where these conditions are adjacent to northern hardwood or spruce-fir forests. There are no known occurrences of Carolina northern flying squirrel within modeled high elevation red oak forests on the Forests. Figure 71 summarizes modeled young and old growth forest conditions for these ecozones under Alternative E, as a surrogate for overall structural diversity. Structural diversity within both spruce-fir and northern hardwood ecozones is expected to increase over time under all alternatives. This is largely due to natural forest aging and the development of old growth forest characteristics.

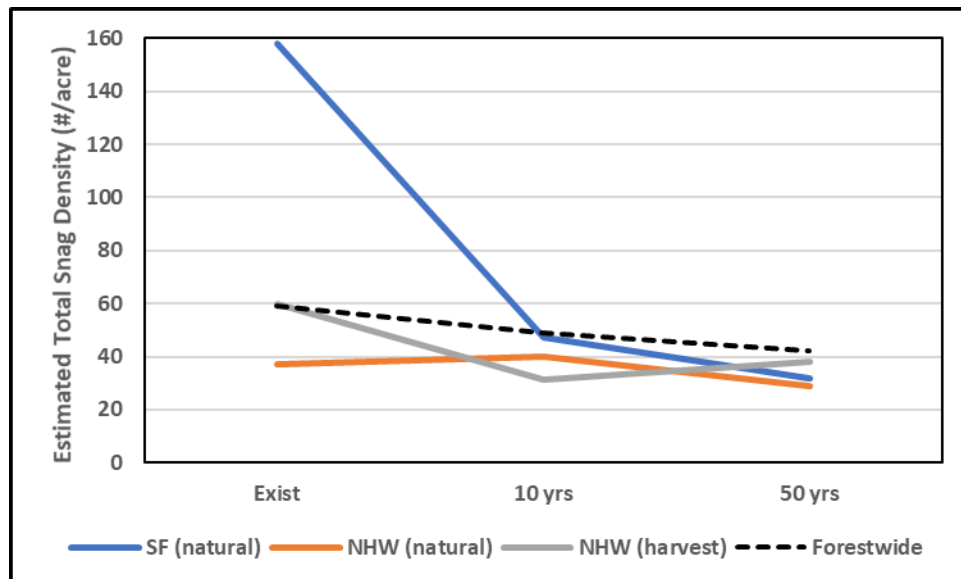
The amount of young forest, also an important part of structurally diverse forests, is expected to largely reflect natural disturbance amounts and patterns rather than active vegetation management (including prescribed fire) within areas occupied by Carolina northern flying squirrel under all alternatives. This is supported by the fact that approximately 11.03% of the spruce-fir ecozone and approximately 22.78% of the northern hardwood ecozone is within Management Area Group 1 (Matrix and Interface, MA Group 1). MA Group 1 is where an estimated 90% of active forest management will occur (across the landscape, not specifically within the spruce-fir or northern hardwood ecozones).

Some vegetation management may occur within northern hardwood forests; therefore, plan components strategizing and constraining these processes contained in Table 83 are critical to maintaining or enhancing habitat for Carolina northern flying squirrel. Additionally, of the area estimated to be occupied by Carolina northern flying squirrel on the Forests, approximately 23.86% is within Management Area Group 1. Of this area, approximately 4% is modeled in the northern hardwood forest ecozone. This situation minimizes the chance that potential adverse effects of vegetation management on Carolina northern flying squirrel would occur. Spruce-fir and northern hardwood forests are generally too moist to burn during prescribed fire and as such, are rarely part of prescribed burn blocks. While the amount of northern hardwood forest within the estimated range of CNFS within MA Group 1 is small, it is included in this summary because it is present.



**Figure 71. Trends in young and old growth forest (as a surrogate for overall structural diversity) within the spruce-fir and northern hardwood ecozones on the Forests**

Within spruce-fir and northern hardwood forests, Carolina northern flying squirrels are highly associated with the presence of suitable denning trees. Figure 72 displays estimated total snag density within spruce-fir and northern hardwood ecozones (and forestwide) over time.



**Figure 72. Trends in total snag density forestwide and within the spruce-fir and northern hardwood ecozones on the Forests**

The noticeable decline in total snag density within the spruce-fir ecozone can largely be attributed to long-term effects of the balsam woolly adelgid, as existing snags from that large-scale disturbance continue to decay. It is more reasonable to expect snag recruitment and retention rates in this ecozone to reflect natural forest aging (i.e., a gradual, slow decline as forests age and become more resilient to broad-scale disturbance, which is demonstrated by the forest-wide trend in Figure 72. Snag density is a fluid forest characteristic, increasing or decreasing in response to disturbance (both natural and anthropogenic, and at multiple scales). The important factor for Carolina northern flying squirrels is that

snags and other appropriate denning trees remain on the landscape at a density to support existing and potentially increasing populations. From this data, it is reasonable to assume that snags and appropriate denning trees will be retained at densities consistent with species persistence and recovery. Additionally, the plan includes a desired condition (WLF-DC-06) and standard (WLF-S-01) as well as several geographic area goals specifically to maintain suitable denning habitat for flying squirrels.

Conditions for Carolina northern flying squirrel are expected to be maintained or improve on the Forests (i.e. the Forests will continue to age and increase in the amount of old growth conditions while maintaining some young forest conditions, contributing to improved structural diversity in suitable habitats).

The revised plan emphasizes restoration of spruce-fir forests (ECO-O-05), which will benefit the Carolina northern flying squirrel. These activities will involve site-specific silvicultural activities to improve the health and resilience of spruce-fir forests. During these activities, all strategies and constraints to avoid short-term effects to Carolina northern flying squirrel and associated habitat will be implemented.

### **Effects of recreational use on Carolina northern flying squirrel**

Most recreation on the national forests takes place along system roads and trails and in developed recreation areas. These areas represent the highest potential for direct or indirect effects of recreational use on rare animals. While some species are more susceptible to direct effects of recreation, such as being trampled by a vehicle (including bicycles) or trampled by foot traffic (including horse traffic), others are susceptible to indirect effects of recreation, such as disturbance of nesting habitats by noise associated with human presence. Carolina northern flying squirrel is generally more mobile and can escape short-term disturbance; however nesting success can be compromised with long-term exposure to human disturbance.

Carolina northern flying squirrel is particularly susceptible to habitat disturbance from high recreational use, including trail and associated off-trail use (i.e., the dense network of undesignated, or “social”, trails), within its range. This disturbance is especially disruptive when it occurs within the reproductive season for the species, generally in spring and summer months. Areas of high susceptibility of Carolina northern flying squirrel include Mount Mitchell and the adjacent Black Mountains, Roan Mountain, the area between Graveyard Fields and Waterrock Knob along the Blue Ridge Parkway, and the Cherohala Skyway.

For this analysis, existing open roads and trails were buffered by 100 meters to include off-road/trail exploration and developed recreation areas were also included. Known occurrence of rare animals was intersected with the buffered roads and trails polygon to estimate the proportion of known occurrences potentially subjected to recreational impacts. Persistence of rare animal species with greater than 50% of known occurrences within 100 meters of a road or trail is particularly susceptible to potential effects of recreational use. Carolina northern flying squirrel is one of these species. Approximately 74% of known occurrences of Carolina northern flying squirrel are within 100 meters of a trail or other high-use recreation site. This is likely due to the fact that next boxes used for monitoring were placed along trails.

Another threat of increased recreational use across the Forests is the dense network of undesignated (or “social”) trails. While cross-country foot travel is not discouraged, there are areas where increased use has resulted in a network of non-system trails that pose just as much risk, if not more, to rare plants, animals, and habitats. The revised forest plan identifies managing for sustainable recreation in detail as one of the Key Plan Concepts (Final Plan, pg. 23). Several plan components in the Dispersed Recreation section of the revised forest plan address issues related to managing a sustainable trail system.

When specific threats from dispersed recreation become an issue for Carolina northern flying squirrel, potential effects can be mitigated through enforceable forest supervisor closure orders, and other local administrative efforts such as signage and barriers in sensitive areas (REC-S-09). The revised Forest Plan

is clear in its intent to minimize and mitigate potential effects of recreation on ecological integrity, including federally listed species such as the Carolina northern flying squirrel.

#### **Effects of acidic deposition and climate change on Carolina northern flying squirrel**

In addition to the analysis of potential effects discussed above, acidic deposition and climate change also have potential effects on Carolina northern flying squirrel. These environmental stresses are outside the control of the Forest Service; however, it is recognized that they are primary stressors for many species, including Carolina northern flying squirrel. High elevation environments will feel the effects of climate change and acidic deposition before lower elevations and likely to a higher degree. This summary addresses climate change from an increased air/water temperature and acidic deposition over time, specifically for species associated with higher elevations. It does not address things like storm/weather event/flooding frequency.

Carolina northern flying squirrel is susceptible to direct and indirect effects of climate change and acidic deposition, because most known occurrences are within high elevation habitats, and the species has a small occupied range at higher elevations. Impacts from acidic deposition and climate change do not differ between the action alternatives. Compared to Alternative A, the action alternatives have a greater emphasis on resilient habitats at high elevations.

The Forest Plan includes direction to restore high elevation forests which would in turn improve resiliency against climate change.

#### **Cumulative Effects**

When these actions are put into perspective across the landscape (specifically, across the estimated range of Carolina northern flying squirrel within Western North Carolina), it becomes apparent that species' persistence at this larger scale is directly related to habitat quality and quantity on the Forests. Potential effects of recreation (i.e., noise disturbance) will continue but will be mitigated through plan components associated with maintaining sustainable recreation. Threats such as those from acidic deposition and climate change will continue to affect Carolina northern flying squirrel and are beyond the inherent capability of the Nantahala and Pisgah NFs to address. Most of the range of this species in western North Carolina is in state or federal ownership. It is assumed that responsible land and resource management will continue on these ownerships.

#### **Conclusion**

This analysis shows that based on potential activities on Forest Service lands discussed above, Carolina northern flying squirrel will continue to persist across the species' estimated range on the Forests. The Forests support approximately 68% of the species occurrence in western NC, making the Forests vital to overall species persistence and recovery.

### **3.3.4.2 Forest-dwelling Bats**

#### **Affected Environment**

This analysis addresses four federally listed bat species: Virginia big-eared bat, gray bat, Indiana bat, northern long-eared bat; and two bat species that are proposed for listing: little brown bat and tricolored bat. These species are associated with a variety of forested habitats, as well as caves and abandoned mines for all or part of their life history. Virginia big-eared bat and gray bat are strongly cave-associated and utilize forested areas mainly for foraging. The remaining four bat species hibernate in caves and abandoned mines during the winter and roost in forested areas during the remainder of the year, including summer maternity season.



Four of the bat species addressed in this analysis are highly susceptible to the devastating effects of white-nose syndrome (WNS) – Indiana bat, northern long-eared bat, little brown bat, and tricolored bat. WNS is the largest and greatest threat to persistence of rare bats on the Forests. It has been documented across the forests and has resulted in cave-associated bat population declines of up to 93%. This assessment does not discuss WNS, except as it relates to the current general rarity of bats on the Forests. It is assumed that WNS will persist on the landscape over the life of the revised forest plan and continue to affect forest-dwelling bats. This assessment focuses on providing quality habitat for these bats across the Forests.

As a species group, bats require a mosaic of habitat conditions across a forested landscape to persist. These habitat conditions are widely described in the literature and are therefore not included here. Forest-dwelling bats have four general requirements to persist on the landscape: insects to eat (foraging habitat) and water to drink (proximity to water), places to rest and raise young (roosting habitat), and places to hibernate (hibernacula). It is also important that connectivity between these habitat characteristics be maintained. This discussion addresses these requirements for the suite of bats included in this assessment followed by species-specific discussions.

## Environmental Consequences

### Foraging Habitat and Access to Water

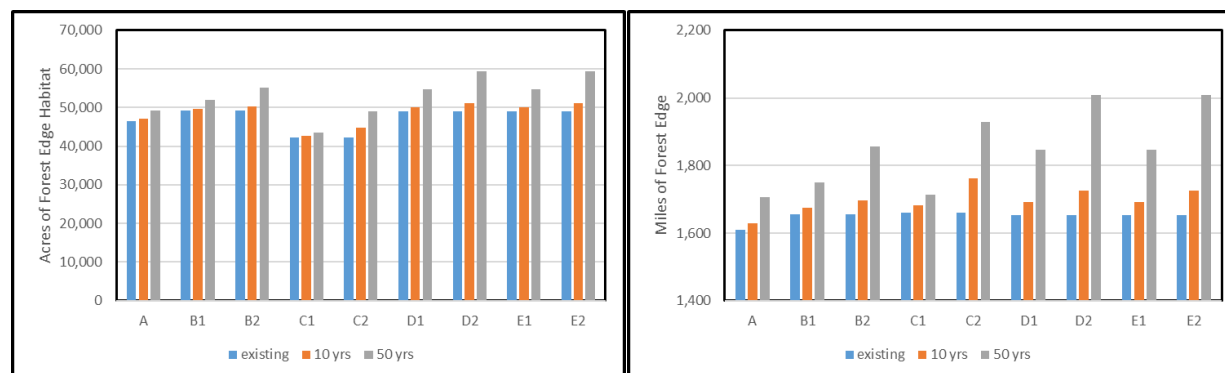
The Nantahala and Pisgah NFs offer abundant foraging and drinking habitat for insectivorous bats. This ranges from forest edges and openings, where insect production is highest, to thousands of miles of streams and rivers and reservoir shorelines. There is so much water on the Forests, that access to water is not a limiting factor for forest-dwelling bats. Table 85 and Figure 73. Estimated edge habitat over time, as summarized from the NP Ecological Sustainability Evaluation for the Edge and Transitional Habitat Associates species group.

Note that while amounts may vary slightly between alternatives, trends are the same summarize estimated edge habitat availability over time by alternative

**Table 85. Estimated Edge Habitat Over Time Under All Alternatives, as Summarized from the NP Ecological Sustainability Evaluation.**

Element Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Acres of forest edge and transitional habitat																			
Miles of forest edge																			
Forest Edge and Transitional Associates –																			

Element Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Composite Score																			



**Figure 73. Estimated edge habitat over time, as summarized from the NP Ecological Sustainability Evaluation for the Edge and Transitional Habitat Associates species group.**

*Note that while amounts may vary slightly between alternatives, trends are the same.*

**Table 86. Forest-Dwelling Bat Association with Openings in the Forest Canopy. Highlighted cells indicate associations with opening size.**

	0-0.25 acre	0.25-0.5 acre	0.5-2 acres	2-5 acres	5-10 acres	10-20 acres	>20 acres
Virginia Big-eared Bat							
Northern Long-eared Bat							
Gray Bat							
Indiana Bat							
Little Brown Bat							
Tricolored Bat							

Virginia big-eared bat and northern long-eared bat are clutter-adapted foragers, utilizing more open mature forested habitats, and occasionally small openings, riparian areas, and forest edges. While especially important these two species, proximity to mature and/or open forests is important to all forest-dwelling bat species. These habitats are utilized for foraging and roosting. Trends in old forest habitat are summarized in Table 87. Trends in open forest condition are summarized in Table 88.

Openings and edges are more important to gray bat and Indiana bat compared to Virginia big-eared bat and long-eared bat; however, both species tend to avoid larger openings (greater than 10 and 20 acres, respectively). Little brown bat and tricolored bat are even more generalist in foraging habitat preferences, utilizing all openings and edges, except the very smallest, which are often associated with tree fall canopy gaps. Gray bat foraging is highest near water, especially larger streams and rivers.

The revised forest plan includes standards that limit opening size and configuration, and while not specifically for bats, these constraints mitigate the potential for openings that would be avoided by

federally listed bats. TIM-S-14 limits the size of harvest areas to not greater than 40 acres in hardwood-dominated forest types and 80 acres in pine-dominated forest types. In recent years, harvest unit size has averaged 20-25 acres across the Forests. The Forest Plan includes a guideline to create irregular edges (i.e. not straight) when planning harvest areas to maximize wildlife habitat benefits (WLF-G-04). Past management activities have resulted in units much smaller than this, averaging 12-20 acres. These constraints, combined with the gap/patch analysis completed for this EIS, ensure that quality edge habitat continues to persist on the Forests under all alternatives, and that forest-dwelling bats will continue to have access to a variety of foraging opportunities.

As mentioned above, Virginia big-eared and northern long-eared bats prefer foraging in mature forests and woodlands. And while other forest-dwelling bats also forage in these conditions, mature forests are especially important for roosting. Additionally, proximity to open areas and edges for foraging is critical to the persistence of species such as gray, Indiana, little brown, and tricolored bats on the Forests. Proximity to open water is also critical for gray bats.

**Table 87. Estimated Old Forest Condition Over Time Under All Alternatives, as Summarized from the NP Ecological Sustainability Evaluation for the Old Forest Associates Species Group. Red = poor, yellow = fair, light green = good, and dark green = very good.**

Element Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
CWD density under natural conditions																			
Percent of each ecozone contributing to old growth forest characteristics																			
Percent of forest represented by small openings (<0.25 acre)																			

As described in the forest structure section of this EIS (see 3.3.2.2 Forestwide Structure), the amount and quality of mature and old forest habitat conditions increases under all alternatives over time.

**Table 88. Estimated Open Forest (Woodland) Condition Over Time Under All Alternatives, as Summarized from the NP Ecological Sustainability Evaluation for the Woodland Associates Species Group. Red = poor, yellow = fair, light green = good, and dark green = very good.**

Element Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Percent of acres burned at desired return interval																			
Percent of acres burned at desired return interval (Buck Creek Serpentine Barrens)																			
Percent of NP exhibiting open forest characteristics																			

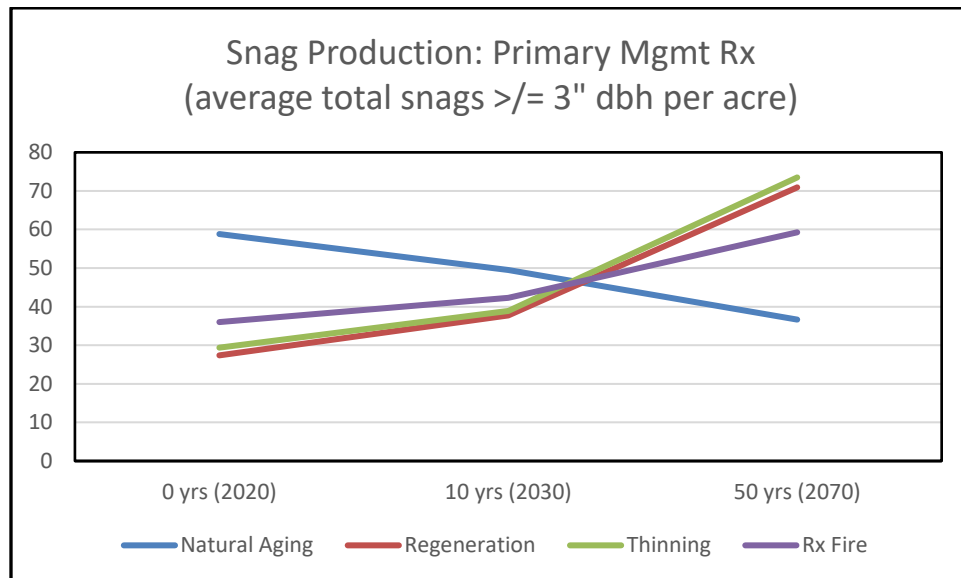
Similarly, as described in the forest structure section of this EIS (see 3.3.2.2 Forestwide Structure), the amount and quality of open (woodland) habitat improves over time but is most evident under Alternative E, due largely to an increased focus on prescribed burning.

#### Roosting Habitat

While it is recognized that some bats utilize manmade structures (e.g., buildings and bridges) for roosting, this discussion focuses on roosting habitat within the forest, such as snags and live trees with furrowed or exfoliating bark. This includes maternity roosting habitat during the appropriate season. It is important to note that snags are ephemeral resources and that bats included in this assessment need a continuous supply of appropriate snags for roosting. Forest management activities will not affect roosting in manmade structures; therefore, this is not addressed in this assessment.

**Table 89. Estimated Snag Density (Recruitment + Retention) Over Time Under All Alternatives, as Summarized from the NP Ecological Sustainability Evaluation for the Snag and Den Tree Associates Species Group. Red = poor, yellow = fair, light green = good, and dark green = very good.**

Element Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Snag Density																			
Snag and Den Tree Associates Composite Score																			



**Figure 74. Estimated snag production (recruitment) over time, by management activity type, as summarized from the Forest Vegetation Simulation model for the Nantahala and Pisgah NFs**

Forest disturbance through active management enhances snag recruitment. The natural recruitment and senescence of snags is demonstrated in natural aging trends in Figure 74 (i.e. natural disturbance recruits snags at a slower rate than anthropogenic disturbance). All potential snag densities displayed in Figure 74 represent high density, noting that active disturbance increases the habitat across the landscape. The Forest Plan includes plan components to identify and prioritize existing snag retention to ensure that snag recruitment and retention remain part of wildlife habitat (see Plan components Table 90 below). This includes a focus on snags  $\geq 8$ " diameter, which is often the factor limiting bat roosting habitat availability.

#### Hibernacula

Caves and abandoned mines, although present, are not common on the Forests. However, known caves, abandoned mines, and other hibernacula (e.g. rock shelters, bridges, tunnels, etc.) are protected in the

revised forest plan to provide hibernation habitat for bats, although there are currently no known hibernacula in these types of landscape features. Knowledge of bat hibernacula type and location on the Forests is constantly evolving (i.e. the data set is growing larger). The revised Forest Plan also applies to newly discovered hibernacula.

Natural caves on the Forests that are known to support bats are identified as Biologically Significant under the Federal Cave Resources Protection Act of 1988 (FCRPA). Additionally, a regional closure of caves, abandoned mines, and other hibernacula to human entrance (except for approved research and monitoring) remains in effect. These protections greatly reduce the potential for incidental spread of white-nose syndrome to, from, and across the Forests.

Several plan components specifically address protection of bat hibernacula (see Table 90, below). PAD-S-08 ensures project-level coordination with the USFS and delineation of site-specific appropriate activity buffers during spring emergence and fall swarming periods. PAD-S-09 identifies caves, abandoned mines, and rock shelters as smoke sensitive targets during prescribed burn activities. PAD-S-10 enforces the regional cave and abandoned mine closure. PAD-S-11 and PAD-S-12 guide the installation of gates or other structures to further prevent human disturbance and decontamination protocols applicable to humans allowed in caves to minimize spread of white-nose syndrome.

In addition to the revised forest plan, adherence to laws, regulations, and policy concerning forest-dwelling bat conservation is required. This direction includes, but is not limited to, the Endangered Species Act, pertinent Code of Federal Regulations, Forest Service manuals and handbooks, and broad scale agency guidance such as the Forest Service Bat Conservation Strategy, North Carolina Wildlife Action Plan, and listing and status updates produced by the USFWS.

In order to achieve improved long-term habitat conditions for forest-dwelling bats (i.e., healthy, resilient, diverse forests), it is necessary to identify and mitigate potential short-term negative effects. The proposed revised forest plan demonstrates this strategy through 539 plan components that directly or indirectly support healthy and resilient habitat conditions associated with forest-dwelling bats (Appendix C, Table 3). These plan components range from very broad direction applicable to the whole forest or ecozone to restore or enhance conditions on the landscape, to specific direction for habitat elements associated with forest-dwelling bats. In addition, 19 of these plan components specifically address and prioritize habitat conditions for federally listed bats (Table 90). This ensures that healthy, resilient, diverse wildlife habitats are at the forefront of all planning efforts, including habitat for forest-dwelling bats. In terms of federally listed species, this management direction translates directly into conservation measures for the species. In fact, maintaining and restoring healthy and resilient forests is a primary theme of the revised forest plan.

**Table 90. Plan Components that Specifically Address Habitat Conditions for and/or Persistence of Six Federally Listed Bats on the Nantahala and Pisgah NFs (Final Plan Language, Alternative E)**

Component	Language
WLF-DC-02	Permanent grass, forb, and shrub openings are positioned within forested habitats to ensure nesting and foraging areas are within proximity of each other for many animals. These openings are located to minimize conflict with recreationists and to ensure streams and native plant communities near these openings are not affected (i.e., stream temperature and channel integrity are not negatively affected). These areas are important to the life histories of many wildlife species but especially to bobwhite quail, wild turkey, white-tailed deer, elk, black bear, golden-winged warblers, and many other birds, bats, and pollinators.

Component	Language
WLF-DC-04	Mature forests, including late seral stages and old growth conditions, provide habitat and forage for species such as black bear, wild turkey, white-tailed deer, cerulean warbler, wood thrush, other species of migratory and resident birds, terrestrial salamanders, bats, and reptiles.
WLF-DC-05	Woodlands and other open forest types provide open understory conditions across all elevations that enhance nesting and foraging opportunities for many bird and bat species, suitable areas for butterflies, bees, and other pollinators, as well as optimal foraging for browsers such as white-tailed deer and elk. Larger native trees with exfoliating bark provide roosting habitat for bats.
WLF-DC-06	<p>Habitat components at finer scales provide for wildlife occupancy, are present in sufficient amounts, and distributed across all ecozones. For example, snags provide roosting and nesting habitat for bats and cavity nesting birds, especially along the edge of openings, and foraging habitat for insectivores such as woodpeckers. Larger-diameter live or dead trees provide habitat for black bear and other species requiring cavity or denning conditions, while smaller live or dead trees with crevices provide critical nesting and roosting habitat for flying squirrels and bats. Coarse wood on the forest floor, in a variety of sizes and shapes, provides habitat for salamanders and other cover and moisture-associated wildlife, nesting areas for some migratory birds (e.g., black and white warbler), as well as drumming logs for ruffed grouse.</p> <p>These habitat components that are retained during young forest restoration perpetuate to later successional stage, either through natural succession or through forest stand improvement practices. Over time, they contribute to the development of old growth characteristics such as large, downed woody debris; abundant snags; variable gap sizes; and tip up mounds.</p> <p>Plan Figure 4 provides desired amounts of finer scale habitat components retained during young forest restoration.</p>

Component	Language		
	Finer-Scale Habitat Desired Conditions for Young Forests		
	Snags	Den Trees	Coarse Woody Debris
	Snags An average of at least 4 snags/ac greater than 9" DBH is present within young forest habitats across the forest, including naturally-occurring and those created incidentally or intentionally during restoration activities. In areas known to be or potentially occupied by federally listed bats, snag recruitment and retention should also include snags ≥ 3" DBH.	Den Trees Trees greater than 9" DBH exhibiting crevices and other suitable denning characteristics are present across the landscape.	Coarse Woody Debris Density will vary by surrounding forest type and age, but some pieces of downed wood that are at least 10" in diameter and at least 10' long are present on the forest floor across the landscape.
WLF-S-01	<p>When identifying wildlife habitat diversity elements for retention during vegetation management activities:</p> <p>i. Maintain an average of four snags (≥ 9" DBH) per acre across the project area to contribute to landscape scale wildlife habitat diversity for species such as bats, woodpeckers, and other cavity nesting birds, except where such snags pose a threat to human health or safety. Retain snags exhibiting suitable wildlife habitat characteristics (e.g., exfoliating or sloughing bark, cavities, or crevices) along the edge of openings or combined with other live trees to extend the life of ephemeral wildlife habitat elements in the project area and reduce threats to human health and safety during vegetation management activities. To minimize the risk of incidental take, in areas known to be or potentially occupied by federally listed bats, snag recruitment and retention should also include snags or live trees with more than 25% exfoliating bark ≥3"DBH.</p> <p>ii. Emphasize hard and soft mast producing species, including mast-bearing trees, berries, and fruit trees, to enhance foraging opportunities for species such as white-tailed deer, wild turkey, ruffed grouse, black bear, songbirds, and small mammals.</p> <p>iii. Emphasize the following:</p> <ul style="list-style-type: none"><li>Native trees with exfoliating bark and natural crevices, including, but not limited to, shagbark hickory, white oaks, yellow pines, yellow birch, and black locust, to provide roosting and denning habitat for bats and Carolina northern flying squirrels. Consider current research, such as United States Fish and Wildlife Service (USFWS), NCWRC, North Carolina Bat Working Group (NCBWG), the USFS bat conservation strategy, or other relevant</li></ul>		



Component	Language					
	<p>guidance to determine appropriate roost and den tree species and condition for retention during project implementation.</p> <ul style="list-style-type: none"><li>• Whenever possible, snags susceptible to windthrow should be identified in clumps and/or buffered by live trees.</li><li>• Standing live and dead trees &gt;9" DBH that exhibit cavities and other denning conditions, except where human safety is of concern.</li><li>• Live eastern hemlock where possible to preserve the gene pool and food source for birds and small mammals.</li></ul> <p>iv. Emphasize retention of woody debris of various sizes where available and include pieces that are at least 10" DBH and 10' long to provide habitat for salamanders and other cover- and moisture-associated wildlife and drumming logs for ruffed grouse. Consider leaving new logging slash.</p>					
WLF-G-02	Open understory conditions should be enhanced to provide the natural range of variation through a reduction in ericaceous shrubs, such as deciduous azaleas and mountain laurel, to benefit many species of birds, bats, and other animals.					
PAD-DC-06	Desired conditions for canopy cover and shrub and herbaceous cover of unique habitats are shown in Plan Figure 4. These conditions may also be enhanced by active management techniques.					
	<b>Desired Conditions of Unique Habitats</b>					
	<table><tr><th>Unique Habitat</th><th>Desired Conditions for Canopy Cover (Other Primary Characteristics)</th><th>Desired Conditions for Shrub and/or Herbaceous Cover</th></tr><tr><td>Caves/Mines</td><td>Not trampled or impacted by recreationists, habitat free from white nose syndrome for a diversity of bats. Caves/mines retain characteristics important to bats (e.g., microclimate, airflow) and are surrounded by healthy forests providing quality spring staging and fall swarming habitat.</td><td></td></tr></table>	Unique Habitat	Desired Conditions for Canopy Cover (Other Primary Characteristics)	Desired Conditions for Shrub and/or Herbaceous Cover	Caves/Mines	Not trampled or impacted by recreationists, habitat free from white nose syndrome for a diversity of bats. Caves/mines retain characteristics important to bats (e.g., microclimate, airflow) and are surrounded by healthy forests providing quality spring staging and fall swarming habitat.
Unique Habitat	Desired Conditions for Canopy Cover (Other Primary Characteristics)	Desired Conditions for Shrub and/or Herbaceous Cover				
Caves/Mines	Not trampled or impacted by recreationists, habitat free from white nose syndrome for a diversity of bats. Caves/mines retain characteristics important to bats (e.g., microclimate, airflow) and are surrounded by healthy forests providing quality spring staging and fall swarming habitat.					
PAD-S-08	Coordinate with the USFWS to ensure that protection of potential and known hibernacula and maternity habitat is consistent with the most recent conservation measures, recovery plans, biological opinions or USFS bat conservation strategy. This includes delineating appropriate fall swarming and spring emergence buffers and applying appropriate conservation measures (e.g., activity type, timing, etc.).					
PAD-S-09	Identify caves, abandoned mines, and large rock shelters supporting bat populations as smoke-sensitive targets where and when bats are present.					
PAD-S-10	Post and enforce the regional cave and abandoned mine closure order at all biologically significant caves and other known bat hibernacula (e.g., abandoned mines, large rock shelters, talus slopes, cliff faces) to control human disturbance and prevent					

Component	Language
	the spread of white-nose syndrome in cave-associated bats, including, but not limited to, the federally endangered Indiana bat and threatened northern long-eared bat.
PAD-S-11	If cave and mine closure orders are found to be ineffective at protecting hibernating bats from human disturbance, construct and maintain gates or other structures that allow for entrance and egress by bats.
PAD-S-12	Follow all USFWS direction concerning mitigation efforts for the effects of white-nose syndrome on susceptible bat species, including decontamination protocols for people permitted to enter caves and mines for purposes identified in the closure.
OGN-DC-02	Old growth characteristics shift over time, and disturbances are a natural part of the system. High quality old growth characteristics, such as large, downed woody debris, abundant snags, variable gap sizes, tip-up mounds, and undisturbed soils, etc., develop over time and are present.
OGN-S-01	<p>In patches identified as part of the designated old growth network, allow vegetation manipulation, including thinning, woodland creation and prescribed burns and limited soil disturbance, for the following purposes and with project specific analysis:</p> <ul style="list-style-type: none"> <li>c. To enhance old growth values and characteristics, including: <ul style="list-style-type: none"> <li>x. Downed logs in all stages of decay;</li> <li>xi. Old trees;</li> <li>xii. Standing snags;</li> <li>xiii. Uneven-aged structure of canopy species;</li> <li>xiv. Single and multiple tree-fall gaps;</li> <li>xv. Abundant fungal component;</li> <li>xvi. Large trees;</li> <li>xvii. Appropriate density and basal area of canopy trees;</li> <li>xviii. Approximate composition of native forest species including trees, shrubs, and herbs.</li> </ul> </li> <li>d. To improve forest health or prevent the spread of disease when the integrity (including characteristics) of the old growth patch or adjacent lands are threatened from conditions within the patch.</li> </ul>
MAT-DC-03	Young forest habitat occurs in greater proportions in Matrix than other management areas, providing proportionally more edge habitats that provide early seral conditions, and supporting species (such as bats, pollinators, ruffed grouse, and golden-winged warblers) that depend on grass and shrub habitat and soft mast.
CDW-DC-03	Natural processes shape habitat and determine the selection, distribution, and population of wildlife species, although the recovery of threatened and endangered species may be promoted. Where present, rare communities and associated species continue to exist. Cavity trees, standing snags, and downed logs are common throughout the area as a result of natural mortality and successional progression.

Component	Language
MIN-DC-04	Abandoned mine lands are reclaimed to provide for public safety and to minimize impacts to cultural and natural resources.

Component	Language
BLM-GLS-03	At mid elevations accessible by existing roads, emphasize restoration of structural and compositional diversity within rich cove ecozones for species such as ruffed grouse, American woodcock, bats, and many salamander species.
NG-GLS-01	Protect cave habitats within Nantahala Gorge, including Blowing Springs, for all species with a focus on Indiana, northern long-eared, and gray bats, and the lost Nantahala cavespider.

The remainder of this discussion on potential effects to forest-associated bats by species aggregates the six bat species into two groups: 1) habitat for cave-obligate bats, and 2) roosting habitat (including maternity roosting habitat) for cave-associated bats.

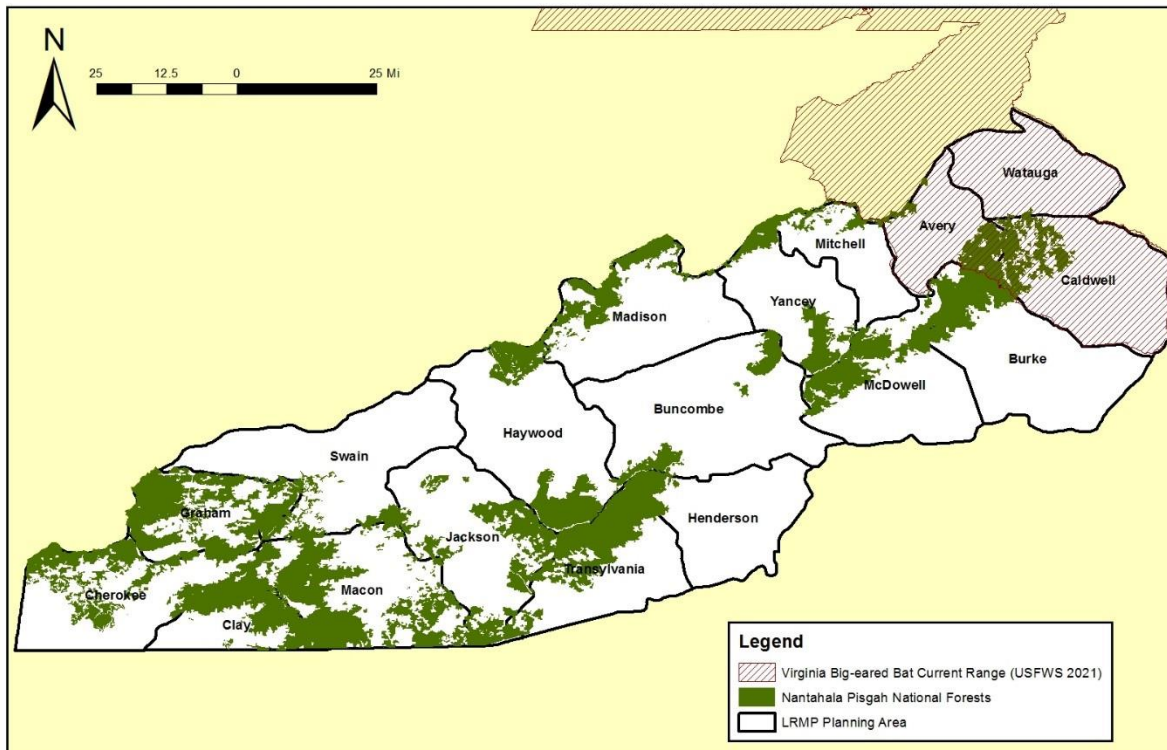
### **Habitat for Cave-obligate Bats**

#### **Virginia Big-Eared Bat (*Corynorhinus townsendii virginianus*)**

##### **Affected Environment**

Virginia big-eared bat is a cave-dwelling species with a known range including the Appalachian Mountains in Virginia, West Virginia, North Carolina, and eastern Kentucky, and presently occurring in decreased numbers throughout much of this historic range. The largest known colonies of this species are associated with several caves in West Virginia, several of which serve as both hibernation and maternity sites.

Virginia big-eared bat was listed as endangered in November 1979 (Federal Register 44: 51144-51145). Critical habitat was designated for this species at the time of listing, although none is identified in North Carolina. In North Carolina, Virginia big-eared bat is known from a handful of locations within Avery, Caldwell, and Watauga Counties. None of these locations are on the forest; however, several are within 0.5 mile of the Pisgah NF so it is reasonable to assume that the species forages on the Forests. Figure 75 displays the known range for the Virginia big-eared bat (there is no designated critical habitat for this species in North Carolina). Since there is no designated critical habitat for this species in North Carolina, no potential effects analysis on it was conducted in this EIS.



**Figure 75. Estimated current range of the Virginia big-eared bat in Western North Carolina, Nantahala and Pisgah NFs, as summarized from USFWS (2020)**

Caves used by Virginia big-eared bats are typically located in limestone karst regions dominated by mature hardwood forests of hickory, beech, maple, and hemlock. These conditions are not present in large amounts on the Nantahala and Pisgah NFs. The species prefers cool, well-ventilated caves for hibernation, with roost sites near cave entrances or in places where there is considerable air movement. Maternity colonies settle deep within caves, far from the entrance. These caves are warmer than those used for hibernation. Virginia big-eared bats are often detected foraging in old fields and above cliffs. The Forests provide foraging habitat for this species.

Limestone quarrying has been identified as a significant threat to this species, especially from disturbances resulting from geologic vibration. Additionally, Virginia big-eared bats are highly sensitive to human disturbance and may completely abandon hibernation or maternity sites following irresponsible contact (i.e., that occurring without regard to this species' life history and sensitivity).

Increased popularity in recreational caving poses a threat on the Forests; however, a regional closure to all entry to biologically significant caves (i.e., those identified as supporting bat populations) remains in effect since the discovery of white nose syndrome on southeastern national forests. White-nose syndrome is now found throughout the Virginia big-eared bat's range. Although co-existing species from the same sites have been dramatically impacted by white nose syndrome, Virginia Big-eared bats appear to not be affected (Turner et al. 2011).

The NCWRC, USFWS, and other partners (including the National Forests in North Carolina) have been monitoring bat populations in Western North Carolina for decades, and even more so since the discovery of white nose syndrome in North Carolina. Although much has been learned about this species over the years, recent monitoring indicates that much more inventory effort is needed to fully document species' range. Although preferred habitat for Virginia big-eared bats (i.e., limestone karst geology) is largely absent from the Forests, maintaining suitable foraging areas for nearby populations is critical to species' persistence into the future.

## Environmental Consequences

Plan components addressing ecosystem conditions discussed above (e.g., oak dominated and northern hardwood forests, caves and abandoned mines) encompass habitat requirements for Virginia big-eared bat and are described in other parts of this analysis (e.g., ecozones, species groups and unique habitat subsections).

EIS Appendix C summarizes key characteristics and indicators of the following ecosystems, unique habitats, and species groups within the Ecological Sustainability Evaluation (ESE) that include Virginia big-eared bat:

- Dry, Dry-mesic, and Mesic Oak Forests (Ecozones),
- High Elevation Red Oak Forest (Ecozone),
- Northern Hardwood Forest (Ecozone),
- Spruce-fir Forest (Ecozone),
- Caves and Abandoned Mines (Unique Habitat)
- Carolina Hemlock Forest (Unique Habitat)
- Grassy and Shrub Balds (Unique Habitat)
- Forest Edge and Transition Associates (Species Group), and
- Woodland Associates (Species Group)

Indicators addressed in Appendix C include topics such as canopy composition and density, young forest, mature forest, old growth forest, and open woodland condition, presence of snags and den trees, and road density.

Table 91 displays the cumulative assessment of the proposed planning framework (i.e., mitigation and management constraints, as well as terrestrial habitat enhancement and restoration) on Virginia big-eared bat. Specifically, this figure reflects species' estimated health and resilience on Forest Service land under all alternatives.

**Table 91. Ecological Sustainability Scores for Indictors Representing Forest Service Ownership Within Coarse Filter Elements Supporting Virginia Big-Eared Bat on the Nantahala and Pisgah NFs (NPESSE 2021). Red = poor, yellow = fair, light green = good, and dark green = very good**

Element Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Dry-Oak Forest																			
Dry-mesic Oak Forest																			
High Elevation Red Oak Forest																			
Mesic Oak Forest																			
Northern																			

Element Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Hardwood Forest																			
Spruce-Fir Forest																			
Caves and Abandoned Mines																			
Carolina Hemlock Forest																			
Grassy Balds																			
Shrub Balds																			
Forest Edge and Transition Associates																			

In addition to the summary presented above, please refer to the detailed discussion of potential effects to open forest conditions at 3.3.2.2. Forestwide Structure as it is relevant to Virginia big-eared bat.

Ecological Sustainability Evaluation modeling for the plan revision shows that conditions for Virginia big-eared bat generally improve over existing condition under all alternatives. Conditions within caves and abandoned mines also improve under all alternatives since the planning framework specifically addresses mitigating white-nose syndrome through several plan components (e.g. PAD-DC-06, PAD-S-08, PAD-S-09, PAD-S-10, PAD-S-11, PAD-S-12).

Open woodlands, which are vital to bat foraging, improve under Tier 2 of Alternative E (see 3.3.2.2 Forestwide Structure). Additionally, general forested habitat conditions for Virginia big-eared bat on the Forests are expected to improve over time under Alternative E and serve as connectors between foraging and roosting habitats. These generally improving trends in habitat quality for Virginia big-eared bat are thought to be a result of maintenance and restoration of forest health and resilience in higher elevation ecosystems, especially opening and edge habitats across the Forests, as well as continuation of the regional cave and mine closure to control incidental human disturbance. It is important to remember that the occupied range of this species on the Forests is limited.

Habitat conditions in northern hardwood forest improve to “good” under Alternatives B and C. Habitat conditions in dry-mesic oak forest improve to “good” under all alternatives except Alternative A and Tier 2 of Alternative B. Habitat conditions improve to “good” in mesic oak forest under Tier 1 of Alternatives B, C, and D.

These generally improving trends in habitat quality for Virginia big-eared bat are thought to be a result of maintenance and restoration of forest health and resilience in higher elevation ecosystems, especially opening and edge habitats across the Forests, as well as continuation of the regional cave and mine closure to control incidental human disturbance. The occupied range of this species on the Forests is limited (Figure 76).

## **Cumulative Effects**

When these actions are put into perspective across the landscape (specifically, across the estimated range for Virginia big-eared bat within Western North Carolina), it becomes apparent that species' persistence at this larger scale is related to the persistence of quality foraging habitat on parts of the Forests. It can be assumed that land uses on other ownerships will continue to affect the quality and quantity of foraging habitat for this species, positively and negatively. Therefore, it is important that foraging habitat quality and quantity for Virginia big-eared bat on the Forests be optimized consistent with the Forest plan.

## **Conclusions**

Persistence of this species across its known range in Western North Carolina is largely dependent on maintaining suitable roosting habitat (i.e., caves) and mitigating the potential threat of white-nose syndrome (see above). This analysis shows that the Nantahala and Pisgah NFs will continue to contribute to foraging habitat for the Virginia big-eared bat and contribute to the persistence of the species across its estimated range in Western North Carolina. No additional conservation measures are needed beyond those outlined in previous sections of this assessment for Virginia big-eared bat.

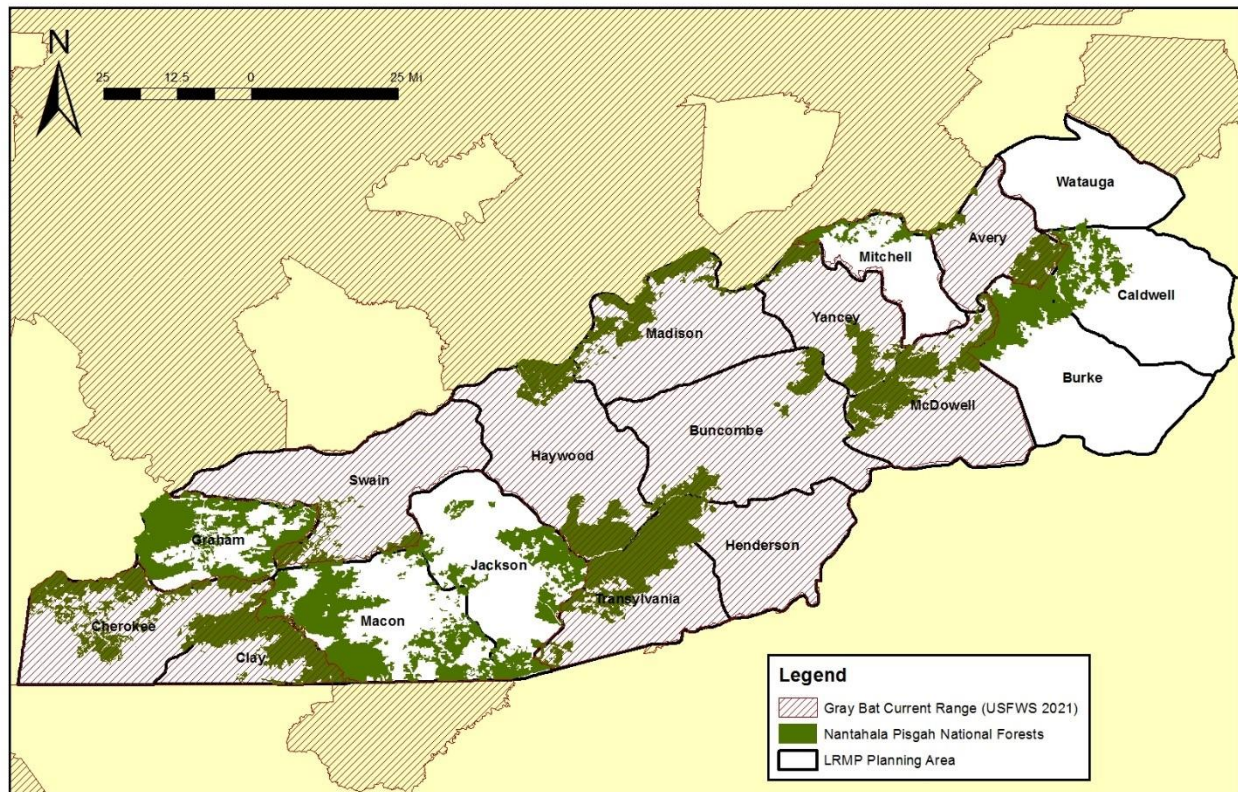
## **Gray Bat (*Myotis grisescens*)**

### **Affected Environment**

The gray bat is a cave-dwelling bat species, known to occur from southeastern Kansas and central Oklahoma east to western Virginia and Western North Carolina, and from Missouri, Illinois, and Indiana south to southern Alabama and northwestern Florida. The species occurs primarily in the cave region of Missouri, Arkansas, Kentucky, Tennessee, and Alabama, with summer and winter ranges being similar.

The species was listed as endangered in April 1976 (Federal Register 41: 17736-17740). There is no critical habitat designated for this species. In North Carolina, gray bat is known from a handful of locations along the Little Tennessee, Pigeon, French Broad, Hiwassee, and Nolichucky Rivers, including parts of the Nantahala and Pisgah NFs (Figure 76). In North Carolina, increased knowledge about the species and its habitat requirements, combined with extensive inventory and monitoring efforts by the North Carolina Wildlife Resources Commission (NCWRC) and USFWS have expanded the known range of the species on the Forests. It is not known whether this represents true range expansion (recolonization) or is a reflection of the amount of effort spent studying the species.





**Figure 76. Estimated range of the gray bat in Western North Carolina, Nantahala and Pisgah NFs, as summarized from USFWS (2020)**

Roost sites are nearly exclusively caves throughout the year, although only a small percentage of available caves are thought to be suitable. Winter roosts are in deep vertical caves with domed halls. Large summer colonies utilize caves that trap warm air and provide restricted rooms or domed ceilings; maternity caves often have a stream flowing through them and are separate from the caves used in summer by males. This type of habitat is extremely uncommon on the Forests. There are reports of bridges, mines, buildings, and storm sewers being used as roost sites for gray bats.

Forested areas along the banks of larger streams, rivers, and lakes provide important protection for adults and young. Young often feed and take shelter in forest areas near the entrance to cave roosts, and do not feed in areas along rivers or reservoirs where the forest has been cleared. Adult foraging is generally parallel to streams, over the water at heights of two to three meters.

The largest threat to gray bats is cave disturbance. Historically, some of the largest colonies of this species have been lost to cave commercialization. Cave protection efforts, such as the regional closure in effect on the Nantahala and Pisgah NFs, have greatly reduced this threat; however, human disturbance is the main reason for the continued decline of gray bats in caves that are not protected. This species is especially vulnerable to disturbance due to its high fidelity to particular caves, and it is very sensitive to disturbance, including the presence of humans with lights. There are no known caves or mines used by gray bats in North Carolina. While white-nose syndrome has been detected in this species, it is unclear if disease develops in this species. No mass mortality has been observed, and the species may be resistant to WNS (Frick et al. 2010).

Another threat to gray bats is the use of insecticides in areas adjacent to riparian corridors where gray bats forage that reduce the prey base or harms bats that ingest contaminated insects. Other threats include deforestation and impoundment of waterways (and subsequent cave inundation), and subsequent sedimentation of aquatic habitats, which affects insect availability. Natural and human-



caused flooding remains a secondary threat at some gray bat sites (USFWS 2009). Climate change can also impact gray bats. It is hypothesized that a rise in ambient temperature could make traditional and currently occupied hibernacula and maternity sites unsuitable for roosting gray bats and cause a shift in the species' range northward; however, no documentation of such effects currently exists (USFWS 2009).

The NCWRC, USFWS, and other partners have recently increased gray bat inventory and monitoring. Although much has been learned about this species over the last several years, these efforts indicate that more inventory is needed to fully document the species' range.

### Environmental Consequences

Plan components addressing larger ecosystem conditions discussed above encompass habitat requirements for gray bat and are described in other parts of this analysis (e.g., unique habitat subsections). EIS Appendix C summarizes key characteristics and indicators of the following ecosystems, unique habitats, and species groups within the Ecological Sustainability Evaluation (ESE) that include gray bat:

- Medium and Large River Associates (Aquatic Species Group),
- Small River Associates (Aquatic Species Group),
- Floodplain Forests (Ecozone),
- Floodplain Pools (Unique Habitat),
- Rocky Bars and Shore (Unique Habitat), and
- Caves and Abandoned Mines (Unique Habitat).

Table 92 displays the cumulative assessment of the proposed planning framework (i.e., mitigation and management constraints, as well as terrestrial habitat enhancement and restoration) on gray bat. Specifically, this figure reflects species' estimated health and resilience on Forest Service land under by alternative.

**Table 92. Ecological Sustainability Scores for Indictors Representing Forest Service Ownership Within Coarse Filter Elements Supporting Gray Bat on the Nantahala and Pisgah NFs (NPSE 2021). Red = poor, yellow = fair, light green = good, and dark green = very good.**

Element Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Floodplain Forest																			
Floodplain Pools																			
Rocky Bars and Shore																			
Caves and Abandoned Mines																			
Small River																			

Element Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Associates																			
Medium and Large River Associates																			

Ecological Sustainability Evaluation modeling for the Nantahala and Pisgah Forest Plan Revision shows that conditions for gray bat are generally “good” or “very good” under all alternatives, with the exception of floodplain forests. This ecosystem is highly dynamic and gray bats are adapted to this. There is very little true floodplain forest on the Nantahala and Pisgah NFs, making ecological sustainability modeling difficult, which also contributes to lower scores. Conditions within caves and abandoned mines improve under all alternatives since the planning framework specifically addresses mitigating white-nose syndrome through several plan components (e.g. PAD-DC-06, PAD-S-08, PAD-S-09, PAD-S-10, PAD-S-11, PAD-S-12).

Additionally, general forested habitat conditions for gray bat on the Forests are expected to improve over time under all alternatives (see discussion below). These generally improving trends in habitat quality for gray bat are thought to be a result of maintenance and restoration of forest health and resilience in higher elevation ecosystems, especially opening and edge habitats across the Forests, as well as continuation of the regional cave and mine closure to control incidental human disturbance. It is important to remember that the occupied range of this species on the Forests is limited.

### Cumulative Effects

When these actions are put into perspective across the landscape (specifically, across the estimated range for gray bat within Western North Carolina), it becomes apparent that species’ persistence at this larger scale is related to the persistence of quality foraging habitat on the parts of the Forests. It is assumed that land uses on other ownerships will continue to affect the quality and quantity of foraging habitat for this species, positively and negatively. Therefore, it is important that foraging habitat quality and quantity for gray bat on Forest lands be optimized consistent with the revised forest plan.

### Conclusions

Persistence of this species across its known range in western North Carolina is largely dependent on maintaining suitable roosting habitat (i.e. caves) and mitigating the potential threat of white-nose syndrome (see above). This analysis shows that the Nantahala and Pisgah NFs will continue to contribute to foraging habitat for gray bat and contribute to the persistence of the species across its estimated range in Western North Carolina. No additional conservation measures are needed beyond those outlined in previous sections of this assessment for gray bat.

### Northern Long-Eared, Indiana Bat, Little Brown, and Tricolored Bats

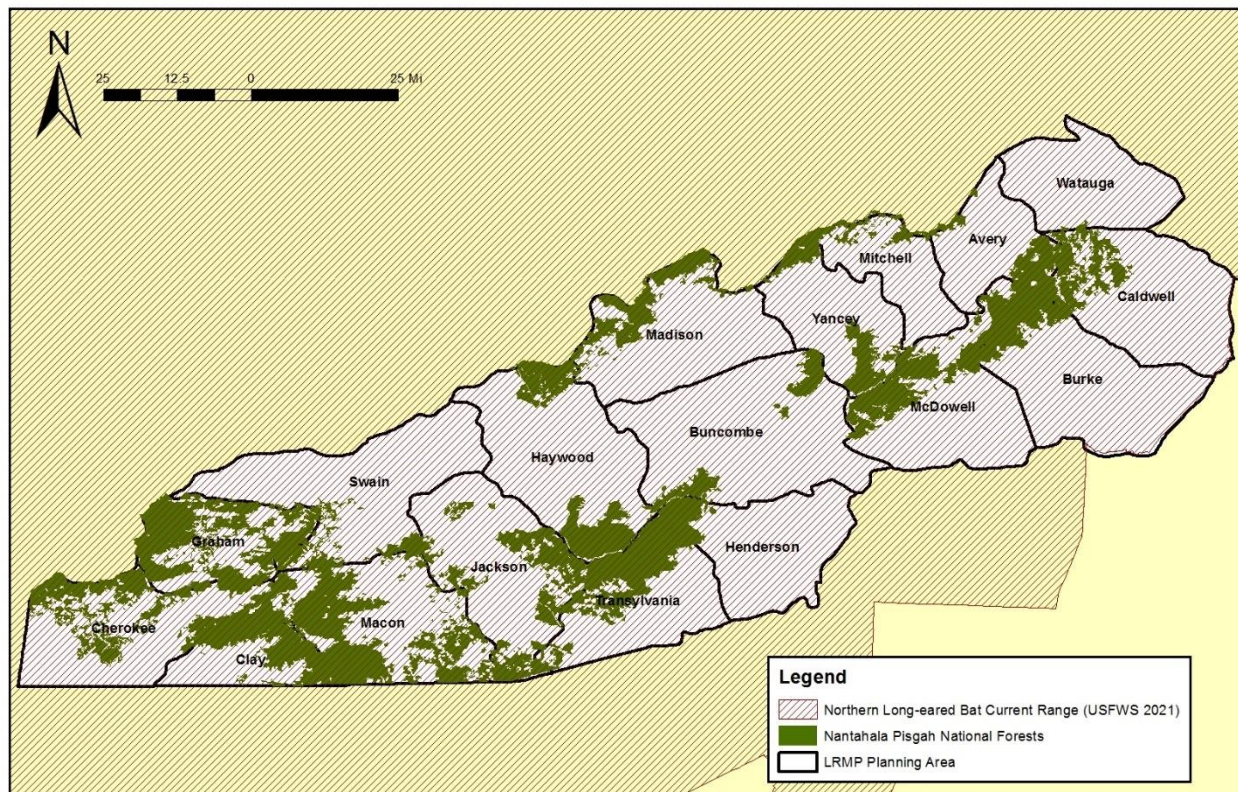
These species are addressed together due to high overlap in suitable habitat and life history. Little brown and tricolored bats are addressed here since it is likely they will be listed under the Endangered Species Act during the first few years of the planning period.

## Affected Environment

### Northern long-eared bat (*Myotis septentrionalis*)

Northern long-eared bat (NLEB) is widely (but patchily) distributed in the eastern and north-central United States and adjacent southern Canada, from eastern British Columbia and southern Yukon, eastward across southern Canada, southward to southern Texas, Louisiana, Alabama, Georgia, and Florida, and westward to the eastern margin of the Great Plains region. Summer (maternity) and winter (hibernation) ranges are essentially the same.

The species was listed (and revised) as threatened (4d) in January 2015 (Federal Register 80: 2371-2378 and 80:5079). There is no critical habitat designated for this species. In North Carolina, this species is known from numerous sites across the Nantahala and Pisgah NFs (Figure 77).



**Figure 77. Estimated current range of northern long-eared bat in Western North Carolina, Nantahala and Pisgah NFs, as summarized from USFWS (2020)**

Northern long-eared bat is generally associated with mature forests and interior forest habitat. Late successional forest characteristics may be favored for several reasons, including the large number of partially dead or decaying trees that the species uses for breeding, summer day roosting, and foraging.

Foraging occurs within forests, along forest edges, over forest clearings, and occasionally over ponds. A lack of suitable hibernacula may prevent occupancy of areas that otherwise have adequate habitat. Principal requirements of a suitable hibernation site are winter-long, low temperatures above freezing, high humidity, and lack of disturbances, both natural (floods) and anthropogenic (visitation).

Most nursery colonies are in cavities or beneath loose bark in trees or snags in upland forests, with roost entrances generally below or within the tree canopy utilizing a variety of tree species. Occasional summer roosts also include buildings, bat houses, and under bridges.

This species is highly susceptible to white-nose syndrome, which is identified as the primary threat to species persistence (USFWS 2013). Other threats include permanent loss of forested habitat and human disturbance in occupied hibernacula.

The NCWRC, USFWS, and other partners (including the National Forests in North Carolina) continue to actively monitor bat populations across Western North Carolina. These efforts have yielded dramatic declines in cave-associated bats in general (including northern long-eared bat), due largely to the devastating effects of white-nose syndrome. This species has always occurred in low numbers when compared to other *Myotis*, making persistence on the landscape more vulnerable to population declines. Several known occupied hibernacula occur on the Nantahala and Pisgah NFs, and summer maternity habitat is widespread across the Forests; therefore, maintaining and restoring habitat within today's known (estimated) occupied range where it overlaps the Forests is critical to species' persistence into the future. Plan components protect known and potential hibernacula and mitigate potential effects of forest management on cave-associated bats.

### **Indiana bat (*Myotis sodalis*)**

Indiana bats' estimated range extends from the western Ozark region in eastern Oklahoma and Iowa, north and east to Michigan, New York, New England, and northern New Jersey, and south to northern Alabama and Arkansas. The species winters and hibernates in caves within this range and has disappeared from or is greatly declined in most of its former range in the northeastern United States.

The species was identified as "in danger of extinction" under the Endangered Species Preservation Act of 1966 (Federal Register 32:4001). Subsequently, the species was listed as endangered under the Endangered Species Act of 1973. Critical habitat for the Indiana bat was identified in September 1976 (Federal Register 41:41914) and revised in September 1977 (Federal Register 42:47840-47845). This designation included hibernacula only, none of which are in North Carolina. Therefore, this assessment does not include effects analysis on designated critical habitat for Indiana bat.

Summer maternity colonies of Indiana bats are known from Western North Carolina and included in the estimated range (Figure 78). This species is known from several sites across the Nantahala and Pisgah NFs.

Most known Indiana bat maternity sites have been located within forested tracts within agriculturally dominated landscapes of the upper Midwest, but several maternity colonies also exist to the south in heavily forested regions of eastern Tennessee and Western North Carolina. Since there are no known Indiana bat hibernacula in North Carolina, summer maternity habitat will be addressed in this analysis.

Summer habitat consists of wooded or semi-wooded areas, often along streams. Solitary females or small maternity colonies bear their offspring in hollow trees or under loose bark of living or dead trees. Dead and dying trees, or trees with naturally exfoliating bark in sunny openings are attractive because the air spaces and crevices under the bark are warmer. Though maternity sites occur mainly in riparian and floodplain forests, recent studies indicate that upland habitats are used by maternity colonies much more extensively than previously reported, specifically south-facing slopes and ridges (O'Keefe et al 2009). Roosts were not found in forests with open canopies (10-30%) or in old fields with less than or equal to 10% canopy cover. In eastern Tennessee and Western North Carolina, several maternity colonies were in sun-exposed conifer snags (roost sites were above the surrounding canopy). Recapture of the same individuals within traditional roost sites during subsequent summers suggests site fidelity.



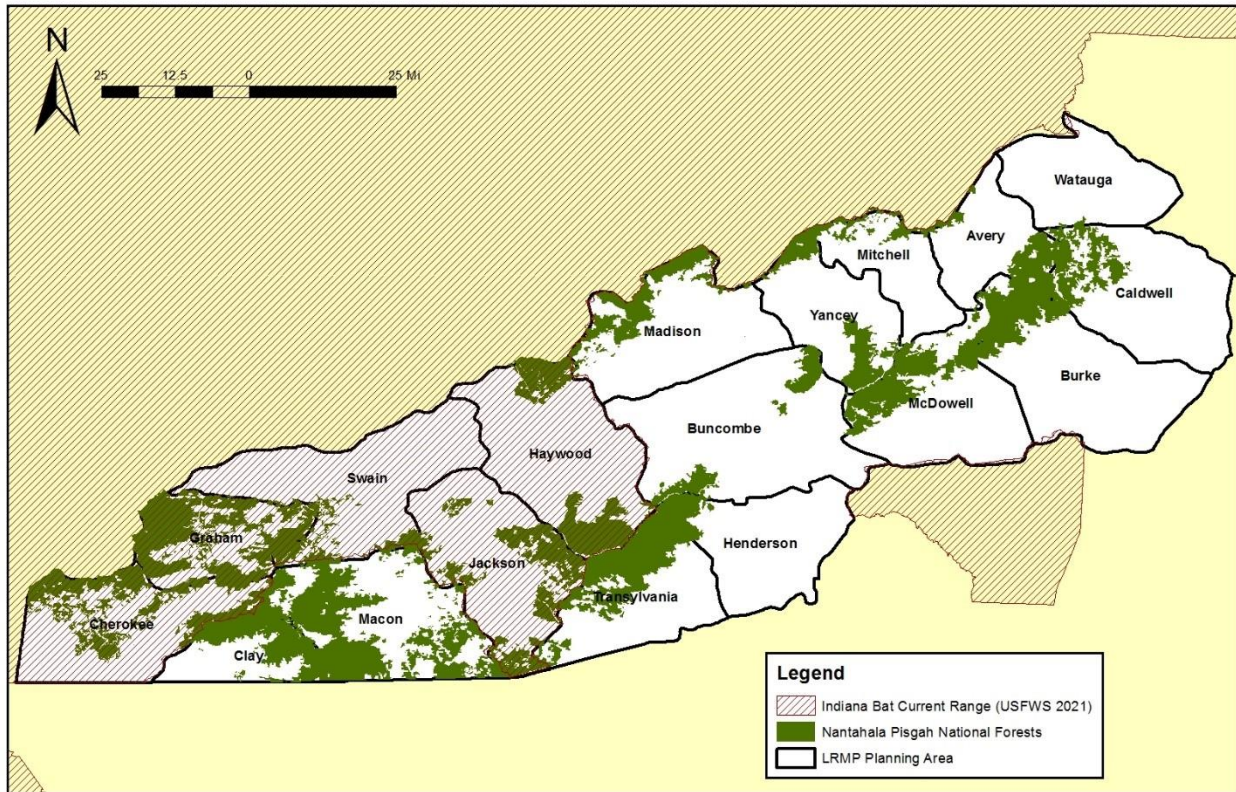


Figure 78. Estimated current range of the Indiana bat in Western North Carolina, Nantahala and Pisgah NFs, as summarized from USFWS (2020)

Indiana bat is highly susceptible to white-nose syndrome, which is identified as a primary threat to species persistence. Other threats include permanent loss of forested habitat, including snag abundance, and human disturbance in occupied hibernacula.

The NCWRC, USFWS, and other partners (including the National Forests in North Carolina) continue to actively monitor bat populations across Western North Carolina. These efforts have yielded dramatic declines in cave-associated bats in general, due largely to the devastating effects of white-nose syndrome. This species has always occurred in low numbers when compared to other *Myotis*, making persistence on the landscape more vulnerable to population declines. Although no known hibernacula for this species are in Western North Carolina, summer maternity habitat is widespread across the Forests. Therefore, maintaining and restoring habitat within today's known (estimated) occupied range where it overlaps the Forests is critical to species' persistence into the future.

### Little Brown Bat (*Myotis lucifugus*)

Little brown bat utilizes a wide range of forested habitats for foraging, which is why they are included in this assessment. The species generally uses human-made structures for resting and maternity sites, and less frequently, caves and hollow trees. Foraging habitat requirements are generalized: foraging occurs over water, along the margins of lakes and streams, or in woodlands near water. Winter hibernation sites (caves, tunnels, abandoned mines, and similar sites) generally have a relatively stable temperature of approximately 2-12°C (Kunz and Reichard 2010). Maternity colonies commonly are in warm sites in buildings (e.g. attics) and other structures, as well as hollow trees, and rock crevices. This species was widespread and abundant prior to WNS.

This species is known to occur across North Carolina, including all of the Nantahala and Pisgah NFs; therefore, no range map is included.

Little brown bat is widespread in North America, occurring from the Alaska-Canada boreal forest south through most of the contiguous United States to central Mexico. The species was formerly very abundant; however, severe declines in abundance in eastern North America have been observed as a result of high mortality caused by white-nose syndrome. The species is also susceptible to mortality by turbines at wind energy facilities; still common in much of the historical range apart from northeastern North America, but this is not a significant threat on the Forests since no wind facilities are on the Forests themselves, and very few are adjacent. Pesticides and other contaminants are also a potential threat, but again, are rarely encountered on the Forests.

Because of measured steep declines in little brown bat numbers and distribution, conservation status of this species is currently being reviewed, which is why the species is included in this assessment. The current range of white-nose syndrome has been expanding across North America, and there appears to be no effective containment of the spread of the pathogen. The fungus that causes WNS (*Pseudogymnoascus destructans*) was likely introduced from Europe. Bats with WNS experience more frequent arousals through winter that in turn cause rapid depletion of limited fat stores, leading to poor health and resilience. Some individuals are able to resist a long-term WNS infection or heal and survive an infection, only to become reinfected the subsequent fall or winter, and populations can persist even in sites exhibiting large population declines (Dobony et al. 2011).

Range-wide little brown bat population trends over the past three generations are not precisely known, but abundance has declined severely in the eastern portion of the range (Frick et al. 2010, Kunz and Reichard 2010). Population decreases in bats at infected hibernacula range from 30 to 99 percent annually, with a regional mean of 73 percent (Frick et al. 2010). Cheng et al. (2020) document a 90% loss in little brown bat populations across their range. Most of the global population of *M. lucifugus* occurs in the region now infected with WNS (Kunz and Reichard 2010).

### **Tricolored Bat (*Perimyotis subflavus*)**

Tricolored bats are associated with forested landscapes, where they forage near trees (including forest perimeters) and along waterways. The species also uses areas with intact, unfragmented forest cover. During spring and summer in deciduous forest in western North Carolina, nonreproductive individuals selected mature stands or buffer zones near perennial streams, and they tended to roost near openings (perhaps to minimize commuting costs when openings comprise a small proportion of a densely forested landscape) (O'Keefe et al. 2009). These bats do not require pristine stream/riparian conditions and may forage along streams receiving wastewater treatment plant effluents (Kalcounis-Rueppell et al. 2007).

Maternity and other summer roosts probably are mainly in dead or live tree foliage (including attached lichen clumps such as *Usnea* and "Spanish moss"). Caves, mines, and rock crevices may be used as night roosts. Maternity colonies also may utilize human-made structures such as buildings and bridges or tree cavities. Sometimes tricolored bats establish maternity roosts in open sites that would not be tolerated by most other bats (Barbour and Davis 1969). Tricolored bat roosts are often characterized by clumps of dead leaves, and less often, live foliage (Perry and Thill 2007, Veilleux et al. 2003). Hibernation sites include caves, mines, or cave-like tunnels, including box culverts near forested areas. Unlike most bat species, tricolored bats do not form large aggregations.

Because of measured steep declines in tricolored bat numbers and distribution, conservation status of this species is currently being reviewed, which is why the species is included in this assessment. As mentioned above, the current range of white-nose syndrome has been expanding across North America, and there appears to be no effective containment of the spread of the pathogen.

Range-wide tricolored bat population trends over the past three generations are not precisely known, but abundance has declined severely in the eastern portion of the range (Langwig et al. 2012). Most of

the global population of tricolored bat occurs in the region now infected with WNS (Kunz and Reichard 2010).

Recent documented range expansion (likely associated with increases in wooded habitats along rivers and increases in the number of human-made structures that might be used as hibernacula) have been recorded along the western edge of the species' range (South Dakota, Texas, and New Mexico)(NatureServe 2021).

### **Environmental Consequences**

Plan components addressing larger ecosystem conditions discussed above encompass habitat requirements for forest-dwelling bats and are described in other parts of this analysis (e.g., ecozone, species group and unique habitat subsections). EIS Appendix C summarizes key characteristics and indicators of the following ecosystems, unique habitats, and species groups within the Ecological Sustainability Evaluation (ESE) that include one or more of the forest-associated bat species listed above:

- Acidic Cove and Rich Cove Forest (Ecozones),
- Dry, Dry-mesic, and Mesic Oak Forests (Ecozone),
- Floodplain Forest (Ecozone),
- High Elevation Red Oak Forest (Ecozone),
- Northern Hardwood Forest (Ecozone),
- Pine-oak Heath Forest (Ecozone),
- Shortleaf Pine Forest (Ecozone),
- Spruce-fir Forest (Ecozone),
- Beech Gaps and Boulderfields (Unique Habitat),
- Calcareous Oak-walnut Forest (Unique Habitat),
- Carolina Hemlock Forest (Unique Habitat),
- Floodplain Pools (Unique Habitat),
- Grassy and Shrub Balds (Unique Habitats),
- Low Elevation Glades (Unique Habitat),
- Low Elevation Rocky Summits (Unique Habitat),
- Montane Red Cedar Hardwood Woodlands (Unique Habitat),
- Rocky Bars and Shore (Unique Habitat),
- Upland Vernal Pools (Unique Habitat),
- White Pine Forest (Unique Habitat),
- Woodlands and Shale Slopes (Unique Habitat),
- Caves and Abandoned Mines (Species Group),
- Closed Canopy Forest Associates (Species Group),
- Forest Edge and Transition Associates (Species Group),
- Interior Forest Associates (Species Group),
- Mature and Old Growth Forest Associates (Species Group),
- Serpentine Woodlands (Species Group),
- Snag and Den Tree Associates (Species Group),
- Woodland Associates (Species Group), and
- Young Forest Associates (Species Group).

The length of this list indicates that the four bat species addressed in this section are basically habitat generalists, optimizing on suitable habitat elements across the landscape. Appendix C summarizes key

characteristics and indicators of ecosystems, and species groups within the Ecological Sustainability Evaluation that include northern long-eared, Indiana, little brown, and tricolored bats. These indicators include things such as canopy composition, young forest, mature forest, old growth forest, and open woodland conditions, snag and den tree density, and other characteristics. Environmental consequences were estimated for each of these indicators, for each alternative, and are presented in Appendix C.

Table 93 displays the cumulative assessment of the proposed planning framework (i.e., mitigation and management constraints, as well as habitat enhancement and restoration) on northern long-eared, Indiana, little brown, and tricolored bats, by alternative. Specifically, this table reflects species' estimated health and resilience on Forest Service land. Alternative E includes plan components to directly or indirectly enhance and/or restore habitat for federally listed species, including northern long-eared, Indiana, little brown, and tricolored bats, on the Nantahala and Pisgah NFs (Appendix C). Note that Table 93 displays ecozones as a representation of forest-wide habitat conditions. Unique habitats are embedded within general forest conditions and are protected through plan components outlined in the revised forest plan.

**Table 93. Ecological Sustainability Scores for Ecosystems and Species Groups Relevant to Forest-Dwelling Bats (NPESE 2021).**

Element Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Acidic Cove Forest																			
Dry Oak Forest																			
Dry-mesic Oak Forest																			
Floodplain Forest																			
High Elevation Red Oak Forest																			
Mesic Oak Forest																			
Northern Hardwood Forest																			
Pine Oak-Heath Forest																			
Rich Cove Forest																			
Shortleaf Pine																			



Element Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Forest																			
Spruce-Fir Forest																			
Forestwide weighted average																			

Ecological Sustainability Evaluation modeling for the Nantahala and Pisgah Forest Plan Revision shows that conditions for forest-dwelling bats generally improves over existing condition under all alternatives. This is slightly more noticeable for Alternatives B, C, and D, but Alternative E is not measurably different. This is thought to be a result of maintenance and restoration of forest health and resilience, the major tenant of the proposed revised forest plan, as well as implementation of terms and conditions within existing Biological Opinions for forest-dwelling bats, regional Bat Conservation Strategy, and continuation of the regional cave and mine closure to control incidental human disturbance. Research has shown that these species are highly opportunistic and while associated with many forest habitats, they tend to utilize areas on the landscape where trees with naturally exfoliating bark or snags in early stages of decay are present. Proximity to open woodland conditions and water for foraging are also important.

As discussed above, conditions within caves and abandoned mines improve under all alternatives because the planning framework specifically addresses mitigating white-nose syndrome through several plan components (e.g. PAD-DC-06, PAD-S-08, PAD-S-09, PAD-S-10, PAD-S-11, PAD-S-12). Similarly, as discussed above, snag retention and recruitment are expected to improve under all alternatives.

Table 94 relates objectives within the proposed forest plan revision for actions that could affect habitat for forest-dwelling bats. These effects are always temporary (i.e., there is no anticipated permanent loss of forest habitat on the Forests) and often short-term negative effects contribute to long-term recovery. For example, short term effects of prescribed fire on maternity roosting bats are mitigated through timing and temperature restrictions. These mitigations are necessary to continue to move towards the long-term goal of species persistence and recovery (i.e., healthy and resilient forest habitats). These mitigative actions are addressed as plan components above.

**Table 94. Forest Management Activities that Could Temporarily Negatively Affect Habitat for Forest-Dwelling Bats Without Mitigative Measures**

Plan Component	Activity	Tier 1 (acres)	Tier 2 (acres)
ECO-O-02	timber harvest	1,200	3,200
ECO-O-03	forest stand improvement	6,000	12,000
ECO-O-04	thinning	400	600
ECO-O-05	thin/burn	600	900
ECO-O-06	Rx burn	20,000	45,000

Table 94 summarizes forest management activities with the potential to affect bat habitat. Other forest activities (e.g. road and trail construction, facility construction and maintenance, etc.) are proposed in relatively small amounts and could affect bat habitat in very small, practically immeasurable, amounts. Activities at this scale are analyzed specifically at the project level.

Under Tier 1, if the upper end of the range of activities described in objectives is accomplished in a given year, that would equate to 28,200 acres of timber harvest and prescribed fire implemented in a single year. Note that this is not likely to be new areas each year; some acres will receive repeated burns, particularly where prescribed fire or timber stand improvement activities are occurring. Further, it is not anticipated that reaching the upper end of both activities would occur regularly, as this represents a large increase in the pace and scale compared to current activity levels. However, for purposes of the most conservative estimation of potential effects of forest management on forest-dwelling bats, if one assumes 28,200 acres of annual activity, then approximately 2.7% of the forest could experience temporary changes in forest-dwelling bat habitat quantity and quality. Plan components and conservation measures identified above minimizes these effects almost entirely. Additionally, natural aging of managed stands further mitigates temporary effects to bat habitat.

Similarly, under Tier 2, approximately 6% of the forest could experience temporary changes in forest-dwelling bat habitat quantity and quality. Plan components and conservation measures identified above mitigate these effects almost entirely. Additionally, natural aging of managed stands further mitigates temporary effects to bat habitat.

All forest-dwelling bats require diverse, healthy habitats to persist, which is the major tenet of the proposed revised forest plan. Therefore, it is important to keep long-term benefits to forest-dwelling bats in mind, while effectively minimizing and/or mitigating potential short-term effects. This is precisely what is proposed through the plan components and conservation measures outlined in this assessment.

### Cumulative Effects

When these actions are put into perspective across the landscape (specifically across the estimated range for northern long-eared, Indiana bat, little brown, and tricolored bats within Western North Carolina), it is apparent that species' persistence at this larger scale is related to the persistence of quality foraging and roosting habitat across the Forests. It is assumed that land uses on other ownerships will continue to affect the quality and quantity of foraging and roosting habitat for this species, positively and negatively. Therefore, it is important that foraging habitat quality and quantity for Indiana and northern long-eared bats on Forest lands be optimized consistent with the revised forest plan.

### Conclusions

Persistence of northern long-eared, Indiana, little brown, and tricolored bats in western North Carolina is largely dependent on maintaining suitable roosting and foraging habitat and mitigating the potential threat of white-nose syndrome. This analysis shows that the Nantahala and Pisgah NFs will continue to

contribute to improved foraging and roosting habitat for these species and contribute to the persistence of the species across its estimated range in western North Carolina in the long term, while effectively minimizing or mitigating short-term effects. No additional conservation measures are needed beyond those outlined in previous sections of this assessment for northern long-eared, Indiana, little brown, and tricolored bats.

### **3.3.4.3 Rusty-Patched Bumblebee (*Bombus affinis*)**

#### **Affected Environment**

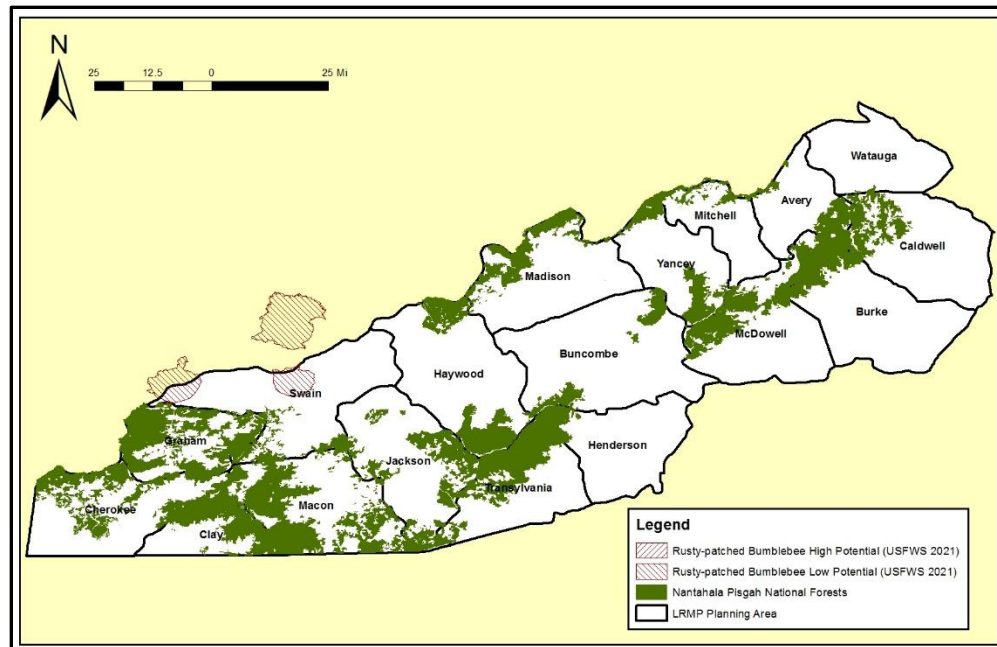
Rusty-patched bumblebee (RPBB) was very widespread in eastern and central North America but has recently (mid-late 1990s) suffered severe declines in number of occurrences, relative abundance, and an estimated 40% loss in occupied range. Historically, this species was broadly distributed in the northeastern United States and adjacent Canada, in the eastern temperate and boreal forest regions, north to southern Quebec, Ontario, and Maine; south in a narrow band along the Appalachian Mountains to the northeast corner of Georgia, and west to the margin of the Great Plains in eastern North Dakota, South Dakota, Minnesota, and Iowa (Williams et al. 2014). Very recently, an increase in observations may reflect conservation and monitoring efforts following widespread publicity of this species imperilment rather than a change in status (NatureServe 2021).

Historically, rusty-patched bumblebee was found across much of North Carolina, including nearly every county within the Nantahala and Pisgah NFs, but has not been detected since 2004. Current efforts by the USFWS are underway to re-document the species in Western North Carolina following successful efforts in neighboring states.

The species was listed as endangered in January 2017 (Federal Register 82: 3186-3209). There is no critical habitat designated for this species.

Rusty-patched bumblebee is usually associated with forest openings and woodlands, urban parks, and gardens (Williams et al. 2014). Food plants include *Aesculus*, *Agastache*, *Dalea*, *Eupatorium*, *Helianthus*, *Impatiens*, *Lonicera*, *Monarda*, *Prunus*, *Solidago*, and *Vaccinium* (Williams et al. 2014).

This species is threatened by disease (from the pathogen *Nosema bombi*), pesticide use, and habitat loss and fragmentation, each of which could cause extirpation because of perilously low estimated population levels (NatureServe 2021).



**Figure 79. Estimated potential for occurrence of rusty-patched bumblebee in western North Carolina, Nantahala and Pisgah NFs, as summarized from USFWS (2021).**

Climate change may also pose a threat to the continued survival of bumblebees, including the rusty-patched bumblebee (Kerr et al. 2015). Climatic changes that are expected to have the most significant effects on bumblebee populations include: increased temperature and precipitation, increased drought, increased variability in temperature and precipitation extremes, early snow melt and late frost events. These changes may lead to increased pathogen pressure, decreased resource availability (both floral resources and hibernacula) and a decrease in nesting habitat availability due to changes in rodent abundance or distribution (Cameron et al. 2011). Changes in the distributions of plants visited by bumblebees have been correlated with a changing climate (Forrest et al. 2010, Inouye 2008), which can cause phenological asynchrony between bumblebees and the plants they use (Memmott et al. 2007, Thomson 2010, Kudo et al. 2004).

As mentioned earlier, the USFWS continues to monitor historically occupied rusty-patched bumblebee habitats, in hopes of reestablishing known occurrence of the species in Western North Carolina.

### Environmental Consequences

Plan components addressing larger ecosystem conditions discussed above (e.g., woodlands, forest edges) encompass habitat requirements for rusty-patched bumblebee and are described in other parts of this analysis (e.g. ecozone, species group and unique habitat subsections). In addition, Appendix C summarizes key characteristics and indicators of the following ecozones, unique habitats and species groups within the Ecological Sustainability Evaluation that include rusty-patched bumblebee:

- Dry and Dry-mesic Oak Forests (Ecozone),
- Northern Hardwood Forests (Ecozone),
- Pine-oak Heath Forests (Ecozone),
- Spruce-fir Forest (Ecozone),
- Southern Appalachian Bogs (Unique Habitat),

- Grassy Balds (Unique Habitat),
- Low Elevation Glades (Unique Habitat),
- Serpentine Woodlands (Unique Habitat),
- Forest Edge and Transition Associates (Species Group),
- Mature and Old Growth Forest Associates (Species Group),
- Woodland Associates (Species Group), and
- Young Forest Associates (Species Group).

These indicators include things such as canopy composition, young forest, mature forest, old growth forest, and open woodland condition, edge forest, and canopy gaps. Environmental consequences were estimated for each of these indicators, for each proposed alternative, and are presented in Appendix C.

EIS Appendix C also summarizes plan components directly or indirectly related to the protection, enhancement, or restoration of habitat for terrestrial animal species, including federally listed species such as rusty-patched bumblebee, via association with one or more of the coarse filter elements above. These plan components range from very broad direction applicable to the whole forest or ecozone to restore or enhance conditions on the landscape, to specific direction for habitat elements associated with RPBB. These efforts contribute to maintaining persistence and facilitating recovery of the species.

Table 95 displays the cumulative assessment of the proposed planning framework (i.e., mitigation and management constraints, as well as habitat enhancement and restoration) on rusty-patched bumblebee, by alternative. Specifically, this table reflects species' estimated health and resilience on Forest Service land. All of the alternatives include plan components to directly or indirectly enhance and/or restore habitat for federally listed species, including the rusty-patched bumblebee, on the Nantahala and Pisgah NFs (Appendix C).

**Table 95. Ecological Sustainability Scores for Ecosystems and Species Groups Relevant to Rusty-Patched Bumblebee (NPESE 2021).** Red = poor, yellow = fair, light green = good, and dark green = very good

Element Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Dry-Oak Forest																			
Dry-mesic Oak Forest																			
Forest Edge/Transition																			
Grass Balds																			
Low elevation glade																			
Northern Hdwd Forest																			

Element Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Pine-oak Heath Forest																			
Serpentine Woodland																			
Shrub Balds																			
Southern App Bogs																			
Spruce-fir Forest																			

\*Table legend: E: Existing Condition, Alternatives: A, B, C, D, numbers 1 and 2 after alternatives indicate Tier 1/Tier 2 objectives. Red = poor; yellow = fair; light green = good; dark green = very good.

In addition to the summary presented above, please refer to the detailed discussion of potential effects to young, old, and open forest conditions at 3.3.2.2. Forestwide Structure as it is relevant to rusty-patched bumblebee.

Ecological Sustainability Evaluation modeling for the Nantahala and Pisgah Forest Plan Revision shows that conditions for rusty-patched bumblebee generally improve over existing condition under all alternatives except Alternative A. Most habitats remain or improve to “good” or “very good”, except low elevation glades, open (woodland) forest conditions, and pine-oak heath forests. These habitats remain “fair” and may represent the least suitable areas for rusty-patched bumblebee, based on current inventory efforts across the southeast (Bryan Tompkins, USFWS, personal communication). These generally improving trends are an indication of the overall intent of the proposed planning framework to improve forest health and resiliency, therefore improving wildlife habitat across the Forests (Alternative A represents the current planning framework).

Major threats to this species, such as disease and climate change are outside of Forest control. The revised forest plan is centered on a framework that promotes overall forest health and resiliency, thereby reducing further threat to rusty-patched bumblebee on the Forests.

## Cumulative Effects

When these actions are put into perspective across the landscape (specifically, across the estimated range for rusty-patched bumblebee within western NC), it becomes apparent that species’ persistence at this larger scale is related to the presence of quality habitat on the Forests. Threats from private land development, acidic deposition, and climate change will continue to affect rusty-patched bumblebee and are out of Forest Service control. Therefore, it is important that habitat quality and quantity for rusty-patched bumblebee on the Forests be optimized. The revised forest plan ensures this. Future inventory efforts will determine whether or not the species is still present on the Forests.

## Conclusions

This analysis summarizes potential improvements to habitat for rusty-patched bumblebee on Forest Service lands under the revised forest plan. Additionally, both the Forest Service and USFWS are

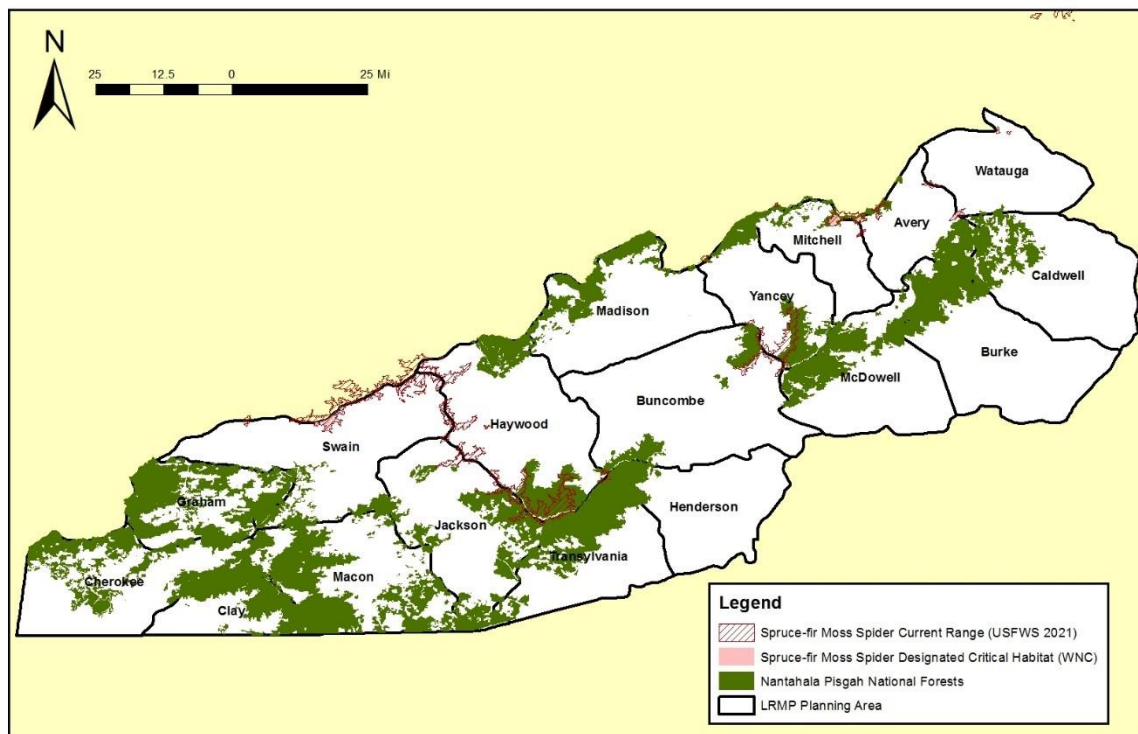
prioritizing inventory for this species on the Forests to better assess species presence (or potential presence) in the planning area.

### 3.3.4.4 Spruce Fir Moss Spider (*Microhexura montivaga*)

#### Affected Environment

The spruce-fir moss spider (SFMS) is historically known from four mountain peaks in Western North Carolina and one in eastern Tennessee (Coyle 1981). While recent inventory efforts have expanded this range slightly, the spruce-fir moss spider remains one of the most range-restricted, environmentally vulnerable species on the Forests - limited to spruce-fir forests along six geographically isolated mountain ranges (USFWS 2021).

The species was listed as endangered in February 1995 (Federal Register 60: 6968-6974). Critical habitat for the spruce-fir moss spider was designated in July 2001 (Federal Register 66: 35547-35566) and includes parts of the Nantahala and Pisgah NFs. In North Carolina, this species is known from a handful of sites across the Forests and is almost always present in low numbers (Figure 80). Coyle (2009) describes the most recent SFMS occupied habitat and range assessment. In April 2021, the North Carolina Natural Heritage Program (NCNHP) identified 71 known occurrences of the SFMS in North Carolina. Eighteen (25%) of these are from the Forests.



**Figure 80. Estimated current range of and designated critical habitat for the spruce-fir moss spider in western North Carolina, as summarized from USFWS (2021)**

Spruce-fir moss spider lives in high-elevation spruce-fir forest communities on moist, but well-drained moss mats growing on rocks and boulders in well-shaded locations. *Dicranodontium* mosses and *Bazzania* liverworts often dominate most bryophyte mats supporting spruce-fir moss spider.

Microhabitat requirements of this species are not met by many rock outcrops, even those covered by bryophytes. Often, large areas of outcrop surface, even on northerly facing outcrops, are devoid of bryophyte mats. Additionally, rock surfaces covered by thick wet mosses (like *Sphagnum*), or relatively

thin and dry bryophyte mats, do not support spruce-fir moss spider. Suitable bryophyte mats almost always have two structural features: 1) a layer of moist soil and/or humus between the moss and the rock surface, and 2) a mat that is at least 20 mm thick. Presence of *Dicranodontium* and *Bazzania* does not guarantee the occurrence of spruce-fir moss spider.

The primary threat to spruce-fir moss spider is loss of habitat due to the decline of red spruce and Fraser fir. Reasons for this decline include the balsam woolly adelgid, climate change, and regional-scale air pollution (acidic deposition) (USFWS 2021). Other potential threats include land use history (past logging and subsequent fires in the Southern Appalachians), vulnerability to extirpation from a single event or activity (i.e. drought, wildfire, or timber harvesting), and human trampling/disturbance of the moss mats and surrounding vegetation shading the moss mats (USFWS 1998). Potential effects of trampling and disturbance are of particular concern to this species within the Forests.

The USFWS continues to monitor spruce-fir moss spiders, although these efforts have not been consistent (i.e. not annual or regular) because searching can damage suitable habitat. The USFWS has been working to develop a long-term monitoring plan that will include frequent but regular surveys (USFWS 2021). The last large-scale effort almost doubled the known occupied range of the species, including a northward extension into southwestern Virginia (Coyle 2009).

### **Environmental Consequences**

Plan components addressing larger ecosystem conditions discussed above (e.g., spruce-fir forest, seeps) encompass habitat requirements for spruce-fir moss spider and are described in other parts of this analysis (e.g. ecozone, species group and unique habitat subsections).

Spruce-fir moss spider is associated with the following coarse filter elements (ecozones, unique habitats, and species groups) within the Ecological Sustainability Evaluation:

- Spruce-fir Forest (Ecozone),
- Northern Hardwood Forest (Ecozone, included to mitigate mapping error),
- High Elevation Red Oak Forest (Ecozone, included to mitigate mapping error),
- Mesic Oak Forest (Ecozone, included to mitigate mapping error),
- Rich Cove Forest (Ecozone),
- Seeps (Unique Habitat), and
- Closed Canopy Forest Associates (Species Group).

EIS Appendix C summarizes key characteristics and indicators of these ecosystems, and species groups within the Ecological Sustainability Evaluation. These indicators include things such as canopy composition and density, young forest, mature forest, old growth forest, and open woodland condition, road density, and effects of balsam woolly adelgid. Environmental consequences were estimated for each of these indicators, for each alternative, and are presented in EIS Appendix C.

The Closed Canopy Forest Associates element is a general assessment of forest-wide canopy cover across the Forests, and not specific to areas suitable for spruce-fir moss spider. This analysis considers this situation and focuses specifically on canopy condition within spruce-fir forests. Similarly, the Seeps element represents a unique habitat that is scattered across the Forests—this analysis addresses them as relevant to the spruce-fir moss spider, and not forest-wide.

Additionally, mesic oak and rich cove forests generally occur at elevations too low to be suitable habitat for the spruce-fir moss spider. These ecozones were initially included here to mitigate for ecozone modeling error (i.e., not all areas of the PNV model have been ground-truthed). However, after examining known occurrences of the species in relation to these estimated ecozones, they will not be included in the potential environmental consequences section below. There are no known occurrences of spruce-fir moss spider within the estimated mesic oak and rich cove ecozones on the forests;



therefore, species association with these coarse filter elements is low within the ESE analysis. Seeps are included here, although the species association is low. SFMS prefers areas of higher moisture associated with exposed moss-covered rocks, which are characteristics of high elevation seeps.

EIS Appendix C summarizes plan components directly or indirectly related to the protection, enhancement, or restoration of habitat for terrestrial animal species, including federally listed species such as the spruce-fir moss spider, via association with one or more of the coarse filter elements above. These plan components range from very broad direction applicable to the whole forest or ecozone to restore or enhance conditions on the landscape, to specific direction for habitat elements associated with the spruce-fir moss spider. These efforts contribute to maintaining persistence and facilitating recovery of the species.

Appendix C identifies four hundred and eighteen plan components that directly or indirectly support healthy and resilient habitat conditions across the Forests in places and ecozones associated with the spruce-fir moss spider. In addition, eight of these components specifically address and prioritize habitat conditions for spruce-fir moss spider (Table 96). These plan components serve specifically as conservation measures for spruce-fir moss spider on the Forests. It is important to remember that restoring and maintaining healthy and resilient forests across the landscape is a primary goal of the revised forest plan.

**Table 96. Plan Components Specifically Addressing Habitat Conditions for and/or Persistence of Spruce-Fir Moss Spider on the Nantahala and Pisgah NFs**

Component	Language
PAD-S-15	Within spruce-fir and northern hardwood forests, maintain a 100' canopy tree buffer around rock outcrops and boulders in appropriate habitat for spruce-fir moss spider and rock gnome lichen. If structural or compositional restoration needs are identified within this area, appropriate field surveys and consultation with the USFWS to design and implement projects to meet multiple objectives shall be conducted.
RM-S-01	Within designated critical and suitable habitat for the spruce-fir moss spider, human access is minimized. All recreation facility development is prohibited to minimize habitat desiccation or loss of habitat quality. Development of new trails or trail relocation is contingent upon coordination, and if needed, consultation with U.S. Fish and Wildlife Service.
BAM-GLS-05	Emphasize restoration of spruce-fir habitat for the Carolina northern flying squirrel and spruce-fir moss spider and maintain the health and resiliency of this forest type in the face of climate change.
BLM-GLS-01	Emphasize restoration of spruce-fir habitat for the Carolina northern flying squirrel and spruce-fir moss spider and maintain the health and resiliency of this critical forest type in the face of climate change.
GB-GLS-01	Conserve and restore high elevation red oak forests, northern hardwood forests, spruce-fir forests, and mesic oak forests. Emphasize restoration of spruce-fir habitat for the Carolina northern flying squirrel and spruce-fir moss spider and maintain health and resiliency of this forest type in the face of climate change.
NS-GLS-03	Emphasize restoration of spruce-fir and northern hardwood forests for the northern flying squirrel, spruce-fir moss spider, and rock gnome lichen, and maintain health and resiliency of these critical forest types in the face of climate change.

Table 97 displays the cumulative assessment of the proposed planning framework (i.e., mitigation and management constraints, as well as terrestrial habitat enhancement and restoration) on spruce-fir moss spider. Specifically, this figure reflects species' estimated health and resilience on Forest Service land under all alternatives.

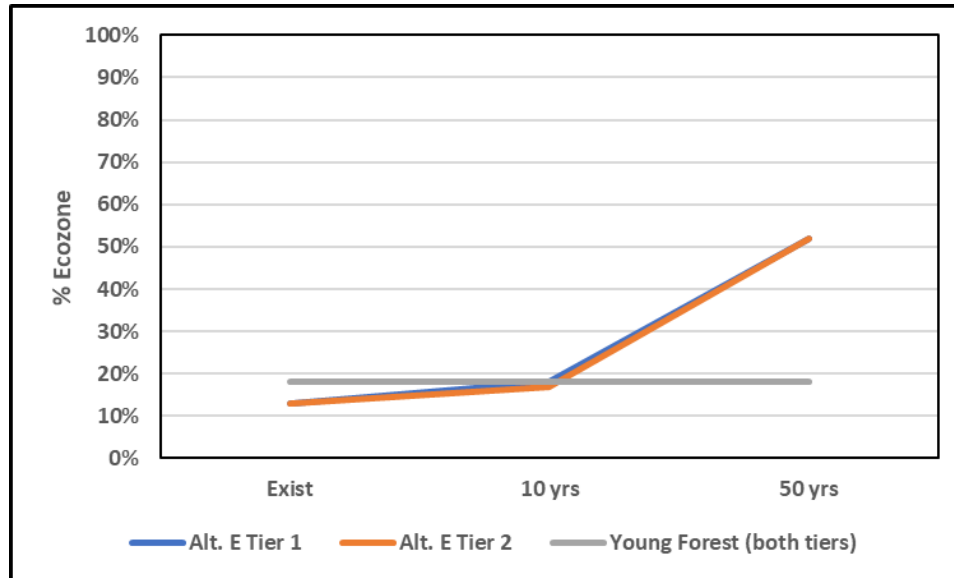
**Table 97. Ecological Sustainability Scores for Indicators Representing Forest Service Ownership Within Coarse Filter Elements Supporting Spruce-Fir Moss Spider on the Nantahala and Pisgah NFs (NPSE 2021). Red = poor, yellow = fair, light green = good, and dark green = very good**

Element Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Spruce-fir forest																			
Northern Hdwd. Forest																			
High Elevation Red Oak Forest																			
Mesic Oak Forest																			
Rich Cove Forest																			
Seeps																			
Closed Canopy Forest Associates																			

Ecological Sustainability Evaluation modeling for the Nantahala and Pisgah Forest Plan Revision shows that conditions for spruce-fir moss spider improve (slightly) over existing conditions under all alternatives. This species is most closely associated with spruce-fir forests, which improve from “good” to “very good” under all alternatives, and specifically with closed canopy forest associates in this ecozone. To a lesser extent, spruce-fir moss spider is associated with adjacent ecozones (e.g., northern hardwood and high elevation red oak forests), where conditions remain or improve to “fair” or good” under all alternatives. There is no emphasis on forest management in northern hardwood or high elevation red oak forests that threatens adjacent spruce-fir forests within the revised forest plan. In fact, restoration of spruce-fir forests is a primary goal of the revised forest plan. This generally improving trend is an indication of the overall intent of the proposed planning framework to improve forest health and resiliency, therefore improving wildlife habitat across the Forests.

Within Table 97, spruce-fir forest, and specifically closed canopy forest associates within this ecozone are the most highly associated habitats for spruce-fir moss spider. The other coarse filter elements are associated mostly as they are related to landscape position and adjacency to spruce-fir forest. Figure 81 summarizes predicted trends in this indicator within spruce-fir forests under Alternative E, but the trend is the same for all alternatives.

Figure 81 also displays predicted young forest conditions within the spruce-fir ecozone over time to demonstrate that conditions for spruce-fir moss spider are expected to improve on the Forests (i.e., the forest will continue to age and increase in the amount of closed canopy condition). Young forest conditions are expected to remain approximately the same over time although specific occurrence across the landscape will vary under natural disturbance regimes and as the forest ages.



**Figure 81. Trends in mature/old growth forest (as a surrogate for closed canopy conditions) within the spruce-fir ecozone on the Forests**

It is not likely that forest management in terms of timber harvest or prescribed fire will influence spruce-fir moss spider under any alternative. This is supported by the fact that approximately 11% of the spruce-fir ecozone is within Management Area Group 1 (Matrix and Interface, MA Group 1). MA Group 1 is where an estimated 90% of active forest management will occur (across the landscape, not specifically within the spruce-fir ecozone); however, risk or potential impacts to SFMS from active management is low since such a small proportion of suitable habitat is within MA Group 1. Additionally, spruce-fir forests are generally too moist to burn during prescribed fire and because fire is not a natural part of these systems, this habitat is rarely included in prescribed fire burn blocks.

The revised forest plan emphasizes restoration of spruce-fir forests (ECO-O-07), which will benefit the spruce-fir moss spider. These activities will involve site-specific silvicultural activities to improve the health and resilience of spruce-fir forests. During these activities, all strategies and constraints to avoid short-term effects to spruce-fir moss spider and associated habitat will be implemented (see Table 96 above, and specifically PAD-S-15).

#### **Effects of recreational use of the forest on spruce-fir moss spider**

Most recreation takes place on system roads and trails. For this analysis, existing open roads and trails were buffered by 100 meters to include off-road/trail exploration. Developed recreation areas not encompassed by this buffer were also included. This area represents the highest potential for direct or indirect effects of recreational use of the Forests on rare animals.

Some species groups are more susceptible to direct effects of recreation, such as being crushed by a vehicle (including bicycles) or trampled by foot traffic (including horse traffic). Spruce-fir moss spider is generally less mobile, and has a small occupied range, and is therefore more susceptible to not being able to escape human disturbance.

Known occurrence of rare animals was intersected with the buffered roads and trails polygon to estimate the proportion of known occurrences potentially subjected to recreational impacts. Persistence of rare animal species with greater than 50% of known occurrences within 100 meters of a road or trail is particularly susceptible to potential effects of recreational use. Spruce-fir moss spider is one of these species. Approximately 60% of known occurrences of spruce-fir moss spider are within 100 meters of a trail or other high-use recreation site. It is recognized that there is still a lot to learn about this species and its occupied range in western NC.

Spruce-fir moss spider is particularly susceptible to habitat disturbance from trail use within its range, especially use that disturbs bryophyte mats on or at the base of rocks. There are no known occurrences of this species within or adjacent to Forest roads. Areas of high susceptibility of spruce-fir moss spider to recreational impacts include Roan Mountain and Mount Mitchell, and especially where high elevation trails are adjacent to suitable habitat. In these areas, uncontrolled recreation and growth could result in local extirpation of spruce-fir moss spider. The revised forest plan includes a standard to maintain a 100' canopy tree buffer around rock outcrops and boulders in appropriate habitat for spruce-fir moss spider and rock gnome lichen (PAD-S-15).

In addition to potential effects discussed above, a primary threat to spruce-fir moss spider from recreation use on the Forests, especially at high elevations, is increasing use of undesignated, or "social" trails. The revised forest plan addresses managing for sustainable recreation as a major theme of the revised forest plan. If specific threats from this type of recreation become an issue for spruce-fir moss spider, potential effects can be mitigated through forest supervisor closure orders, increased law enforcement, and other local administrative efforts. The revised Forest Plan includes plan components to minimize and mitigate potential effects of recreation on ecological integrity, including federally listed species such as the spruce-fir moss spider (PAD-S-15, and REC-S-08).

#### **Effects of acidic deposition and climate change on spruce-fir moss spider**

In addition to the analysis of potential effects outlined above, the following summary addresses the potential for effects of acidic deposition and climate change on spruce-fir moss spider. USFWS (2021) identifies climate change as the primary threat to the continued existence of spruce-fir moss spider and discusses this subject in detail. These environmental stresses are outside the control of the Forest Service; however, it is recognized that they are primary stressors for many species, including spruce-fir moss spider. Twenty-five percent of the known occurrence of this species is on the Forests; therefore, maintaining and restoring overall forest health and resiliency on the Forests plays a measurable role in the persistence and recovery of this species.

High elevation environments will feel the effects of climate change and acidic deposition first, and perhaps, most when compared to lower elevations. This summary addresses climate change from an increased air/water temperature and acidic deposition over time, specifically for species associated with higher elevations. Species such as spruce-fir moss spider are more susceptible to direct and indirect effects of climate change and acidic deposition, because most of its known occurrences are within high elevation habitats, it has a small occupied range at higher elevations, and is generally less mobile.

Without plan components to protect and conserve rare species, persistence of rare animal species with greater than 50% of known occurrences within high elevation habitats is particularly susceptible to potential effects of environmental stressors like climate change and/or acidic deposition. Spruce-fir moss spider is one of these species. All known occurrences of spruce-fir moss spider are associated with high elevation habitats. The proposed planning framework is centered around restoring healthy and resilient forests, which will help buffer effects of climate change in the future.

At the smaller habitat scale, spruce-fir moss spiders are extremely sensitive to microclimate conditions such as forest floor temperature and moisture, and pH. Plan components to protect unique habitats and

streamside forests are present in the revised forest plan (see Table 96, specifically SZ plan components). The plan also includes direction that requires project-specific surveys for rare species when existing data and knowledge is insufficient to make sound management decisions (PAD-S-03, PAD-S-15).

Designated critical habitat identifies specific areas that are essential to the conservation of a listed species and that may require special management considerations or protection. The ESA requires federal agencies, in consultation with the USFWS, to ensure that management activities are not likely to jeopardize the continued existence of an endangered or threatened species or result in the destruction or adverse modification of critical habitat.

Critical habitat for spruce-fir moss spider was designated on July 6, 2001. This habitat is described in detail in the formal designation and other listing documentation (e.g. species recovery plan, status updates, etc.). Additionally, the recovery plan for the species, and subsequent status assessments describe habitat for spruce-fir moss spider, set recovery milestones, and document range-wide movement towards (or away from) these conditions.

The ESA requires that designated critical habitat provide physical and biological features (primary constituent elements) essential to the conservation of the species and that may require special management considerations or protection. These physical and biological features include, but are not limited to, space for individual and population growth and for normal behavior; food, water, air, light, minerals, or other nutritional or physiological requirements; cover or shelter; sites for breeding, reproduction, and rearing of offspring; and habitats that are protected from disturbance or are representative of the historical, geographical, and ecological distribution of a species. These factors are deemed essential to the conservation of the species.

Based on the best available information concerning the habitat and life history of the spruce-fir moss spider, primary constituent elements essential for the conservation of the species include (Federal Register 66(130): 35547-35566):

1. Fraser fir or fir-dominated spruce-fir forests at and above 1,646 m (5,400 ft) in elevation, and
2. Moderately thick and humid, but not wet, moss (species in the genus *Dicranodontium*, and possibly *Polytrichum*) and/or liverwort mats on rock surfaces that are adequately sheltered from the sun and rain (by overhang and aspect) and include a thin layer of humid soil and/or humus between the moss and rock surface.

These elements, plus the importance of spruce-fir and pure spruce forests, are addressed in USFWS (2021), which represents to most current evaluation of the status of this species. Additionally, the analysis presented above for spruce-fir moss spider also applies to designated critical habitat for the species and generally encompasses key habitat requirements listed above. Therefore, no additional analysis is needed for this forestwide (programmatic) assessment. Specific habitat characteristics, including those listed above, will be addressed at the project level. This programmatic assessment does not alleviate the NEPA and ESA requirements to document project-specific potential effects.

Approximately 36% of designated critical habitat for spruce-fir moss spider is in western North Carolina. The balance is in eastern Tennessee. Twenty-one percent of designated critical habitat for spruce-fir moss spider is within the Nantahala and Pisgah NFs.

### **Cumulative Effects**

When these actions are considered across the landscape (specifically, across the estimated range for spruce-fir moss spider within Western North Carolina), it is apparent that species' persistence at this larger scale is directly related to habitat quality and quantity on the Forests. Threats from acidic deposition and climate change will continue to affect spruce-fir moss spider under all alternatives and

are out of Forest Service control. Potential effects of recreation use (i.e., trampling) will continue, although mitigated by the revised forest plan framework. Most of the range of this species in western North Carolina is in state or federal ownership. It is assumed that responsible land and resource management will continue on these ownerships.

### **Conclusions**

This analysis shows that potential improvements on Forest Service lands and overall maintenance and restoration of forest health and resiliency will continue to contribute to quality habitat for spruce-fir moss spider on the Forests, and that the species will continue to persist across its estimated range on the Forests. Specifically, existing trails and social trails are an issue for SFMS, and the proposed revised forest plan has elements to reduce impacts from trails. Additionally, restoration of spruce-fir forests will help improve conditions and create resiliency against climate change and little, if any, active management (timber harvest, prescribed burning) will occur within spruce-fir forests. It is important to remember that the Forests represent approximately 25% of the known occurrences of the species.

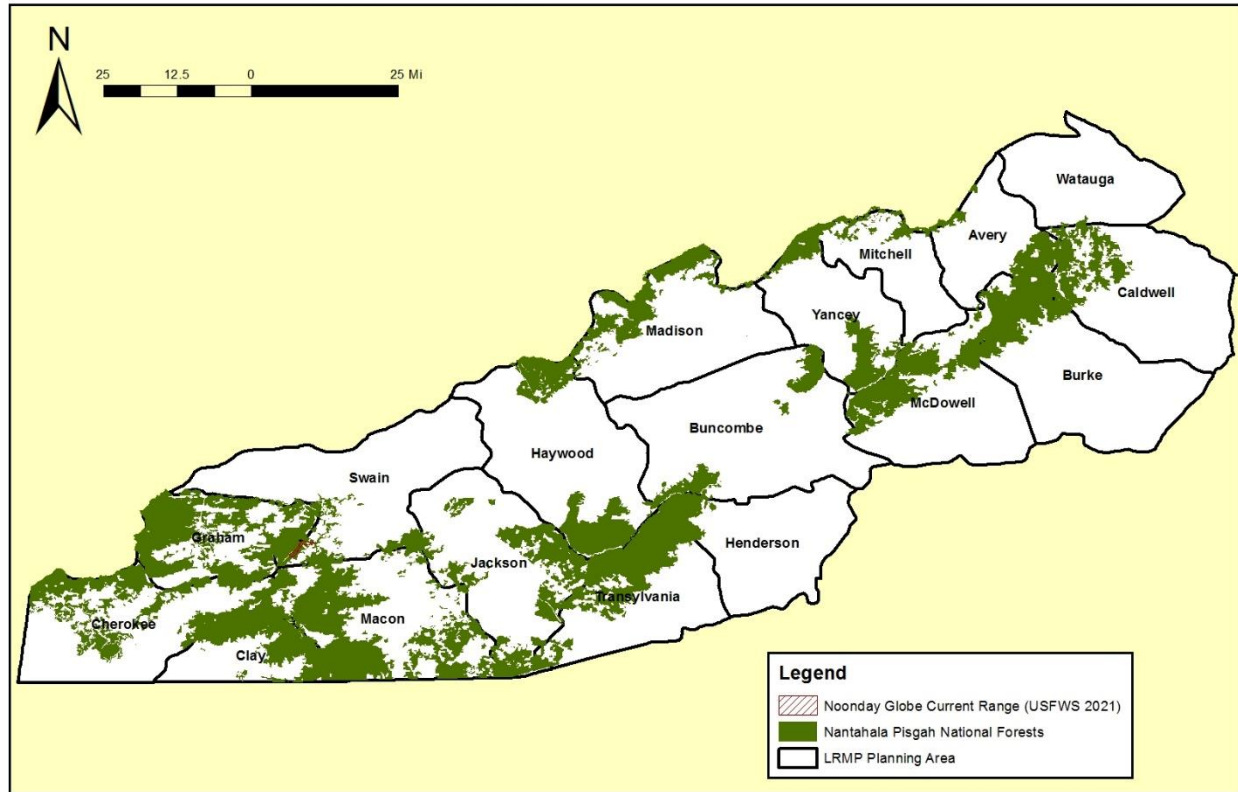
This analysis concludes that designated critical habitat for spruce-fir moss spider, as represented by potential effects of the proposed planning framework on species' habitat conditions analyzed with the ESE and other analyses, will continue to persist on Forest Service lands where relevant. In fact, it is possible that habitat conditions for spruce-fir moss spider will improve on the Forests under all alternatives, including relevant designated critical habitat.

#### **3.3.4.5 Noonday Globe (*Patera clarki nantahala*)**

##### **Affected Environment**

The noonday globe is a snail endemic to a small area in western North Carolina within and immediately adjacent to the Nantahala NF. Within this small area, the species is frequently found in steep terrain, often on ground characterized by talus slopes or sheer cliff faces associated with mesic conditions interrupted frequently by small streams and waterfalls. The distribution of noonday globe snail within its range suggests that it prefers basic soils in areas that are protected from direct sunlight by slope aspect and closed tree canopy.

The species was listed as threatened in February 1978 (Federal Register 43: 28932-28935). There is no critical habitat designated for this species. This species is estimated to occupy less than two square miles of the Nantahala NF and to have a population in the few tens of thousands (Jason Mays, USFWS, personal communication). Very little is known about the life history of this species.



**Figure 82. Estimated current range of noonday globe in western North Carolina, as summarized from USFWS (2021)**

The noonday globe was likely never widely distributed. Steep wet slopes with calcareous rocks are rare in western North Carolina. However, the species was likely somewhat more widely distributed within the gorge before the gorge was altered for a railroad and highway. The associated loss of the forest canopy allowed more sunlight to penetrate the gorge and likely dried the lower slope of the gorge. This habitat alteration also allowed such non-native plants as kudzu and Japanese honeysuckle to invade some roadside areas, changing the area’s natural plant and animal community (NatureServe 2021).

Prior to 2016, it was assumed that a primary threat to this species’ persistence was wildfire (and associated drying effects). During November 2016, the Nantahala Gorge experienced historic wildfires, burning entirely across the known range of noonday globe. Snails are not highly mobile, and it is assumed that noonday globe was protected from these drying effects only by their association with moist substrates that generally do not burn as intensely as surrounding areas. It was the post-fire monitoring efforts that expanded the known range of the species that is recognized today. The USFWS and USFS continue to monitor noonday globe to further document species’ habitat and occupied range.

### Environmental Consequences

Plan components addressing larger ecosystem conditions discussed above encompass habitat requirements for noonday globe and are described in other parts of this analysis (e.g., ecozone subsections). In addition to these ecozones, Appendix C summarizes key characteristics and indicators of the following species groups within the Ecological Sustainability Evaluation (ESE) that include noonday globe:

- Acidic and Rich Cove Forests (Ecozone),
- Dry-mesic and Mesic Oak Forest (Ecozone),
- Northern Hardwood Forest (Ecozone).

- Calcareous Oak Walnut Forest (Unique Habitat),
- Carolina Hemlock Forest (Unique Habitat),
- Seeps (Unique Habitat), and
- Fire Intolerant Species (Species Group)

These indicators include canopy composition, young forest, mature forest, old growth forest, and open woodland conditions, road density, and fire frequency. Environmental consequences were estimated for each of these indicators, for each alternative, and are presented in EIS Appendix C.

Appendix C summarizes plan components directly or indirectly related to the protection, enhancement, or restoration of habitat for terrestrial animal species, including federally listed species such as noonday globe, via association with one or more of the coarse filter elements above. These plan components range from very broad direction applicable to the whole forest or ecozone to restore or enhance conditions on the landscape, to specific direction for habitat elements associated with noonday globe.

Three hundred and sixteen plan components directly or indirectly support healthy and resilient habitat conditions associated with noonday globe. In addition, the plan includes a goal in the Nantahala Gorge GA to maintain and restore intact forest habitat for the noonday globe (NG-GLS-02).

Table 98 displays the cumulative assessment of the proposed planning framework (i.e., mitigation and management constraints, as well as habitat enhancement and restoration) on noonday globe for Alternative E. Specifically, this table reflects species' estimated health and resilience on Forest Service land. All action alternatives include plan components to directly or indirectly enhance and/or restore habitat for federally listed species, including noonday globe, on the Nantahala and Pisgah NFs (Appendix C).

**Table 98. Ecological Sustainability Scores for Indictors Representing Forest Service Ownership Within Coarse Filter Elements Supporting Noonday Globe on the Nantahala and Pisgah NFs (NPESE 2021). *Red = poor, yellow = fair, light green = good, and dark green = very good***

Element Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Acidic Cove Forest																			
Rich Cove Forest																			
Northern Hardwood Forest																			
Calcareous Oak Walnut Forest																			

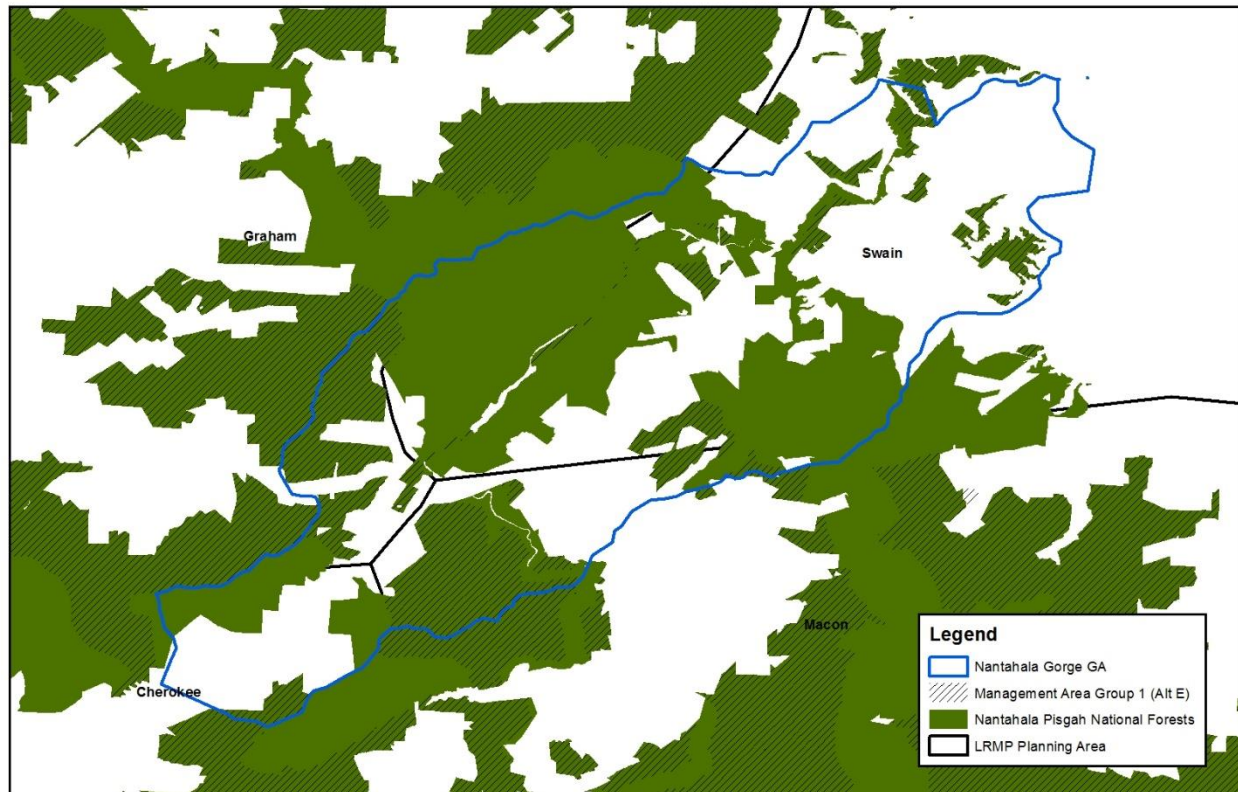


Element Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Seeps																			
Fire Intolerant Species																			

Ecological Sustainability Evaluation modeling for the Nantahala and Pisgah Forest Plan Revision shows that conditions for noonday globe generally improve over existing condition under all alternatives, although at the landscape level, rich cove, mesic oak, and dry-mesic oak conditions improve over time, but remain fair. Of particular importance for noonday globe are habitats supporting higher calcium levels in the soil and geology (e.g. calcareous oak-walnut forest) and conditions on the landscape for fire-intolerant species (NatureServe 2021). These scores remain “good” or “very good” under Alternative E. This is an indication of the overall intent of the proposed planning framework to improve forest health and resiliency, therefore improving wildlife habitat across the Forests.

Known distribution of noonday globe is limited to the Nantahala Gorge Geographic Area. Approximately 53% of this area is in Forest Service ownership. While the FS is a primary landowner, other land uses are also occurring in the area, including mining and heavy recreational development (whitewater rafting). The Nantahala River, a world-class whitewater boating experience, bisects this geographic area, and the area occupied by noonday globe. An active quartz mine (private ownership) is adjacent to areas known to be occupied by noonday globe.

Approximately 31% of the Forest Service ownership in the Nantahala Gorge Geographic Area is in Management Area Group 1 (Figure 83). MA Group 1 is where approximately 90% of active management (timber harvest, etc.) is expected to occur forest-wide (not just within the Nantahala Gorge GA). The remaining approximately 69% of Forest Service lands are in management areas where active management is not a primary focus. In fact, all currently known occurrences of noonday globe on the Forests are within the areas not proposed for active management under any action alternative of the revised forest plan.



**Figure 83. Nantahala Gorge Geographic Area in relation to areas of potential active management under Alternative E of the revised forest plan**

The area occupied by noonday globe was severely burned in 2016. It was the post-fire monitoring that expanded the known occupied range of the species. Following these fires, parts of the burned areas experiences landslides as fire-damaged vegetation decayed and the stability of the slopes became an issue. The threat of future landslides remains relevant to the persistence of noonday globe. The U.S. Fish and Wildlife Service and the Forest Service continue to monitor this species and mitigate potential losses from past and future landslides.

In addition to the analysis of potential effects outlined above, the following summary addresses the potential for effects of acidic deposition and climate change on noonday globe. These environmental stresses are outside the control of the Forest Service; however, it is recognized that they are primary stressors for many species, including noonday globe.

Effects of climate change and acidic deposition will be felt at higher elevations first, and perhaps, most. Some species are more susceptible to direct and indirect effects of climate change and acidic deposition, such as those where all or most known occurrences are within higher elevation habitats (i.e.  $\geq 2,500'$ ), especially those with small occupied ranges at higher elevations, and those that are generally less mobile. Noonday globe fits this description.

Without plan components to protect and conserve rare species, persistence of rare animal species with greater than 50% of known occurrences within higher elevation habitats is particularly susceptible to potential effects of environmental stressors like climate change and/or acidic deposition. Noonday globe is one of these species. Within the Nantahala Gorge, noonday globe is associated with areas supporting consistent moisture regime. Noonday globe is extremely sensitive to microclimate conditions such as forest floor temperature and moisture, and pH (NatureServe 2021). The forest plan includes plan components to protect unique habitats and streamside forests. The plan also includes a standard that

requires project-specific surveys for rare species when existing data and knowledge is insufficient to make sound management decisions (PAD-S-03, PAD-S-15).

### Cumulative Effects

When these actions are considered across the landscape (specifically, across the estimated range for noonday globe), it becomes apparent that species' persistence is directly related to habitat quality and quantity, and specifically to continuous tree canopy, on the Forests. The U.S. Fish and Wildlife Service and the Forest Service will continue to work cooperatively to identify and mitigate potential effects of existing and future landslides following the 2016 wildfires on noonday globe. Threats such as those from acidic deposition and climate change will continue to affect noonday globe across all alternatives and are out of Forest Service control.

### Conclusions

This analysis recognizes that despite recent increases in knowledge of the presence of the species on the landscape following the 2016 wildfires, there is still a paucity of information on the life history and habitat associations of this species. This analysis shows that despite potential improvements on Forest Service lands discussed above, and active species monitoring, this lack of knowledge of occupied habitats for noonday globe prohibits conclusions on species' recovery. The USFWS and USFS are actively working towards refining recovery trajectories for noonday globe. The species will continue to persist on the Forests under any alternative.

#### 3.3.4.6 Aquatic Wildlife Species

Within the Ecological Sustainability Evaluation watershed-level analysis, nine indicators were evaluated. These indicators, values, weights, and relevance to the revised forest plan are described in detail in EIS Appendix C. Three of these indicators do not affect the persistence or recovery of federally listed aquatic species and will therefore not be discussed in this assessment: 1) presence of brown or rainbow trout, 2) presence of chytrid, 3) presence of whirling disease or gill lice. Additionally, Asian clam (*Corbicula sp.*) has been present on the landscape for decades. While it likely affected freshwater mussels in the past, it is not seen as a limiting factor to the persistence and recovery of native mussels on the Forests.

Therefore, this analysis of potential effects of all alternatives on federally listed aquatic species will focus on five indicators of overall watershed health and resilience:

1. **Percent of watershed in agricultural or urban land uses.** This indicator represents potential for nonpoint source pollution such as sedimentation and other toxics across the watershed, regardless of ownership.
2. **Percent of riparian areas in forested land uses.** This indicator represent potential for changes in thermal regime across the watershed, regardless of ownership.
3. **Number of permitted discharges.** This indicator represents potential for point source pollution within the watershed, regardless of ownership.
4. **Riparian road and trail density** (open/designated routes). This indicator represents potential for sedimentation of aquatic habitats resulting from forest management. This threat (sedimentation) is long recognized as a primary stressor on aquatic populations. The revised forest plan specifically addresses this threat through identification of priority watersheds for resource restoration and numerous plan components to mitigate potential effects of forest management.
5. **Stream crossing and dam density.** This indicator represents hydrologic connectivity as it relates potential versus occupied aquatic habitat within the watershed. This threat (habitat connectivity) is long recognized as a primary stressor on aquatic populations. The revised forest

plan specifically addresses this threat through identification of priority watersheds for resource restoration and emphasis on providing aquatic organism passage.

This provides an opportunity to assess the Forest Service’s ability to affect overall species persistence across the landscape in the long-term on a landscape with fragmented ownership. Other analyses outside of the ESE will be referenced as appropriate.

### Appalachian Elktoe (*Alasmidonta raveneliana*)

#### Affected Environment

The Appalachian elktoe is a freshwater mussel endemic to the upper Tennessee River system in Western North Carolina and eastern Tennessee. This species once lived in most of the rivers and larger creeks of the upper Tennessee River system in North Carolina (except the Hiwassee and Watauga River systems—the species has never been recorded there). While recent inventory efforts have expanded the known range of the species in North Carolina, overall species’ range loss keeps the Appalachian elktoe in peril.

The species was listed as endangered in November 1994 (Federal Register 58: 46940-46945). Critical habitat was designated in September 2001 (Federal Register 67: 61016-61040). In North Carolina, this species is known from a handful of locations in the French Broad and Little Tennessee River basins, including parts of the Nantahala and Pisgah NFs (Figure 84).

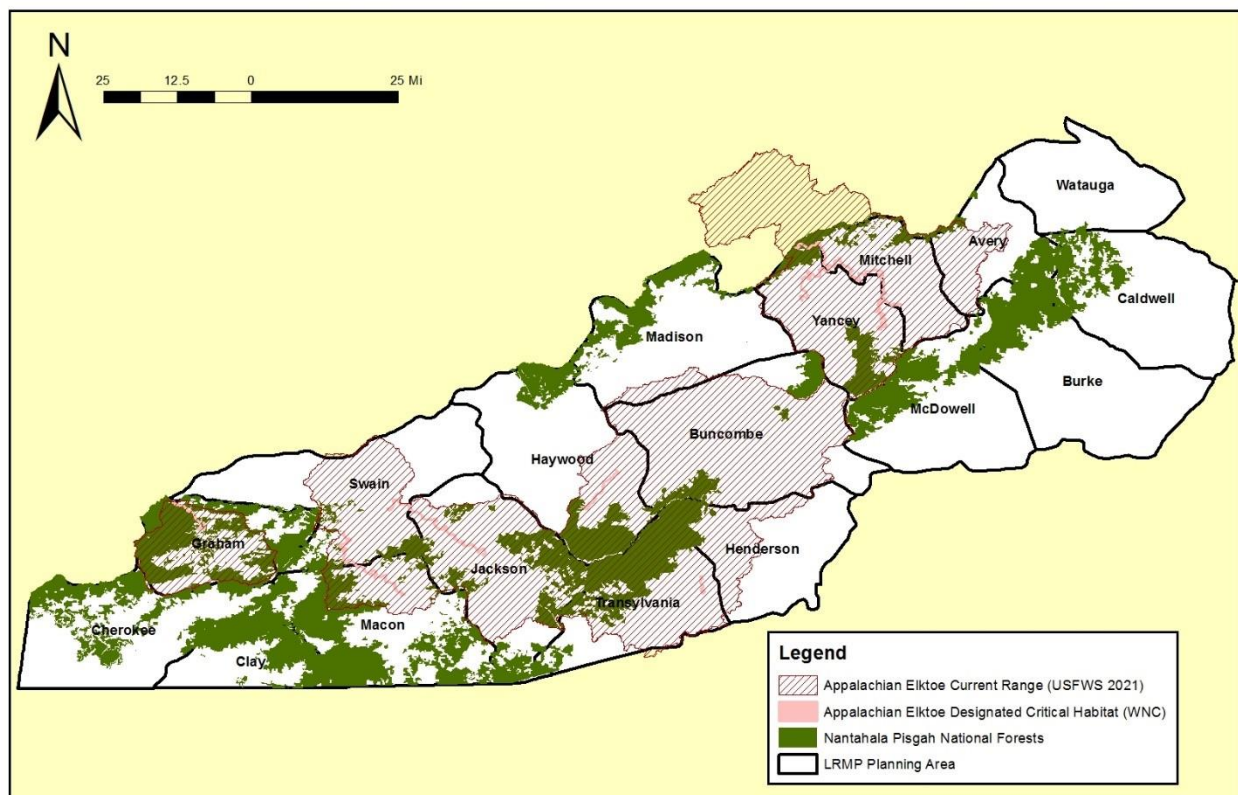


Figure 84. Estimated current range of and designated critical habitat for the Appalachian elktoe in Western North Carolina, as summarized from USFWS (2021)

Appalachian elktoe has been found in gravelly substrate, often mixed with cobble and boulder, or in cracks in bedrock. Water depths typically are shallow, with moderate to fast current. The species occupies shallow, medium-sized creeks and rivers with cool, well-oxygenated water, and is found most often in riffles, runs, and shallow pools with stable, silt-free, coarse sand and gravel mixed with cobble, boulders, or bedrock. Stability of substrate is critical (NatureServe 2021).

The main threats to the species are habitat loss and water quality deterioration from impoundments, industrial and municipal pollution, acid mine drainage, and siltation. However, some losses may be due to other changes in water and habitat quality since some populations have been extirpated from stream reaches that still contain mussel communities.

Most remnant Appalachian elktoe populations are small and isolated, which restricts the natural interchange of genetic material among populations. Small population sizes increase the chances of genetic variation loss due to genetic drift. The loss of genetic variation could adversely affect, over time, the species' ability to evolve and respond to natural habitat changes.

As filter feeders generally confined to the bottom of the stream or river, clean, free-flowing water is critical to the persistence of this species. Healthy, diverse fish communities are also important to the persistence of freshwater mussels, since many species of fish are larval hosts for freshwater mussels.

Freshwater mussels represent some of the rarest animals in the United States, including Western North Carolina. The U.S. Fish and Wildlife Service (USFWS), North Carolina Wildlife Resources Commission (NCWRC), and other partners (including the National Forests in North Carolina) have been monitoring freshwater mussel populations in Western North Carolina for decades. Although much has been learned about this group of species over the years, recent monitoring indicates that much more inventory effort is needed to fully document species' range. Some freshwater mussel species exist in such low numbers that years of combined sampling effort are often needed to confirm or deny species' presence. Maintaining persistence of these species within today's known (estimated) occupied range where it overlaps the Nantahala and Pisgah NFs is critical to species' persistence into the future.

### Environmental Consequences

Plan components addressing the larger ecosystem (watershed) conditions (e.g., watershed health) encompass habitat requirements for Appalachian elktoe. These components are described in the revised Forest Plan (e.g., watershed, water resources, and aquatic ecosystem subsections). Potential environmental consequences of the alternatives on watersheds supporting Appalachian elktoe are summarized below.

Table 99 summarizes land ownership within watersheds associated with Appalachian elktoe. This allows us to gauge the role and potential effectiveness of Forest Service management on federally listed aquatic species persistence and recovery. Overall, 28.78% of watersheds known to support Appalachian elktoe and its designated critical habitat in western North Carolina is in Forest Service ownership. Often, but not always, this ownership is in the headwaters and upper reaches of the watershed and not necessarily immediately adjacent to stream reaches suitable for Appalachian elktoe. Forest Service ownership is almost always fragmented on the landscape (i.e., Forest Service ownership is not continuous within the watershed, but rather, composed of multiple tracts of land of varying sizes). In this sense, activities on Forest Service lands are important to overall watershed health and resilience and the degree to which this can be influenced is related to the amount of Forest Service ownership present in relation to other land uses in the watershed.

**Table 99. Watersheds with at Least Some Forest Service Ownership Within the Known Range of and Designated Critical Habitat for Appalachian Elktoe in Western North Carolina**

	HUC12	% FS
Alarka Creek	060102020406	15.92
Avery Creek-French Broad River	060101050704	6.05
Bent Creek-French Broad River	060101050705	27.52
Big Crabtree Creek	060404080105	7.41
Big Rock Creek	060404080603	23.06

	<b>HUC12</b>	<b>% FS</b>
Boylston Creek	060101050401	6.51
Brush Creek-Little Tennessee River	060102020405	14.33
Burningtown Creek	060102020403	53.54
Catheys Creek	060102030105	63.55
Cherryfield Creek-French Broad River	060101050105	14.69
Conley Creek-Tuckasegee River	060102030304	15.29
Cowee Creek	060102020402	33.55
Davidson River	060101050202	89.45
East Fork Pigeon River	060101060103	44.12
Fontana Lake-Nantahala River	060102020306	38.21
Fontana Lake-Tuckasegee River	060102030405	6.39
Hollow Poplar Creek-Nolichucky River	060101080604	34.37
Lake Cheoah-Little Tennessee River	060102040401	22.96
Lake Emory-Little Tennessee River	060102020401	9.21
Little East Fork Pigeon River-West Fork Pigeon	060101060102	40.58
Little Rock Creek	060101080602	17.60
Lower Cane River	060101080306	28.56
Lower Hominy Creek	060101050503	9.12
Lower South Toe River	060101080203	8.95
Mills River	060101050403	46.83
Santeetlah Lake	060102040106	42.39
Savannah Creek	060102030301	26.90
South Fork Mills River	060101050402	84.00
South Hominy Creek	060101050501	22.34
Sweetwater Creek	060102040102	22.48
Tellico Creek-Little Tennessee River	060102020404	32.16
Upper Cane River	060101080303	15.95
Upper Fontana Lake-Little Tennessee River	060102020407	30.96
Williamson Creek-French Broad River	060101050203	13.97
Yellow Creek-Cheoah River	060102040107	76.11

Within the context of the revised Nantahala and Pisgah Forest Plan, and based on the ESE framework, Appalachian elktoe are associated with seven coarse filter ecosystems or species groups across the Forests:

- Small River Associates
- Medium and Large River Associates
- Aquatic Species Sensitive to Invasive Species
- Hydrologic Modification Sensitive Species
- Non-point Source Pollution Sensitive Species
- Point Source Pollution Sensitive Species
- Sediment Sensitive Species

Previous sections of the EIS describe the effects of proposed alternatives on the water resources and aquatic species groups and aquatic ecosystems related to the Appalachian elktoe. Appendix C

summarizes plan components directly or indirectly related to the protection, enhancement, or restoration of habitat for aquatic species, including federally listed species such as the Appalachian elktoe, via association with one or more of the coarse filter elements above.

Table 100 displays the cumulative assessment of the proposed planning framework (i.e., mitigation and management constraints, as well as aquatic habitat enhancement and restoration) on Appalachian elktoe. Specifically, this figure reflects species' estimated health and resilience on Forest Service land under all alternatives.

**Table 100. Ecological Sustainability Scores for Indicators Representing Forest Service Ownership within Watersheds Supporting Appalachian Elktoe Within the Nantahala and Pisgah NFs (NPESE 2021). Red = poor, yellow = fair, light green = good, and dark green = very good**

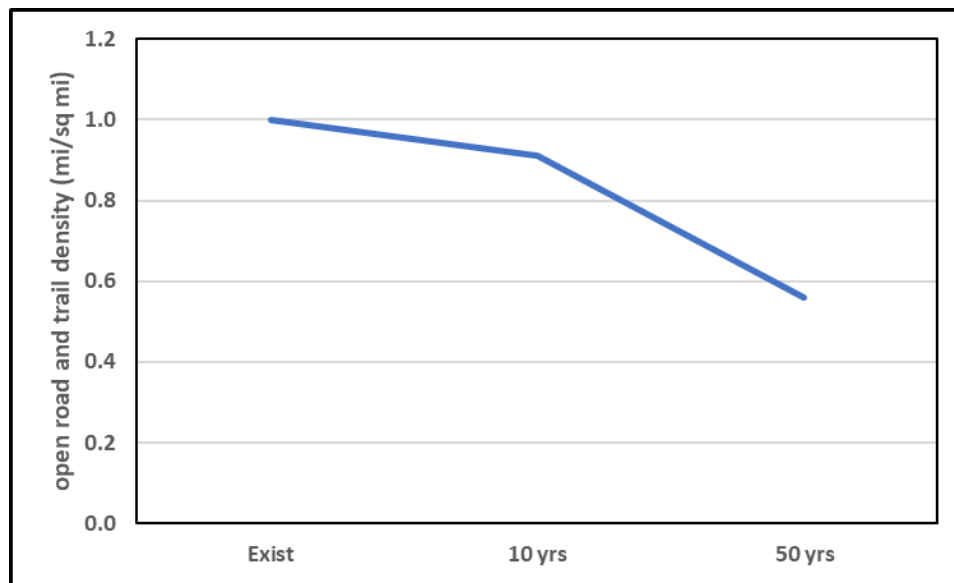
	Exist	Alts ABCDE 10 yrs	Alts ABCDE 50 yrs
Alarka Creek			
Avery Creek-French Broad River			
Bent Creek-French Broad River			
Big Crabtree Creek			
Big Rock Creek			
Boylston Creek			
Brush Creek-Little Tennessee River			
Burningtown Creek			
Catheys Creek			
Cherryfield Creek-French Broad River			
Conley Creek-Tuckasegee River			
Cowee Creek			
Davidson River			
East Fork Pigeon River			
Fontana Lake-Nantahala River			
Fontana Lake-Tuckasegee River			
Hollow Poplar Creek-Nolichucky River			
Lake Cheoah-Little Tennessee River			
Lake Emory-Little Tennessee River			
Little East Fork Pigeon River-West Fork Pigeon			
Little Rock Creek			
Lower Cane River			
Lower Hominy Creek			
Lower South Toe River			
Mills River			
Santeetlah Lake			
Savannah Creek			
South Fork Mills River			
South Hominy Creek			
Sweetwater Creek			
Tellico Creek-Little Tennessee River			
Upper Cane River			



	Exist	Alts ABCDE 10 yrs	Alts ABCDE 50 yrs
Upper Fontana Lake-Little Tennessee River			
Williamson Creek-French Broad River			
Yellow Creek-Cheoah River			

Ecological Sustainability Evaluation modeling for the Nantahala and Pisgah Forest Plan Revision shows that conditions for Appalachian elktoe on the Forests improve over existing condition under all alternatives, including the Mills River and Tellico Creek watersheds where habitat for the species is currently in fair condition. This is a direct reflection of the proposal to maintain watershed restoration as a priority (i.e., provide clean and abundant water) in the proposed plan.

Within the Mills River watershed, riparian road and trail density (sedimentation) is influencing aquatic habitat conditions on the Forests currently and is expected to improve over time (i.e., decrease) under all alternatives (Figure 85). This is through the emphasis of the revised forest plan on eliminating resource damage from open roads and trails through project-level mitigation and decommissioning of unneeded roads or trails across the Forests.



**Figure 85. Open riparian road and trail density within the Mills River watershed on Forest Service lands**

Within the Tellico Creek watershed, combined dam and stream crossing density (hydrologic connectivity) is currently influencing aquatic habitat conditions on the Forests and is expected to improve over time (i.e. decrease) under all alternatives. This is because of the emphasis of the revised forest plan on restoring aquatic organism passage across the Forests.



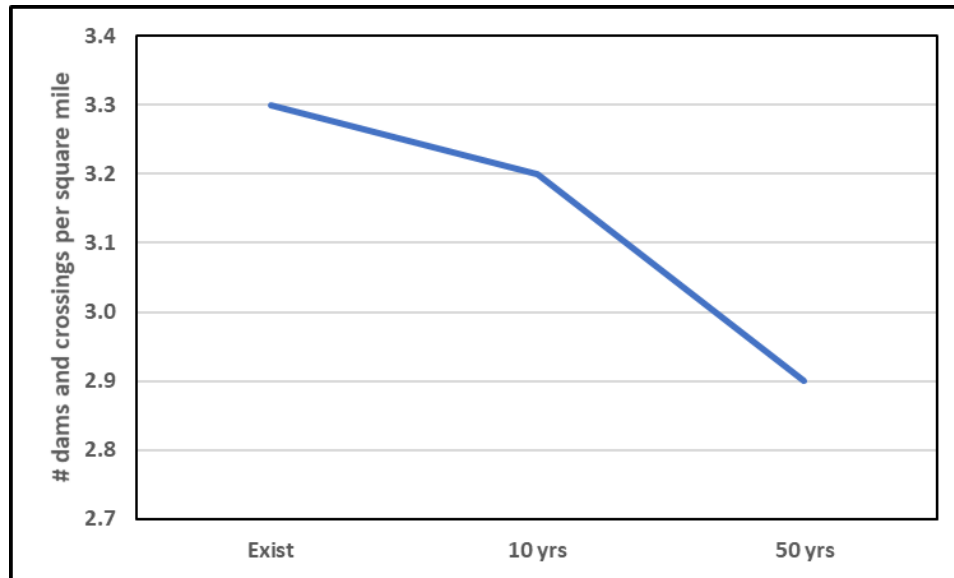


Figure 86. Combined dam and stream crossing density within the Tellico Creek watershed on Forest Service lands

Therefore, implementation of any alternative will improve this situation on NFS lands and contribute positively to watershed-level (cumulative) effects discussed below.

### Cumulative Effects

When these actions are put into perspective across the landscape (specifically, across the estimated range for Appalachian elktoe within Western North Carolina), a different picture is painted. Table 101 reflects Ecological Sustainability Evaluation scores from all aquatic indicators (including those that address non-Forest service lands). All alternatives are combined because the results do not meaningfully differ between alternatives. This analysis shows that despite estimated improvements on Forest Service lands discussed above, overall (i.e., range-wide) conditions for Appalachian elktoe remain generally “fair” over time. Additionally, USFWS (2017) describes the most recent status assessment for Appalachian elktoe in detail. These assessments allude to the situation where persistence of the species at levels contributing to species’ recovery may be at risk if conservation efforts (e.g. reintroduction, population augmentation, etc.) do not continue.

**Table 101. Ecological Sustainability Scores for Indicators Representing All Lands Within Watersheds Supporting Appalachian Elktoe Within the Nantahala and Pisgah NFs (NPESE 2021). Red = poor, yellow = fair, light green = good, and dark green = very good**

	Exist	ABCDE 10 yrs	ABCDE 50 yrs
Alarka Creek	light green	light green	light green
Avery Creek-French Broad River	yellow	yellow	yellow
Bent Creek-French Broad River	yellow	yellow	yellow
Big Crabtree Creek	yellow	yellow	yellow
Big Rock Creek	yellow	yellow	yellow
Boylston Creek	red	red	red
Brush Creek-Little Tennessee River	yellow	yellow	yellow
Burningtown Creek	light green	light green	light green
Catheys Creek	dark green	dark green	dark green
Cherryfield Creek-French Broad River	red	red	red

	Exist	ABCDE 10 yrs	ABCDE 50 yrs
Conley Creek-Tuckasegee River			
Cowee Creek			
Davidson River			
East Fork Pigeon River			
Fontana Lake-Nantahala River			
Fontana Lake-Tuckasegee River			
Hollow Poplar Creek-Nolichucky River			
Lake Cheoah-Little Tennessee River			
Lake Emory-Little Tennessee River			
Little East Fork Pigeon River-West Fork Pigeon			
Little Rock Creek			
Lower Cane River			
Lower Hominy Creek			
Lower South Toe River			
Mills River			
Santeetlah Lake			
Savannah Creek			
South Fork Mills River			
South Hominy Creek			
Sweetwater Creek			
Tellico Creek-Little Tennessee River			
Upper Cane River			
Upper Fontana Lake-Little Tennessee River			
Williamson Creek-French Broad River			
Yellow Creek-Cheoah River			

This analysis highlights several watersheds that may not support conditions suitable for Appalachian elktoe into the future (see the red cells above), and that habitat condition for Appalachian elktoe in many watersheds may be marginal into the future (see yellow cells above). Cumulatively speaking, Tables 100 and 101 indicate that this condition is related to activities on ownerships other than Forest Service. These ESE scores are largely influenced by percent agricultural and urban land use and percent forested riparian areas within the watersheds, things that are outside Forest Service control.

### Designated Critical Habitat

Designated critical habitat identifies specific areas that are essential to the conservation of a listed species and that may require special management considerations or protection. The ESA requires federal agencies, in consultation with the USFWS, to ensure that management activities are not likely to jeopardize the continued existence of an endangered or threatened species or result in the destruction or adverse modification of critical habitat.

Critical habitat for Appalachian elktoe was designated on September 27, 2002. This habitat is described in detail in the formal designation and other listing documentation (e.g. species recovery plan, status updates, etc.), and is summarized above. Additionally, the recovery plan for the species, and subsequent status assessments describe habitat for Appalachian elktoe, set recovery milestones, and document range-wide movement towards (or away from) these conditions.

The ESA requires that designated critical habitat provide physical and biological features (primary constituent elements) essential to the conservation of the species and that may require special management considerations or protection. These physical and biological features include, but are not limited to, space for individual and population growth and for normal behavior; food, water, air, light, minerals, or other nutritional or physiological requirements; cover or shelter; sites for breeding, reproduction, and rearing of offspring; and habitats that are protected from disturbance or are representative of the historical, geographical, and ecological distribution of a species. These factors are deemed essential to the conservation of the species.

Based on the best available information concerning the habitat and life history of the Appalachian elktoe, primary constituent elements essential for the conservation of the species are (Federal Register 67(88): 61016-61040):

1. Permanent, flowing, cool, clean water,
2. Geomorphically stable stream channels and banks,
3. Pool, riffle, and run sequences within the channel,
4. Stable sand, gravel, cobble, and boulder or bedrock substrates with no more than low amounts of fine sediment,
5. Moderate to high stream gradient,
6. Periodic natural flooding, and
7. Fish hosts, with adequate living, foraging, and spawning areas for them.

These elements are addressed in USFWS (2017), which represents to most current evaluation of the status of this species. Additionally, the analysis presented above for Appalachian elktoe also applies to designated critical habitat for the species and generally encompasses key habitat requirements listed above. Therefore, no additional analysis is needed for this forestwide (programmatic) assessment. Specific habitat characteristics, including those listed above, are addressed at the project level.

Approximately 4.2% of designated critical habitat for Appalachian elktoe in western North Carolina flows through the Forests.

## **Conclusions**

This analysis concludes that Appalachian elktoe, as represented by potential effects of the proposed planning framework on species' habitat conditions analyzed with the ESE, will continue to persist on Forest Service lands. Improved habitat conditions may lead to population increases on the Forests, although this is limited due to land ownership patterns. Because ownership patterns are generally fragmented, and much of the species' estimated range is not under Forest Service stewardship, it is possible that habitat for and populations of Appalachian elktoe may continue to persist range-wide, although at lower densities than can effectively contribute to species' recovery at this larger scale. It should be noted that species propagation and population augmentation continue to be a priority for the USFWS, NCWRC, and the Forests. These partners continue to inventory new habitats and monitor existing populations as part of species recovery efforts.

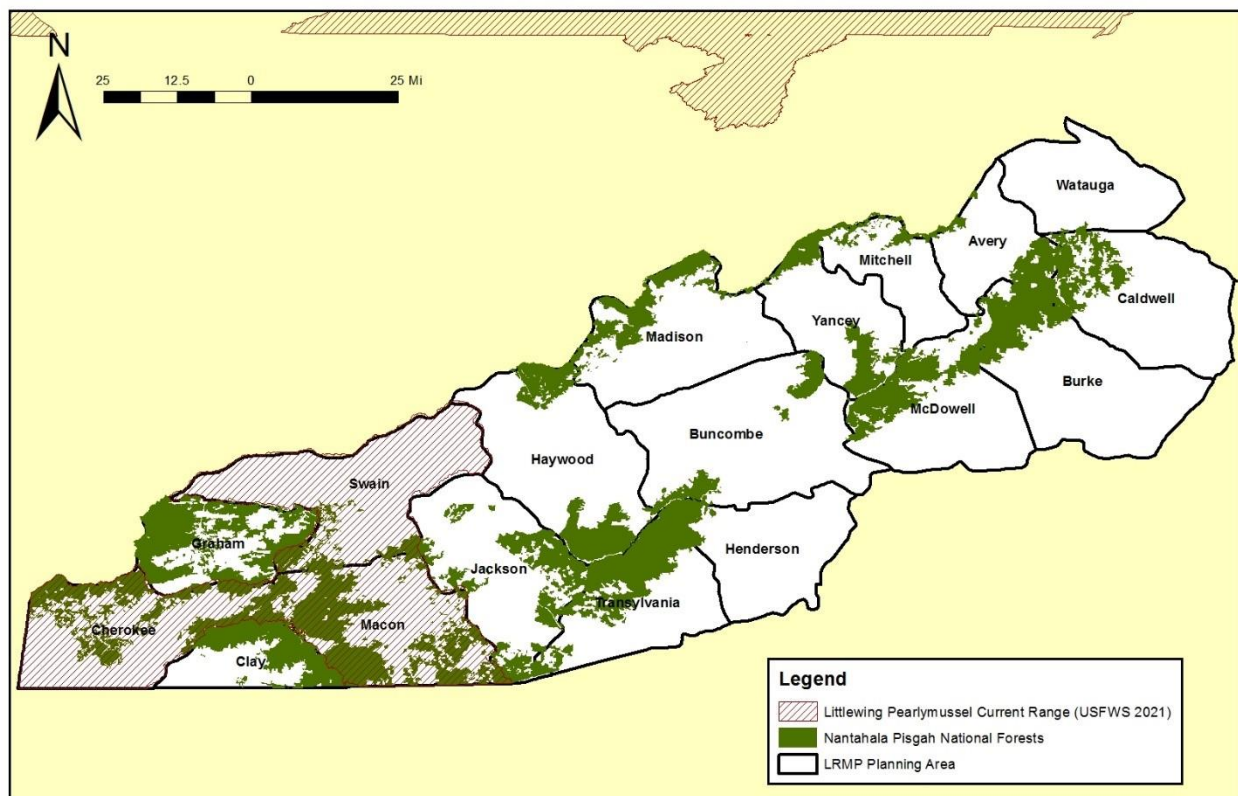
This analysis concludes that designated critical habitat for Appalachian elktoe, as represented by potential effects of the proposed planning framework on species' habitat conditions analyzed with the ESE, will continue to persist on Forest Service lands where relevant. In fact, it is possible that habitat conditions for Appalachian elktoe will improve on the Forests under all alternatives, including relevant designated critical habitat.

## Littlewing Pearlymussel (*Pegias fabula*)

### Affected Environment

Little-wing pearlymussel was described by Lea in 1838. It is the only species in the genus *Pegias*. All records indicate this species is restricted to tributary streams of the Tennessee and Cumberland Rivers, and is generally very rare. The species was listed as endangered in November 1988 (Federal Register 53: 45861). There is no critical habitat designated for this species. In North Carolina, this species is known from a handful of locations in the Little Tennessee River basin within Macon and Swain Counties, including part of the Nantahala National Forest (Figure 87).

This species is becoming increasingly rare in North Carolina, with the last documented occurrence in 2005. In October 2018, a single dead shell was collected. Therefore, the status of this species in western North Carolina is uncertain, though likely declining. While the species is not considered extirpated from North Carolina, it is suspected that population levels are so low that they are basically “undetectable”. It is not known whether the species is in decline, or if population levels are too low to be detected on a regular basis. It often takes hundreds (even thousands) of survey hours to document rare mussels.



**Figure 87. Estimated current range of little-wing pearlymussel in Western North Carolina, as summarized from NCNHP (2021) and USFWS (2021)**

Little-wing pearlymussel is small, rarely exceeding 1.5 inches in length and 0.5 inches in width. The shell's outer surface is light green or dark yellowish brown with dark rays of variable width along the anterior surface, although it is usually eroded, giving the shell a chalky or ashy-white appearance. It inhabits coolwater streams that are small to medium in size, have low turbidity, and high to moderate gradient. It may be found in riffles lying on top of the substrate, buried in or on top of the substrate in the transition

zone between a pool and riffle, or buried beneath boulders. Generally, little is known about the life history of this species (NatureServe 2021).

The main threats to the species are habitat loss and water quality deterioration from impoundments, industrial and municipal pollution, acid mine drainage, and siltation. However, some losses may be due to other changes in water and habitat quality since some populations have been extirpated from stream reaches that still contain other mussel communities.

Most remnant little-wing pearlymussel populations are small and isolated, which restricts the natural interchange of genetic material among populations. Small population sizes increase the chances of genetic variation loss due to genetic drift. The loss of genetic variation could adversely affect the species' ability to evolve and respond to natural habitat changes.

As filter feeders generally confined to the bottom of the stream or river, clean, free-flowing water is critical to the persistence of this species. Healthy, diverse fish communities are also important to the persistence of freshwater mussels, since many species of fish are larval hosts for freshwater mussels.

Freshwater mussels represent some of the rarest animals in the United States, including Western North Carolina. The U.S. Fish and Wildlife Service (USFWS), North Carolina Wildlife Resources Commission (NCWRC), and other partners (including the National Forests in North Carolina) have been monitoring freshwater mussel populations in Western North Carolina for decades. Although much has been learned about this group of species over the years, recent monitoring indicates that much more inventory is needed to fully document the species' range. Some freshwater mussel species exist in such low numbers that years of combined sampling effort are often needed to confirm or deny species' presence. This is especially the case with the little-wing pearlymussel. Maintaining persistence of this species within today's known (estimated) occupied range where it overlaps the Nantahala and Pisgah NFs is critical to species' persistence into the future.

### Environmental Consequences

Plan components addressing the larger ecosystem (watershed) conditions (e.g., watershed health) encompass habitat requirements for little-wing pearlymussel. These components are described in the revised Forest Plan (e.g., watershed, water resources, and aquatic ecosystem subsections). Potential environmental consequences of all alternatives on watersheds supporting little-wing pearlymussel are summarized below.

Table 102 summarizes land ownership within watersheds associated with little-wing pearlymussel. This allows us to gauge the role and potential effectiveness of Forest Service management on federally listed aquatic species persistence and recovery. Overall, 30.86% of watersheds known to support little-wing pearlymussel in western North Carolina is in Forest Service ownership. Often, but not always, this ownership is in the headwaters and upper reaches of the watershed and not necessarily immediately adjacent to stream reaches suitable for little-wing pearlymussel. Forest Service ownership is almost always fragmented on the landscape (i.e., Forest Service ownership is not continuous within the watershed, but rather, composed of multiple tracts of land of varying sizes). In this sense, activities on Forest Service lands are important to overall watershed health and resilience and the degree to which this can be influenced is related to the amount of Forest Service ownership present in relation to other land uses in the watershed.

**Table 102. Watersheds with at Least Some Forest Service Ownership Within the Known Range of Little-Wing Pearlymussel in Western North Carolina.**

	HUC12	% FS
Brush Creek-Little Tennessee River	060102020405	14.33
Burningtown Creek	060102020403	53.54

	HUC12	% FS
Fontana Lake-Nantahala River	060102020306	38.21
Tellico Creek-Little Tennessee River	060102020404	32.16
Upper Fontana Lake-Little Tennessee River	060102020407	30.96

Within the context of the revised Nantahala and Pisgah Forest Plan, and based on the ESE framework, little-wing pearlymussel is associated with six coarse filter ecosystems or species groups across the Forests:

- Medium and Large River Associates
- Aquatic Species Sensitive to Invasive Species
- Hydrologic Modification Sensitive Species
- Non-point Source Pollution Sensitive Species
- Point Source Pollution Sensitive Species
- Sediment Sensitive Species

Previous sections of the EIS describe the effects of plan alternatives on water quality, and the aquatic habitats and species groups associated with little-wing pearly mussel. Appendix C summarizes plan components directly or indirectly related to the protection, enhancement, or restoration of habitat for aquatic species, including federally listed species such as the little-wing pearlymussel, via association with one or more of the coarse filter elements above.

Table 103 displays the cumulative assessment of the proposed planning framework (i.e., mitigation and management constraints, as well as aquatic habitat enhancement and restoration) on little-wing pearlymussel. Specifically, this figure reflects species' estimated health and resilience on Forest Service land under all alternatives.

**Table 103. Ecological Sustainability Scores for Indicators Representing Forest Service Ownership Within Watersheds Supporting Little-Wing Pearlymussel Within the Nantahala and Pisgah NFs (NPSE 2021).**  
*Red = poor, yellow = fair, light green = good, and dark green = very good*

	Exist	Alts ABCDE 10 yrs	Alts ABCDE 50 yrs
Brush Creek-Little Tennessee River			
Burningtown Creek			
Fontana Lake-Nantahala River			
Tellico Creek-Little Tennessee River			
Upper Fontana Lake-Little Tennessee River			

Ecological Sustainability Evaluation modeling for the Nantahala and Pisgah Forest Plan Revision shows that conditions for little-wing pearlymussel improve over existing condition under all alternatives, including the Tellico Creek watershed where habitat for the species is currently in fair condition on the Forests. This is a direct reflection of the proposal to maintain watershed restoration as a priority (i.e., provide clean and abundant water) in the proposed plan.

Within the Tellico Creek watershed, combined dam and stream crossing density (hydrologic connectivity) is currently influencing aquatic habitat conditions on the Forests and is expected to improve over time (i.e., decrease) under all alternatives. This is through the emphasis of the revised forest plan on restoring aquatic organism passage across the Forests.

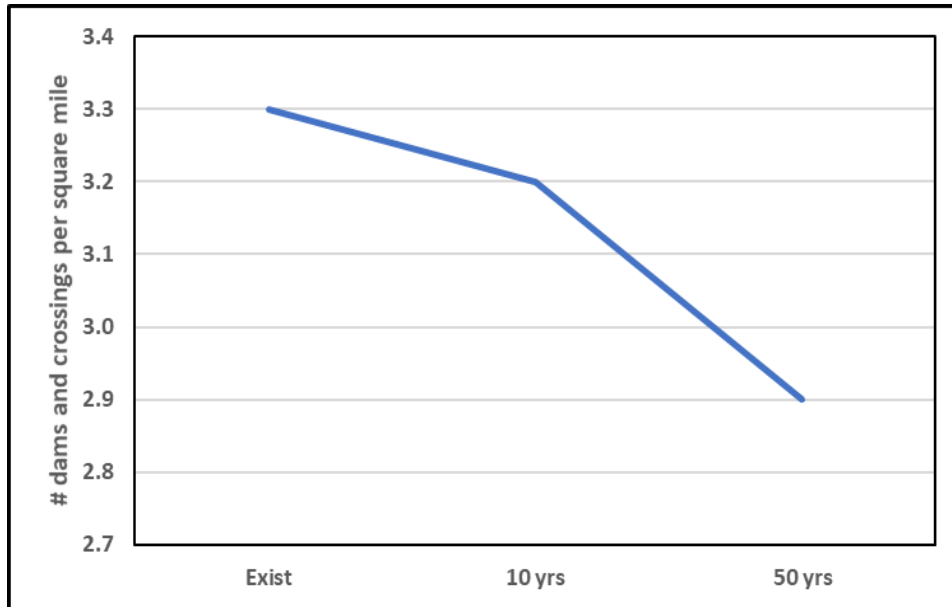


Figure 88. Combined dam and stream crossing density within the Tellico Creek watershed on Forest Service lands

Therefore, implementation of any alternative will improve this situation on Forest lands and contribute positively to watershed-level (cumulative) effects discussed below.

### Cumulative Effects

When these actions are put into perspective across the landscape (specifically, across the estimated range for little-wing pearlymussel within Western North Carolina), a different picture is painted. Table 104 reflects Ecological Sustainability Evaluation scores from all aquatic indicators (including those that address non-Forest service lands). All alternatives are combined because the results do not meaningfully differ between alternatives. This analysis shows that despite estimated improvements on Forest Service lands discussed above, overall (i.e., range-wide) conditions for little-wing pearlymussel remain generally “fair” over time. Additionally, USFWS (2020) describes the most recent status assessment for little-wing pearlymussel in detail. These assessments allude to the situation where persistence of the species at levels contributing to species’ recovery may be at risk without additional conservation efforts (e.g., reintroduction, population augmentation, etc.).

**Table 104. Ecological Sustainability Scores for Indicators Representing All Lands Within Watersheds Supporting Little-Wing Pearlymussel Containing the Nantahala and Pisgah NFs (NPESE 2021).**

**Red = poor, yellow = fair, light green = good, and dark green = very good**

	Exist	ABCDE 10 yrs	ABCDE 50 yrs
Brush Creek-Little Tennessee River	Yellow	Yellow	Yellow
Burningtown Creek	Light Green	Light Green	Light Green
Fontana Lake-Nantahala River	Yellow	Yellow	Yellow
Tellico Creek-Little Tennessee River	Yellow	Yellow	Yellow
Upper Fontana Lake-Little Tennessee River	Light Green	Light Green	Light Green

This analysis highlights that habitat for little-wing pearlymussel may be marginal into the future within the Brush Creek-Little Tennessee River, Fontana Lake-Nantahala River, and Tellico Creek-Little Tennessee River watersheds.

Cumulatively speaking, Tables 103 and 104 indicate that this condition is related to activities on ownerships other than Forest Service. These ESE scores are largely influenced by percent agricultural and urban land use and percent forested riparian areas within the watersheds, things that are outside Forest Service control.

The presence of so few populations and individuals across its range, and the isolation of those populations makes little-wing pearl mussel particularly vulnerable to extirpation from intentional or accidental toxic chemical spills, habitat modification, progressive degradation from land surface runoff (nonpoint-source pollutants) and natural stochastic events (e.g., floods, drought). The lack of connection to other little-wing pearl mussel populations eliminates the possibility for recolonization. Additionally, this species is difficult to propagate for restoration efforts. Because of low numbers and apparent declining trends, it is possible this species does not occur, at least at detectable levels, in western North Carolina anymore, including on the Forests

### **Conclusions**

This analysis concludes that little-wing pearl mussel, as represented by potential effects of the proposed planning framework on species' habitat conditions analyzed with the ESE, will continue to persist on Forest Service lands—if it does still exist in western North Carolina. However, because ownership patterns are generally fragmented, and much of the species' estimated range is not under Forest Service stewardship, it is possible that habitat for and populations of little-wing pearl mussel may continue to persist range-wide. Because of extremely low numbers and known occurrences, it is critical that inventory for this species continue to be a priority for the USFWS, NCWRC, and the Forests. These partners continue to inventory new habitats and monitor existing populations as part of species recovery efforts.

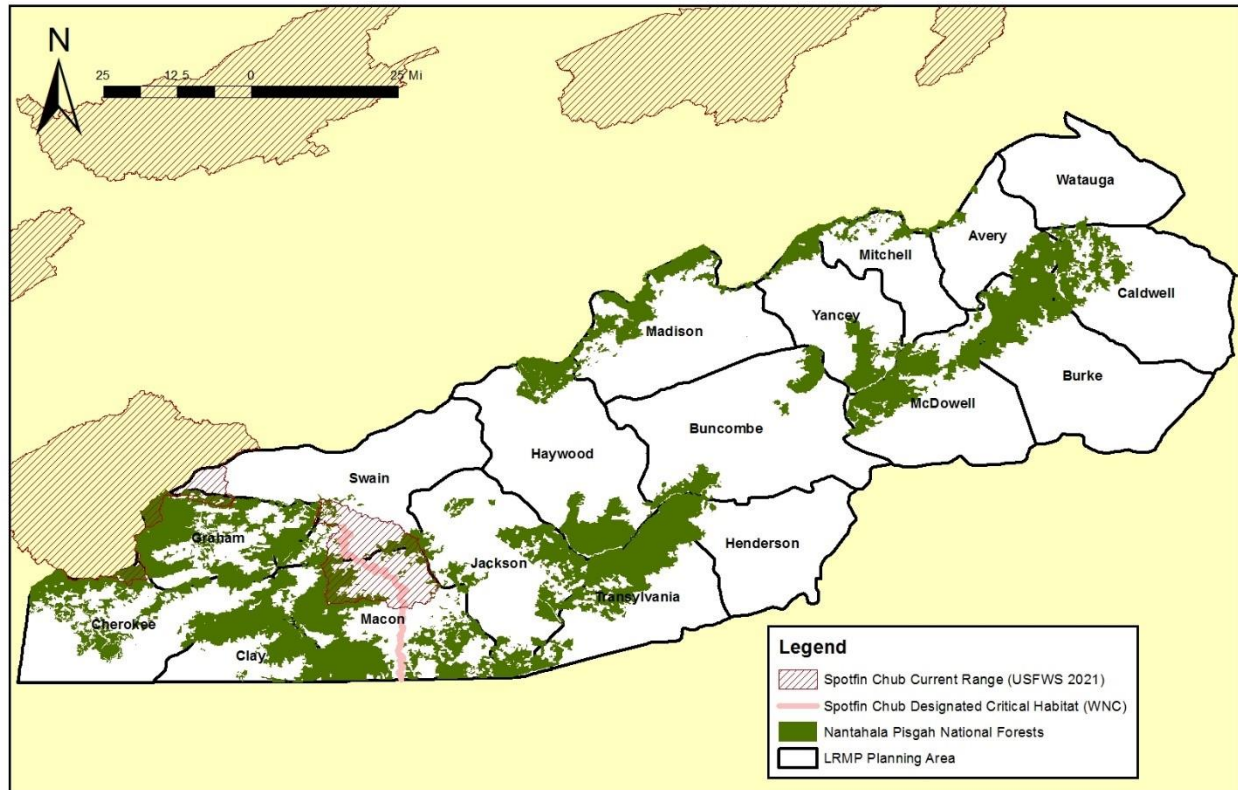
### **Spotfin Chub (*Erimonax monachus*)**

#### **Affected Environment**

The spotfin chub is a small freshwater fish, a member of the minnow family. The species was once widespread within the upper and middle Tennessee River system, but is now considered extirpated from Alabama, Georgia, and Virginia. Disjunct, relict populations remain present in North Carolina, Tennessee, and Virginia. Spotfin chub has been reintroduced into at least three rivers in North Carolina, and there are plans for more reintroductions in the future.

The species was listed as threatened September 1977 (Federal Register 42: 45526-45530) and critical habitat was designated at the time of listing. In North Carolina, this species is known from a handful of locations in the French Broad, Little Tennessee, and Cheoah Rivers, including parts of the Nantahala and Pisgah NFs (Figure 89).





**Figure 89. Estimated current range of and designated critical habitat for spotfin chub in western North Carolina, as summarized from USFWS (2021)**

Habitat for spotfin chub includes cool and warm, typically clear, large creeks or medium-sized rivers of moderate gradient, in upland and montane areas, generally in or near moderate and swift currents over gravel to bedrock, rarely over sand or silt. Eggs are laid in stone cracks, crevices, or in the narrow interface of two touching rocks, in moderate current of shallow portions of runs, in areas with silt-free rubble and boulders (NatureServe 2021).

The main threat to spotfin chub is habitat loss from impoundment; however, sedimentation and other pollution resulting from land use are also affecting distribution and density of this species.

This species is generally rare or uncommon and usually sharply localized in distribution, including within western North Carolina. Localized populations are restricted to a small part of any riffle-run sequence, which restricts the natural interchange of genetic material among populations. Small population sizes increase the chances of genetic variation loss due to genetic drift. The loss of genetic variation could adversely affect the species' ability to evolve and respond to natural habitat changes.

The U.S. Fish and Wildlife Service, North Carolina Wildlife Resources Commission, and other partners (including the National Forests in North Carolina) have been monitoring spotfin chub populations in Western North Carolina for decades. Although much has been learned about this species, recent monitoring indicates that much more inventory is needed to fully document species' range and life history.

While most suitable habitat for this species is downstream of Forest Service ownership, maintaining or improving watershed health and resilience on Forest Service lands is important to the persistence of this species.

## Environmental Consequences

Plan components addressing the larger ecosystem (watershed) conditions (e.g., watershed health) encompass habitat requirements for spotfin chub. These components are described in the revised Forest Plan (e.g., watershed, water resources, and aquatic ecosystem subsections). Potential environmental consequences of all alternatives on watersheds supporting spotfin chub are summarized below.

Table 105 summarizes land ownership within watersheds associated with spotfin chub. This allows us to gauge the role and potential effectiveness of Forest Service management on federally listed aquatic species persistence and recovery. Overall, 31.66% of watersheds known to support spotfin chub and its designated critical habitat in western North Carolina is in Forest Service ownership. Often, but not always, this ownership is in the headwaters and upper reaches of the watershed and not necessarily immediately adjacent to stream reaches suitable for spotfin chub. Forest Service ownership is almost always fragmented on the landscape (i.e., Forest Service ownership is not continuous within the watershed, but rather, composed of multiple tracts of land of varying sizes). In this sense, activities on Forest Service lands are important to overall watershed health and resilience and the degree to which this can be influenced is related to the amount of Forest Service ownership present in relation to other land uses in the watershed.

**Table 105. 6<sup>th</sup> Level Hydrologic Units (HUCs) with at Least Some Forest Service Ownership Within the Estimated Current Range of and Designated Critical Habitat for Spotfin Chub in Western North Carolina.**

	HUC12	% FS
Alarka Creek	060102020406	15.92
Big Pine Creek-French Broad River	060101051103	9.26
Brush Creek-Little Tennessee River	060102020405	14.33
Buck Creek-Tusquitee	060102020301	96.90
Burningtown Creek	060102020403	53.54
Cowee Creek	060102020402	33.55
Fontana Lake-Tuckasegee River	060102030405	6.39
Lake Emory-Little Tennessee River	060102020401	9.21
Shut-in Creek-French Broad River	060101051203	64.85
Spring Creek	060101051202	18.77
Tellico Creek-Little Tennessee River	060102020404	32.16
Upper Fontana Lake-Little Tennessee	060102020407	30.96
Yellow Creek-Cheoah River	060102040107	76.11

Within the context of the revised Nantahala and Pisgah Forest Plan, and based on the Ecological Sustainability Evaluation framework, spotfin chub are associated with six coarse filter ecosystems or species groups across the Forests:

- Small River Associates
- Medium and Large River Associates
- Hydrologic Modification Sensitive Species
- Non-point Source Pollution Sensitive Species
- Point Source Pollution Sensitive Species
- Sediment Sensitive Species

Appendix C summarizes plan components directly or indirectly related to the protection, enhancement, or restoration of habitat for aquatic species, including federally listed species such as the spotfin chub, via association with one or more of the coarse filter elements above.

Table 106 displays the cumulative assessment of the proposed planning framework (i.e., mitigation and management constraints, as well as aquatic habitat enhancement and restoration) on spotfin chub. Specifically, this table reflects species' estimated health and resilience on Forest Service land under all alternatives.

**Table 106. Ecological Sustainability Scores for Indicators Representing Forest Service Ownership Within Watersheds Supporting Spotfin Chub Within the Nantahala and Pisgah NFs (NPESE 2021).**

**Red = poor, yellow = fair, light green = good, and dark green = very good**

	Exist	Alts A,B,C,D,E 10 yrs	Alts A,B,C,D,E 50 yrs
Alarka Creek			
Big Pine Creek-French Broad River			
Brush Creek-Little Tennessee River			
Buck Creek-Tusquitee			
Burningtown Creek			
Cowee Creek			
Fontana Lake-Tuckasegee River			
Lake Emory-Little Tennessee River			
Shut-in Creek-French Broad River			
Spring Creek			
Tellico Creek-Little Tennessee River			
Upper Fontana Lake-Little Tennessee			
Yellow Creek-Cheoah River			

Ecological Sustainability Evaluation modeling for the Nantahala and Pisgah Forest Plan Revision shows that on Forest Service lands, conditions for spotfin chub improve over existing condition under all alternatives, including the Tellico Creek watershed where habitat for the species is currently in fair condition on the Forests. This is a direct reflection of the proposal to maintain watershed restoration as a priority (i.e., provide clean and abundant water) in the proposed plan.

Within the Tellico Creek watershed, combined dam and stream crossing density (hydrologic connectivity) is influencing aquatic habitat conditions on the Forests currently and is expected to improve over time (i.e., decrease) under all alternatives (Figure 90). This is through the emphasis of the revised forest plan on restoring aquatic organism passage across the Forests.

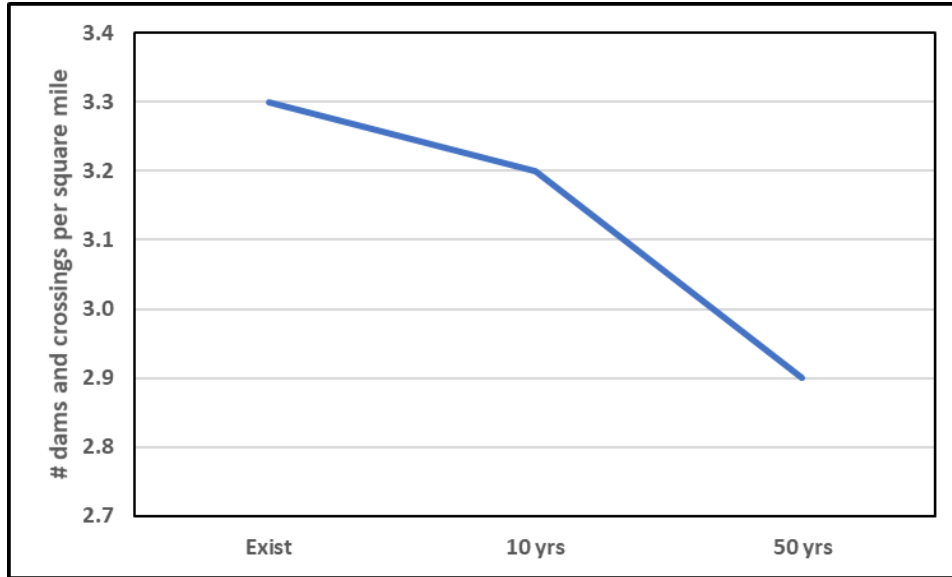


Figure 90. Combined dam and stream crossing density within the Tellico Creek watershed on Forest Service lands

Therefore, implementation of any alternative will improve this situation on Forest lands and contribute positively to watershed-level (cumulative) effects discussed below.

### Cumulative Effects

When these actions are put into perspective across the landscape (specifically, across the estimated range for spotfin chub within Western North Carolina), a different picture is painted. Table 107 reflects Ecological Sustainability Evaluation scores from all aquatic indicators (including those that address non-Forest service lands). All alternatives are combined because the results do not meaningfully differ between alternatives. This analysis shows that despite estimated improvements on Forest Service lands discussed above, overall conditions for spotfin chub reflect all land use within the species' range, not just Forest Service activities.

Table 107. Ecological Sustainability Scores for Indicators Representing All Lands Within Watersheds Supporting Spotfin Chub Within the Nantahala and Pisgah NFs (NPESE 2021).

*Red = poor, yellow = fair, light green = good, and dark green = very good*

	Exist	A,B,C,D,E 10 yrs	A,B,C,D,E 50 yrs
Alarka Creek			
Big Pine Creek-French Broad River			
Brush Creek-Little Tennessee River			
Buck Creek-Tusquitee			
Burningtown Creek			
Cowee Creek			
Fontana Lake-Tuckasegee River			
Lake Emory-Little Tennessee River			
Shut-in Creek-French Broad River			
Spring Creek			
Tellico Creek-Little Tennessee River			
Upper Fontana Lake-Little Tennessee			

	Exist	A,B,C,D,E 10 yrs	A,B,C,D,E 50 yrs
Yellow Creek-Cheoah River			

This analysis highlights the Spring Creek and Yellow Creek-Cheoah River watersheds may not support conditions suitable for spotfin chub into the future, and that habitat conditions for spotfin chub within four other watersheds may be marginal into the future (Brush Creek-Little Tennessee River, Fontana Lake-Tusksegee River, Lake Emory-Little Tennessee River, and Tellico Creek-Little Tennessee River).

Cumulatively speaking, Tables 106 and 107 indicate that this condition is related to activities on ownerships other than Forest Service. These ESE scores are largely influenced by percent agricultural and urban land use and percent forested riparian areas within the watersheds, things that are outside Forest Service control.

### Designated Critical Habitat

Designated critical habitat identifies specific areas that are essential to the conservation of a listed species and that may require special management considerations or protection. The ESA requires federal agencies, in consultation with the USFWS, to ensure that management activities are not likely to jeopardize the continued existence of an endangered or threatened species or result in the destruction or adverse modification of critical habitat.

Spotfin chub was listed as threatened September 1977 and critical habitat was designated at the time of listing. At the time of listing and critical habitat designation, description of specific critical habitat features was generally vague and reflected a description of known occupied habitat at the time. Suitable habitat for spotfin chub and a summary of threats to the species and its habitat are described above. Additionally, the recovery plan for the species, and subsequent status assessments describe habitat for spotfin chub, set recovery milestones, and document range-wide movement towards (or away from) these conditions.

There is no designated critical habitat for spotfin chub on the Forests, although there is Forest Service ownership within the watersheds supporting this critical habitat (see Figure 89). The analysis presented above for spotfin chub also applies to designated critical habitat for the species. Therefore, no additional analysis is needed.

### Conclusions

This analysis concludes that spotfin chub, as represented by potential effects of the proposed planning framework on species' habitat conditions analyzed with the ESE, will continue to persist on Forest Service lands. Improved habitat conditions may lead to population increases on the Forests. However, it is important to remember that ownership patterns are generally fragmented, and much of the species' estimated range is not under Forest Service stewardship. USFWS status assessments indicate that spotfin chub continue to persist and are contribute to species' recovery at this larger scale (see below). It should be noted that species propagation and population augmentation continue to be a priority for the USFWS, NCWRC, and the Forests.

The most recent 5-year status review for spotfin chub (USFWS 2014) states:

*The species continues to persist in the entire ~23-RM reach of Little Tennessee River between Fontana Reservoir and Franklin Dam. This represents a slight increase in range from that stated in the Recovery Plan (USFWS 1983). In addition, the species is seasonally found in nearly a dozen tributaries of the main stem in this reach. Sampling in recent years demonstrates that the current extent of its range in Little Tennessee River meets recovery criterion 1.b.*

This analysis concludes that designated critical habitat for spotfin chub, as represented by potential effects of the proposed planning framework on species' habitat conditions analyzed with the ESE, will continue to persist on Forest Service lands where it occurs. In fact, it is possible that habitat conditions for spotfin chub will improve on the Forests under any alternative, including relevant designated critical habitat.

### **Longsolid (*Fusconaia subrotunda*)**

Longsolid is addressed here since it is likely the species will be listed under the Endangered Species Act during the first few years of the planning period.

### **Affected Environment**

Longsolid was described by Lea in 1831. It is historically known from 12 states, though now only occurs in nine. This species is currently found in three major river basins: the Ohio (where it is most prevalent), Cumberland (where it is rarest), and Tennessee. It is considered extirpated from the Great Lakes basin. Known populations have declined in number, from 162 historically to 60 today, and projections 50 to 70 years into the future indicate that the number of populations could remain at 60 or drop to as low as 16 (USFWS 2018). In addition, it is highly likely that Longsolid could disappear entirely from the Cumberland River basin given current and possible future conditions in the last remaining population within that basin.

Longsolid was proposed for listing in 2020 (85 Federal Register 61384:61458). The status assessment for this species was completed in September 2018 (USFWS 2018). It is likely that a decision on listing will be made during the life of this revised plan; therefore, this species is included in this analysis.

In North Carolina, this species is known from a handful of locations in the French Broad, Little Tennessee, and Hiwassee River basins, including part of the Nantahala National Forest (Figure 91). This species is exceedingly rare in North Carolina. Aquatic Biologists continue intensive inventory for this species as it moves through the federal listing process. It is suspected that population levels are so low that they are basically "undetectable". It is not known whether the species is in decline, or if population levels are too low to be detected on a regular basis. It often takes hundreds (even thousands) of survey hours to document rare mussels.



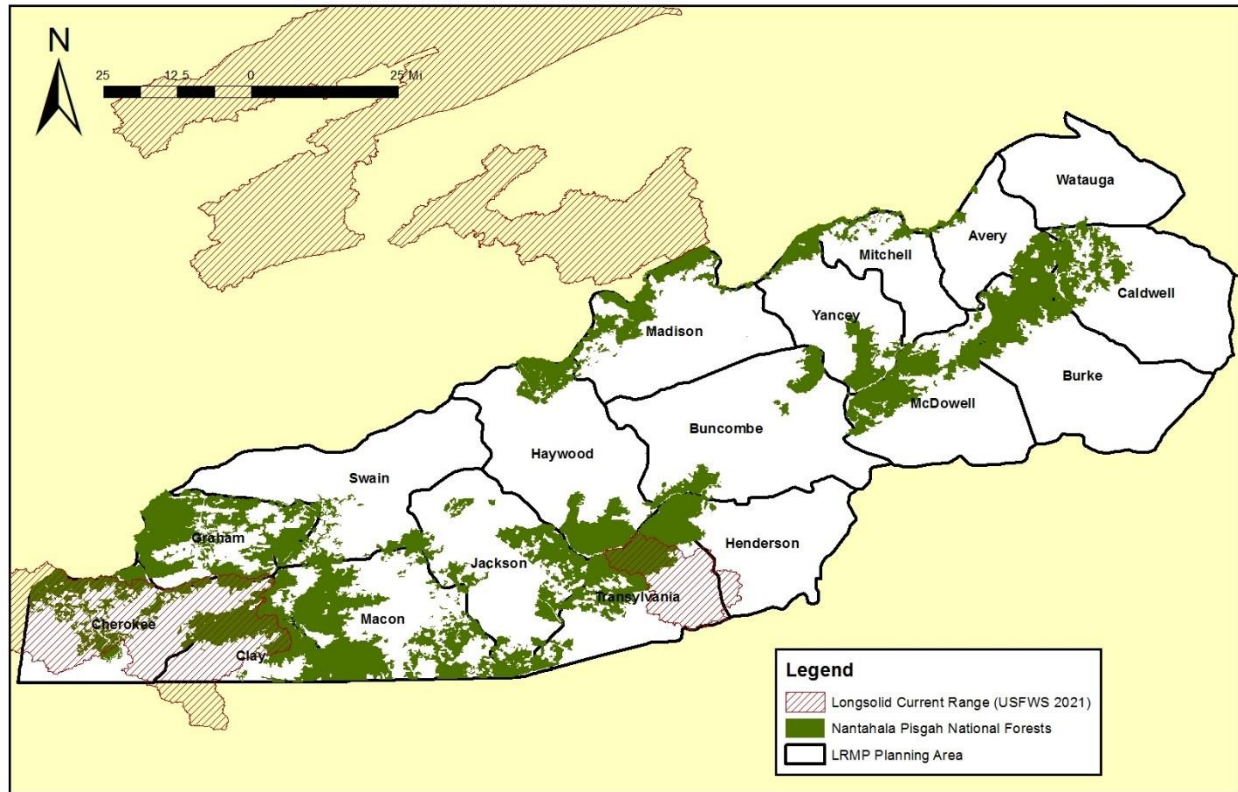


Figure 91. Estimated current range of longsolid in Western North Carolina, as summarized from USFWS (2021)

Longsolid is a medium-sized mussel, up to 5 inches (125 millimeters (mm) in size, which can be long-lived-potentially up to 50 years. It is found in small streams to large rivers (such as the Ohio River mainstem), and prefers a mixture of sand, gravel, and cobble substrates. Generally, little is known about the life history of this species. Limited life history and habitat requirements of this species can be found in USFWS (2018) and on NatureServe (<http://explorer.natureserve.org/>).

Longsolid has suffered impacts from negative influences on aquatic species commonly found in the central and eastern U.S. including habitat fragmentation from dams and other barriers; habitat loss; degraded water quality from chemical contamination and erosion from poorly managed development, agriculture, mining, and timber operations; direct mortality from dredging and harvest; and the proliferation of invasive species, such as the zebra mussel.

As filter feeders generally confined to the bottom of the stream or river, clean, free-flowing water is critical to the persistence of this species. Healthy, diverse fish communities are also important to the persistence of freshwater mussels, since many species of fish are larval hosts for freshwater mussels.

Freshwater mussels represent some of the rarest animals in the United States, including Western North Carolina. The U.S. Fish and Wildlife Service (USFWS), North Carolina Wildlife Resources Commission (NCWRC), and other partners (including the National Forests in North Carolina) have been monitoring freshwater mussel populations in Western North Carolina for decades. Although much has been learned about this group of species over the years, recent monitoring indicates that much more inventory is needed to fully document the species' range. Some freshwater mussel species exist in such low numbers that years of combined sampling effort are often needed to confirm or deny species' presence. This is especially the case with the longsolid. Maintaining persistence of these species within today's known (estimated) occupied range where it overlaps the Nantahala and Pisgah NFs is critical to species' persistence into the future.

## Environmental Consequences

Plan components addressing the larger ecosystem (watershed) conditions (e.g., watershed health) encompass habitat requirements for longsolid. These components are described in the revised Forest Plan (e.g., watershed, water resources, and aquatic ecosystem subsections). Potential environmental consequences of all alternatives on watersheds supporting longsolid are summarized below.

Table 108 summarizes land ownership within watersheds associated with longsolid. This allows us to gauge the role and potential effectiveness of Forest Service management on federally listed aquatic species persistence and recovery. Overall, 17.21% of watersheds known to support longsolid in western North Carolina is in Forest Service ownership. This increases to 27.11% in watersheds containing at least some Forest Service ownership. Often, but not always, this ownership is in the headwaters and upper reaches of the watershed and not necessarily immediately adjacent to stream reaches suitable for longsolid. Forest Service ownership is almost always fragmented on the landscape (i.e. Forest Service ownership is not continuous within the watershed, but rather, composed of multiple tracts of land of varying sizes). In this sense, activities on Forest Service lands are important to overall watershed health and resilience and the degree to which this can be influenced is related to the amount of Forest Service ownership present in relation to other land uses in the watershed.

**Table 108. Watersheds with at least some Forest Service ownership within the known range of longsolid in Western North Carolina.**

	HUC12	% FS
Brush Creek-Little Tennessee River	060102020405	14.33
Fires Creek	060200020202	94.76
Lower Valley River	060200020404	8.46
Fall Branch-Hiwassee River	060200020303	19.73
Sweetwater Creek-Hiwassee River	060200020203	10.11
Grape Creek-Hiwassee Lake	060200020702	29.16
(Hiwassee River)	(06020002090010)	(0%)
(Little River)	(06010105010080)	(0%)

Within the context of the revised Nantahala/Pisgah Forest Plan, and based on the ESE framework, longsolid is associated with six coarse filter ecosystems or species groups across the Forests:

- Medium and Large River Associates
- Aquatic Species Sensitive to Invasive Species
- Hydrologic Modification Sensitive Species
- Non-point Source Pollution Sensitive Species
- Point Source Pollution Sensitive Species
- Sediment Sensitive Species

Appendix C summarizes plan components directly or indirectly related to the protection, enhancement, or restoration of habitat for aquatic species, including federally listed species such as the longsolid, via association with one or more of the coarse filter elements above.

Table 109 displays the cumulative assessment of the proposed planning framework (i.e., mitigation and management constraints, as well as aquatic habitat enhancement and restoration) on longsolid. Specifically, this figure reflects species' estimated health and resilience on Forest Service land under all alternatives.

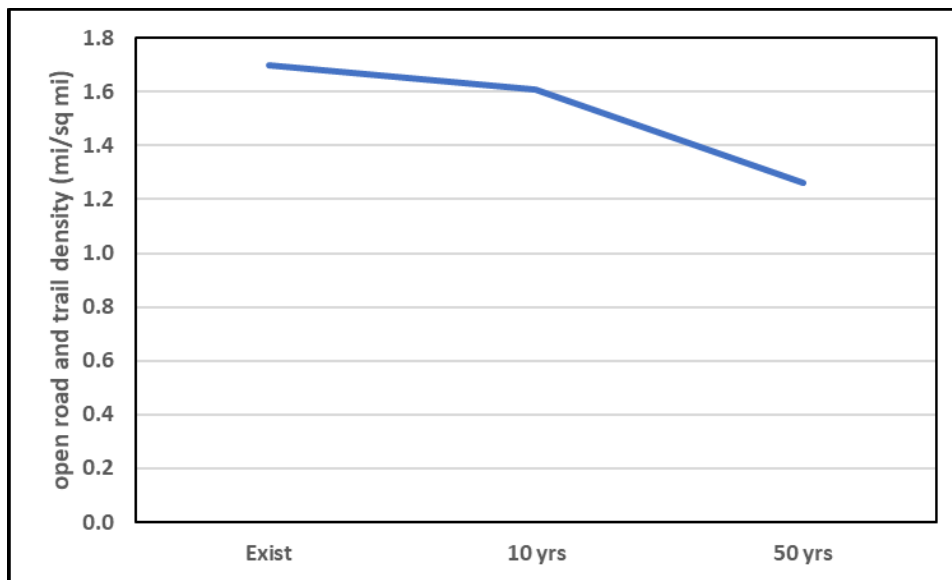


**Table 109. Ecological Sustainability Scores for Indictors Representing Forest Service Ownership Within Watersheds Supporting Longsolid Within the Nantahala and Pisgah NFs (NPESE 2021).****Red = poor, yellow = fair, light green = good, and dark green = very good**

	Exist	Alts A,B,C,D,E 10 yrs	Alts A,B,C,D,E 50 yrs
Brush Creek-Little Tennessee River			
Fires Creek			
Lower Valley River			
Fall Branch-Hiwassee River			
Sweetwater Creek-Hiwassee River			
Grape Creek-Hiwassee Lake			

Ecological Sustainability Evaluation modeling for the Nantahala and Pisgah Forest Plan Revision shows that conditions for longsolid are maintained or improved under all alternatives, including the Fires Creek watershed where habitat for the species is currently in fair condition on the Forests. This is a direct reflection of the proposal to maintain watershed restoration as a priority (i.e., provide clean and abundant water) in the proposed plan.

Within the Fires Creek watershed, riparian road and trail density (sedimentation) is influencing aquatic habitat conditions on the Forests currently and is expected to improve over time (i.e., decrease) under all alternatives (Figure 92). This is through the emphasis of the revised forest plan on eliminating resource damage from open roads and trails through project-level mitigation and decommissioning of unneeded roads or trails across the Forests.

**Figure 92. Open riparian road and trail density within the Fires Creek watershed on Forest Service lands**

### Cumulative Effects

When these actions are put into perspective across the landscape (specifically, across the estimated range for longsolid within Western North Carolina), a different picture is painted. Table 110 reflects Ecological Sustainability Evaluation scores from all aquatic indicators (including those that address non-

Forest service lands). All alternatives are combined because the results do not meaningfully differ between alternatives. This analysis shows that despite estimated improvements on Forest Service lands discussed above, overall (i.e., range-wide) conditions for longsolid remain generally “fair” to “good” over time. Additionally, USFWS (2018) describes the most recent status assessment for longsolid in detail. These assessments allude to the situation where persistence of the species at levels contributing to species’ recovery may be at risk without additional conservation efforts (e.g., reintroduction, population augmentation, etc.).

The presence of so few populations and individuals across its range, and the isolation of those populations makes longsolid particularly vulnerable to extirpation from intentional or accidental toxic chemical spills, habitat modification, progressive degradation from land surface runoff (nonpoint-source pollutants) and natural stochastic events (e.g., floods, drought). The lack of connection to other populations eliminates the possibility for recolonization. Additionally, this species is difficult to propagate for restoration efforts.

**Table 110. Ecological Sustainability Scores for Indicators Representing All Lands Within Watersheds Supporting Longsolid Containing the Nantahala and Pisgah NFs (NPESE 2021).**

**Red = poor, yellow = fair, light green = good, and dark green = very good**

	Exist	ABCDE 10 yrs	ABCDE 50 yrs
Brush Creek-Little Tennessee River			
Fires Creek			
Lower Valley River			
Fall Branch-Hiwassee River			
Sweetwater Creek-Hiwassee River			
Grape Creek-Hiwassee Lake			

This analysis highlights that habitat for longsolid may be marginal into the future within the Fires Creek and Sweetwater Creek-Hiwassee River watersheds.

Cumulatively speaking, Tables 109 and 110 indicate that this condition is related to activities on ownerships other than Forest Service. These ESE scores are largely influenced by percent agricultural and urban land use and percent forested riparian areas within the watersheds, things that are outside Forest Service control.

The presence of so few populations and individuals across its range, and the isolation of those populations makes longsolid particularly vulnerable to extirpation from intentional or accidental toxic chemical spills, habitat modification, progressive degradation from land surface runoff (nonpoint-source pollutants) and natural stochastic events (e.g., floods, drought). The lack of connection to other longsolid populations eliminates the possibility for recolonization. Additionally, this species is difficult to propagate for restoration efforts. Because of low numbers and apparent declining trends, it is possible this species does not occur, at least at detectable levels, in western North Carolina anymore, including on the Forests.

## Conclusions

This analysis concludes that longsolid, as represented by potential effects of the proposed planning framework on species’ habitat conditions analyzed with the ESE, will continue to persist on Forest Service lands. However, because ownership patterns are generally fragmented, and much of the species’ estimated range is not under Forest Service stewardship, it is possible that habitat for and populations of longsolid may continue to persist range-wide. Because of extremely low numbers and known

occurrences, it is critical that inventory for this species continue to be a priority for the USFWS, NCWRC, and the Forests. These partners continue to inventory new habitats and monitor existing populations as part of species recovery efforts.

### 3.3.5 Rare Animal Species Persistence and Recovery

The 2012 Planning Rule requires national forests to provide ecological conditions to maintain the diversity of plant and animal communities and the persistence of native species in the plan area. The revised plan does that through the plan direction for ecozones, wildlife habitat and diversity, unique habitats, plant and animal diversity, species groups, and in some cases individual species.

The primary analysis of effects to biodiversity, including rare species, is captured in the ESE Tool analysis presented in the EIS. Appendix C identifies the association of rare animals with coarse filter elements such as ecozones, unique habitats, and species groups and potential effects of the proposed revised forest plan on habitat for rare animals are inferred from these associations.

While there are indicators in the ESE Tool, the analysis does not highlight the effects from recreation use and factors that are outside the control of the Forest Service, such as climate change and acidic deposition, on rare species. Therefore, we are including additional analysis here that considers an overall assessment of potential effects to rare animal occurrences from vegetation management (including prescribed fire), general recreation management, and threats that are out of Forest Service control, such as climate change and acid deposition.

This analysis used existing Forest Service data sets (as of July 2020) and rare animal element occurrences (NCNHP April 2020). It considers spatial elements such as ownership, road and trail network (buffered by 100 meters), existing and proposed management areas, and high elevation areas with NC Natural Heritage Program's (NCNHP) element occurrences.

This analysis includes 12 federally listed animal species (threatened and endangered) and 63 Species of Conservation Concern (SCC) animals as identified in Appendix C, and assumes that these species represent the diversity and sensitivity of rare animals to the effects of forest management. Known occurrences of these rare animals range from one to thousands across North Carolina, and from zero to several hundred on the Nantahala and Pisgah NFs. Seventeen species included in this analysis are not known directly from the Forests; however, records indicate occurrences immediately adjacent to or downstream of FS ownership (shown below).

#### Species with known occurrences immediately adjacent to or downstream of FS ownership.

Group	Species
Bird	S. App. Black-capped Chickadee
Fish	Banded Sculpin
Fish	Spotfin Chub
Fish	Southern Blotched Chub
Fish	Sharphead Darter
Fish	Rosyface Chub
Fish	American Brook Lamprey
Fish	Sicklefin Redhorse

Group	Species
Fish	Stonecat
Fish	Blotchside Logperch
Mammal (bat)	Virginia Big-eared Bat
Freshwater Mussel	Tennessee Pigtoe
Freshwater Mussel	Tennessee Heelsplitter
Freshwater Mussel	Littlewing Pearlymussel
Freshwater Mussel	Tennessee Clubshell
Freshwater Mussel	Mountain Creekshell
Freshwater Snail	Christy's Elimia

Four species of conservation concern are not tracked by the NCNHP: *Rhyacophila amicus* (a caddisfly), *Ophiogomphus mainensis* (Maine Snaketail), *Eulonchus marialiciae* (Mary Alice's Small-headed Fly), *Eptesicus fuscus* (Big Brown Bat), and *Helicodiscus triodus* (Talus Coil); therefore, these species are not included in this analysis because of extremely limited information. Additionally, all known occurrences of *Patera clarki nantahala* (Noonday Globe) are included in USFWS databases and available for this analysis.

Maintaining persistence of rare species is of particular importance when the species is especially rare. In this analysis, 23 rare animals with less than 30 known occurrences across North Carolina were considered (shown below) Species with fewer than 30 known occurrences statewide and more than 25% of those occurrences on the Forests, are shown in bold. This list represents increased importance of FS habitat management and species conservation on overall species persistence

**Species with less than 30 known occurrences across NC, 25% or more of which are on the Forests.**

Group	Species
<b>Salamander</b>	<b>Dwarf Blackbelly Salamander</b>
<b>Salamander</b>	<b>Chattahoochee Slimy Salamander</b>
Bird	Southern Appalachian Black-capped Chickadee
Crustacean	Hiwassee Headwaters Crayfish
<b>Crustacean</b>	<b>Yancey Sideswimmer</b>
Fish	Banded Sculpin
<b>Fish</b>	<b>Turquoise Darter</b>
Fish	Rosyface Chub
Fish	American Brook Lamprey
Fish	Blotchside Logperch
Aquatic Insect	Edmund's Snaketail
<b>Mammal</b>	<b>Allegheny Woodrat</b>
Freshwater Mussel	Tennessee Pigtoe
Freshwater Mussel	Tennessee Heelsplitter
Freshwater Mussel	Littlewing Pearlymussel
Freshwater Mussel	Mountain Creekshell
Aquatic Snail	Christy's Elimia
<b>Terrestrial Snail</b>	<b>Fragile Glyph</b>
<b>Terrestrial Snail</b>	<b>Spiral Coil</b>

Group	Species
<b>Terrestrial Snail</b>	<b>Velvet Covert</b>
Terrestrial Snail	High Mountain Supercoil
<b>Terrestrial Snail</b>	<b>Sculpted Supercoil</b>
<b>Terrestrial Snail</b>	<b>Roan Supercoil</b>
<b>Terrestrial Snail</b>	<b>Noonday Globe</b>

Generally, the species we know the least about are terrestrial snails. The Forest Service and NCNHP are actively working to integrate all historical records into the Natural Heritage Element Occurrence database and develop a strategy for reviewing, updating, and expanding knowledge of this species group.

The influence of FS habitat management on overall species persistence is higher for rare animals with more known occurrences (i.e. >30) statewide, where greater than 30% of known occurrences are on the Forests. This analysis is meant to highlight rare animal species where the FS has a measurable role in maintaining persistence at a larger scale. In the table below rare animal species with greater than 50% of known occurrences on the Forests are shown in bold. This emphasizes the Forests' critical role in maintaining species persistence at the statewide scale.

**Species with 30 or more occurrences statewide, more than 30% of which are on the Forests.**

Group	Species
Salamander	Hellbender
Salamander	Northern Pygmy Salamander
Salamander	Junaluska Salamander
<b>Salamander</b>	<b>Tellico Salamander</b>
<b>Salamander</b>	<b>Cheoah Bald Salamander</b>
Salamander	Southern Zigzag Salamander
Bird	Peregrine Falcon
Bird	Cerulean Warbler
Bird	Golden-winged Warbler
Crustacean	Chauga Crayfish
<b>Insect</b>	<b>Appalachian Tawny Crescent</b>
Mammal (bat)	Rafinesque's Big-eared Bat
Mammal (bat)	Little Brown Bat
Mammal (bat)	Northern Long-eared Bat
<b>Mammal (bat)</b>	<b>Indiana Bat</b>
<b>Mammal</b>	<b>Carolina Northern Flying Squirrel</b>
<b>Mammal</b>	<b>Southern Water Shrew</b>
Mammal	Appalachian Cottontail

## Environmental Consequences

### Effects of vegetation management on the persistence of rare animals

The effects of forest plan objectives for vegetation management are considered through coarse filter analysis in the ESE Tool. The analysis presented here is intended to supplement the ESE Tool analysis by

presenting effects to animal species persistence and recovery at a broader perspective. This analysis does not vary much by alternative but provides insight on species most at risk to inform decision making.

Species with limited mobility and small occupied ranges are more susceptible to direct effects of vegetation management compared to species that can disperse away from the impacted area. Salamanders and terrestrial snails are examples of species that have limited mobility and are susceptible to trampling from heavy equipment, vehicles, and foot traffic.

Other species are susceptible to indirect effects of vegetation management, such as disturbance of nesting and roosting habitats following structural changes in the forest. Examples include nesting migratory birds and roosting bats. These species are generally more mobile and can escape short-term disturbance; however nesting and roosting success can be compromised by changes in forest structure and composition. This is especially critical for federally listed species such as the Carolina Northern Flying Squirrel, Indiana Bat, Northern Long-eared Bat, and Gray Bat. The effects to these species are discussed in more detail in the federally listed species section of the EIS.

Some rare animals are dependent on vegetation disturbance and associated structural changes, such as the Golden-winged Warbler and Cerulean Warbler. Additionally, forest openings provide optimal foraging habitat for many species of bat.

Aquatic animals such as fish, mussels, and crayfish are particularly susceptible to the indirect effects of sediment transport to aquatic and riparian habitats. Many animal species, not just the rare species included in this analysis, depend on the association of different habitat elements in proximity to each other for persistence.

To address potential impacts, the revised forest plan includes plan components to mitigate impacts from management and ensure that the plan is providing for persistence within Forest Service authority and consistent with the inherent capability of the plan area. Plan components are provided for ecozones, species groups, unique habitats, or individual species based on their need. Appendix C includes a crosswalk of the plan components that provide ecological conditions to sustain persistence of individual species. These plan components are incorporated into the ESE Tool analysis.

Under the proposed forest plan, most vegetation management would take place in the Matrix and Interface MAs under the action alternatives (or similar management areas under Alternative A). Therefore, it is assumed that potential effects to rare animals would be highest in these MAs. Under all alternatives, approximately 51% of the rare animal species analyzed have no known occurrences within Matrix or Interface MAs (or similar MAs under Alt A). Of the remaining 36 rare animal species analyzed, 32 of them have at least 20% of known occurrences within Matrix or Interface under all alternatives. In Alternatives B and D, 23 species have at least 40% of known occurrences within Matrix or Interface, whereas Alternative C has 20 species with at least 40% of known occurrences within Matrix or Interface MAs. To ensure persistence of rare species across the Forests, including occurrences within Matrix and Interface MAs, the Forest Plan includes desired conditions, objectives, standards and guidelines for plant and animal diversity. Standard PAD-S-03 specifically requires field surveys for rare species when there is potential effects to species and mitigations are necessary to reduce effects. Coordination with the USFWS and the NC Natural Heritage Program will ensure the best available information regarding habitat and element occurrences is being used during project design.

Twenty rare animal species have greater than 50% of their known occurrences within Matrix and Interface MAs. Several of these species have additional plan standards that are specific to ensuring persistence across the Forests (federally listed bats, bald eagle, green salamander).

**Rare animal species that have greater than 50% of known occurrences within Matrix and Interface MAs**

		Alt B	Alt C	Alt D	Alt E
Salamander	Green Salamander	-	-	X	X
Salamander	Southern Pygmy Salamander	-	-	X	X
Salamander	Longtail Salamander	X	X	x	x
Salamander	Chattahoochee Slimy Salamander	X	X	X	X
Salamander	Southern Zigzag Salamander	X	x	X	X
Salamander	Weller's Salamander	X	X	X	X
Bird	Cerulean Warbler	X	X	X	X
Bird	Golden-winged Warbler	X	X	X	X
Bird	Bald Eagle	X	X	X	X
Crustacean	Hiwassee Headwaters Crayfish	X	X	X	X
Butterfly	Appalachian Tawny Crescent	X	-	X	X
Mammal	Rafinesque's Big-eared Bat	X	X	X	X
Mammal	Gray Bat	X	X	X	X
Mammal	Eastern Small-footed Bat	X	X	X	X
Mammal	Little Brown Bat	X	X	X	X
Mammal	Northern Long-eared Bat	X	X	X	X
Mammal	Indiana Bat	X	-	X	X
Mammal	Tri-colored Bat	X	X	X	X
Terr Snail	Velvet Covert	X	X	X	X
Terr Snail	High Mountain Supercoil	X	X	X	X

All of the species identified above are subject to general disturbance by human presence (noise, etc.). This is especially critical during the spring and summer when most species are reproducing, including when migratory birds are nesting and bats are raising non-volant pups. Spring, summer, and fall are also times of peak forest management activity on the Forests.

To address the vulnerability of rare salamanders to the effects of forest management on forest floor and microclimate conditions, the proposed plan includes plan components to maintain coarse woody debris and protect streamside forests under all alternatives (AQS-DC-03, WTR-G-02, SZ-S-03, WLF-S-01). The Forest Plan also includes a standard that requires project-specific surveys for rare species when existing data and knowledge is insufficient to make sound management decisions (PAD-S-03). Effects to terrestrial salamanders are also addressed in EIS section 3.3.5.4.

Some migratory birds such as the Cerulean Warbler and Golden-winged Warbler, require forest management to restore habitat conditions across the landscape. These two species are associated with NCWRC Wildlife Habitat Active Management Areas within the revised forest plan that directs management activities specifically to restore and maintain habitat for these declining species. The Forest Plan includes plan components and management approaches that provide for Cerulean Warbler and Golden-winged Warbler (WLF-DC-04) under all action alternatives. Golden-winged warbler and cerulean warbler and are also addressed in more detail in EIS sections 3.3.5.1 and 3.3.5.2 Other migratory bird species are protected through an extensive network of designated old growth forest, and identification of interior and other mature forest conditions across the landscape.

Bald Eagle nesting on the Forests will be protected through compliance with the Bald and Golden Eagle Protection Act. This law is referenced in plan components and is applicable to all management activities, including vegetation management.

Some insects and other pollinators, such as the Appalachian Tawny Crescent, require open areas and edges provided by features such as roads and vegetation management to persist. The forest plan contains objectives for creating or maintaining these features across the landscape (ECO-O-01, ECO-O-02, PAD-O-04).

Aquatic species, such as the Hiwassee Headwaters Crayfish are susceptible to sedimentation of occupied habitats from runoff associated with forest management. Research demonstrates that when referring to vegetation management and timber harvest, most runoff is associated with roads and access rather than the vegetation removal. The revised forest plan contains plan components to reduce or eliminate this threat. Additionally, laws such as the Clean Water Act and North Carolina Sediment and Pollution Control Act and the North Carolina Forest Practice Guidelines Related to Water Quality guide management activities. All of this guidance is incorporated into all alternatives of the revised forest plan.

Generally, bats are more threatened by the persistence of white-nosed syndrome on the landscape than a lack of roosting and foraging habitat. The forest plan includes plan components to maintain critical habitat features such as snags and open canopy conditions for foraging under all alternatives (cite plan components). Additionally, caves and abandoned mines are protected through a regional closure to recreational use, and also designated as smoke-sensitive areas during prescribed burning. Effects to federally listed bats are discussed in more detail in the Federally Listed Species section of the EIS.

Terrestrial snails are susceptible to direct crushing from vegetation management activities, specifically from the use of heavy equipment. Perhaps more important however, is the potential for reduced habitat suitability following timber harvest in terms of forest floor drying. Terrestrial snails are dependent on moist leaf litter, and although reductions in leaf litter are temporary following timber harvest, drying of the forest floor impacts habitat. There is a real lack of information on terrestrial snails in general; therefore, the Forest Service and the NC Natural Heritage Program use historical data and are focused on increasing data collection across Western North Carolina to learn more about presence of snails and impacts to their persistence. The primary threat to these species is habitat loss through desiccation, rather than crushing. Leaf and other organic matter associated with these species likely reduces effects of direct foot or vehicle crushing. The Noonday Globe is listed in this threat; however, the species' known range is within a major roadway corridor (the Nantahala Gorge) that is not particularly susceptible to trail and off-trail use. Landslides, such as those that occurred following wildfires in 2016, are another primary threat to this species.

#### **Effects of Recreation Forest Use on the persistence of rare animals**

The effects of recreation on rare animals are not expected to vary much by alternative, but can inform decision making, especially when prioritizing road and trail construction, relocation and decommissioning, which occurs at the project level, or when other actions, such as forest closures, are needed to support maintaining rare species impacted by recreation.

Most recreation takes place on system roads and trails. For this analysis, roads and trails were buffered by 100 meters to include off-road/trail exploration and most developed recreation areas (although these areas could be merged into the recreation polygon). This area represents the highest potential for direct or indirect effects of recreational use of the Forests on rare animals.

Animals that have limited mobility or have small occupied ranges, such as snails and terrestrial salamanders, are more susceptible to direct effects of recreation, including trampling by vehicles or foot traffic.



Animals such as migratory birds and bats are susceptible to indirect effects of recreation, through disturbance of nesting and roosting habitats by noise and other human presence. While birds and bats are generally more mobile and can escape short-term disturbance, nesting and roosting success can be compromised with longer-term exposure to human disturbance. This is especially critical for federally listed species such as the Carolina Northern Flying Squirrel, Indiana Bat, Northern Long-eared Bat, and Gray Bat.

Aquatic animals such as fish, mussels, and crayfish are susceptible to the indirect effects of sediment transport to aquatic and riparian habitats. Additionally, the effects of recreation on hellbenders (i.e. moving rocks in occupied habitats) is well documented, as well as the effects of rock climbing on nesting Peregrine Falcons, caver use of areas occupied by hibernating bats, and boating traffic on nesting Bald Eagles.

To address potential impacts, the revised plan includes plan components to mitigate these impacts and ensure that the plan is providing for persistence within Forest Service authority and consistent with the inherent capability of the plan area. Appendix C includes a crosswalk of the plan components that provide ecological conditions to sustain persistence of individual species. Plan components are provided for sustainable recreation and trails, transportation and access, and are contained in specific management areas, such as Roan Mountain, based on the need. The Recreation section of the EIS includes more detail regarding the sustainable recreation plan language.

Approximately 42% (25 species) of the rare animal species analyzed have no known occurrences within 100 meters of roads and trails, and therefore have minimal risk from potential effects of recreation. In contrast, rare animal species with greater than 50% of known occurrences within 100 meters of a road or trail are particularly susceptible to potential effects of recreational use (table below).

**Rare animal species with greater than 50% of known occurrences within 100 meters of a road or trail.**

<b>Group</b>	<b>Species</b>
Salamander	Green Salamander
Salamander	Hellbender
Salamander	Dwarf Blackbelly Salamander
Salamander	Northern Pygmy Salamander
Salamander	Southern Pygmy Salamander
Salamander	Junaluska Salamander
Salamander	Longtail Salamander
Salamander	Chattahoochee Slimy Salamander
Salamander	Cheoah Bald Salamander
Salamander	Southern Zigzag Salamander
Arachnid	Spruce Fir Moss Spider
Bird	Peregrine Falcon
Bird	Cerulean Warbler
Bird	Golden-winged Warbler
Crustacean	Chauga Crayfish
Crustacean	Hiwassee Headwaters Crayfish (Parrish Crayfish)
Crustacean	Yancey Sideswimmer (Carolina Seep Scud)
Fish	Turquoise Darter
Fish	Wounded Darter
Fish	Logperch
Fish	Olive Darter

Group	Species
Insect	Appalachian Tawny Crescent
Insect	Rusty-patched Bumblebee
Mammal (bat)	Gray Myotis (Gray Bat)
Mammal (bat)	Eastern Small-footed Bat
Mammal (bat)	Little Brown Myotis (Little Brown Bat)
Mammal (bat)	Northern Long-eared Bat (Northern Myotis)
Mammal (bat)	Tri-colored Bat
Mammal	Carolina Northern Flying Squirrel
Mammal	Alleghany Woodrat
Mammal	Southern Water Shrew
Mammal	Appalachian Cottontail
Freshwater Mussel	Appalachian Elktoe
Freshwater Mussel	Brook Floater
Terrestrial Snail	Fragile Glyph
Terrestrial Snail	Velvet Covert
Terrestrial Snail	Sculpted Supercoil
Terrestrial Snail	Roan Supercoil
Terrestrial Snail	Noonday Globe

All of the species identified in Table 5 are subject to general disturbance by human presence (noise, etc.). This is especially critical during the spring and summer when most species are reproducing, including when migratory birds are nesting and bats are raising non-volant pups. Spring and summer are times of high recreational use on the Forests. The Forest Plan provides direction to temporarily mitigate impacts or close areas if needed until actions can be taken to address the threats (REC-S-08).

The Spruce-fir Moss Spider is particularly susceptible to habitat disturbance from recreation use within its range, especially use that disturbs wet areas with moss-covered rocks within and adjacent to trails. There are no known occurrences of this species within or adjacent to Forest roads. (See the section on Spruce-Fir Moss Spider, 3.3.4.4.)

All but two of the rare salamanders considered in this analysis are vulnerable to the effects of recreation on species' persistence because these species are generally less mobile and unable to escape direct threats. Salamanders are also susceptible to over-collection (from angler bait collection, personal collections, or for the pet trade), and roadkill (some species migrate across roads, especially at night, during breeding season). To address the over-collection threat, the plan includes PAD-S-02 to restrict collection of federally listed species or SCC except for approved scientific purposes and after coordinating with the USFWS. Plan direction in the transportation and access section addresses mitigating road impacts (TA-DC-08, TA-S-04). (See the sections on terrestrial salamanders 3.3.5.4.)

To address the effects of rock climbing on peregrine falcon nesting, the Forests maintain a seasonal closure of rock faces used by Peregrine Falcons for nesting. The local rock-climbing community is heavily involved in the successful protection of peregrine falcon nesting. The plan includes PAD-S-05 to manage climbing, rappelling, hang gliding, the use of drones, and other nest disturbing activities in the vicinity of active peregrine falcon nesting sites from January 15th to August 15th to control human disturbance and encourage successful nesting and fledging.

Aquatic species, such as crayfish, fish, and mussels are susceptible to sedimentation of occupied habitats from runoff associated with nearby roads and trails. Southern Water Shrew is also vulnerable to the impacts of aquatic habitat sedimentation. The Yancey Sideswimmer has a very small known distribution

and is particularly susceptible to the disturbance of seeps it is associated with. Plan direction in the soil, watersheds, and transportation and access sections is designed to address soil erosion and sedimentation, including an emphasis on conducting road maintenance that are known to be hydrologically connected to the stream network (TA-O-03, WSD-O-01, etc).

In addition to other threats to habitat quality, the Appalachian Tawny Crescent and Rusty-patched Bumblebee are susceptible to over-collection by forest users. The presence of roads and trails for easy forest access exacerbate this threat. To address the over-collection issue, the plan includes PAD-S-02 to restrict collection of federally listed species or SCC except for approved scientific purposes and after coordinating with the USFWS.

Allegheny Woodrat is particularly susceptible to trail use where it occurs across occupied rocky areas. The Forest Plan includes a standard that specifically addresses trails in rocky areas to minimize disturbance to Allegheny woodrat (PAD-S-06).

Terrestrial snails are susceptible to direct crushing from road and trail use because they are not mobile and able to escape direct threats. The primary threat to these species is habitat loss via desiccation, rather than crushing. Leaf and other organic matter associated with these species likely reduces effects of direct foot or vehicle crushing. The Noonday Globe is listed in this threat; however, the species' known range is within a major roadway corridor (the Nantahala Gorge) that is not particularly susceptible to trail and off-trail use. Landslides, such as those that occurred following wildfires in 2016, are another primary threat to this species.

#### **Effects of climate change and acidic deposition on the persistence of rare animals**

Climate change and acidic deposition are environmental stresses that are outside the control of the Forest Service; however, they are the primary stressors for many rare species. While this analysis does not vary by alternative it is intended to highlight potential effects of key environmental stressors on rare animal persistence. This analysis will also provide insight on species most at risk to inform decision making, especially at the project level. The climate change section of this EIS also examines this threat in more detail.

The forest plan's climate change section includes several desired conditions and management approaches to address the climate change threat; additionally, the plan monitoring program includes unit and broadscale monitoring questions focused on adaptive management.

Animals that are more susceptible to direct and indirect effects of climate change and acidic deposition are those species with all or most known occurrences within high elevation habitats. Examples of this include some species of salamanders and terrestrial snails. These species are generally less mobile, or have small occupied ranges, and are therefore more susceptible to not being able to escape environmental change. Federally listed Spruce-fir Moss Spider and Noonday Globe are included in this risk. (See section on spruce-fir Moss Spider, section 3.3.4.4.)

Other species groups are susceptible to indirect effects of compositional and/or structural vegetation changes associated with unmitigated environmental change. Examples of this are nesting migratory birds and roosting bats. These species are generally more mobile and can escape short-term disturbance; however nesting and roosting success can be compromised with longer-term exposure to changes in forest structure and composition. This is especially critical for federally listed species such as the Carolina Northern Flying Squirrel and Northern Long-eared Bat. (See sections on Carolina Northern Flying Squirrel, 3.3.4.1, and Federally Listed Bats, 3.3.4.2.)

Approximately 68% of the rare animal species analyzed have no to minimal potential effects from climate change and/or acidic deposition because known occurrences are not within high elevation environments (44 species), or there is not enough data to evaluate these effects (6 species).

Of the remaining 24 rare animal species analyzed, 17 (89%) of them have at least 20% of known occurrences within high elevation habitats. This demonstrates the high potential for environmental stressors like climate change and acidic deposition to affect rare animal species habitat, and even persistence on the Forests.

Rare animal species with greater than 50% of known occurrences within high elevation habitats are particularly susceptible to environmental stressors like climate change and/or acidic deposition (table below).

**Rare animal species with greater than 50% of known occurrences within high elevation habitats.**

<b>Group</b>	<b>Species</b>
Salamander	Northern Pygmy Salamander
Salamander	Tellico Salamander
Salamander	Cheoah Bald Salamander
Salamander	Weller's Salamander
Arachnid	Spruce Fir Moss Spider
Crustacean	Yancey Sideswimmer
Insect	Rusty-patched Bumblebee
Mammal	Carolina Northern Flying Squirrel
Mammal	Appalachian Cottontail
Terrestrial Snail	Fragile Glyph
Terrestrial Snail	High Mountain Supercoil
Terrestrial Snail	Noonday Globe

The plan monitoring program includes a question to monitor adaptation strategies in high elevation habitats and the climate change section includes management approaches that support suitable habitat enhancement where there are species at risk susceptible to the effects of climate change. The climate change section of the plan includes a management approach for facilitating species migration and adaptation when possible.

Because terrestrial salamanders are extremely sensitive to changes in microclimate conditions such as forest floor temperature and moisture, all of the rare salamanders considered in this analysis are vulnerable to the effects of climate change and acidic deposition on species' persistence. The Forest Plan includes direction to maintain coarse woody debris and protect streamside forests, and therefore maintain habitat for most salamander species (cite plan component). The plan also includes a standard that requires project-specific surveys for rare species when existing data and knowledge is insufficient to make sound management decisions (PAD-S-03). (See section on terrestrial salamanders, 3.3.5.4)

Green Salamanders, which are not associated with high elevation habitats, are also particularly susceptible to the effects of climate change and acidic deposition. This species is highly associated with crevices within shaded, moist rock outcrops in a small area of the Forests and changes to this microclimate (drying, pH, etc.) could negatively affect the persistence of the species. The proposed revised Forest Plan includes a standard directed specifically at protecting and conserving this species (PAD-S-14). (See section on green salamanders, 3.3.5.5.)

Some insects and other pollinators, such as the Rusty-patched Bumblebee, require open areas and edges provided by features such as roads and vegetation management to persist. The revised forest plan

contains criteria for creating or maintaining these features across the landscape. (See section on Rusty-patched bumblebee, 3.3.4.3.)

Like salamanders, terrestrial snails are susceptible to changes in forest floor microclimate. These species are dependent on moist leaf litter, and although reductions in leaf litter are temporary following timber harvest, drying of the forest floor remains of concern. There is a real lack of information on this species group in general. Therefore, the Forest Service and the NC Natural Heritage Program are currently focusing on historical data and increasing data collection across Western North Carolina.

## **Conclusion**

While rare species occur within areas of the forest that are impacted by timber harvest, recreation use and climate change, the revised plan includes plan components to mitigate these impacts where possible and ensure that the plan is providing for persistence within Forest Service authority and consistent with the inherent capability of the plan area. Plan components are provided for all of the species of conservation concern and federally listed species. Appendix C includes a crosswalk of plan components that provide ecological conditions to sustain persistence of individual species.

### **3.3.5.1 Golden-winged Warbler (*Vermivora chrysoptera*)**

Three individual species of conservation concern (golden winged warbler, cerulean warbler, and elk), and one species group (terrestrial salamanders) are discussed in detail in this section of the EIS. These species were added in the FEIS because they were discussed regularly during collaborative dialogue for this plan revision and were raised in comments on the draft plan and EIS.

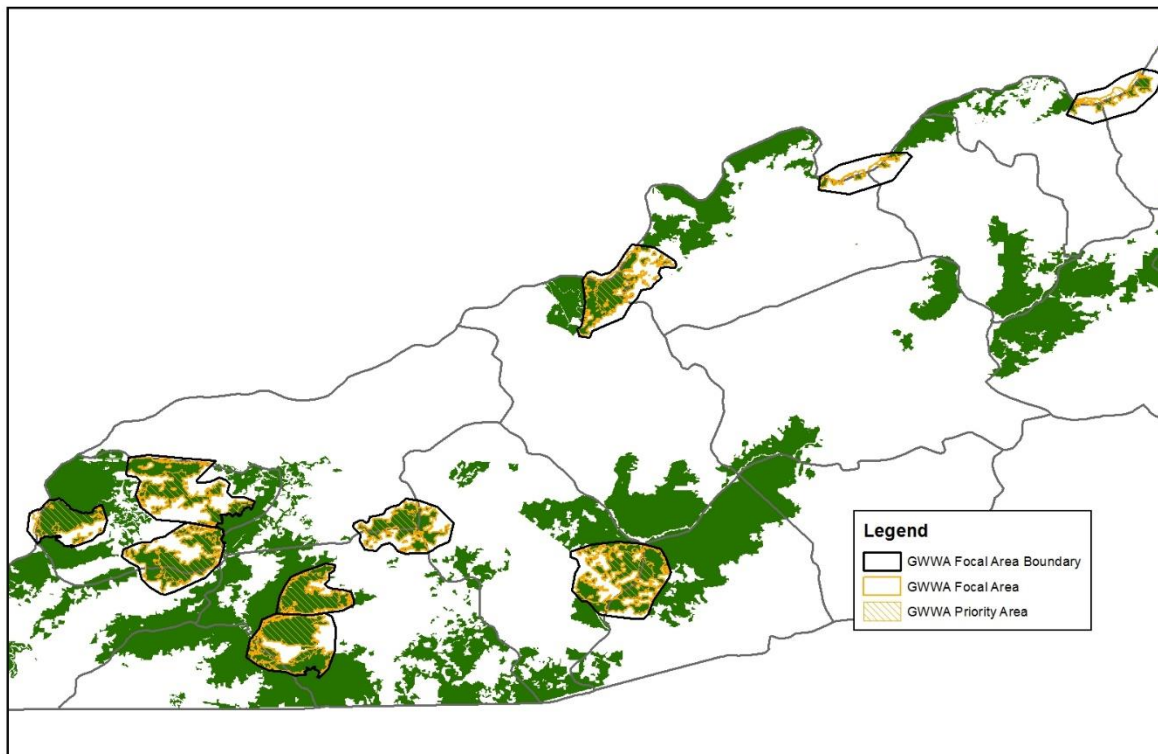
## **Affected Environment**

Golden-winged Warbler (GWWA) is identified as a Species of Greatest Conservation Need (SGCN) in the North Carolina Wildlife Action Plan (NCWAP) (NCWRC 2015), and as a Species of Conservation Concern (SCC) on the Nantahala and Pisgah NFs for the forest plan revision process under the 2012 Planning Rule. Additionally, the Appalachian Mountain Joint Venture (AMJV) identifies this species as a top landbird conservation priority (AMJV 2020).

GWWA is a migratory species, with documented persistent breeding in western North Carolina, including on the Forests (Matseur et al. 2020). Suitable nesting habitat consists of a mosaic of grassy and herbaceous openings, shrubs or saplings, and taller deciduous trees that borders mature forest within a landscape matrix of deciduous forest. Population declines have been attributed to a variety of threats, including loss of breeding habitat, interactions with Blue-winged Warbler (competition, hybridization) and Brown-headed Cowbird (brood parasitism), migration hazards, and land use changes across their range (GWWG 2019).

Migratory connectivity (i.e., the relationship between breeding and wintering habitats, including the migration corridor itself) influences many bird species populations, including GWWA. Kramer et al. (2018) documents strong evidence to support the hypothesis that population trends of *Vermivora* warblers are associated with changes in nonbreeding wintering habitats in Central and South America, in addition to breeding habitat suitability and availability in the eastern United States. Kramer et al. (2018) further summarizes that the ecological complexity and habitat requirements throughout the life history of many migratory species makes it unlikely that there is a single driver of these trends. However, identification of spatial isolation between populations of *Vermivora* warblers suggests that the drivers of historical declines in populations of Appalachian Mountains-breeding GWWAs are linked to their nonbreeding distribution in northern South America or the migratory pathways between breeding and nonbreeding habitats.

While the loss of habitat (humid mid-elevation tropical forest) may have direct effects on nonbreeding GWWAs, habitat fragmentation and reduced habitat quality and quantity may also contribute to nonlethal effects on reproductive success and survival of individuals returning to North America to



**Figure 93. Wildlife habitat active management areas (WHAMAs) for Golden-winged Warbler in western North Carolina**

breed. Additionally, because GWWAs breeding in the Appalachian Mountains migrate further than other nearctic-neotropical migrant songbird species, it is possible that the species is more sensitive to declines in available food resources, phenology mismatches during migration, and/or higher risk of encountering predators or other obstacles during migration (Kramer et al. 2018). It is unlikely that GWWAs are the only broadly dispersed nearctic-neotropical migrant songbird species that exhibits strong migratory connectivity and shows population trends consistent with being limited by nonbreeding factors (Kramer et al. 2018). It is clear from this study that maintaining, restoring, and enhancing migratory songbird breeding habitat, in appropriate places and amounts, across breeding ranges is critical to the persistence of many species experiencing population declines wholly or in part due to the loss of migratory connectivity.

As part of the forest plan revision process, the North Carolina Wildlife Resources Commission (NCWRC) and biologists from the National Wild Turkey Foundation (NWTf) and Audubon North Carolina (ANC) used the best available science on habitat associations and population trends to identify Wildlife Habitat Active Management Areas (WHAMAs) for the GWWA across the Forests (NCWRC 2016). These efforts will aid in the prioritization of forest management activities with potential to contribute to stabilizing or reversing the well-documented decline of GWWA. In addition, this process identified other species that will benefit from active management in areas identified for GWWA, including: Eastern Bluebird, American Woodcock, Indigo Bunting, Field Sparrow, American Goldfinch, Common Yellowthroat, and Appalachian Cottontail. Note that this list identifies examples of species associations with young and early successional forest habitats and is not inclusive.

In this process, a GWWA WHAMA focal area of approximately 325,504 acres was identified across all ownerships. Of this area, 165,216 acres (51%) are on the Forests. Within the WHAMA focal area on the Forests, approximately 102,736 acres (62%) have been identified as GWWA WHAMA priority areas for habitat restoration (and therefore, species population) and enhancement under the revised forest plan (Figure 94). The Forest plan includes management approaches that emphasize the need for active management in WHAMAs (WLF-DC-01, WLF-DC-02, WLF-DC-08, WLF-G-01, WLF-G-03, WLF-G-04, Wildlife Habitat Diversity Management Approaches, etc.) and highlights the integration of Best Management Practices for Golden-winged Warbler Habitats in the Appalachian Region into project-level prescriptions (Bakermans et al. 2011, GWWG 2019).

### Environmental Consequences

Based on forest-wide and management area direction, the best opportunity to restore or enhance habitat for GWWA across the Forests is within the Matrix and Interface Management Areas (MA Group 1) because these are the areas where active management is most likely to occur. More specifically, proposed management will be most effective at restoring or enhancing habitat for GWWA when it is within a GWWA WHAMA priority area. While habitat for GWWA occurs in other parts of the forest, the GWWA WHAMA priority areas are identified as the places where the best chance of successful habitat management for the species occurs.

**Table 111. Summarization of Management Area Group 1 (MA Group 1) and the GWWA WHAMA Priority Areas, by Action Alternative**

	% MA Group 1 = WHAMA	% WHAMA = MA Group 1	% WHAMA = MA Group 4
B	17%	75%	0.01%
C	21%	59%	0.01%
D	17%	69%	0.01%
E	17%	67%	0.01%

Based on the percent of MA Group 1 within GWWA WHAMA priority areas, Alternative C has a slightly higher proportion of acres identified in GWWA WHAMA priority areas compared to Alternatives B, D, and E. These minor differences across alternatives demonstrates that under all alternatives, effective GWWA habitat restoration or enhancement would be focused on a relatively small proportion of the Matrix and Interface MAs.

When considering the ability to prioritize meaningful habitat restoration or enhancement for GWWA, based on the amount of WHAMA priority areas that are within MA Group 1, Alternative B (75%) provides the greatest opportunity for effective restoration or enhancement of GWWA habitat, followed by Alternatives D and E (69% and 67%) (Table 111). Alternative C includes a lower percent of the GWWA WHAMA in MA Group 1 (59%) and therefore a slightly lower opportunity for effective restoration or enhancement of GWWA habitat. Less than a tenth of one percent of the GWWA WHAMA is within MA Group 4 under all action alternatives.

This analysis also considers where the designated old growth network overlaps with GWWA WHAMA priority areas. While forest management may occur within the designated old growth network, the treatments are more limited than in other parts of the Matrix and Interface MAs. The designated old growth network varies by alternative, and therefore poses different levels of impact on opportunities for GWWA habitat restoration or enhancement. Under all alternatives, the amount designated old growth network within MA Group 1 that overlaps with the GWWA WHAMA priority areas is less than 6%. Alternative E has a 6% overlap, Alternative B has 5% overlap, Alternative C has 4% overlap, and Alternative D has 3% overlap. With a 6% or less overlap of the designated old growth and GWWA WHAMA priority areas in the Matrix and Interface MAs, the designated old growth network should not impact the ability to restore or enhance GWWA habitat in priority WHAMAs in any alternative.

## Summary of Potential Effects

Overall, because Alternative B has the highest percentage of the forest in Matrix and Interface MAs, it provides the greatest opportunity for restoration or enhancement of habitat for Golden-winged Warblers and other species associated with young and early successional habitats at higher elevations (i.e., >3,000'). Alternatives D and E also provide good opportunity for restoration or enhancement of habitat, and Alternative C provides slightly less. Neither the allocation of land to recommended wilderness (MA Group 4) nor the designated old growth network have a considerable impact on the ability to manage within GWWA WHAMA priority areas.

### 3.3.5.2 Cerulean Warbler (*Setophaga cerulea*)

Three individual species of conservation concern (golden winged warbler, cerulean warbler, and elk), and one species group (terrestrial salamanders) are discussed in detail in this section of the EIS. These species were added in the FEIS because they were discussed regularly during collaborative dialogue for this plan revision and were raised in comments on the draft plan and EIS.

#### Affected Environment

Cerulean Warbler (Ceruleans) is identified as a Species of Greatest Conservation Need (SGCN) in the North Carolina Wildlife Action Plan (NCWAP) (NCWRC 2015), and as a Species of Conservation Concern (SCC) on the Nantahala and Pisgah NFs for the forest plan revision process under the 2012 Planning Rule. Additionally, the Appalachian Mountain Joint Venture (AMJV) identifies this species as a top landbird conservation priority (AMJV 2020).

Cerulean Warbler is a migratory species, with documented persistent breeding in Western North Carolina, including on the Forests (Matseur et al. 2020). Habitat associations include canopy gaps and internal forest edges such as narrow roads, trails, narrow utility rights-of-way, and edges of small timber harvests. Ceruleans are less abundant near abrupt or “hard” edges between forest cover and large expanses of open land (e.g., commercial, residential, and industrial development). They will use relatively small forest patches (~25 acres) but are typically associated with landscapes that have a greater than 75% forest cover (Wood et al. 2013).

In the Appalachians, Cerulean Warblers occur primarily along ridges and steep upper slopes, and often cluster near areas of local relief such as knobs and bluffs. The soil characteristics and topography of these features contribute to stratification of canopy trees so that ridge top forests often have a complex overstory structure containing large oaks with expansive crowns. Thus, ridge top forests offer the structure and composition sought by breeding ceruleans. Within ridge top forests, ceruleans favor mesic, north- and northeast-facing slopes, although other aspects are also used. Ceruleans place territories and nests in hardwood forests with well-spaced, large diameter trees (>16 inches dbh). Nests are typically in the largest trees available at a site (Wood et al. 2013).

Landscape factors such as large-scale edges can also influence Cerulean Warblers’ breeding habitat quality. Weakland and Wood (2005) found that Ceruleans avoided large-scale edges produced by mines and were positively associated with larger areas of mature forest. It is uncertain if edges resulting from forest management at the scale presented in the revised forest plan constitute “large-scale” edges such as those observed during mining operations in West Virginia by Weakland and Wood (2005). Harvest unit size on national forests is dictated by existing law, regulation, and policy and edges are typically ephemeral on the landscape as new forest regenerates. It is also important to note that the revised Forest Plan highlights and emphasizes silvicultural recommendations contained in Wood et al. 2013 to contribute to the maintenance, restoration, and enhancement of habitat for the Cerulean Warbler.



As part of the forest plan revision process, the North Carolina Wildlife Resources Commission (NCWRC) and biologists from the National Wild Turkey Foundation (NWTf) and Audubon North Carolina (ANC) used the best available science on habitat associations and population trends to identify Wildlife Habitat Active Management Areas (WHAMAs) for the Cerulean Warbler across the Forests (NCWRC 2016). These efforts will aid in the prioritization of forest management activities with potential to contribute to stabilizing or reversing the well-documented decline of Ceruleans. In addition, this process identified other species that will benefit from active management in areas identified for Cerulean Warbler, including: Eastern Wood Pewee, Red-eyed Vireo, White-breasted Nuthatch, and Hairy Woodpecker. Note that this list identifies examples of species associations with moderately open forest habitat (i.e., not woodlands, as described in the revised Forest Plan) and is not inclusive.

In this analysis, a Cerulean Warbler WHAMA focal area of approximately 46,860 acres was identified across all ownerships. Of this area, 25,860 acres (55%) are on the Forests. Within the WHAMA focal area on the Forests, approximately 12,870 acres (62%) have been identified as Cerulean Warbler WHAMA priority areas for habitat (and therefore, species population) restoration and enhancement under the revised forest plan (Figure 94). Forest plan direction emphasizes need for active management in WHAMAs WLF-DC-04, Wildlife Habitat Diversity Management Approaches, BAC-DC-04, etc. and highlights the integration of management approaches for enhancing Cerulean Warbler breeding habitat in Appalachian hardwood forests (Wood et al. 2013) into project-level prescriptions.

### **Environmental Consequences**

Based on forest-wide and management area direction, the best opportunity to restore or enhance habitat for Cerulean Warblers across the Forests is within the Management Area Group 1 (MA Group 1) because these are the areas where active management is most likely to occur. More specifically, proposed management will be most effective at restoring or enhancing habitat for Ceruleans when it is within a Cerulean Warbler WHAMA priority area. While habitat for Ceruleans occurs in other parts of the forest, the Cerulean Warbler WHAMA priority areas are identified as places where the best chance of successful habitat management for the species occurs. Habitat restoration or enhancement for Ceruleans can also be met by managing for moderately open mature forest conditions across the Forests, but especially within the WHAMA for the species.

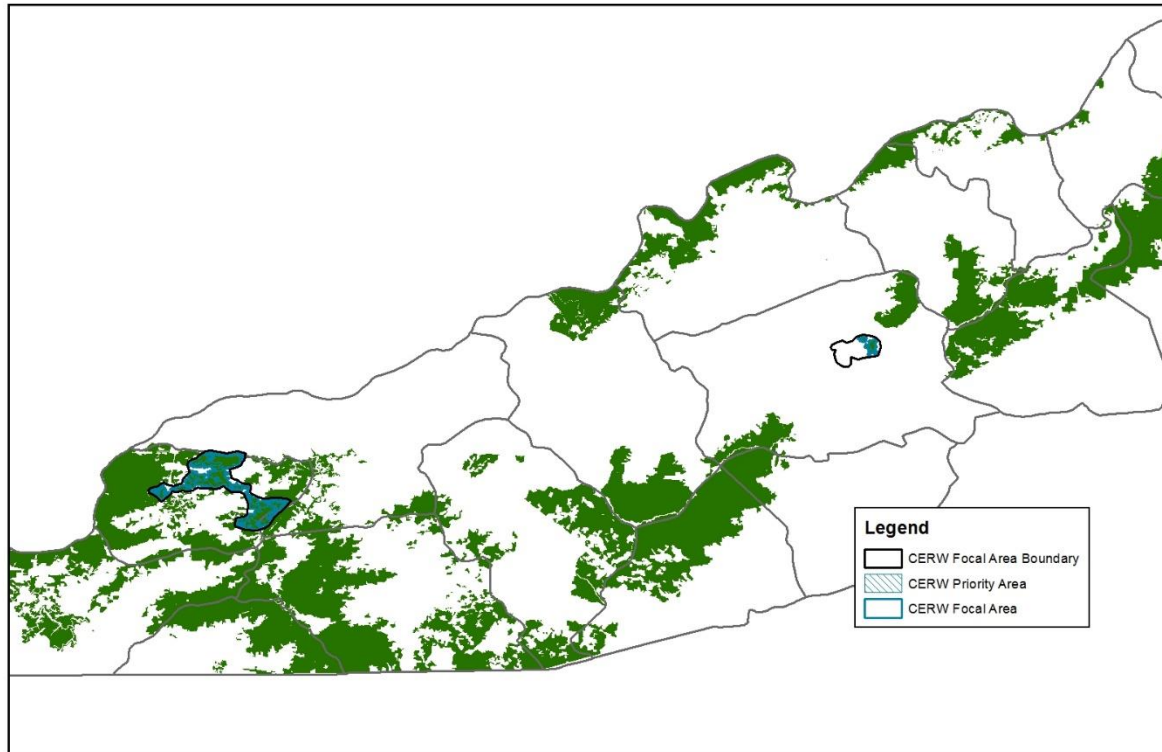


Figure 94. Wildlife habitat active management areas for Cerulean Warbler in western North Carolina.

Table 112. Summarization of Management Area Group 1 (MA Group 1) and the Cerulean Warbler WHAMA Priority Areas, by Action Alternative

	% MA Group 1 = WHAMA	% WHAMA = MA Group 1	% WHAMA = MA Group 4
B	22%	46%	0%
C	27%	44%	0%
D	25%	46%	0%
E	25%	46%	0%

Based on the percent of MA Group 1 within Cerulean Warbler WHAMA priority areas, Alternative C has a slightly higher proportion of acres identified in Cerulean Warbler WHAMA priority areas compared to Alternatives B, D and E (Table 112). These minor differences across alternatives demonstrates that under all alternatives, effective Cerulean habitat restoration or enhancement should be focused on a relatively small proportion of the Matrix and Interface MAs. Habitat restoration or enhancement for Ceruleans can also be met by managing for moderately open mature forest conditions across the Forests, but especially within the WHAMA priority areas for the species.

When considering the ability to prioritize meaningful habitat restoration or enhancement for Ceruleans, based on the amount of WHAMA priority areas that are within MA Group 1, Alternatives B, D, and E (46%) provide the greatest opportunity for effective active restoration or enhancement of Cerulean habitat, followed closely by Alternative C (44%) (Table 112). None of the Cerulean Warbler WHAMA is within MA Group 4 under any action alternative.

Additionally, based on potential mature forest habitats, as represented by management areas other than Matrix or Interface across the Forests, Alternative C has a higher proportion of the Cerulean Warbler WHAMA priority areas in MA Groups 2-4 (56%), followed closely by Alternatives B, D, and E (54%) (Table 113).

It is important to note that most of MA Group 1 will trend towards mature forest habitats over time, and that disturbance in these areas is also related to natural disturbance events. Prescribed fire will be a vital tool in restoring moderately open mature forest habitat for Cerulean Warbler across the Forests, including within the Cerulean Warbler WHAMA priority areas, under all alternatives. In this scenario, Alternative C provides the greatest opportunity for passive restoration and enhancement of CERW habitat (56%), followed closely by Alternatives B, D, and E (54%). The use of prescribed fire in these areas is integral to restoration or enhancement of moderately open forest habitats for Cerulean Warbler under all alternatives.

**Table 113. Summarization of Management Areas Other Than Matrix and Interface, Where a Majority of the Forest is Trending Toward Mature Forest Habitat Conditions, by Alternative**

	% NP = MA Groups 2-4	% WHAMA = MA Groups 2-4
B	50%	54%
C	53%	56%
D	48%	54%
E	39%	54%

This analysis also considers where the designated old growth forest network overlaps with Cerulean Warbler WHAMA priority area in MA Group 1. While forest management may occur within the designated old growth network, the treatments are more limited than in other parts of the Matrix and Interface MAs. The designated old growth network varies by alternative, and therefore poses different levels of impact on opportunities for Cerulean warbler habitat restoration or enhancement. Under all action alternatives, the amount of designated old growth network within MA Group 1 that overlaps with the Cerulean Warbler WHAMA priority areas is less than 5%. Alternative E has the highest overlap (5%), Alternative C has 4% overlap, and Alternatives B and D have 3% overlap. With a 5% or less overlap of the designated old growth and Cerulean Warbler WHAMA priority areas in the Matrix and Interface MAs, the designated old growth network should not impact the ability to restore or enhance habitat for Ceruleans in priority areas under any alternative. Additionally, habitat restoration or enhancement for Cerulean Warbler can also be met by managing for moderately open mature and old growth forest conditions across the Forests, but especially within the WHAMA priority areas.

### **Summary of Potential Effects**

Because Cerulean Warbler benefits from both active and passive management (including the use of prescribed fire), there is little difference between Alternatives B, C, D, and E in terms of opportunities for restoration or enhancement of habitat for Cerulean Warblers and other species associated with moderately open mature forest conditions. This restoration may be in the form of active management within the Cerulean Warbler WHAMA priority area, passive restoration across other parts of the Forests, or through the increased use of prescribed fire across the Forests. For this species, the proposed increased use of prescribed fire under Alternative E provides habitat benefits for cerulean warbler during the restoration phase. Desired open forest conditions resulting from repeated prescribed burns may not always meet habitat requirements of cerulean warblers (i.e. they may be too open). Neither the allocation of land to recommended wilderness (MA Group 4) nor the designated old growth network have a considerable impact on the ability to manage within Cerulean Warbler WHAMA priority areas.

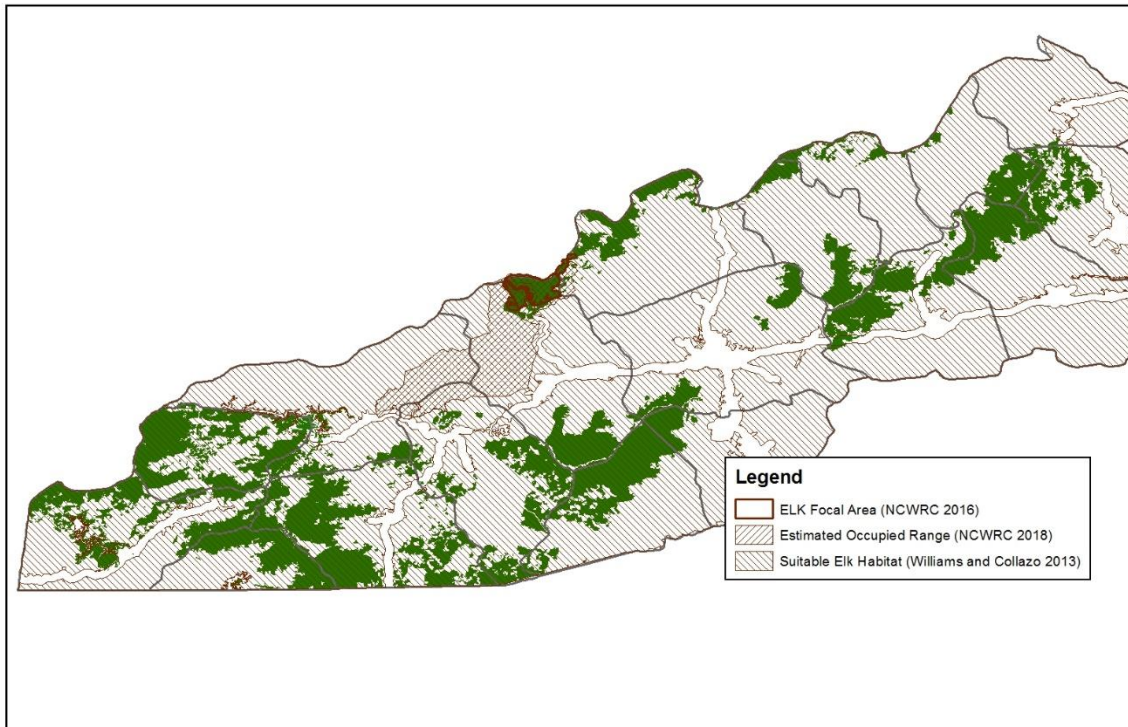
#### **3.3.5.3 Elk (*Cervus elaphus*)**

Three individual species of conservation concern (golden winged warbler, cerulean warbler, and elk), and one species group (terrestrial salamanders) are discussed in detail in this section of the EIS. These species were added in the FEIS because they were discussed regularly during collaborative dialogue for this plan revision and were raised in comments on the draft plan and EIS.

#### **Affected Environment**

Eastern Elk (*Cervus elaphus canadensis*) once roamed throughout the eastern United States, including North Carolina. After the arrival of European settlers, unregulated hunting and loss of habitat led to rapid population declines through the 1700s. By the early 1800s, Eastern Elk was extirpated from North Carolina, and by the mid-1800s, had almost disappeared entirely throughout their range. The last known wild Eastern Elk was killed in in Pennsylvania in 1877.

Today, North Carolina's elk are the Manitoban subspecies (*C. e. manitobensis*), following reintroduction by the National Park Service (NPS) into the Cataloochee area of the Great Smoky Mountain National Park (GSMNP) in 2001 and 2002. This reintroduction was part of an experimental project to determine if elk could survive and reproduce in the area. Some of these elk migrated outside the Park's boundaries and established ranges there, including parts of the Nantahala and Pisgah NFs (Figure 95).



**Figure 95. Current estimated occupied range of Elk (*Cervus elaphus*) and modeled suitable habitat in Western North Carolina.**

Currently, the NCWRC estimates there are between 150 and 200 elk residing in North Carolina (NCWRC 2021). While the species is hunted in neighboring states (e.g., Tennessee, where limited hunting is allowed within the designated Elk Management Area (TWRA 2021)), it is managed as a nongame species in North Carolina (NCWRC 2021). Harvest is not allowed because the population has not been determined to be huntable in North Carolina (RTI 2014).

Elk live in a variety of habitats, such as deciduous and coniferous forests, swamps, young forests, and other open areas such as meadows and farmed land. They feed primarily on grasses, but will also browse on shrubs, small branches, leaves and acorns, and even tree bark if no other food is available or is sparse. A single elk can eat up to 20 pounds of vegetation a day. Historically, it is thought that elk and American Bison kept grassy balds open through grazing (NCWRC 2015).

Today, the greatest threat to Western North Carolina's elk herd is Chronic Wasting Disease (CWD), a disease of the nervous system in deer and elk (family Cervidae) that is characterized by spongy degeneration of brain tissue resulting in emaciation, abnormal behavior, loss of bodily functions, and ultimately death. There currently is no treatment for the disease and it is typically fatal for infected animals. It is not known to infect livestock or humans at the present (USGS NWHC 2021).

The North Carolina Elk Management Plan (NCWRC 2013, Goal #3) identifies expanded and improved cooperative habitat management efforts. Currently, elk currently occur across ownerships, including the Forests, National Park Service (NPS), Eastern Band of Cherokee Indians (EBCI), North Carolina Gamelands, and private lands. Restoring and maintaining habitat for elk on these ownerships represents an important component of any efforts to significantly expand the current range or species abundance.

The Forests are the largest public ownership in Western North Carolina with potential for elk habitat enhancement or restoration. The NPS has specific restrictions regarding habitat creation and development due in part to differing purposes and use of NPS lands, but there is opportunity for habitat improvement within GSMNP. Lands managed by the EBCI may represent the greatest opportunity for elk



habitat development in the short term. While limited, there are some opportunities to develop and expand elk habitat on private lands, although the NCWRC has not traditionally incorporated elk habitat management into the technical guidance for wildlife habitat management on private ownerships (NCWRC 2013).

As part of the forest plan revision process, the NCWRC used the best available science on habitat associations and population trends to identify Wildlife Habitat Active Management Areas (WHAMAs) for elk across the Forests (NCWRC 2016) (Figure 96). These efforts will aid in the prioritization of forest management activities with potential to contribute to herd expansion on public lands. In addition, this process identified other species that will benefit from active management in areas identified for Elk, including Ruffed Grouse and other species associated with woodlands and other open forest habitats.

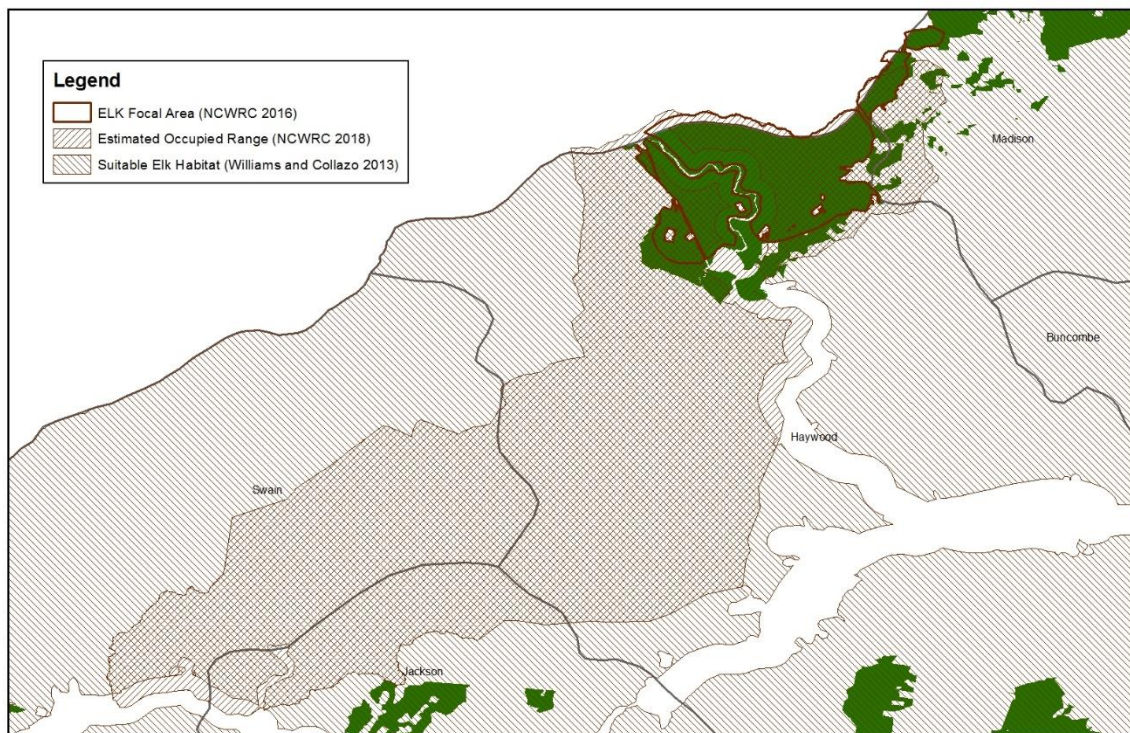


Figure 96. Wildlife habitat active management area (WHAMA) for Elk (NCWRC 2016)

## Environmental Consequences

In this process, an Elk WHAMA of approximately 22,922 acres was identified across the Forests. This area has been identified as a priority for habitat (and therefore, species population) restoration and enhancement under the revised forest plan (Figure 96). Forest plan direction emphasizes the need for active management in WHAMAs and highlights the integration of management approaches for enhancing elk habitat into project-level prescriptions (WLF-DC-10, Wildlife Habitat Diversity Management Approaches, etc.).

Based on forest-wide and management area direction, the best opportunity to restore or enhance habitat for elk across the Forests is within the Matrix and Interface Management Areas (MA Group 1) because these are the areas where active management is most likely to occur. More specifically, proposed management will be most effective at restoring or enhancing habitat for elk when it is within an Elk WHAMA. While habitat for elk occurs in other parts of the forest, the Elk WHAMA identifies where the best chance of successful habitat management for the species occurs. Habitat restoration or

enhancement for elk can also be met by managing for open forest conditions across the Forests, but especially within the WHAMA for the species.

**Table 114. Summarization of Matrix and Interface Management Areas (MA Group 1) and the Elk WHAMA, by Alternative**

	% MA Group 1 = WHAMA	% WHAMA = MA Group 1	% WHAMA = MA Group 4
B	4%	73%	0%
C	5%	64%	0%
D	4%	72%	0%
E	4%	72%	0%

In general, the Elk WHAMA is small in comparison to the rest of the landscape, representing 4-5% of the Matrix and Interface across the Forests under all alternatives (Table 114). Therefore, no Alternative provides a better relative opportunity for active elk habitat restoration or enhancement, but rather highlights that under all alternatives, effective elk habitat restoration or enhancement would be focused on a relatively small proportion of the Matrix and Interface MAs. Habitat restoration or enhancement for elk can also be met by managing for woodlands and other open forest conditions across the Forests, but especially within the WHAMA for the species.

When considering the ability to prioritize meaningful habitat restoration or enhancement for elk, based on the amount of WHAMA priority areas that are within MA Group 1, Alternatives B, D, and E appear to provide the greatest opportunity for effective restoration or enhancement of elk (73%, 72%, and 72%, respectively). Alternative C (64%) provides slightly less opportunity for effective active restoration or enhancement of elk habitat (Table 114). None of the Elk WHAMA is within MA Group 4 under any action alternative.

It is important to note that most of MA Group 1 will trend towards mature forest habitats, and that disturbance in these areas is related to relatively small amounts of active forest management and natural disturbance events. Prescribed fire will be also be a vital tool in restoring open forest habitat for Elk across the Forests, including within the Elk WHAMA, under all alternatives.

This analysis also considers the presence of designated old growth forest areas within MA Group 1, and specifically portions that are also within an Elk WHAMA. While forest management may occur within designated old growth forest, the treatments are more limited than in other parts of the Matrix and Interface MAs.

The designated old growth network varies by alternative, and therefore poses different levels of impact to the potential for successful elk habitat restoration or enhancement. Summarization of the amounts of designated old growth forest within Matrix or Interface MAs that are within the Elk WHAMA revealed small amounts (<7%) for all alternatives. Alternative E has the highest overlap (7%), Alternative C has 6% overlap, Alternative B has 4% overlap, Alternative D has 3% overlap, and Alternative A has 2% overlap. None of the alternatives have enough designated old growth network within the Elk WHAMA to impact the opportunities for habitat enhancement and restoration. Additionally, habitat restoration or enhancement for elk can be met by managing for open mature and old growth forest conditions across the Forests, but especially within the WHAMA for the species. Alternative E has the best potential for restoration of elk habitat based on an emphasis on restoring and maintaining woodland habitat through the increased use of prescribed fire.

## Summary of Potential Effects

Because elk benefit from active management (including the use of prescribed fire), there is little difference between Alternatives B, D, and E in terms of opportunity for restoration or enhancement of habitat for elk and other species associated with woodlands and other open forest conditions. Alternative C offers slightly less opportunity for this habitat restoration. Habitat restoration may be in the form of active management within the Elk WHAMA, or through the increased use of prescribed fire across the Forests. Neither the allocation of land to recommended wilderness (MA Group 4) nor the designated old growth network have an impact on the ability to manage within the Elk WHAMA.

### 3.3.5.4 Terrestrial Salamanders

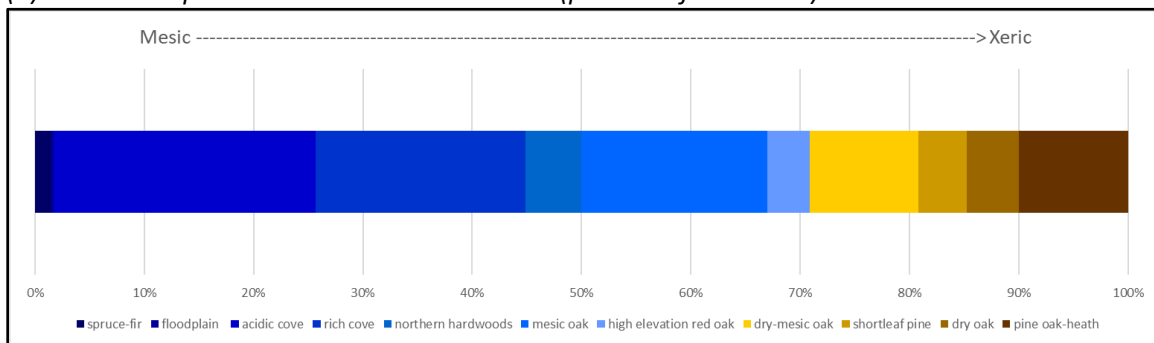
Three individual species of conservation concern (golden winged warbler, cerulean warbler, and elk), and one species group (terrestrial salamanders) are discussed in detail in this section of the EIS. These species were added in the FEIS because they were discussed regularly during collaborative dialogue for this plan revision and were raised in comments on the draft plan and EIS.

### Affected Environment

Amphibian and reptile populations are experiencing measurable declines, with habitat alteration, fragmentation, and loss collectively considered to be the primary challenge in the conservation of these species (a.k.a. herpetofauna). With herpetofauna populations declining, and human populations and land development expanding, Partners for Amphibian and Reptile Conservation (PARC) developed regional habitat management guidelines to provide proactive guidance for improving the compatibility of land management practices with these animals (PARC 2021). Amphibians are considered sensitive environmental indicators because they are susceptible to a variety of environmental contaminants due to their permeable skin and most have aquatic eggs and larvae. While this discussion specifically addresses terrestrial salamanders, the same conclusions can be applied to other herpetofauna.

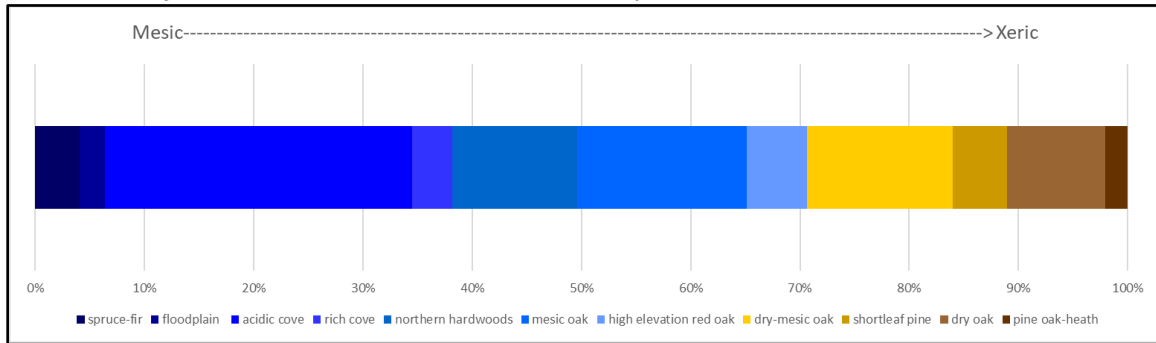
The revised forest plan considers approximately thirty species of terrestrial salamander in the ecological sustainability analysis, which while extensive, does not represent the entire herpetofauna of the Forests. Many of these species are identified as Species of Conservation Concern (SCC) in the revised Forest Plan, Species of Greatest Conservation Need (SGCN) in the North Carolina Wildlife Action Plan (NCWAP, NCWRC 2015), or of other conservation concern in the Ecological Sustainability Evaluation Tool (ESE Tool) for the Nantahala and Pisgah NFs, and are identified in EIS Appendix C.

(a) Ecozone representation across the Forests (percent of land base).





(b) Percent of known rare salamander occurrences by ecozone.



**Figure 97. Ecozone distribution across the Nantahala and Pisgah NFs (a), and rare salamander occurrence (NCNHP 2021) by ecozone (b)**

Bailey et al. (2006) associates terrestrial salamanders with a variety of habitats across all forest types (ecozones). Often, certain forest types are associated with specific suites or assemblages of species, and some suitable habitats are relatively small (e.g. seeps, seasonal wetlands) and embedded within larger habitats. A summarization of terrestrial salamander occurrence (NCNHP 2021) by ecozone (Figure 97) demonstrates that occurrence across the Forests aligns with habitat associations described by Bailey et al. (2006), and that salamanders are associated with more humid conditions within all forest types, such as denser canopy cover, and microhabitat features such as rock outcrops and coarse woody debris.

In response to the need for identification of discrete areas on the landscape that provide exceptional herpetofaunal diversity, PARC developed Priority Amphibian and Reptile Conservation Areas (PARCAs). These areas are intended to meet the following criteria: 1) capable of supporting viable amphibian and reptile populations; 2) occupied by rare, imperiled, or at-risk species; and 3) rich in species diversity or endemism (Sutherland and deMaynadier 2012).

There are six PARCAs that occur wholly or partially on the Nantahala and Pisgah NFs (Figure 98). While these areas are important to the conservation of amphibians in Western North Carolina, a review of known occurrences of rare amphibians and consultation with species group experts in Western North Carolina revealed that these areas alone will not offer conservation value to all terrestrial salamanders (i.e., several areas of known importance to amphibians, and specifically terrestrial salamanders, are not within an identified PARCA). Therefore, this approach to summarizing potential effects by alternative on terrestrial salamanders was not used.

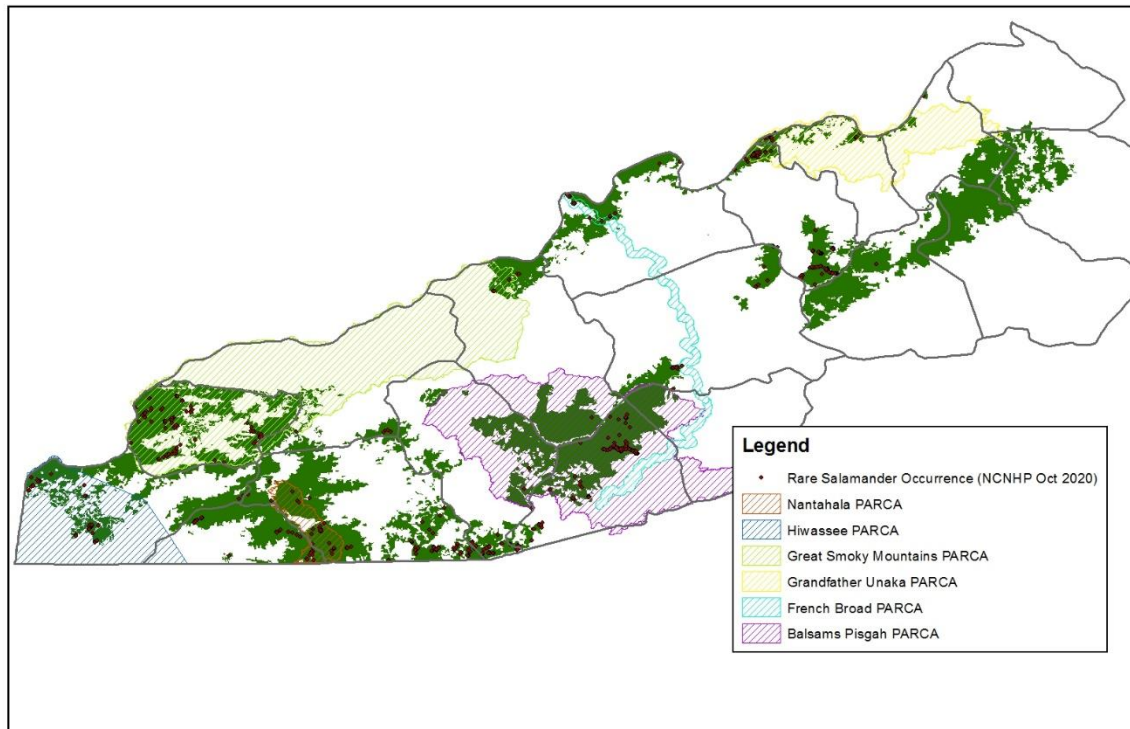


Figure 98. PARCAs identified within the Nantahala and Pisgah NFs

## Environmental Consequences

Based on forest-wide and management area direction, the best opportunity to maintain, restore, or enhance habitat for terrestrial salamanders is within mature and old growth forests, as well as management areas where less active management will occur. This will ensure the maintenance of large areas of closed canopy forest across the Forests, and an abundance of habitat conditions suitable to support the diversity of terrestrial salamanders known from the Forests.

Where active management does occur, the action alternatives include plan components for the protection and retention of key habitat features for terrestrial salamanders, such as unique habitats and coarse woody debris, as well as residual canopy cover following timber harvest (see Appendix C for a complete list of plan components).

Apodaca and Smith (2019) examined the importance of terrestrial salamander metapopulation health in Western North Carolina, including the Forests, through the identification of suitable habitat patches and examination of potential intact- and connectedness on the landscape. This effort involved creating environmental niche models (ENMs) for seventeen terrestrial salamander species known to occur across the landscape using the Maximum Entropy (MaxEnt) modeling system integrating 23 climate and habitat variables. Species modeled in this effort were stratified across four general habitat associations: rock outcrop, streamside, woodland (i.e., general forest conditions), and high elevation.

These model results were examined in the context of the proposed revised Forest Plan for the Nantahala and Pisgah NFs to evaluate several things: 1) the role of the Forests in overall salamander conservation within the 18-county planning area used for the plan revision, and 2) potential risk of forest plan implementation to terrestrial salamanders in general across the Forests.

As discussed in other parts of this EIS, the 18-county planning area contains highly fragmented ownership. This disparate situation can impact the efficacy of forest-level management at different scales. Specifically, proposed revised forest plan direction can be highly effective at the stand and forest

levels in protecting, conserving, and restoring wildlife habitat, while not having a measurable impact at the multi-ownership landscape scale depending on the amount and spatial arrangement of other ownerships. These effects are often magnified for less mobile, dispersal-limited species since barriers are often not related to forest management at all, but rather to situations beyond the Forests' authority. Largely, but not solely because of this situation, partnership and collaboration is a major theme of the proposed revised forest plan.

Table 115 summarizes terrestrial salamander core habitat areas and least cost paths (i.e., habitat connectedness on the landscape) in relation to land ownership within the same 18-county area.

**Table 115. Summary of NP Ownership Within Terrestrial Salamander Core Habitat Areas and Least Cost Path Corridors, as Identified in Apodaca and Smith (2019)**

Habitat Association	Core Habitat	Least Cost Path	Core Habitat + Least Cost Path*
High Elevation	36.60%	15.51%	36.25%
Rock Outcrop	44.23%	52.71%	45.27%
Streamside	51.44%	39.87%	49.51%
Forested	37.24%	45.08%	39.98%
Total*	42.08%	42.06%	43.17%

*\*eliminates duplication of acres between habitat associations and model results*

In terms of potential to influence terrestrial salamander conservation on the landscape, this summary illustrates that the Forests play a measurable part, although it is also clear that other ownerships can influence landscape-level habitat quality, quantity, and connectedness. It is possible that due to fragmented ownership patterns, terrestrial salamander movement among and between patches could be affected on the Forests, despite comprehensive planning efforts on the Forests. This highlights the need for partnership and collaboration among landowners and land uses to ensure long-term terrestrial salamander metapopulation health and resilience.

On the Forests, this analysis assumes that locations that have the greater potential for active management (i.e. Management Area Group 1), would have a greater potential to apply project specific standards to support salamander habitat than the other management area groups which are more passively managed. Table 116 summarizes the amount of Management Area Group 1 (Matrix and Interface) within important salamander habitats identified by Apodaca and Smith (2019).

**Table 116. Summary of Management Area Group 1 Within Terrestrial Salamander Core Habitat Areas and Least Cost Path Corridors, as Identified in Apodaca and Smith (2019), by Alternative**

Habitat Association	Alternative B	Alternative C	Alternative D	Alternative E
High Elevation	1.05%	0.00%	1.05%	1.05%
Rock Outcrop	34.30%	27.59%	33.74%	33.74%
Streamside	48.83%	40.55%	49.01%	49.01%
Forested	69.14%	59.84%	70.04%	70.04%
Total*	21.55%	16.63%	21.50%	21.51%

*\*eliminates duplication of acres between habitat associations and model results*

High elevation habitats would not regularly be encountered in timber harvest activities under any alternative. However, high elevation habitats could be impacted by other forest activities, such as recreation, which is addressed further below.

Rock outcrop habitats are less likely to be part of timber management activities under Alternative C than under Alternatives B, D, and E. This unique habitat is particularly relevant to the Green Salamander, which is discussed in more detail below.

Streamside and general forested habitats, in terms of terrestrial salamander habitat associations, are more likely to be included in areas planned for timber management under all alternatives than the other associations addressed in Apodaca and Smith (2019). The revised forest plan includes numerous plan components to protect and conserve streamside habitats (Forest Plan: Streamside Forests). Application of these plan components would protect and conserve terrestrial salamander habitats under all alternatives.

Similarly, the revised forest plan contains plan components to conserve and restore key habitat components for terrestrial salamanders, such as unit size and residual basal area and canopy cover during timber harvest, as well as smaller scale habitat features such as retention of coarse woody debris in harvested areas (including WLF-DC-04, WLF-DC-06, WLF-S-01, PAD-S-14, TIM-S-07, TA-DC-08, BAC-DC-04, etc.). See Appendix C for a complete list of associated plan components. Potential effects on these characteristics are discussed throughout the EIS and can be inferred on the revised plan's ability to protect and conserve terrestrial salamander habitat under all alternatives.

### **Summary of Potential Effects**

In general, because it places fewer acres in MA Group 1, Alternative C would probably result in the least frequency to apply project specific standards to support salamander habitat than the other alternatives. However, there is little difference between alternatives due largely to the very small percentage of the Forests to be actively managed and plan direction to mitigate key salamander habitat features such as unique habitats, coarse woody debris, and canopy cover under all action alternatives. It will be important to evaluate occupied habitat at the project level during implementation given the relatively small migration areas of this species.

### **3.3.5.5 Green Salamander (*Aneides aeneus*)**

#### **Affected Environment**

Because of unique habitat associations, life history, and general rarity, Green Salamander is of focused management importance. Much of the following habitat and life history description is taken from Rossell et al. (2019).

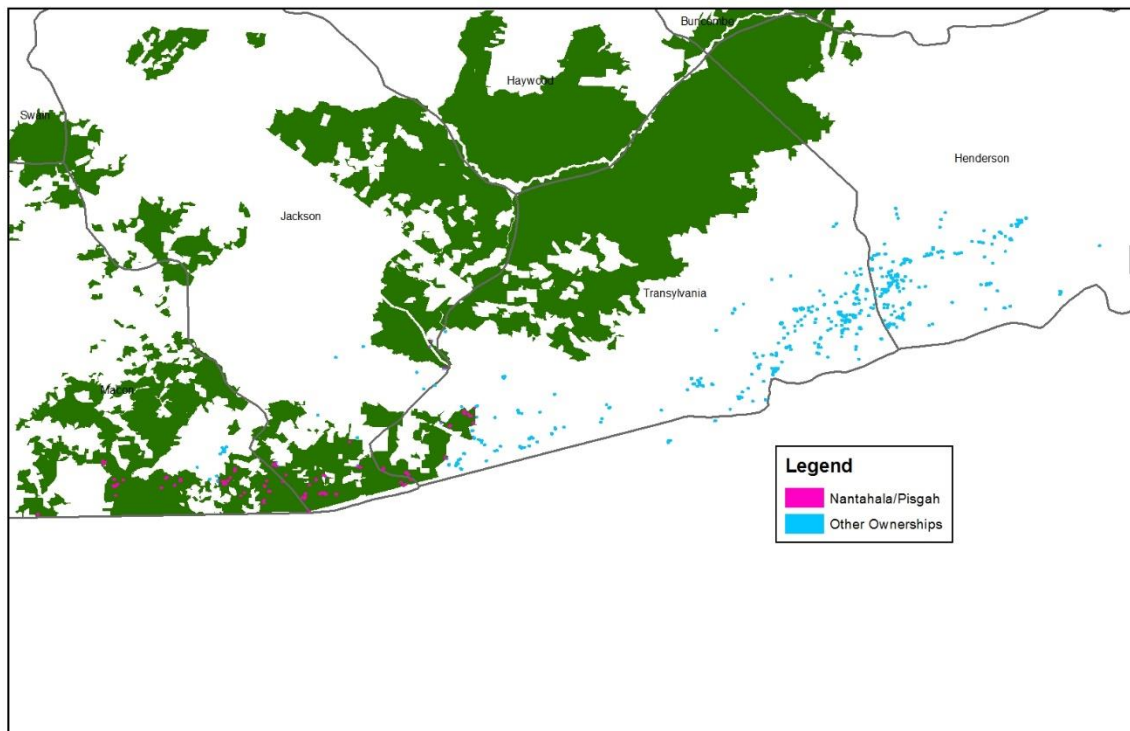
Green Salamander is generally rare across its range (Appalachian Plateau and Blue Ridge Province) and is often associated with rock outcrop habitats (Petranka 1998). As a result of this association, the species has a patchy distribution, ranging from southwestern Pennsylvania to northern Alabama and extreme northeastern Mississippi (Pauley and Watson 2005). This distribution includes a group of disjunct populations along the Blue Ridge Escarpment in southwestern North Carolina and adjacent areas in South Carolina and Georgia, which is the focus of this summary.

Green Salamander is listed as rare or endangered throughout its range (NatureServe 2021). In North Carolina, it is listed as Threatened and identified as a Species of Greatest Conservation Need (SGCN) in the North Carolina Wildlife Action Plan (NCWAP, NCWRC 2015), as well as a Species of Conservation Concern (SCC) for the Nantahala and Pisgah NFs. Additionally, Green Salamander is listed as a Federal Species of Concern by the U.S. Fish and Wildlife Service and is currently under status review because of its continual decline throughout its range. Threats to the species include loss and alteration of habitat, over-collecting, epidemic disease, and climate change (Corser 2001; Wilson 2001).

The Blue Ridge Escarpment is thought to be a refugium for Green Salamander because of relatively stable microclimates during periods of widespread climate change (Bruce 1968). Prior to the mid-1970s,

the species occurred at relatively high densities on the escarpment; however, a dramatic decline in populations occurred in the mid-late 1970s (Bruce 1968; Snyder 1991) and continued at least through the 1990s (Corser 2001; Wilson 2001). In these studies, no definitive causes for the decline were identified, although reproductive success was suspected (Corser 2001; Rossell et al. 2019).

This species can be found in damp (but not wet) crevices in shaded rock outcrops and ledges, or beneath loose bark and in cracks of standing or fallen trees. It can sometimes also be found in or under logs on the ground. It sometimes reaches high population densities in logged areas where the tree canopies are left. Eggs are laid in rock crevices, rotting stumps, or similar dark, damp places (IUCN 2004). Green Salamanders are habitat specialists that require exposed rock with crevices that provide specific microhabitats. They also use large trees in proximity to rock outcrops for foraging and nesting (Waldron and Humphries 2005; Smith et al. 2017), where they are most often associated with loose bark and other crevices. Green salamanders use two types of rock crevices, breeding and transitory, which are considered the basis of a Green Salamander's territory (Rossell et al. 2019).



**Figure 99. Known range of Green Salamander in Western North Carolina, including the Nantahala and Pisgah NFs**

In Western North Carolina, all known occurrences of Green Salamander are from the Blue Ridge Escarpment. When species movement and migration is considered (Hammerson 2004), known Green Salamander occupied habitat is approximately 4,500 acres, in a series of small, disjunct populations associated with exposed rock (see described and habitat association above). Of these acres, 728 (16%) are known from the Forests (Figure 99).

## Environmental Consequences

**Table 117. Percent of Known Green Salamander Occupied Habitat on the Forests and Across North Carolina that is Within Management Areas Where Active Management is Emphasized**

	% NP Occupied Habitat = MA Group 1	% NC Occupied Habitat = MA Group 1
B	42.52%	6.87%
C	32.45%	5.25%
D	46.63%	7.54%
E	46.63%	7.54%

Approximately 23-47% of known occupied Green Salamander habitat on the Forests is within management areas where active forest management is emphasized (MA Group 1). It is important to remember that the revised forest plan contains specific protections, PAD-S-13 for occupied and suitable habitat for this species:

*Within the documented range of Green Salamanders, shaded rocks greater than 36 square feet in size, and suitable arboreal habitat within 300 feet of these rocks, shall be surveyed for species' presence. If present, project activities shall be designed to avoid direct and indirect disturbance of the species and habitat, protect thermal and moisture characteristics of the rocks and occupied arboreal habitat (e.g., when appropriate, identification of a 300 foot no canopy removal buffer or other appropriate mitigations around occupied habitat), and provide for habitat connectivity and dispersal. If rocks and adjacent trees are determined to be unoccupied, design activities to maintain suitable habitat.*

## Summary of Potential Effects

In general, because it places fewer occupied habitat acres in MA Group 1, Alternative C would probably result in the least potential to need or apply project specific standards to support green salamander habitat than the other alternatives, followed by Alternative B, and then Alternatives D and E. It will be important to evaluate occupied habitat at the project level during implementation given the relatively small migration areas of this species.

### 3.3.6. Demand Wildlife Species

For purposes of this analysis, demand wildlife species are those that are commonly hunted, fished, or trapped—species that are regulated, in terms of season and harvest, by the North Carolina Wildlife Resources Commission. Species addressed here are those which received significant public interest through the collaborative process for the plan revision. The following section considers the effects of the revised forest plan, specifically vegetation management, on habitat for ruffed grouse, white-tailed deer, turkey, and black bear.

#### 3.3.6.1 Ruffed Grouse (*Bonasa umbellus*)

##### Affected Environment

Ruffed grouse is North America's most widely distributed upland game bird and North Carolina's only grouse species. The species is found throughout most of Canada, much of the eastern United States and portions of the Rocky Mountains in the West. In North Carolina, ruffed grouse are found in Western North Carolina and a few northern Piedmont counties (NCWRC 2021). Ruffed grouse is identified as a Species of Greatest Conservation Need (SGCN) in the North Carolina Wildlife Action Plan (NCWAP) (NCWRC 2015). Additionally, the Appalachian Mountain Joint Venture (AMJV) identifies this species as a top landbird conservation priority (AMJV 2020). Because of the unique situation where a demand species is experiencing severe enough habitat and population declines to warrant conservation attention, it is addressed in more detail than other demand species.

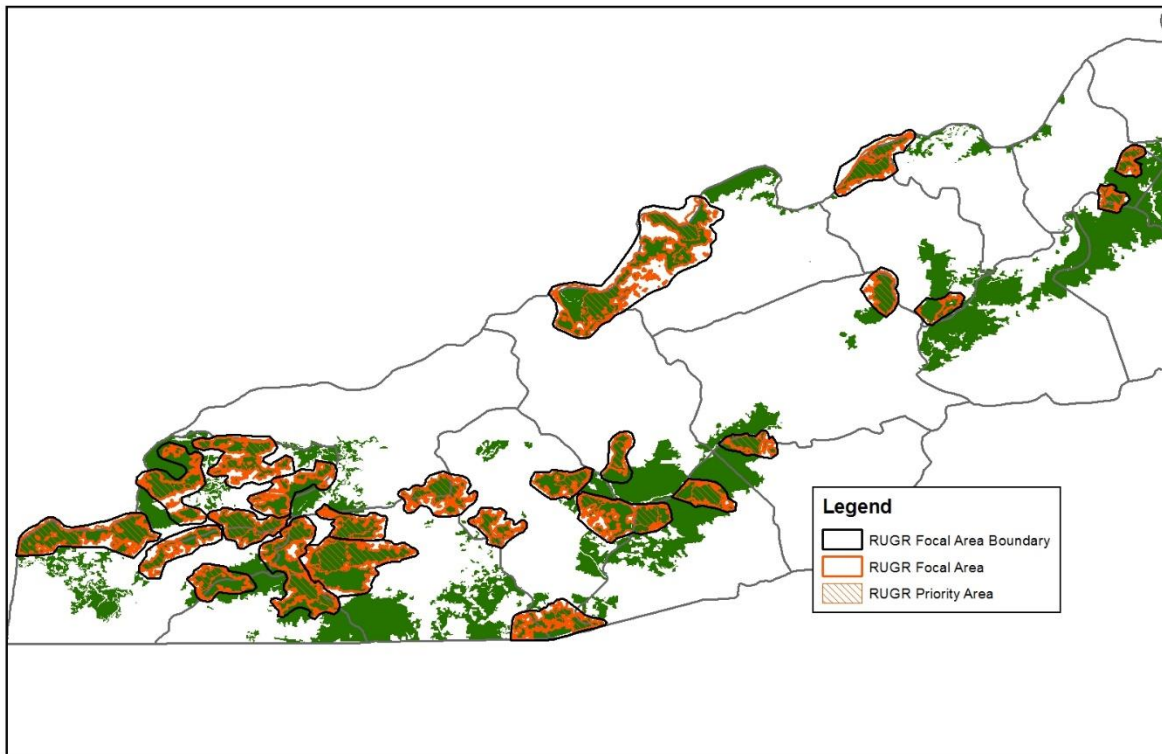
Ruffed grouse life history strategies are centered around maximizing reproduction and survival for several life stages. Each of these stages has specific habitat needs, and often differ between sexes. What is critical to the overall survival and persistence of the species, however, is the juxtaposition (spatial arrangement) and interspersions (mixing) of these habitats across the landscape (Stauffer et al. 2011).

In the Appalachian Mountains, ruffed grouse can be found in virtually any forest type, but the highest densities are associated with northern hardwood, mixed-mesophytic (rich cove), and oak forests (including high elevation red oak, mesic oak, dry-mesic oak, and mixed pine/oak ecozones). Within these areas, patches of young forest, especially those with high stem densities, openings, forest edges and transitional areas, and mature forests are all occupied by ruffed grouse at some point in their life history. In addition, male grouse select drumming sites during mating season based on the presence of coarse woody debris on the forest floor. This microhabitat characteristic is the focal point of male grouse home range. Hens place nests on, under, or within stumps, and coarse woody debris, also emphasizing the importance of microhabitat quality. Again, the importance of the juxtaposition and interspersions of these landscape-level habitat and microhabitat characteristics to species persistence cannot be overemphasized (Stauffer et al. 2011).

As part of the forest plan revision process, the North Carolina Wildlife Resources Commission (NCWRC) and biologists from the National Wild Turkey Foundation (NWTf) and Audubon North Carolina (ANC) used the best available science on habitat associations and population trends to identify Wildlife Habitat Active Management Areas (WHAMAs) for ruffed grouse across the Forests (NCWRC 2016). These efforts will aid in the prioritization of forest management activities with potential to contribute to stabilizing or reversing the well-documented decline of ruffed grouse. In addition, this process identified other species that will benefit from active management in areas identified for ruffed grouse, including: Eastern Towhee, Alder Flycatcher, Canada Warbler, Winter Wren, and Brown Thrasher. Note that this list identifies examples of species associations with young and early successional forest habitats and is not inclusive.

In this process, a ruffed grouse WHAMA (RUGR WHAMA) focal area of approximately 705,581 acres was identified across all ownerships. Of this area, 404,962 acres (57%) are on the Forests. Within the

WHAMA focal area on the Forests, approximately 228,537 acres (56%) have been identified as RUGR WHAMA priority areas for habitat restoration and enhancement under the revised forest plan (Figure 100). Forest plan direction emphasizes the need for active management in WHAMAs and highlights specific habitat characteristic needed by ruffed grouse.



**Figure 100. Wildlife habitat active management areas (WHAMAs) for ruffed grouse in Western North Carolina.**

Also important to the potential for successful habitat restoration or enhancement for ruffed grouse on the Forests is the representativeness of appropriate forest types (ecozones) within the RUGR WHAMA. Ecozones associated with the highest grouse densities are highlighted in Table 118, which summarizes representativeness of these ecozones at the landscape (forest-wide) and WHAMA focal and priority area scales. Approximately 70% of the Forests supports vegetation types contributing to ruffed grouse preferred habitats, and that increases to approximately 75% within the RUGR WHAMA Focal and Priority areas.

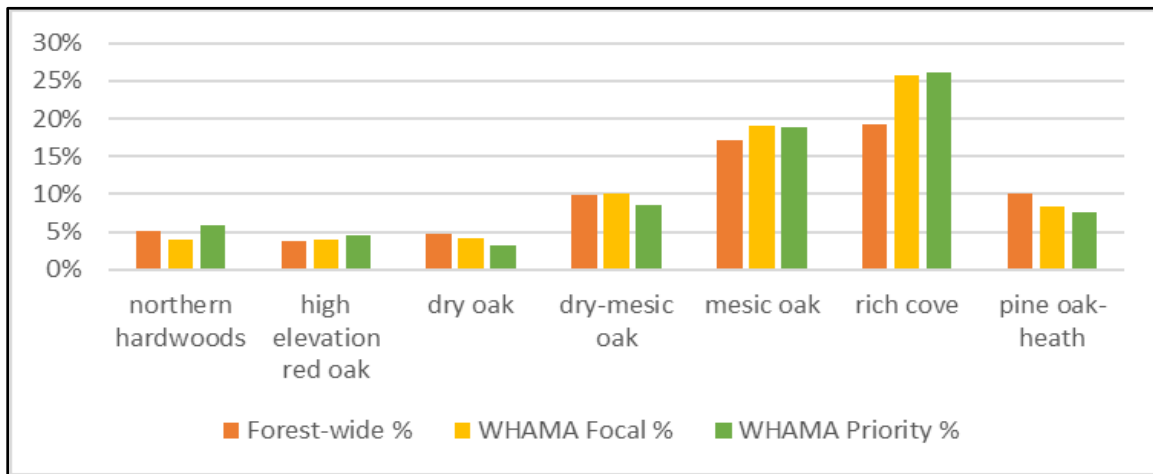
**Table 118. Ecozone Representativeness Across the Forests, and Within the RUGR WHAMA Focal and Priority Areas. Highlighted Ecozones Represent Forest Types Associated with the Highest Grouse Densities in the Southern Appalachian Mountains (Stauffer et al. 2011)**

	Forestwide		WHAMA Focal		WHAMA Priority	
	acres	%	acres	%	acres	%
spruce-fir	15,528.95	1.49%	1,336.86	0.33%	522.77	0.23%
northern hardwoods	53,564.16	5.15%	16,309.47	4.04%	13,298.13	5.83%
high elev. red oak	40,188.27	3.86%	15,947.09	3.95%	10,450.74	4.58%
dry oak	49,260.19	4.73%	16,896.86	4.19%	7,212.33	3.16%
dry-mesic oak	103,187.28	9.92%	40,501.59	10.04%	19,644.04	8.62%
mesic oak	177,269.69	17.04%	77,043.22	19.11%	42,854.48	18.80%



	Forestwide		WHAMA Focal		WHAMA Priority	
	acres	%	acres	%	acres	%
acidic cove	249,253.17	23.96%	85,803.72	21.28%	47,833.51	20.98%
rich cove	199,477.01	19.17%	103,601.86	25.69%	59,419.76	26.07%
pine oak-heath	103,843.98	9.98%	34,046.24	8.44%	17,258.32	7.57%
shortleaf pine	46,478.77	4.47%	11,030.45	2.74%	9,129.98	4.01%
floodplain	2,341.95	0.23%	706.62	0.18%	327.40	0.14%

In ecozones with the highest degree of habitat association by ruffed grouse (northern hardwoods, high elevation red oak, mesic oak, and rich cove), representativeness is maintained or increased within the RUGR WHAMA priority area. Habitat association decreases (albeit slightly) in dry oak, dry-mesic oak, and pine oak-heath ecozones (Figure 101. Ruffed grouse highest associated ecozone representativeness across the Forests, and within the RUGR WHAMA Focal and Priority Areas). This is because the RUGR WHAMA was identified by the NCWRC et al. using for forest type/ecozone data (NCWRC 2016). This does not differ by alternative.



**Figure 101. Ruffed grouse highest associated ecozone representativeness across the Forests, and within the RUGR WHAMA Focal and Priority Areas**

The North Carolina Wildlife Resources Commission (NCWRC) has been monitoring ruffed grouse relative abundance on the Nantahala and Pisgah NFs since 2002 (Figure 102). These monitoring efforts document a slight downward trend in grouse populations across the Forests and highlight moderate annual variability.

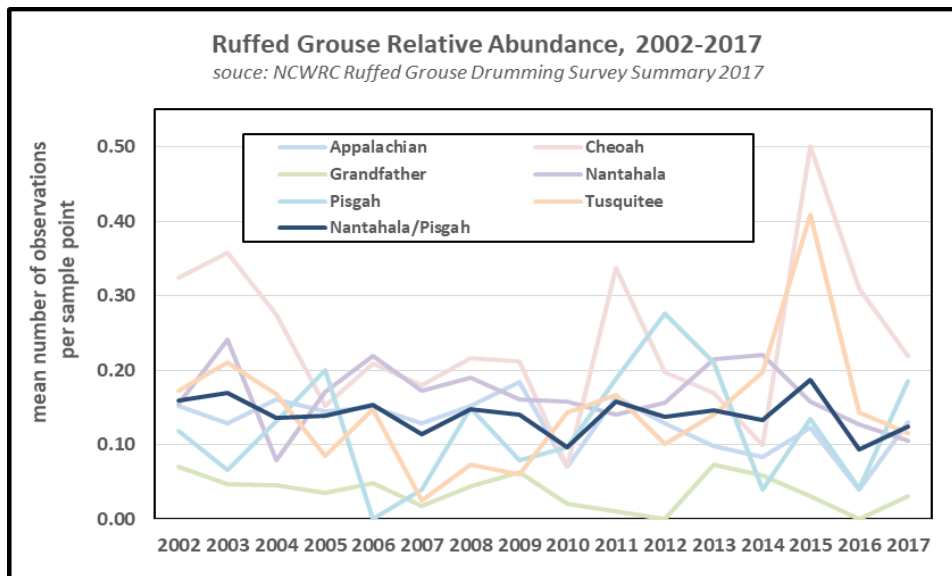


Figure 102. Ruffed grouse relative abundance, 2002-2017, summarized from NCWRC (2018)

This slightly declining trend does not coincide with the steeper decline in average flush rates by grouse hunters over the same time period (Figure 103). Relative abundance estimates do not incorporate hunter-associated bias, and therefore serve as a reliable indicator of ruffed grouse population trends.

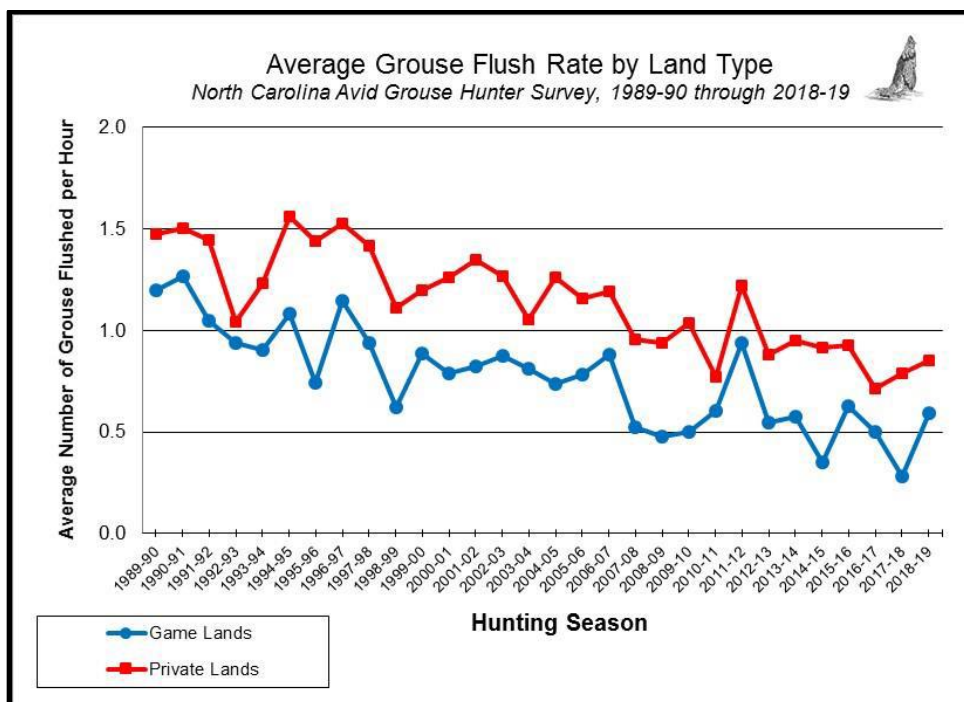


Figure 103. Average grouse flush rate, 1989-2018, taken directly from NCWRC 2018-19 North Carolina Avid Grouse Hunter Survey (NCWRC 2019)

Although the estimated population decline is slight (Figure 102), ruffed grouse population levels are low when compared to historic levels (NCWRC 2019). Currently, suitable habitats such as open woodland and young forest structural classes that support reproductive success and overall survival, are in short supply across the Forests (see structural classes above for more information). Without a continued presence of

these suitable habitats, it is possible that ruffed grouse populations would continue to decline on the Forests.

### Environmental Consequences

In addition to plan components addressing the larger ecosystem conditions discussed above (e.g., forest type and seral stages), habitat requirements for ruffed grouse are addressed through the establishment of plan components to maintain or enhance fine-scale habitat requirements such as hard and soft mast production and coarse woody debris recruitment during land management activities.

In Alternative A, the existing forest plan concentrated management for grouse within MAs 1B and 3B, including forest wide direction to manage foraging habitat and a standard to manage MA 1B for deer and grouse. The existing forest plan also mentions management within the balds MA (17) for deer and grouse. Management areas 2A and 2C also provide associated benefits to wildlife species, including grouse.

Within the proposed plan action alternatives B through E, adjacency of structural habitat components needed for grouse habitat is discussed at many levels, including four desired condition statements covering permanent openings, young forests, open woodlands, and habitat adjacency. The proposed plan also covers finer scale habitat elements relevant to grouse, including downed woody debris, hard and soft mast, and edge and interior forest conditions. To address what is perhaps the primary factor limiting ruffed grouse habitat suitability across the Forests, the Matrix MA includes a desired condition for young forest to exceed average natural disturbance gap size to provide for habitat diversity and benefit wildlife (MAT-DC-02).

Based on forest-wide and management area direction, the best opportunity to restore or enhance habitat for ruffed grouse across the Forests is within the Matrix and Interface Management Areas (or management equivalents in Alternative A) (MA Group 1) because these are the areas where active management is most likely to occur. More specifically, proposed management would be most effective at restoring or enhancing habitat for ruffed grouse when it is within a RUGR WHAMA priority area. This does not mean that ruffed grouse habitat does not occur in other areas, but rather identifies where the best chance of successful habitat management for the species occurs on the Forests.

**Table 119. Summarization of Matrix and Interface Management Areas (MA Group 1) and the RUGR WHAMA Priority Areas, by Alternative**

	% MA Group 1 = WHAMA	% WHAMA = MA Group 1	% WHAMA = MA Group 4
B	37%	78%	5.88%
C	46%	60%	0.18%
D	37%	77%	0.43%
E	37%	75%	0.63%

Based on the percent of MA Group 1 within RUGR WHAMA priority areas, Alternatives C has a slightly higher proportion of acres identified in RUGR WHAMA priority areas compared to Alternatives B, D, and E. This demonstrates that Alternative C provides a better relative opportunity for RUGR habitat restoration or enhancement.

When considering the ability to prioritize meaningful habitat restoration or enhancement for ruffed grouse, based on the amount of WHAMA priority areas that are within MA Group 1, Alternative B (78%) provides the greatest opportunity for effective restoration or enhancement of ruffed grouse habitat, followed by Alternative D (77%) and E (75%) (Table 119). Alternative C provides less, but still significant, opportunity for effective restoration or enhancement of ruffed grouse habitat (60%). Alternative B has the greatest amount of RUGR WHAMA in MA Group 4 (5.88%) due to the greater amount of areas that

are recommended for wilderness in Alternative B. Alternatives C, D, and E have less than 1% of the WHAMA within MA Group 4.

This analysis also considers the presence of designated old growth forest within the Matrix and Interface Management Areas, and specifically portions that are within a RUGR WHAMA priority area. Forest management is not dis-allowed within designated old growth forest; however, the tools available are more limited than in other parts of the Matrix and Interface MAs. Designated old growth forest varies by alternative, and therefore poses different levels of influence on potential for successful ruffed grouse habitat restoration or enhancement. Summarization of the amounts of designated old growth forest within Matrix or Interface MAs that are within the RUGR WHAMA priority areas revealed less than 5% overlap for all alternatives. Specifically, Alternatives B, C, and E have the highest overlap (5%), Alternatives D, and A have less overlap (3% and 2%, respectively). None of these values are high enough to influence identification of one alternative over another based on the presence of old growth forest within Matrix or Interface MAs within RUGR WHAMA priority areas, especially given that mature forest conditions in proximity to younger forests are critical to species persistence.

### Summary of Potential Effects

All action alternatives include plan components to directly or indirectly enhance and/or restore habitat for ruffed grouse on the Nantahala and Pisgah NFs (Appendix C). Part of the foundation of the planning framework incorporates WHAMAs specifically for ruffed grouse (NCWRC 2016), including the consideration of management area boundaries and plan objectives for young forest habitat and open woodlands. Results of the Ecological Sustainability Evaluation (ESE) summarize this across ecozones supporting habitat for ruffed grouse (Table 120). This summary reveals that habitat conditions for ruffed grouse will improve under all alternatives, and reach “good” conditions in the long term (i.e., in 50+ years) under Alternatives B, C, and D.

**Table 120. ESE Results Across Ecozones and Overall Forest-Wide Trends by Alternative at 10 and 50 Years (red=poor, yellow=fair, light green=good, dark green=very good)**

Element Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Acidic Cove Forest																			
Dry Oak Forest																			
Dry-mesic Oak Forest																			
Floodplain Forest																			
High Elevation Red Oak Forest																			
Mesic Oak Forest																			
Northern Hardwood Forest																			
Pine Oak -Heath Forest																			

Element Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Rich Cove Forest																			
Shortleaf Pine Forest																			
Spruce-fir Forest																			
Forest-wide Weighted Average																			

Table 121 summarizes ESE scores for species groups containing ruffed grouse and indicates that young and open forest conditions are what is limiting ruffed grouse populations on the Forests. This is addressed in the discussion above.

**Table 121. ESE Results for Species Groups Containing Ruffed Grouse (red=poor, yellow=fair, light green=good, dark green=very good).**

Element Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
CWD and Downed Wood Associates																			
Forest Edge and Transition Associates																			
Hard/Soft Mast Dependent Species																			
Interior Forest Associates																			

In addition to the summary presented above, please refer to the detailed discussion of potential effects to young, old, and open forest conditions at 3.3.2.2. Forestwide Structure as it is relevant to ruffed grouse.

In summary, Alternatives B, D, and E provide the best opportunity for restoration or enhancement of habitat for ruffed grouse and other species associated with young and early successional habitats at higher elevations (i.e., >2,500'). Alternatives A and E also provide good opportunity for restoration or enhancement of grouse habitat, although less than the other alternatives. Alternative C provides the

least opportunity for restoration or enhancement of habitat for RUGR, although only slightly less than Alternatives A and E.

## Conclusions

This analysis concludes that ruffed grouse, as represented by potential effects of the proposed planning framework on species' habitat conditions analyzed with the ESE Tool, would continue to be present, with increasing population levels under all alternatives.

### 3.3.6.2 White-Tailed Deer (*Odocoileus virginianus*)

#### Affected Environment

White-tailed deer utilize almost all forest types and successional stages during their annual life cycle (Johnson et al. 1995). The range of this species is expanding in North Carolina, and therefore, white-tailed deer are not considered to be of conservation concern (NCWAP 2015). However, hunting success is declining on the Nantahala and Pisgah NFs, and is thought largely to be related to the loss of habitat diversity (e.g., young and old forests, mast production, etc.) as the forest ages and active management decreases.

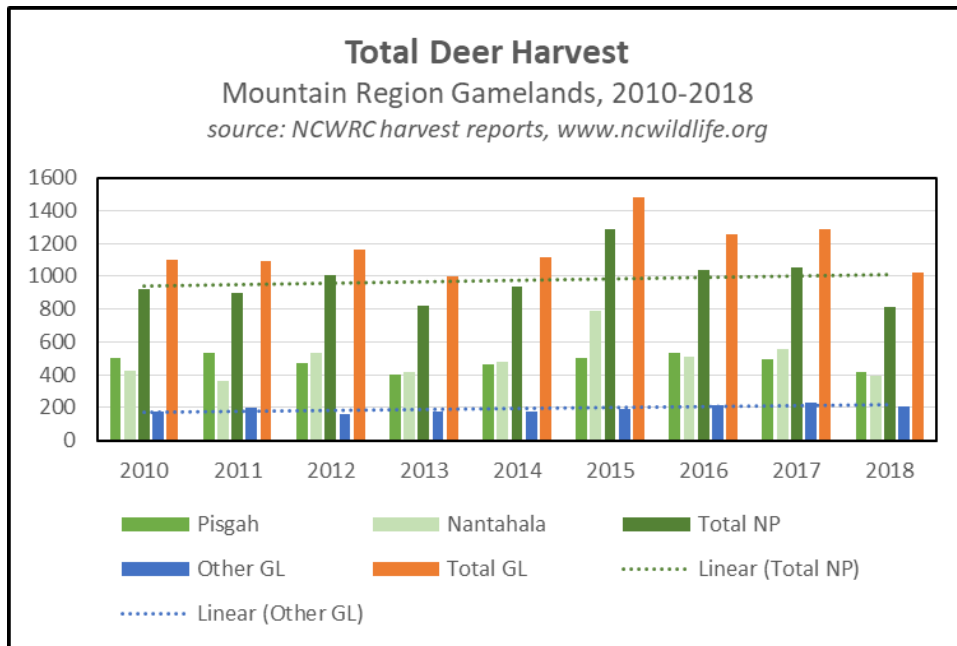
Older forests, especially those with significant oak components, are important white-tailed deer habitat in the fall and winter, when acorns become a dominant fall and winter food item (Wentworth et al. 1990a). Deer nutrition and overall health, reproduction, weight, and antler characteristics are influenced by the availability of acorns (Harlow et al. 1975, Feldhammer et al. 1989, Wentworth et al. 1990a, 1992), making forest mast production critical. Year-round use of vegetation in the form of woody browse, soft mast, and grasses and forbs is also extremely important, and is most abundantly in early successional woody habitat, open woodlands, grasslands, and shrub lands of varying sizes (Wentworth et al. 1990b, Ford et al. 1993).

White-tailed deer rely on a diversity of habitat types adjacent to each other on the landscape. High quality deer habitat is most often characterized by the interspersed mature oak forest (or other hard-mast bearing forest type) and other habitats that provide forage and cover (e.g., openings, young forests with high stem density, or open woodland conditions with well-developed grass and forb development and pockets of dense understory). In eastern hardwood forests, Barber (1984) recommended that at least 50% of the landscape should consist of mature mast trees, with the remainder containing an interspersed evergreens, shrubs and vines, and openings with herbaceous and early successional woody vegetation. Based on utilization data, current deer densities in the Southern Appalachians can be maintained by providing approximately 5% of the landscape in regenerating forest vegetation (Wentworth et al. 1990b). Additionally, Wentworth et al. (1989) concluded that approximately 2% of the area in high quality grasslands and shrub lands is necessary to adequately buffer the effects of a poor hard mast year.

White-tailed deer are present throughout the Appalachian Mountains, where population densities are medium to high in the Northern Ridge and Valley, Allegheny Mountains, Northern Cumberland Mountains, and Southern Appalachian Piedmont Sections, and low to medium in the remainder of the Southern Appalachian Assessment area (SAMAB 1996). High population densities are associated with greater amounts of cropland and lesser amounts of developed and coniferous forestland. For example, deer densities are generally higher on private lands than on national forest and state lands in Virginia (VDGIF 2007).

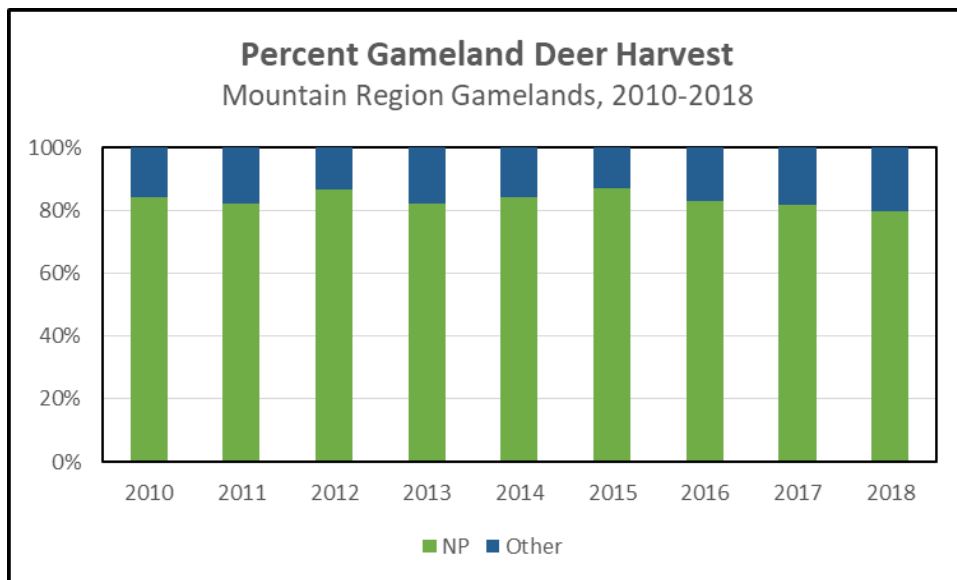
The NCWRC monitors white-tailed deer harvest the Nantahala and Pisgah NFs. Figure 104 summarizes this data for the 2010-2018 period. Monitoring efforts document a slight increase in total deer harvested from the Forests during this period. This same trend is reflected in total deer harvest rates from other

game lands (displayed below as “other GL”) and overall deer harvest rates from all game lands combined (displayed below as “total GL”).



**Figure 104. Total white-tailed deer harvest from western region game lands (including the Nantahala and Pisgah NFs), 2010-2018, summarized from NCWRC (2018)**

What is not reflected in Figure 104 is that approximately 17% of game land deer harvest is from game lands off the national forests, while the Forests comprise approximately 97% of Western North Carolina game lands (Figure 105). Parts of non-Forest game lands are intensively managed for habitat conditions supporting white-tailed deer. Although deer harvest remains stable to slightly increasing on the Nantahala and Pisgah NFs, hunting deer requires covering larger areas and longer timeframes. This is thought to be a result of the loss of habitat diversity (e.g., young and old forests, mast production, etc.) as the forest ages and active management decreases.



**Figure 105. Total deer harvest from mountain region game lands, 2010-2018, summarized from NCWRC 2018**

Using deer harvest as a surrogate for population trends (which includes hunter-bias and therefore may not completely reflect actual population trends), white-tailed deer populations appear to be relatively stable over the last eight years (Figure 104).

There is no doubt that landscape capacity for deer on the Forests is much greater, especially given harvest rates from other mountain game lands, where parts of the land base are managed intensively for deer (Figure 105). Suitable habitats such as openings, open woodland conditions, hard and soft mast production potential, are limited across the Nantahala and Pisgah NFs. Without a continued presence of these suitable habitats, it is possible to see declines in white-tailed deer populations on the Nantahala and Pisgah NFs.

### **Environmental Consequences**

In addition to plan components addressing the ecosystem conditions mentioned above (e.g., forest type and seral stages), habitat requirements for white-tailed deer are addressed through the establishment of plan components to maintain or enhance vegetative (i.e., habitat) diversity across the landscape, as well as retention or enhancement of fine-scale habitat requirements such as hard and soft mast production during land management activities (described above).

Appendix C lists key characteristics and indicators of ecosystems and species groups within the Ecological Sustainability Evaluation (ESE) that include white-tailed deer. Environmental consequences for each alternative considered in detail were estimated for these indicators. Ecological sustainability scores were generated to reflect overall effects of each alternative on the health and resilience of habitat to support white-tailed deer populations at the landscape scale.

In Alternative A, the existing forest plan concentrated management for deer within MAs 1B and 3B, including forest wide direction to manage foraging habitat and a standard to manage MA 1B for deer and grouse. The existing forest plan also mentions management within the balds MA (17) for deer and grouse. Management areas 2A and 2C also provide associated benefits to wildlife species, including white-tailed deer.

Within the proposed plan action alternatives B through E, adjacency of structural habitat components needed for quality deer habitat is discussed at many levels, including four desired condition statements covering permanent openings, young forests, open woodlands, and habitat adjacency. The proposed plan also covers finer scale habitat elements relevant to grouse, including hard and soft mast, and edge and interior forest conditions. To address what is perhaps the primary factor limiting white-tailed deer habitat suitability across the Forests, the Matrix MA includes a desired condition for young forest to exceed average natural disturbance gap size to provide for habitat diversity and benefit wildlife (MAT-DC-02).

### **Summary of Potential Effects**

All action alternatives include plan components to directly or indirectly enhance and/or restore habitat for white-tailed deer on the Nantahala and Pisgah NFs (Appendix C). Part of the foundation of the planning framework incorporates Wildlife Habitat Active Management Areas (WHAMAs) specifically for deer (NCWRC 2016), including the consideration of management area boundaries and plan objectives for young forest habitat and open woodlands.

Results of the Ecological Sustainability Evaluation (ESE) summarize this across ecozones supporting habitat for white-tailed deer (Table 122). This summary reveals that habitat conditions for deer will improve under all alternatives, and reach “good” conditions in the long term (i.e., in 50+ years) under Alternatives B, C, and D.



**Table 122. ESE Results Across Ecozones and Overall Forest-Wide Trends by Alternative at 10 and 50 years (red=poor, yellow=fair, light green=good, dark green=very good)**

Element Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Acidic Cove Forest																			
Dry Oak Forest																			
Dry-mesic Oak Forest																			
Floodplain Forest																			
High Elevation Red Oak Forest																			
Mesic Oak Forest																			
Northern Hardwood Forest																			
Pine Oak -Heath Forest																			
Rich Cove Forest																			
Shortleaf Pine Forest																			
Spruce-fir Forest																			
Forest-wide Weighted Average																			

Table 123 summarizes ESE scores for species groups containing white-tailed deer and indicates that the lack of young and open forest conditions is what is limiting deer populations on the Forests. This is addressed in the discussion above, as it relates to deer harvest on the Forests. Additionally, young and open forest conditions are discussed in detail in the Forest Structure sections of this EIS.

**Table 123. ESE Results for Species Groups Containing White-Tailed Deer (red=poor, yellow=fair, light green=good, dark green=very good)**

Element Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Forest Edge and Transition Associates																			
Hard/Soft Mast Dependent Species																			
Interior Forest Associates																			

In addition to the summary presented above, please refer to the detailed discussion of potential effects to young, old, and open forest conditions at 3.3.2.2. Forestwide Structure as it is relevant to white-tailed deer.

In summary, Alternatives B and D provide the best opportunity for restoration or enhancement of habitat for white-tailed deer and other species associated with young and early successional habitats (Table 123). Alternatives A and E also provide good opportunity for restoration or enhancement of deer habitat. Alternative C provides the least opportunity for restoration or enhancement of habitat for deer, although only slightly less than Alternatives A and E. This is supported by Ecological Sustainability Evaluation (ESE) results across ecozones inhabited by white-tailed deer on the Forests (Table 122).

## Conclusions

This analysis concludes that white-tailed deer, as represented by potential effects of the proposed planning framework on species' habitat conditions analyzed with the ESE, would continue to be present on the Forests, with increasing (although slightly) population levels, under all alternatives.

### 3.3.6.3 Wild Turkey (*Meleagris gallopavo*)

#### Affected Environment

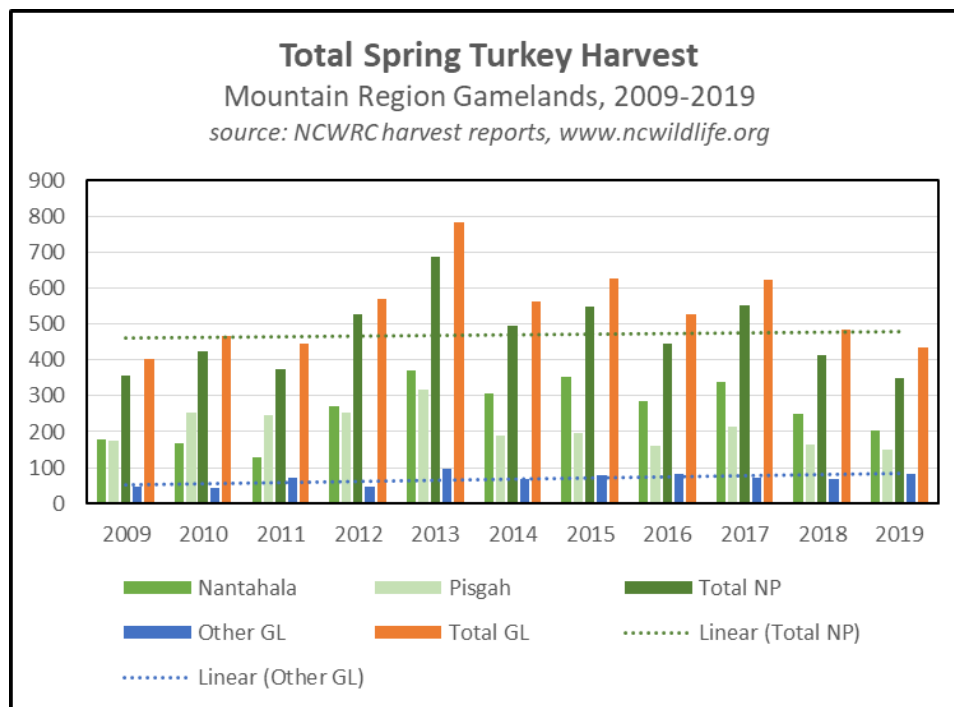
Eastern wild turkey occupies a wide range of habitats, meaning landscape-level habitat diversity provides optimum conditions (Schroeder 1985). This includes mature mast-producing stands during fall and winter, shrub dominated stands for nesting, and herb dominated communities, including grasslands, for brood rearing. Other important habitat components include spring seeps, especially in areas with seasonal snow cover, and a reliable source of soft mast-producing plants (e.g., dogwood, black gum, grape, blueberries, etc.).

The complex life history of wild turkey demonstrates the need for a diversity of habitat types adjacent to each other on the landscape. High quality wild turkey habitat is most often characterized by the interspersed of mature oak forest (or other hard-mast bearing forest type) and other habitats that provide forage and cover (e.g. openings, edge habitats along openings or roads, or open forest conditions with good grass and forb development and pockets of dense understory). Habitat conditions

for wild turkey can be enhanced by management activities such as prescribed burning and thinning (Hurst 1978; Pack et al. 1988), and the development of herbaceous openings (Nenno and Lindzey 1979, Healy and Nenno 1983). Within the eastern hardwood region, Wunz and Pack (1992) recommend maintaining 50-75% of the area in mast producing condition (i.e., mature forest), and approximately 10% of the area in well-distributed forest edges adjacent to permanent grass- and shrub lands, and/or open woodlands, in addition to the early successional habitats (i.e., young forest conditions) that result from timber harvest and other vegetation management activities.

Eastern wild turkeys are present throughout the southeast. Population densities are medium to high in the Northern Ridge and Valley, Allegheny Mountains, Northern Cumberland Mountains, and Southern Appalachian Piedmont Sections, and low to medium in the remainder of the SAA area (SAMAB 1996). High population densities are associated with greater amounts of oak forest and cropland, and lesser amounts of developed and coniferous forestland. Wild turkey populations have expanded in range and density in the last 25 years, which is likely a long-term result of extensive restoration efforts by the NCWRC, protection, and conservative harvest strategies, as well as increased acorn production resulting from the increase in mid-to late successional oak forests.

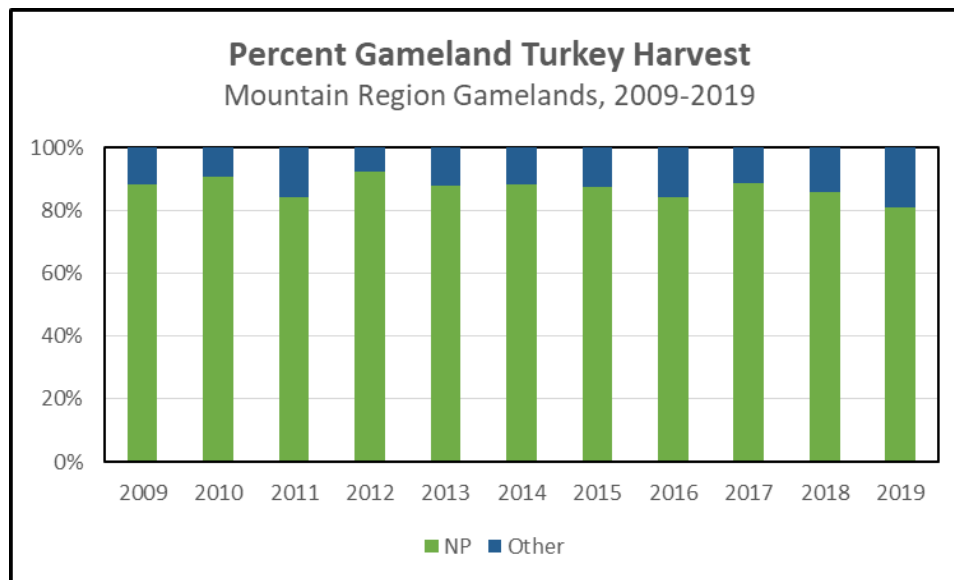
The NCWRC monitors wild turkey harvest from the Nantahala and Pisgah NFs. Figure 106 summarizes this data for the 2009-2019 period. These efforts document a slight increase in total turkey harvested from the Forests during this time period (spring season only). This same trend is reflected in total turkey harvest rates from other game lands (displayed as “other GL” below) and overall spring turkey harvest rates from all game lands combined (displayed as “total GL”).



**Figure 106. Total wild turkey harvest (spring) from western region game lands (including the Nantahala and Pisgah NFs), 2009-2019, summarized from NCWRC (2019)**

What is not reflected in Figure 106 is that approximately 13% of game land turkey harvest is from non-Forest Service game lands, while the Forests comprise approximately 97% of the game lands in the Western North Carolina (Figure 107). This may indicate that some non-Forest Service game lands are intensively managed for habitat conditions supporting wild turkey. While turkey harvest remains stable to slightly increasing on the Forests, hunting turkey requires covering larger areas and longer

timeframes. Again, this reflects the loss of habitat diversity (e.g. young and old forests, mast production, etc.) as the forest ages and active management decreases.



**Figure 107. Total wild turkey harvest from mountain region game lands, 2009-2019, summarized from NCWRC 2019**

Using turkey harvest as a surrogate for population trends (which includes hunter-bias and therefore may not completely reflect actual population trends), wild turkey populations appear to be relatively stable (Figure 106). The landscape capacity is much greater, especially given harvest rates from other mountain game lands (Figure 107). Suitable habitats discussed above, such as openings, open forest conditions, hard and soft mast production potential are limited across the Forests. Without a continued presence of these suitable habitats, it is possible to see declines in wild turkey populations on the Forests.

### Environmental Consequences

In addition to plan components addressing the larger ecosystem conditions mentioned above (e.g., forest type and seral stages), habitat requirements for wild turkey are addressed through the establishment of plan components to maintain or enhance vegetative (i.e., habitat) diversity across the landscape, as well as retention or enhancement of fine-scale habitat requirements such as hard and soft mast production during land management activities. These resources are described in other parts of this analysis (i.e., ecosystem and/or species group subsections).

Appendix C lists key characteristics and indicators of ecosystems and species groups within the Ecological Sustainability Evaluation (ESE) that include wild turkey. Environmental consequences for each alternative considered in detail were estimated for these indicators. Ecological sustainability scores were generated to reflect overall effects of each alternative on the health and resilience of habitat to support turkey populations at the landscape scale.

In Alternative A, the existing forest plan concentrated management for turkey within MAs 1B and 3B. Management areas 2A and 2C also provide associated benefits to wildlife species, including wild turkey.

Within the proposed plan alternatives B through E, adjacency of structural habitat components needed for quality turkey habitat is discussed at many levels, including four desired condition statements covering permanent openings, young forests, open woodlands, and habitat adjacency. The proposed plan also covers finer scale habitat elements relevant to wild turkey, including hard and soft mast, and edge and interior forest conditions. To address what is perhaps the primary factor limiting wild turkey habitat suitability across the Forests, the Matrix MA includes a desired condition for young forest to

exceed average natural disturbance gap size to provide for habitat diversity and benefit wildlife (MAT-DC-02).

### Summary of Potential Effects

All action alternatives include plan components to directly or indirectly enhance and/or restore habitat for wild turkey on the Nantahala and Pisgah NFs (Appendix C). Part of the foundation of the planning framework incorporates Wildlife Habitat Active Management Areas (WHAMAs) specifically for turkey (NCWRC 2016), including the consideration of management area boundaries and plan objectives for young forest habitat and open woodlands.

Results of the Ecological Sustainability Evaluation (ESE) summarize this across ecozones supporting habitat for wild turkey (Table 124). This summary reveals that habitat conditions for turkey will improve under all alternatives, and reach “good” conditions in the long term (i.e., in 50+ years) under Alternatives B, C, and D.

**Table 124. ESE Results Across Ecozones and Overall Forest-Wide Trends by Alternative at 10 and 50 Years (red=poor, yellow=fair, light green=good, dark green=very good)**

Element Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Acidic Cove Forest																			
Dry Oak Forest																			
Dry-mesic Oak Forest																			
Floodplain Forest																			
High Elevation Red Oak Forest																			
Mesic Oak Forest																			
Northern Hardwood Forest																			
Pine Oak -Heath Forest																			
Rich Cove Forest																			
Shortleaf Pine Forest																			
Spruce-fir Forest																			

Element Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Forest-wide Weighted Average																			

Table 125 summarizes ESE scores for species groups containing wild turkey and indicates that young and open forest conditions are what is limiting wild turkey on the Forests. This is addressed in the discussion above, as it relates to turkey harvest on the Forests. Additionally, young and open forest conditions are discussed in detail in the Forest Structure sections of this EIS.

**Table 125. ESE Results for Species Groups Containing Wild Turkey (red=poor, yellow=fair, light green=good, dark green=very good)**

Element Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Forest Edge and Transition Associates																			
Hard/Soft Mast Dependent Species																			
Interior Forest Associates																			

In addition to the summary presented above, please refer to the detailed discussion of potential effects to young, old, and open forest conditions at 3.3.2.2. Forestwide Structure as it is relevant to wild turkey.

In summary, Alternatives B and D provide the best opportunity for restoration or enhancement of habitat for wild turkey and other species associated with young and early successional habitats (Table 125). Alternatives A and E also provide good opportunity for restoration or enhancement of turkey habitat. Alternative C provides the least opportunity for restoration or enhancement of habitat for deer, although only slightly less than Alternatives A and E. This is supported by Ecological Sustainability Evaluation (ESE) results across ecozones inhabited by wild turkey on the Forests (Table 124).

## Conclusions

This analysis concludes that wild turkey, as represented by potential effects of the proposed planning framework on species' habitat conditions analyzed with the ESE, would continue to be present on the Forests, with increasing (although slightly) population levels, under all alternatives.

### 3.3.6.4 Black Bear (*Ursus americanus*)

#### Affected Environment

Black bears occupy a wide variety of habitats in the southern Appalachians, occurring primarily on national forests and national parks of the Southern Blue Ridge, Northern Cumberland, and Allegheny Mountains and the Northern Ridge and Valley. Public lands in Virginia, West Virginia, North Carolina, Tennessee, and Georgia connect to form a forested landscape of over six million acres where bears are generally distributed at low to medium densities. The increase of older oak forests in this region, along with increased protection and conservative hunter harvest, has allowed bear populations throughout the southeastern mountain region to increase over the past 30 years (SAMAB 1995:61).

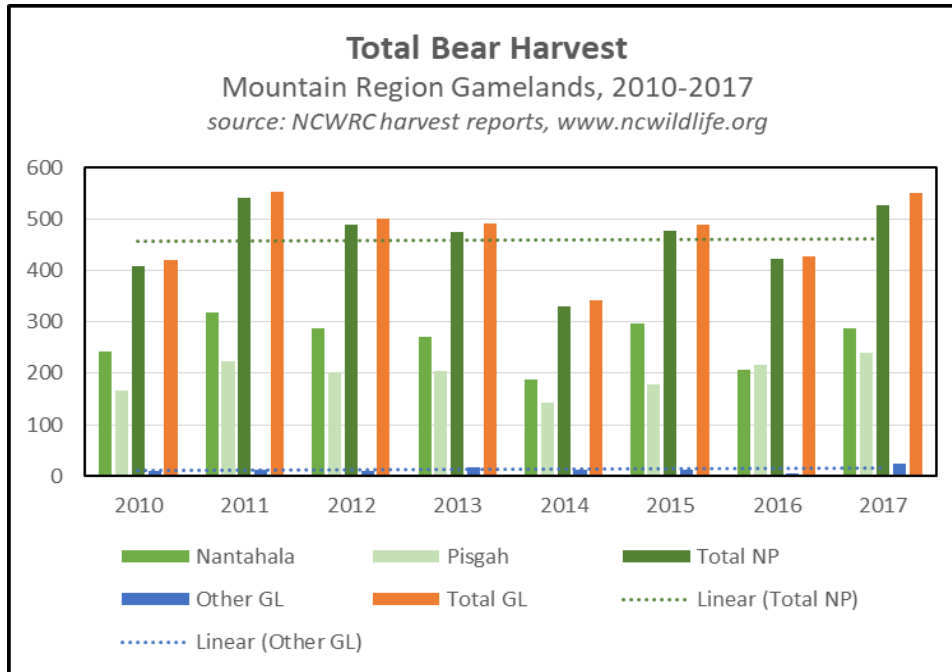
In the southern Appalachians, including the Nantahala and Pisgah NFs, important habitat elements include low human disturbance, habitat diversity, den site availability, and availability of hard mast. Black bears are opportunistic omnivores and consume a variety of seasonal plant and animal foods including flowering plants, grasses, various roots and tubers, and soft mast (e.g. grapes, berries, apples, etc.). However, availability of hard mast (e.g. acorns and hickory nuts) is critical throughout the winter, and reproductive success is closely related to hard mast availability (Eiler 1981; Wathen 1983; Eiler et al. 1989).

Since bears utilize nearly any abundant plant or animal food, they are likely to thrive when a diversity of forest age classes and food sources are available. Vegetation management can provide much of this diversity (Reagan 1990). Naturally occurring disturbances, such as ice storms, wildland fires, and hurricanes provide habitat diversity, but at random intervals and locations, providing limited and unreliable wildlife habitat diversity benefits.

Bears den in a wide variety of sites including road culverts, abandoned buildings, and in vegetation (Carlock et al. 1983). Traditional bear dens are found in caves and rockfalls, or under the root mass of uprooted trees, and in hollow trees. Carlock et al. (1983) identifies hollow trees as preferred denning locations, while Brody (1984) found that ground dens are preferred in Western North Carolina. Preference may be related to availability and may be a learned behavior (Brody 1984). Levels of human access within bear habitat determine the degree of negative effects on bears (Beringer 1986; Brody and Pelton 1989) and generally, high bear population densities are associated with areas of low open road density (SAMAB 1995:87). Low-traffic roads and trails are used by bears as travel ways and provide the benefit of additional edge and associated soft mast, whereas high traffic volumes have a negative impact, with bears generally avoiding these areas. Effects of roads vary based the duration and time of year the road or trail is open for use and the amount and type of human disturbance.

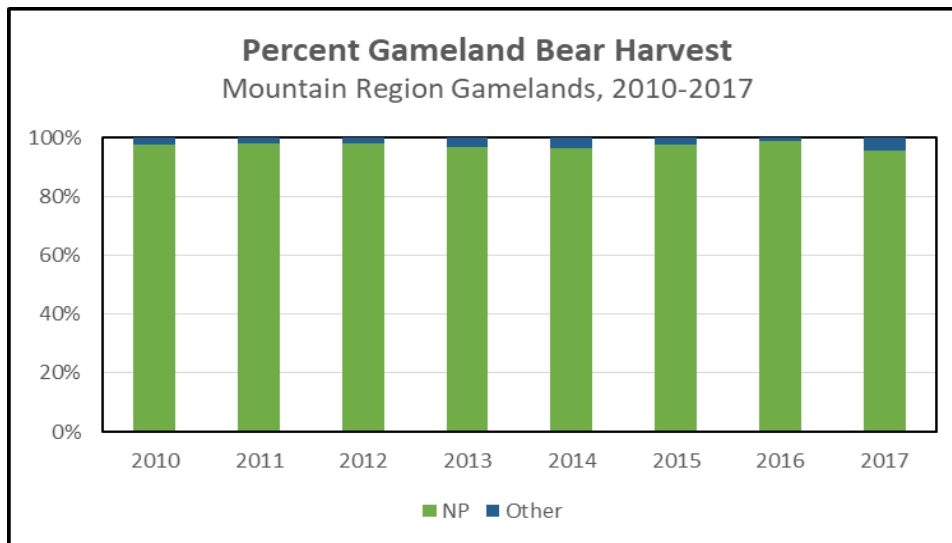
The complex life history of black bears demonstrates the need for a diversity of habitat types adjacent to each other on the landscape. High quality black bear habitat is most often characterized by the interspersed of large blocks of mature forest with other habitats that provide forage and cover (e.g. openings, edge habitats along openings or roads, or open forest conditions with good grass and forb development and pockets of dense understory).

The NCWRC monitors black bear harvest from the Nantahala and Pisgah NFs. Figure 108 summarizes this data for the 2010-2017 period. Monitoring data show a relatively stable trend in black bear harvested from the Forests during this time period, with noticeable annual variation. The same trend is reflected in total bear harvest rates from other game lands and overall black bear harvest rates from all game lands combined.



**Figure 108. Total black bear harvest from western region game lands (including the Nantahala and Pisgah NFs), 2010-2017, summarized from NCWRC (2019)**

Black bear harvest is relatively proportional to game land ownership in Western North Carolina (Figure 109). This may indicate that black bears are reliant on larger blocks of contiguous, older forest and key habitat elements such as mast production and denning site availability. This translates into hunters having success where these conditions occur, regardless ownership.



**Figure 109. Total black bear harvest from mountain region game lands, 2010-2017, summarized from NCWRC (2019)**

Using bear harvest as a surrogate for population trends (which includes hunter-bias and therefore may not completely reflect actual population trends), black bear populations appear to be relatively stable (Figure 108), although increases in bear populations over the last several decades are well-documented. Increases are largely a result of hunting regulations and bear sanctuaries (areas where no bear hunting is



allowed), rather than habitat quality or quantity; however, key habitats elements remain critical to the continued persistence of black bear on the landscape.

### Environmental Consequences

In addition to plan components addressing the larger ecosystem conditions mentioned above (e.g., forest type and seral stages), habitat requirements for black bear are addressed through the establishment of plan components to maintain or enhance fine-scale habitat requirements such as hard and soft mast production and denning tree recruitment during land management activities. These resources are described in other parts of this analysis (i.e., ecosystem and/or species group subsections).

In Alternative A, the current plan provides emphasis for black bear habitat conditions within several management area descriptions and MA level direction. It draws distinction between management areas that will provide conditions for forage (1B, 3B) and for mature forest habitat (4A, D, 5). MA 4 includes general direction for black bear habitat and retention of den trees during vegetation management.

Within the revised plan's action alternatives B through E, black bear habitat conditions are identified at several levels (terrestrial ecozone descriptions, GA descriptions and goals, and forest wide direction). The forest wide desired conditions cover permanent openings, mature, old growth, and open structural conditions, and fine scale habitat components (snags, mast). The goals for three GAs include emphasizing access for hunting opportunities including black bear. Finally, the Backcountry MA includes a DC supporting the habitat of rare, unique, and game species.

Appendix C lists key characteristics and indicators of ecosystems and species groups within the Ecological Sustainability Evaluation (ESE) that include wild turkey. Environmental consequences for each alternative considered in detail were estimated for these indicators. Ecological sustainability scores were generated to reflect overall effects of each alternative on the health and resilience of habitat to support turkey populations at the landscape scale.

### Summary of Potential Effects

All of the action alternatives include plan components to directly or indirectly enhance and/or restore habitat for black bear on the Nantahala and Pisgah NFs (Appendix C). Results of the Ecological Sustainability Evaluation (ESE) summarize this across ecozones supporting habitat for black bear (Table 126). This summary reveals that habitat conditions for bear will improve under all alternatives, and reach "good" conditions in the long term (i.e. in 50+ years) under Alternatives B, C, and D.

**Table 126. ESE Results Across Ecozones and Overall Forest-Wide Trends by Alternative at 10 and 50 Years (red=poor, yellow=fair, light green=good, dark green=very good)**

Element Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Acidic Cove Forest																			
Dry Oak Forest																			
Dry-mesic Oak Forest																			
Floodplain																			

Element Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Forest																			
High Elevation Red Oak Forest																			
Mesic Oak Forest																			
Northern Hardwood Forest																			
Pine Oak -Heath Forest																			
Rich Cove Forest																			
Shortleaf Pine Forest																			
Spruce-fir Forest																			
Forest-wide Weighted Average																			

Table 127 summarizes ESE scores for species groups containing black bear. A general lack of young and open forest conditions limits black bear less than other demand species such as deer and grouse. Interior and old growth forest conditions remain in large amounts across the Forests under all alternatives. This is addressed in the discussion above, as it relates to bear harvest on the Forests. Additionally, mature and old growth forest conditions are discussed in detail in the Forest Structure section of this EIS.

**Table 127. ESE Results for Species Groups Containing Black Bear (red=poor, yellow=fair, light green=good, dark green=very good)**

Element Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
CWD and Downed Wood Associates																			

Element Name	Existing Condition	Alt A 10 yrs	Alt A 50 yrs	Alt B T1 10 yrs	Alt B T1 50 yrs	Alt B T2 10 yrs	Alt B T2 50 yrs	Alt C T1 10 yrs	Alt C T1 50 yrs	Alt C T2 10 yrs	Alt C T2 50 yrs	Alt D T1 10 yrs	Alt D T1 50 yrs	Alt D T2 10 yrs	Alt D T2 50 yrs	Alt E T1 10 yrs	Alt E T1 50 yrs	Alt E T2 10 yrs	Alt E T2 50 yrs
Snag and Den Tree Associates																			
Forest Edge and Transition Associates																			
Hard/Soft Mast Dependent Species																			
Interior Forest Associates																			

In addition to the summary presented above, please refer to the detailed discussion of potential effects to young, old, and open forest conditions at 3.3.2.2. Forestwide Structure as it is relevant to black bear.

In summary, all alternatives provide good opportunity for restoration or enhancement of habitat for black bear and other species associated with interior and older forest habitats (Table 127).

## Conclusions

This analysis concludes that black bear, as represented by potential effects of the proposed planning framework on species' habitat conditions analyzed with the ESE Tool, would continue to be present on the Forests, and even thrive under all alternatives.

### 3.3.7 Designated Old Growth Network

This section uses the term “old growth” to mean those forests that have the characteristics described below. There are multiple descriptors of old growth that are needed for context in this section:

- **“Old forest”** is forest lands that met the minimum age threshold to be considered old seral state, but these lands may or may not have other characteristics of old growth.
- **“Current old growth”** is the term used to describe forests that currently contain the old growth characteristics described below. These forests are sometimes called existing old growth.
- **“Designated old growth network”** are lands identified in the plan and managed to become old growth forest in the future, independent of their current condition. This designated network contains both current old growth forest and forest that has the potential to acquire old growth characteristics in the future (future old growth). This is abbreviated in this section as the Designated OG Network.
- **“Old forest trending landscape”** includes the designated network as well as other lands in management areas where management activities are generally unlikely. These lands outside the designated network contain both current old growth forest and forest that has the potential to acquire old growth characteristics in the future. This is abbreviated in this section as OFT Landscapes.

#### Affected Environment

In the revised plan, old growth forests are recognized as a valuable natural resource worthy of protection, restoration, and management. Old growth forests provide a variety of values—biological diversity, plant and animal habitat, recreation, carbon sequestration, hydrologic function, soil productivity, esthetics, spiritual values, and high-quality wood products—consistent with the Forest Service Southern Region Old Growth Guidance (R8 Guidance 1997).

The Southern Region of the Forest Service (1997) cites a definition provided by Dale Robertson in 1989:

*“Old-growth forests are ecosystems distinguished by old trees and related structural attributes. Old growth encompasses the later stages of stand development that typically differ from earlier stages in a variety of characteristics which may include tree size, accumulation of large wood material, number of canopy layers, species composition, and ecosystem function.”*

*“The age at which old growth develops and the specific structural attributes that characterize old growth will vary widely according to forest type, climate, site conditions, and disturbance regime. Old growth in fire-dependent forest types may not differ from younger forests in the number of canopy layers or accumulation of down woody material. However, old growth is typically distinguished from younger growth by several of the following attributes:*

1. *Large trees for the species and site.*
2. *Wide variation in tree sizes and spacing.*
3. *Accumulations of large-sized dead standing and fallen trees that are high relative to earlier stages.*
4. *Decadence in the form of broken or deformed tops or boles and root decay.*
5. *Multiple canopy layers.*
6. *Canopy gaps and understory patchiness.”*

Other definitions also include the importance of high tree species diversity, rich herbaceous diversity, abundant lichens and fungi, downed wood in all sizes and stages of decay, pit and mound topography, undisturbed soils and soil macropores, and limited evidence of human disturbance (Martin 1992,

Chester et. al. 1995, Byrd and Davis 1996, Franklin et. al 2002). Despite a variety of definitions, old growth forest is often cited as the presence of old trees that have been mostly undisturbed by man since their origin (Barton 2018, Hunter and White 1997).

Many plant and animal species are associated with old growth forest communities (Byrd and Davis 1996). In the Southern Appalachians few species are known to be obligate to old growth forest communities, including four lichen species: hot dots (*Arthonia kermesia*), golden spruce dots (*Arthonia cupressina*), ol' birch spots (*Arthopyrenia betulicola*), sterling Lips (*Graphis sterlingiana*) (Tripp and Lendemer 2020). Additionally, mature and old growth forest may serve as optimal habitat for some species such as landbirds that require forest interior habitats. Few studies have been completed within the canopy of old growth forests, particularly within the higher canopy with different microhabitats (Juday 1990, Ciegler et.al. 2003). Most old growth studies have concentrated on rich cove forest with high species diversity and high elevation spruce-fir or conifer forests in the Appalachians, Pacific Northwest, or northern Europe (Coghill and White 1991, Duffy and Meir 1992, Elliott and Loftis 1993, Busing and White 1993, Essen et.al. 1996, Dey 1984, Franklin et.al 2002, Jackson et.al. 2009, Butler et.al. 2014). Several epiphytic lichens have only been located within old growth forest communities in the southern Appalachians (Lendemer, Harris, and Tripp 2013). Two of these species occur on the Nantahala and Pisgah NFs. Other studies have noted higher diversity or cover of epiphytic bryophytes, epiphytic lichens, arboreal invertebrates, or fungi in old growth stands (McMullin et al. 2008, McGee and Kimmerer 2002, Root et al. 2007, Miller et al. 2008, Rubinio and McCarthy 2008).

In addition to the ecological values described above, old growth forests are valued by individuals for their aesthetic, spiritual, or intrinsic existence values which can be embodied in feelings of respect, reverence, cultural connectedness, and sacredness. Some believe that old growth forests should be preserved and protected and that their values may be compromised by any active forest management. (Owen et al 2008)

The revised plan identifies mature and old growth forests as a desired habitat type needed throughout the landscape (LMP Plan, Table 3). Old growth forest communities are currently rare in the Southern Appalachians. Opinions differ on the rarity based on the definition of old growth forest, and some authors have estimated more than 250,000 acres of old growth forests within the southern Appalachians (Pyle 1985, Messick 2004).

The majority of lands that currently comprise the Nantahala and Pisgah NFs have been managed historically prior to acquisition as national forests. Past land use practices of the area included burning, clearing for agriculture, and cutting timber for wood products. Much of the forest land in the 18-county area has been harvested at least once. Due to the harvest activity occurring over a relatively short period, much of the forests are of uniform age, while both young and old growth forests are underrepresented (Greenberg et al. 2011). About 40% of the Forests are 80 to 100 years of age, 22% are 101 to 120 years of age, and 14% are greater than 120 years of age. Young forest represents about 1% of the current age-class distribution; old growth forest is currently about 9% of the forest. Open forest woodlands are also underrepresented on the forest, currently comprising about 1.6%. (See Terrestrial Ecosystems, Forestwide structure for more information).

The proposed plan acknowledges that old growth forest need not be primeval or virgin but can develop over time from human or natural disturbance. For example, the Joyce Kilmer Memorial Forest (Nantahala NF) is the prototypical old growth example with its huge cathedral-like trees, diverse carpets of moss and wildflowers, and a park-like setting that inspires reverence, art, and literature. However, where old growth forest exists on the Forest, it is usually not in this condition but instead is comparable to what is currently older, closed canopy forests with somewhat smaller trees.

## Current Old Growth Forest Management

Current Federal laws and regulations associated with the management of national forests do not specify old growth forest management strategies. These laws and regulations do, however, provide direction on Forest Service management of multiple natural resources and values that would be expected in an ecologically resilient forest, including protecting and recovering federally listed threatened and endangered species and their habitats, providing habitats to sustain viable populations of species, and maintaining and enhancing the diversity of plant and animal communities.

The southern region of the Forest Service developed guidance for managing old growth forest, *Guidance for Conserving and Restoring Old-Growth Forest Communities on National Forests in the Southern Region* (1997). This guidance was drafted following the Nantahala and Pisgah 1994 plan amendment. It considered the techniques that were applied on the Nantahala and Pisgah NFs as forerunners within the region and relied on similar principles as those built into the plan. This guidance paper is not binding agency policy.

The 1994 plan, as amended, identifies “the desired future condition for old growth across the forest is to have a network of small, medium and large sized old growth areas, representative of sites, elevation gradients, and landscapes found in the Southern Appalachians and on the Forests, that are well dispersed and interconnected by forested lands.”

The plan established a network of future old growth by designating a system of old growth in three different patch sizes: large patches at least 2,500 acres in size; medium patches for watersheds with no large patch with a minimum size of 5% of the administrative watershed; and small patches within compartments without either a portion of a large or medium patch with a size of 5% of the compartment or a minimum of 50 acres. While these patches do not always contain existing old growth forest, all are designated to allow old growth characteristics to develop over the long term.

The 1997 Regional Old Growth Guidance allows for timber management within the designated old growth network. Management activities for restoration, protection, or maintenance of old growth forest could be prescribed (pg. 20). An example could be to provide open canopy conditions of the dry and xeric oak forest, woodland, and savanna old growth stands. A thinning followed by a prescribed burn could provide those conditions.

Within the designated old growth network managed for future old growth in the Nantahala and Pisgah 1994 plan, vegetation manipulation is only allowed for the enhancement of old growth values and characteristics and for maintaining forest health of adjacent lands. Salvage operations and road construction have additional constraints.

The designated old growth network is established to ensure old growth conditions develop and persist into the future. It does not account for all the pockets of old forest that may exist. When old growth conditions or near old growth conditions are found at the project level, projects must consider the 1994 plan standard that requires a “field check when project proposals may directly affect areas in the initial inventory of possible old growth.” The initial inventory considered stands that were aged 100 years or more. The 1994 plan requires a certain amount of designated old growth patches across the forest and explains when additional patches are and are not needed. The plan clarifies that adding existing old growth patches to the network of designated old growth is not required when the old growth network is already sufficiently distributed by the following criteria:

In each compartment containing 250 acres of national forest land, select a small patch for future old growth management. If 5% of the compartment acres are already part of a large or medium patch, an additional small patch is not needed. Whenever possible, areas should incorporate some riparian habitat to enhance old growth values.

Select the small patches prior to the first ground disturbing project of at least 5 acres proposed in the compartment.

Select a contiguous area at least 5% of the size of the NF land in the compartment or at least 50 acres, whichever is greater. Management areas 14 and 18 can contribute to old growth acreage when they are included in the selected area. Compartments containing part of a large or medium patch do not need an additional small patch.

When projects discover existing old growth characteristics outside the designated network, the 1994 plan offers discretion about whether these patches should be managed for old growth characteristics versus other resource interests. The 1994 direction identified small patches as anything 50 acres or more; the Region 8 Guidance identifies small patches as between one and 99 acres.

The current resulting network from implementing this management direction is 211,503 acres. The network includes 33 patches exceeding 2,500 acres, 74 patches from 100 to 2,500 acres, and 135 patches sized less than 100 acres. Five of the patches exceed 10,000 acres, and one of the 33 larger patches exceeds 20,000 acres.

The designated old growth network would provide a portion of future old growth. However, the forest is continuing to age outside of the designated old growth network as well. Overall, the potential for old growth forest, based on minimum age criteria for individual ecozones, will increase dramatically as the forest ages over the next 50 years. This is highlighted by individual ecozones within Figure 110. More mesic types are slower to acquire the minimum age threshold. As the forest ages disproportionately, some ecozones would exceed the percent desired by the modeled Natural Range of Variation (NRV). It should be noted old growth conditions consider more than just the age of the forest, therefore not all of the forest that is aging toward older successional forest will have old growth characteristics.

### **Analysis Methods and Indicators**

The revised plan has a desired condition that the designated old growth network should represent all ecozones and elevations dispersed across the forests in large, medium, and small patches (OGN-DC-1). To analyze the impacts of the revised plan on the development of old growth characteristics across the forests, this EIS considers the following: the size and configuration of the designated old growth network, the total amount of old forest characteristics being developed on the broader forest, requirements for designation of small patches at the project level, and objectives and monitoring of old growth conditions. The alternatives are analyzed in the context of the NRV by ecozone, as well as the forestwide distribution, representation and redundancy of the designated old growth network

Also, the revised plan considers that the current amount of old forest is underrepresented for ecozones compared with the NRV, however, an extensive amount of the forest is trending toward old forest conditions both inside and outside the designated old growth network. For example, currently all ecozones are trending toward older age classes and vary in the rate of achieving the desired conditions for old forest after 50 years assuming no further active management. The driest types, the pines and dry oak, and a few of the high elevation mesic types, northern hardwoods and spruce-fir, are close to desired conditions for old forest after 10 years. In contrast, most of the more mesic types, representing 70% of the Nantahala & Pisgah NFs, are moving slower toward desired conditions for old forest with all achieving these by 50 years. (See Figure 110).

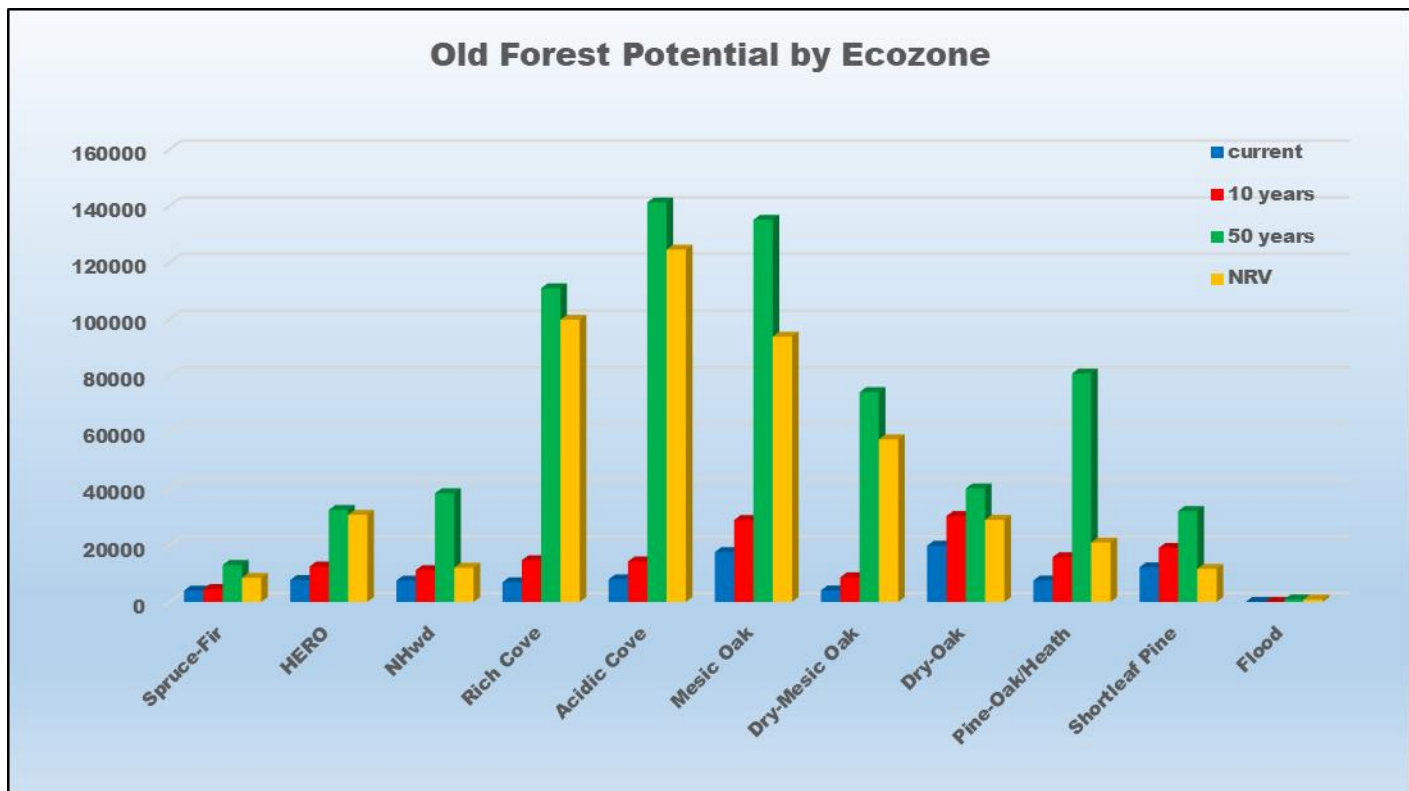


Figure 110. Estimates of the old forest successional class by ecozone over time, not considering background disturbance

The draft plan identifies a desired condition that old growth characteristics shift over time and disturbances are a natural part of the system (OGN-DC-2). Should a disturbance occur such that a designated patch is returned to an earlier seral stage, that patch need not be replaced. (Revised Plan, Designated Old Growth Network, Background).

### Size and configuration

The Planning Rule lays out some key principles that plan revisions should consider when planning to sustain resilient conditions. The Planning Rule directives explain that “understanding the natural range of variation is fundamental in strategic thinking and planning, even if restoration to historical conditions is not the management goal or possible on parts of the plan area. Understanding the natural range of variation of an ecosystem provides an understanding of how ecosystems are dynamic and change over time. The natural range of variation is useful for understanding each specific ecosystem, for understanding its existing ecological conditions, and for understanding its likely future character, based on projections of climate regimes. The natural range of variation is a guide to understanding how to restore a resilient ecosystem with structural and functional properties that will enable it to persist into the future” (FSH 1909.12 §23.11a).

To guide the development of desired conditions for the Nantahala and Pisgah National Forests plan revision, the Forests developed a NRV model of forest ecosystems to provide a scientific reference of functional and sustainable ecosystems. In a multiple step process (further described in the project record), the Forests identified ecozones, age classes for each ecozone, and the range of expected acres by ecozone by age and structure (open or closed). Using the best available scientific information, that analysis found that the ranges of acres in Table 128 below would be expected to be old forest, by ecozone, at any given moment in time. An analysis by ecozone is important, because there are substantial differences in the species compositions, tree longevities, sizes, densities, and variations in the



types, intensities, and frequencies of natural disturbances across ecozones (Harmon et al. 1983, Harrod et.al. 1983, Elliott and Swank 1994, Lafon 2006, Flatley et.al. 2013, Runkle and Yetter 1987). These biological and ecological factors result in different tree structures, densities, distributions, and landscape patterns when a forest type is in its old stage.

In order to determine the NRV for old forest, it was necessary to determine an age for onset of old growth conditions by ecozone. The ages for the beginning of the old forest successional class were based on the Region 8 Guidance (1997) for most of the ecozones. Exceptions are dry-mesic oak forest, pine-oak heath forest, northern hardwood forest and floodplain forest. For each of those types, the minimum old forest age was increased to 130 years for the first three and 140 years for the latter, as these ages more closely represent the onset of old growth conditions. These ages may not represent areas of existing old growth or areas of high-quality old growth. Other older age classes have also been suggested for these old growth types (Martin 1992, Byrd and Davis 1996). As such, it should be noted the old forest NRV estimates indicate the oldest modeled age class when old growth characteristics are developed or beginning to be developed. Within this age time frame, the presence of high-quality old growth can vary by site due to past land use history or micro site dynamics.

The results from the NRV modeling are shown below, including the estimated desired old forest acres by ecozone. This includes both open and closed canopy structural conditions of ecozone. Many of the more xeric ecozones, such as pine-oak/heath or shortleaf pine-oak, have a significant percentage of an open canopy condition for the desired old forest percentage.

Comparing the NRV estimates to the current condition is also an estimate. The Forest Service does not have a comprehensive old growth forest survey within the current designated old growth network, and there is variability within age documentation with the USFS FSveg layer, particularly in more remote areas such as wilderness or wilderness study areas. This analysis estimates slightly more than sixteen percent of the existing designated old growth network meets the minimum age for the 11 ecozones. These vary from a high of 55.1% for dry oak and a low of 1.4% for floodplain forest. The two largest ecozones, rich and acidic cove forest, currently have less than 10% at a minimum age.

**Table 128. NRV Estimates of Desired Old Forest Conditions on the Nantahala and Pisgah NFs**

Ecozone	Age of Onset for Old Growth Conditions (years)	Percent of the Ecozone in Old Forest Using a Range of NRV Estimates	Estimated Total Acres of the Nantahala and Pisgah NFs
Spruce-Fir	120+	48-61%	7,500 - 9,500
High Elevation Red Oak	130+	51-64%	27,300 - 34,300
Northern Hardwood	130+	24-36%	9,600 - 14,500
Acidic Cove	140+	46-54%	114,600 - 134,600
Rich Cove	140+	46-54%	91,800 - 107,800
Mesic Oak	130+	47-59%	83,300 - 104,600
Dry Mesic Oak	130+	50-61%	51,500 - 63,000
Dry Oak	100+	45-73%	22,100 - 36,000
Pine-Oak Heath	130+	12-29%	12,500 - 30,000
Shortleaf Pine	100+	17-33%	7,900 - 15,300
Floodplain forest	140+	31-43%	700 - 1,000

While the 2012 Planning Rule directives require consideration of the NRV in the development of plan components, the directives are also clear that NRV may not always equate to desired conditions, such as in situations where ecological conditions have changed, when the system is no longer capable of sustaining key ecosystem characteristics identified as common in the past, or when conditions common in the past are directly opposed to integrated desired conditions (desired conditions that represent a balance of social, economic, cultural and ecological needs).

The planning directives in 23.11a.2 indicate: In some situations, the responsible official may determine that certain key ecosystem characteristics are outside the NRV and that it is not appropriate, practical, or possible to contribute to the restoration of NRV conditions. Examples of situations when restoring conditions is not appropriate, practical, or possible include when:

- a. *The system is so degraded that restoration is not possible.*
- b. *Restoration needs are either socially unacceptable or are not economically feasible. The system is no longer capable of sustaining key ecosystem characteristics relative to NRV based upon likely future environments.*
- c. *The ability to restore the desired ecological conditions or key ecosystem characteristics is beyond the authority of the Agency or the inherent capability of the plan area. (FSH 1909.12 sec 23.11a)*

Given that many ecosystem characteristics dominant in historic times are different today (such as the loss of American chestnut, decline of Fraser fir and eastern hemlock from insect pests, change in fire regimes, hydrology etc.), it is appropriate to consider other approaches beyond NRV when establishing a resilient old growth network. Therefore, the method of representativeness and redundancy is included in this analysis.

## **Representativeness and redundancy**

Using this approach, this analysis considers the representativeness and redundancy of the old growth network.

- *Representativeness* is used in two very different ways by the conservation community (Stevens 2002). The way representativeness is used here is in the strict sense (Stevens 2002); that is, the system under consideration should contain a proportional amount of each ecosystem characteristic under consideration. Ecosystem characteristics that are not adequately represented within the forest may necessitate more attention to ensure adequate function; likewise, characteristics that are over-represented within the forest may impose a greater responsibility to maintain integrity.
- *Redundancy* is obtained when an ecosystem characteristic occurs repeatedly over the landscape and occurs in widely separated areas. A system is not redundant when it occurs only a few times within a very limited geographic area. A system lacking redundancy is vulnerable to events (or actions) that could lead to a loss of integrity over a high proportion of the known occurrences; a system with high redundancy is less vulnerable to such events since such events would affect a smaller proportion of the total at any time. Thus, less redundancy equals a greater risk to system integrity.

## **Scale and continuity**

Other important criteria to consider are scale, specifically larger patches, and forest continuity. Larger scale patches have advantages, because natural disturbances and successional stages occur across a landscape, and larger patches are of sufficient size to recover from a range of disturbance events. Forest continuity is a concept that considers the land area that has not been directly disturbed by logging or agriculture regardless of the canopy age. These concepts were developed in a recent publication (White,

Peter S.; Tuttle, Julie P.; Collins, Beverly S.; 2018). In this publication, it is recommended that the focus should not just be on the big tree stands or the older successional states but the complete mosaic of successional states that is possible at larger scales to create tracts of “minimum dynamic area” and landscape resilience. The minimum dynamic area is defined as the “smallest area with a natural disturbance regime, which maintains internal recolonization, and minimizes extinction” (Pickett and Thompson 1978).

Lands that are designated in management areas where natural processes would prevail have a high potential for recovery of old growth characteristics, regardless of whether they reside in the designated old growth network. In this analysis, these lands are analyzed as patches called the Old Forest Trending Landscape, described in detail below. Also, lands in other ownerships (beyond the borders of the Nantahala and Pisgah NFs) that are managed where natural processes would prevail are also evaluated for contributing to larger patches of old forest and called All Lands.

### **Topographic variation and patch size**

The heterogeneity of ecozones provides an estimate of ecosystem diversity and biological diversity. The highest predictors of the ecozones were geophysical factors. The highest predictors were elevation and carbonate geology (Simon Steve A., 2011) followed by other subclasses of geology such as sulfidic, mafic, and siliciclastic geology. Important variables also included landform shape, slope steepness, and landform index.

Researchers have been investigating the relationship of geophysical settings and biological diversity. Geophysical variables explain 92% of the variation of species diversity of eastern states and provinces (Anderson M.G. et al. 2014). Because biodiversity is so strongly correlated with the variety of geophysical settings, conserving the full spectrum of geophysical settings offers a way to maintain current and future biodiversity. Hunter, et al 1988 advocates basing the coarse filter approach on physical environments as arenas of biological activity rather than on communities, the temporary occupants of those arenas. Elevation was more important than aspect and slope, but where relationships existed, functional diversity was higher on steeper and more north facing slopes (Chapman J.I, McEwan R.W, 2018).

Providing ecozone heterogeneity, and therefore ecosystem diversity, across a landscape for the goal of accruing old growth characteristics is accommodated by large patch sizes. Intuitively, the larger patch size allows for more heterogeneity and abundance of ecozones. Researchers have found that landscape diversity, the variety of landforms created by a land area’s topography, together with its range of its elevation gradients, increases a site’s resilience by offering micro-topographic micro climate options to resident species, buffering them to changes in climate (Anderson M.G. et al. 2014, Willis and Bhagwat 2009, Alcerly et al. 2010). The size, shape, and diversity of patches influence patterns of species abundance-larger, more heterogeneous forests had more species and bird pairs, suggesting that regional conservation strategies should maximize both patch size and forest heterogeneity. (Turner, M.G. 1989, Freemark, K.E. et al. 1986).

Patch sizes for forest reserves is a continuing research topic. While researchers differ, larger patches are found to be more resilient than smaller ones, because they have greater ability to recover from natural disturbance. (Turner, M.G. 1989, Freemark, K.E. et al 1986, Shugart, H.H., 1984.) The premise is to provide a minimum dynamic area defined as the “smallest area with a natural disturbance regime, which maintains internal recolonization, and... minimizes extinction” (Pickett and Thompson 1978). While small patches may have a role in providing local areas that are potential refugia for rare species, large patches provide for resiliency of ecosystems across the landscape, allowing for greater resiliency and recovery from natural disturbances and providing refugia for plant and animal species that were displaced by the disturbances. Large patches also allow for a range of micro-climates and conditions that support the various habitat needs of plants and animals. As such, examining how diverse ecozones are represented in

in various patch sizes in the designated old growth network is reviewed in this analysis, including the percent increase or decrease of large patches.

Across the landscape, larger scale disturbances are relatively infrequent, while the majority of disturbances are fine scaled. These numerous fine scale disturbances create heterogeneity that contributes to biodiversity.

The draft plan and the 1997 Regional Guidance classify large patches as 2,500 acres or larger, and this analysis is not altering that size classification. Similarly, this analysis assumes continuation of small, medium, and large patch sizes in the designated network.

### **Project level action**

Each alternative has a unique standard for considering old growth characteristics of forest stands that are outside the Designated Old Growth Network. Criteria for the analysis includes estimates of how the Designated Old Growth Network would likely change, the effect of managing for old growth forest rather than other multiple use objectives in the plan, and the expected level of controversy for small patch project level decisions.

One purpose for different approaches was to examine the need for additional old growth patches versus the need to meet other multiple use objectives in the proposed plan. Projects affected by the standard are primarily where vegetation treatments are designed to provide for young forest conditions, which is underrepresented on the forests. Designated OG Network lands are no longer eligible for young forest creation. Young forest creation requires regular human intervention to sustain the desired conditions over time, whereas old growth conditions accrue over time, because active management is not required. Costs and timing increase when needing to consider old growth characteristics for every potential stand treatment including differing opinions among stakeholders and managers over the criteria and whether old growth conditions are actually present on the ground. Nearly all projects that propose vegetation treatments have had controversial issues about how to assess old growth conditions and the appropriate action to take. The standard is designed to address this challenge at the project level.

The existing condition of the forest further exacerbates the controversy, because both young forests and old growth are currently underrepresented on the Forests. Due to the advancing age of many forest stands, creating young forest will affect the late and older serial forest stands on and immediately nearby the acres proposed for management. From observations with Spectrum modeling, in the next fifty years more than half of the forest will be at the old forest successional age, even with meeting objectives for young forest. This is particularly true for more xeric and high elevation ecozones, where less active management has been implemented more recently and is not proposed in the future. However, since existing old growth forest is rare, some believe any existing old growth conditions should be retained.

Further, there is a natural tension between setting this direction at the plan level versus relying on site-specific considerations at the project level. There are two philosophies about this tension. Those who advocate for plan level structure believe that where conflicts can be solved in the forest plan, it allows for more efficient implementation at the project level. Providing plan level guidance increases certainty of outcomes while also reducing the opportunity to be nimble to local conditions. Alternatively, providing more flexibility in the plan allows more opportunity for projects to adjust as needed, but this does not provide the same degree of certainty for achieving forest objectives. This is the tension that was considered in developing the range of alternatives to allow different amounts of flexibility for adjusting the old growth network at the project level.

### **Between draft and final**

This tension about whether or not the old growth network should be set at the plan level vs adjusted in project level decisions was clear in the comments received on the draft forest plan. Comments received

on the draft forest plan varied in terms of whether the old growth network should be set at the plan level vs adjusted in project level decisions. Some commenters favored identifying old growth forest at the plan level to provide certainty about the old growth's defined spatial role. Supporters of setting the network at the plan level stated that identifying the designated network in the plan reduces the analysis at the NEPA project level, improving project efficiencies, and ensuring consistency in approach across districts and through changes in leadership. Others favored project level adaptability, stating that old growth forest is not static on the landscape, it is not well inventoried, and that the best location for the designated network may need to move during the next 10 to 20 years. Still others advocated for a cap-and-trade style designated OG network where the overall size of the network is established (capped) in the plan, but the individual patches are traded in and out during projects. Conceptually, a cap-and-trade approach would allow for high quality existing old forest or old growth forest to be added to the network when it is found at the project level, while patches with lower old growth forest potential that are in the network could be removed from the network for other types of multi-use management. However, commenters, and best available science disagree on starting point acreage for that network, and the criteria for adjusting acres in and out. Some advocated for adding to the network based on local conditions, others suggested it should be based on the management area assignment. Overall, there are strong disagreements on the size of the network and what and how to trade. A cap-and-trade style method is untested, would likely depend on an additional level of project survey for old growth characteristics at the project level, and would likely be regularly challenged. Even if a cap-and-trade old growth committee was formed representing diverse interests, it is very uncertain if area specific agreements would be possible.

After considering public comments and the DEIS findings, Alternative E changed the size and configuration of the designated OG network to strategically enhance the network's resiliency and ecological diversity. Alternative E's more than 54,000 acres of additions to the designated old growth network include areas where creation of young forest is unlikely to be prioritized, including designated wilderness, wilderness study areas, recommended wilderness, research natural areas and the corridors of designated wild and scenic rivers that are classified as wild. Beyond these management areas, additional patches were selected with consideration of the full range of biodiversity representation, using ecozone representation, moisture and elevation gradient diversity, as well as spatial distribution and redundancy. The adjustments focused on increasing overall patch size for resiliency (White, Tuttle, and Collins 2018), overall network diversity (McGee and Kimmerer 2002, McGee 2018, Wyatt and Silman 2010, CCEA 1992, Margules and Pressey 2000, Noss and Copperrider 1994), and contribution to an efficient network (Kukkala and Moilanen, 2003, Margules and Pressey 2000). The question of whether the designated old growth network is the right size does not have a definitive answer in scientific literature (Ardron et al. 2010, Watson et al. 2016). The adjusted network size and configuration incorporates landscape planning concepts from scientific literature, academic input, as well as local information provided by commenters and the NC Natural Heritage Program regarding inventoried locations of existing old growth patches.

The resulting network includes 291 separate patches totaling 265,385 acres that represent approximately 25% of the Nantahala and Pisgah NFs. Under this new configuration, Alternative E would provide the largest network of any alternative and would increase the amount of larger patches by 25% more than the existing network, increasing overall resiliency and connectivity. If the Forest were to continue existing old growth forest management direction, it would take several decades to establish a network of this size.

Also, in Alternative E, the size and configuration of the network is set at the plan level, and projects will not be able to add, subtract or adjust the footprint of the designated OG network. The Forest Service recognizes that some want to preserve every small patch of old forest and values exceptional trees. This approach provides the local line officer discretion about what to do when additional high-quality old

forest is found during this planning cycle. The district ranger, or the forest supervisor for multi-district projects, will retain the option of how to manage old trees, old stands, or old growth forest patches in the project itself, depending on the management area direction, site-specific conditions, and ecological needs in the area. If an area is identified as best managed for old growth characteristics, then the project can manage for those conditions, but the area will not be added to the forestwide Designated OG Network. The monitoring program will measure whether the forest is moving towards desired conditions for old growth forests across the landscape and may make recommendations for changes needed in the next planning cycle.

## Indicator measures

**Distribution** is analyzed at three scales:

- First, all the Designated Old Growth Network patches are analyzed directly. This analysis is labeled the Designated Old Growth Network (Designated Old Growth Network).
- Second, a landscape analysis is conducted for each alternative that includes locations where the forest would generally be trending toward an older forest condition, where natural disturbance would be the dominate disturbance pattern. This analysis is labeled the old forest trending landscape (hereafter called OFT Landscape).

In Alternatives A, B, C and D, the OFT Landscape and includes the following

- Designated Old Growth Small, Medium, and Large Patches
- Backcountry Management Area
- Special Interest Areas Management Area
- Research Natural Areas Management Area
- Wilderness Study Areas & Recommended Wilderness Management Area
- Roan Mountain Management Area except for Grassy Balds management portions
- Inventoried Roadless Areas (incorporated into Backcountry in the action alternatives)

Since all lands in the designated wilderness are already in the Designated OG Network, they were not additional lands to add to the OFT Landscape.

In Alternative E, Research Natural Areas, Wilderness Study Areas and Recommended Wilderness Areas were incorporated directly into the Designated Old Growth Network itself, rather than the OFT Landscape.

This analysis assumes that limited active management activities may occur in some of the OFT Landscape, however, it is assumed the activities would be isolated, small scale, and would mimic natural disturbances as much as possible. For example, a stand of white pine may be removed to restore composition in a dry mesic oak ecozone. However, the prevailing disturbance regime would be from natural events.

- Third, an *all lands analysis* was completed across the larger landscape in western NC including all other public and private lands as part of the cumulative effects analysis. These other lands were considered if they were adjacent to USFS network lands identified above, and their management direction is toward an older forest seral condition with natural disturbance patterns as the primary change. In total, the incorporated other lands varied by alternative from about 127,000 to 153,000 acres. The *all lands analysis* incorporated non-USFS lands include:
  - Regional land trusts including
    - Mainspring Conservation
    - Highlands Cashiers land trust

- Conserving Carolina
  - Southern Appalachian Highlands Conservancy
  - Foothills Conservancy
- North Carolina land trusts
  - The Conservation Trust of North Carolina (Beetree watershed)
- National land trusts
  - The Nature Conservancy
  - The Conservation Fund
- North Carolina State Parks Dedicated Nature Preserves
- North Carolina Wildlife Commission NC Natural Heritage Natures Preserves
- North Carolina Forest Service Dedicated Nature Preserves
- North Carolina Plant Conservation Program Preserves
- Adjacent National Forests (Sumter, Chattahoochee, and Cherokee) Wilderness
- Adjacent Cherokee NF Inventory Roadless Areas

Other large areas, such as the Great Smoky Mountains National Park, Grandfather Mountain State Park, Lake James State Park, and Canton city drinking water watershed, provide large patch sizes in the ecoregion but are not directly adjacent to the OFT Landscape and therefore were not included in the analysis.

**Representation** is analyzed using proportional amounts of forest ecozones, elevations, rare habitats, species of conservation concern, and federally listed species found within the Designated Old Growth Network and OFT Landscape.

**Redundancy** is analyzed by assessing the total number of each patch size on the Forests by ranger district.

Project level actions are analyzed by estimating how the Designated OG Network would likely change as a result of implementing standards that are unique for each alternative, the effect of reaching other multiple use desired conditions and objectives, and likelihood of resolving controversy at the project level.

## Environmental Consequences

A summary of the results of analysis methods described above follow below. More detailed analysis results are located in the project record.

### Common to All Action Alternatives

Under all forest plan alternatives, the forests are aging into the old forest successional classes and toward the desired condition range of old forest per ecozone. While the Designated OG Network emphasizes the development of high-quality old growth forest as a primary goal, there is an additional proportion of the Forests that is aging toward old forest conditions. Based on Spectrum modeling, all the ecozones will reach the desired conditions for old forest in 50 to 75 years under Tier 1 objectives, while it will take 75 to 100 years with Tier 2 objectives. Depending on ecozone, the net annual gain of older forests varies from dry to mesic types (See Terrestrial Ecosystems, Forest Structure and Ecozones).

Long-term management strategies are needed to ensure dynamic landscape patches of old growth that are able to withstand wildfire, parasites, diseases, human disturbances, and climate change. The Action

Alternatives include a Tier 2<sup>28</sup> objective to enhance or accelerate the development of old growth characteristics (ECO-O-03 in Alternatives B/C/D and OGN-O-01 in Alternative E). This would be accomplished by actively managing to improve the quality of old growth characteristics in the short-term. That objective calls for enhancing or accelerating the development of old growth characteristics through activities such as increasing downed woody debris within all size classes by felling variable size trees, creating woodlands in appropriate ecozones by thinning and prescribed burning, enhancing the composition of native species, creating snags by girdling trees, and harvesting products as a side benefit of removing uncharacteristic vegetation. There is not a comparable emphasis in Alternative A.

There is also Tier 2 monitoring of old growth conditions that would allow the Forest Service to better monitor whether old growth characteristics are accruing in the designated old growth network and whether interior forest conditions are provided and functioning within the network. (See Monitoring question MQ 2-3-T2.) There is not a comparable monitoring element in Alternative A.

### Size and configuration: Designated Old Growth Network

The Designated Old Growth Network (Designated OG Network) identifies lands where old growth characteristics are developing for future high-quality old growth forests. The size of the Designated OG Network varies by alternative. Under all alternatives, the size and configuration of the Designated OG Network is consistent with the Region 8 Guidance. Table 129 summarizes differences of the Designated OG Network by alternative.

**Table 129. Designated Old Growth Network by Patch Size (Acreage and Number) by Alternative**

Size Class	Alternatives				
	Acres (Number Patches)				
	A	B	C	D	E
Large +	25,226 (1)	25,226 (1)	25,226 (1)	25,226 (1)	28,091 (1)
Large	149,334 (32)	140,033 (29)	171,354 (35)	154,068 (30)	190,197 (35)
Medium	30,103 (74)	30,822 (75)	50,056 (133)	39,292 (95)	38,970 (87)
Small	6,839 (135)	6,839 (135)	9,719 (222)	7,886 (165)	8,127 (168)
<b>Total</b>	<b>211,502 (242)</b>	<b>202,980 (240)</b>	<b>256,355 (391)</b>	<b>226,472 (291)</b>	<b>265,385 (291)</b>
<b>Percent of Total Forest</b>	<b>20</b>	<b>19</b>	<b>24</b>	<b>22</b>	<b>25</b>
Comments		6 existing medium or large patches modified	All of NGO delineated old growth added	6 existing medium or large patches modified	Class A NGO delineated old growth added
% Larger Patch Acres Compared with current designated Larger Patch ac	0	-5.3	+12.6	+2.7	+25.1

<sup>28</sup> Tier 2 objectives and monitoring questions are beyond the scope of existing Forest Service capacity and are achieved with the help of additional resources.



**Alternative A:** With the 1994 amendment, the Forests identified a network of designated old growth patches. The Designated OG Network in Alternative A includes 242 separate patches totaling 211,502 acres which represent about 20% of the Nantahala and Pisgah National Forests (Table 129). The resulting network includes 33 patches exceeding 2,500 acres, 74 patches from 100 to 2,500 acres, and 135 patches that are less than 100 acres. Five of the patches exceed 10,000 acres, and one of the 33 larger patches exceeds 20,000 acres.<sup>29</sup> Approximately 82% of the network are in the larger patch sizes which provide for higher buffering capacity and resiliency from disturbances.

Thirty-one large patches and all 16 medium patches were delineated and designated after the 1994 plan was approved. The Alarka Laurel area was added as a large growth patch after it came into federal ownership. Two large patch areas do not contain the minimum 2,500 acres. One patch, east of Scaly Mountain, is 2,432 acres. The other patch, east of Grassy Ridge on Roan Mountain, is 1,110 acres. This latter patch is within 1.5 aerial miles of another large patch that is 2,900 acres in size. In addition to the large and medium old growth patches, additional small patches have been designated at the project level since the 1994 plan amendment was signed. The Forest Service has spatial records of 135 designated small patches, which comprise most of the project level designated small patches. Some small patches were not recorded in the GIS database, and spatial data is uncertain as to their location.

**Alternative B:** This alternative includes 240 separate patches totaling 202,524 acres that represent approximately 20% of the Nantahala and Pisgah NFs (Table 129). This alternative is designed to provide the highest amount of acreage available for more intensive vegetative management as well as lands recommended for wilderness. As such, it modifies the Alternative A Designated OG Network by removing 8,594 acres (three large patches) from designation. One designated patch near Mackey Mountain was found to need fewer active management restrictions over the next few decades in order to more easily protect adjacent communities from the risks of wildfire, and the boundaries were redrawn to accommodate this consideration. Old growth patches with existing road access were identified in the Nantahala and Cowee Mountains. It was determined that these patches, which have been logged in the past and are not high-quality old growth forests, could help contribute to meeting other forest plan ecological desired conditions through more active management; and medium and large patches in the Roy Taylor forest, Wine Spring Creek, Wayah Bald, and Alarka Laurel areas were modified to address this finding.

As a result, Alternative B has more than a 5% decrease in the larger patches than the existing Designated OG Network, which could impact capacity to recover from disturbances.

**Alternative C:** This alternative has the second largest Designated OG Network, because it includes the existing network in Alternative A (211,516 acres) plus all areas mapped by local non-government organizations (NGOs) as existing old growth stands, which total 90,162 acres<sup>30</sup> (see Appendix B, Map: NGO's Existing Old Growth Inventory). These areas were provided to the Forest Service in 2013 by Mountain True, a local NGO, based on fieldwork from the Southern Appalachian Forest Coalition. Most of these areas have not been field-verified by the Forest Service. A portion of the local NGO inventory was already in the existing Designated OG Network; the additional amount outside of the existing network (44,840 acres) covers a total network amount of 256,356 acres. Alternative C would provide a

<sup>29</sup> Some patch sizes that were designated as large are actually medium, and some medium designated patches are actually large. Numbers shown in this chapter reflect the number and size of patches based on their mapped acreage. To understand how this differs from designated sites, refer to the project record, which contains more information.

<sup>30</sup> In 2013, during the revision process, the Forest Service received maps of existing old growth areas that Mountain True, a local NGO, identified as existing old growth forest based on fieldwork from the Southern Appalachian Forest Coalition. These 90,162 acres have not been field-verified by the Forest Service, nor has the agency confirmed that these stands meet Forest Service definitions of old growth forest.

larger, more representative network *now* compared to Alternatives A, B, and D, all of which would take many decades to achieve such a network when designating at the project level. Alternative E covers a larger size compared to Alternative C but does not have the density of patches.

Alternative C has the greatest number of patches of all alternatives, these primarily consisting of medium (38-59-increase) and small sizes (54-89), which could be more readily impacted by natural disturbance events. As a result, approximately 76% of this network is designated in the larger patch sizes, which is the least of all the alternatives. However, this alternative increases the amount of larger patches by 12.6% more than the existing network, and would therefore provide greater buffering capacity and resiliency from disturbance.

**Alternative D:** The Designated OG Network for this alternative reflects an intermediate approach between Alternatives B and C with moderate acreage available for more intensive vegetative management as well as recommended wilderness. This alternative incorporates the modification of large and medium patches from Alternative B by removing 8,594 acres from the existing network but adds about 23,560 acres from the NGOs' delineated old growth patches. The result is a Designated OG Network of 226,486 acres, approximately 22% of the Nantahala and Pisgah NFs. Most of the areas added from the NGO inventory of old growth forests are on the Grandfather Ranger District with scattered areas on four other districts. Concentrated areas include Santeetlah Creek drainage, Big Stamp to Tusquitee Bald on north and east facing slopes, Iron Mountain, Gibbs Mountain, Dobson Knob, southern portion Linville Gorge Wilderness, and Breakneck Ridge.

The addition of the NGO patches increases the small and medium patches compared to Alternatives A and B. Alternative D would provide a larger network *in the present day* compared with the current network and Alternative B. It would take several decades to achieve such a network for either of those alternatives. However, Alternative D does not have as many large patches as the current designated area in Alternative A and only has one additional large patch compared to Alternative B. While it does have two fewer large patches than the existing network, it has 4,000 more acres (about 2.7% more) within this size class compared to the existing network.

**Alternative E:** As described above, between the draft plan and the final revised plan, an alternative was added that considered a different size and configuration for the designated old growth network. More than 54,000 acres of additions were added to the designated network to strategically enhance the network's resiliency and ecological diversity. Patches were selected with consideration of ecozone representation, moisture and elevation gradient contributions, patch size, and contribution to an efficient network. The alternative was built in consideration of the latest scientific literature, academic input, and information provided by commenters and the NC Natural Heritage Program regarding inventoried locations of existing old growth patches. The resulting network includes 291 separate patches totaling 265,385 acres that represent approximately 25% of the Nantahala and Pisgah NFs (Table 129). For detailed information on the process used to modify the network, see EIS Appendix B.

Alternative E would provide the largest network of any alternative. Only Alternative C is close in size, with about 9,000 fewer acres. Under Alternatives A, B, and D, it would take many decades to achieve such a network. Additionally, this alternative increases the amount of larger patches by 25% more than the existing network, increasing overall resiliency and connectivity. Only Alternative C has as many larger (36) patches as Alternative E, however Alternative E has an additional 20,000 acres dispersed across these large patches, improving their resiliency.

### **Size and configuration: Old Forest Trending landscapes**

Old Forest Trending landscape (OFT Landscape) is broader than the Designated OG Network and has high potential of accruing old growth characteristics in the foreseeable future. The OFT Landscape provides

larger patch sizes and a higher potential for building ecological resiliency with any selected Designated OG Network. Table 130 summarizes differences among the OFT Landscape by alternative.

**Table 130. Old Forest Trending Landscapes by Patch Size (Acreage and Number) by Alternative**

Size Class	Alternative Acres (Number Patches)				
	A	B	C	D	E
Large +	76,674 (3)	99,344 (4)	135,158 (5)	53,709 (2)	53,142 (2)
Large	242,137 (35)	246,430 (34)	254,066 (34)	264,536 (34)	270,873 (37)
Medium	28,679 (78)	36,100 (88)	46,506 (112)	39,869 (94)	51,245 (103)
Small	6,183 (135)	6,707 (152)	8,196 (208)	6,978 (160)	7,734 (188)
Total	353,673 (251)	388,351 (278)	443,926 (359)	365,092 (290)	382,994 (331)
% Total Forest	34%	39%	43%	35%	38%
compared to OG Network	14% increase	18% increase	19% increase	13% increase	13% increase
% Larger Patch Acres Compared with Current Designated Larger Patch Acres	82%	98%	123%	82%	86%

This analysis assumes that limited active management activities may occur in some of the OFT Landscape management areas; however, it is assumed the activities would be isolated, small scale, and would mimic natural disturbances as much as possible. Within the Spectrum vegetation model, beyond natural disturbance, prescribed burning is the primary active management activity analyzed. Of these prescribe burns, only isolated acres were modeled to burn to create young forest. Currently, less than 1% of active management occurs within these OFT Landscape management areas.

**Under all alternatives**, in places that are not actively managed outside the OFT Landscape, additional portions of the Forests will age toward older forest. Some portions of the land, including those in Matrix, will be inaccessible areas and will not be available for active management (because of steep slopes, riparian areas, etc.).

**Alternative A:** Lands with high potential for future old forest development expand to 34% (Table 130) of the Forests, or about 14% more acreage than the current Designated OG Network. Larger patches that contribute to higher buffering capacity to disturbances increase by 82% compared with the larger patches in the current Designated OG Network. For spatial reference, see Appendix B, Map: Alt A, Old Forest Trending Landscape.

**Alternative B:** The OFT Landscape in Alternative B is similar to Alternative A with the majority of the acreage within the two largest patch size classes and more than a quarter of the OFT Landscape exceeding 20,000 acres. Approximately 37% of the Forests would trend toward old forest conditions, about 18% more of the Nantahala and Pisgah NFs when compared to the Designated OG Network for Alternative B (Table 130). Larger patches that contribute to higher buffering capacity increase by 98% compared with the larger patches in the current Designated OG Network. The increase in larger patches results from the higher amount of recommended wilderness in the alternative. For spatial reference, see Appendix B, Alt B OFT Landscape.

**Alternative C:** This alternative has the most acreage in the OFT Landscape compared to other alternatives, with about 43% of the total Forests in OFT Landscape. This is largely attributed to having the largest Backcountry MA of any alternative. This is approximately 19% higher than the Designated OG Network for Alternative A. Larger patch configurations are about 123% higher than the larger patches in the current Designated OG Network (Table 130), which would provide the highest buffering capacity from natural disturbances compared with the other alternatives. These increases are the outcome of management area designations for Alternative C that result in five patches over 20,000 acres in size, more than any other alternative. For spatial reference, see Appendix B, Alt C Old Forest Trending Landscape.

**Alternative D:** The OFT Landscape are 35% (Table 130) of the Forests and approximately a 13% increase in the Designated OG Network for Alternative D. Larger patch configurations are about 82% higher than the larger patches in the current Designated OG Network, which is similar to Alternative A. While the Designated OG Network for Alternative D is larger than Alternative B (Table 130), the OFT Landscape is lower, because the amount of recommended wilderness is lower, and the dispersal of management area designations across the Forests results in two fewer of the large+ patches in Alternative D. For spatial reference, see Appendix B, Map: Alt D Old Forest Trending Landscape.

**Alternative E:** Along with Alternative C, Alternative E has the highest number (39) of the two largest patches, aiding in redundancy and resilience for both these alternatives. Alternative E has a smaller OFT Landscape than Alternative C because there is more land in the Designated Old Growth Network itself. This alternative's OFT Landscape increases the least in acreage of all the alternatives from the Designated OG Network, although as a percent is similar to Alternatives A and D. For spatial reference, see Appendix B, Map: Alt E Old Forest Trending Landscape.

### Representation: ecozones and elevations

The occurrences of ecozones are highly correlated with elevation position on the landscape and are, therefore, evaluated together. Spruce fir, northern hardwood, and high elevation red oak occur primarily on high elevations, whereas shortleaf pine and floodplain forests occur on lower elevations. Pine-oak/heath, the other oak dominated ecozones, and the coves occur primarily on mid-elevation slopes. To estimate representation, Table 131 displays the percentage of the total forest for each ecozone and the percentages of each ecozone in both the Designated OG Network and the OFT Landscape.

Table 132 displays the percentages of elevation categories in both the Designated OG Network and the OFT Landscape.

**Table 131. Ecozone Representation for Designated OG Network and OFT Landscape**

Ecozone	Ecozone % of Total Forest	Alternative % of Designated OG Network ( ) % of OFT Landscape				
		A	B	C	D	E
Spruce Fir	1.5	2.9 (3.7)	2.9 (3.4)	2.7 (3.1)	2.9 (3.6)	2.9 (3.5)
Northern Hdwd	5.1	8.9 (8.3)	9.0 (8.3)	8.9 (7.8)	9.2 (8.7)	8.2 (8.5)
High Elev Red Oak	3.9	7.2 (5.9)	6.7 (5.5)	7.3 (5.7)	6.7 (5.7)	6.7 (6.1)
Mesic Oak	17.0	16.1 (16.3)	16.0 (16.4)	16.6 (16.2)	16.3 (16.5)	15.9 (16.3)
Acidic Cove	23.9	21.4 (23.7)	21.4 (23.2)	20.9 (23.2)	21.2 (23.2)	22.5 (23)
Rich Cove	19.2	17.4 (17.0)	17.5 (17.0)	17.7 (17.7)	17.3 (16.7)	17.1 (17.1)

Ecozone	Ecozone % of Total Forest	Alternative % of Designated OG Network ( ) % of OFT Landscape				
		A	B	C	D	E
Dry Mesic Oak	9.9	7.4 (6.4)	7.7 (7.3)	6.9 (7.3)	7.3 (7.0)	7.6 (6.9)
Dry Oak	4.7	5.5 (5.0)	5.5 (5.1)	5.5 (5.2)	5.3 (5.2)	5.8 (5.3)
Pine Oak Heath	10.0	11.3 (12.2)	11.5 (11.8)	12.0 (12.3)	12.1 (11.9)	11.6 (11.5)
Shortleaf Pine	4.5	1.6 (1.4)	1.6 (1.8)	1.4 (1.3)	1.5 (1.4)	1.5 (1.4)
Floodplain Forests	0.2	0.1 (0.2)	0.1 (0.2)	0.1 (0.2)	0.1 (0.2)	0.1 (0.2)

**Table 132. Elevation of Designation OG Network and OFT Landscape**

Elevation Category	% of Total Forest	Alternative % of Designated OG Network ( ) % of OFT Landscape				
		A	B	C	D	E
High Elevation	13	26 (23)	25 (22)	24 (21)	25 (23)	24 (23)
Mid Elevation	67	60 (63)	60 (64)	61 (66)	60 (64)	60 (63)
Low Elevation	20	14 (14)	15 (14)	15 (13)	15 (14)	16 (14)

**Alternative A:** The result of implementing the 1994 plan amendment is a well-distributed Designated OG Network with some exceptions. These exceptions include: 1) high elevation (greater than 4,200 ft) ecozones are overrepresented by about twice as much, and 2) low elevation ecozones are underrepresented by two to three times in comparison with ecozone representation at the forestwide scale. However, high elevation ecozones comprise less than 11% of the Forests and low elevation ecozones less than five percent. The remaining six ecozones, which comprise about 84% of the Forests, are represented within one to three percent of the forestwide scale.

The OFT Landscapes exhibit percentages similar to the Designated OG Network with a few exceptions. Of the high elevation ecozones, high elevation red oak exhibits a slight shift downward (1.3%) bringing these ecozones closer to forestwide representation. Acidic cove ecozones tend to increase slightly more than two percent bringing these closer to forestwide representation.

**Effects Common to Action Alternatives:** The trends of ecozone representation in the Designated OG Networks and the OFT Landscapes for all the action alternatives are similar to Alternative A – well-represented for high elevation and under-represented for the two low elevation ecozones with a few exceptions. The shortleaf pine ecozone is the least represented in the Designated OG Network with about three times less than forestwide; however, this ecozone only comprises about 4.5 percent of the Forests and active management is needed to restore shortleaf ecosystems which would be a challenge in the Designated OG Network. Many of the potential older, greater than 80 years, stands are not currently dominated by shortleaf pine, have a significant white pine component, or have had pine beetle outbreaks within the last 20 years. Dry-mesic oak, mesic oak, acidic cove, and rich cove are also slightly underrepresented; however, these ecozones are two to four times as abundant forestwide compared to shortleaf pine. Of these four more widely distributed ecozones, only acidic cove has more consistent improvement with representation in OFT landscapes, mesic oak has a slightly better representation, while rich cove and dry-mesic oak either are stable or even less well represented.

## Rare habitat and rare species: Designated OG Network and OFT Landscapes

### Rare species occurrences

Rare species, both federally listed and species of conservation concern (SCC), occur within the Designated OG Network. An analysis considered the spatial distribution, point, line, and polygon data of these forest occurrences regardless of overlapping population counts. Of these, rare plant species are more abundant within the Designated OG Network in comparison to rare animal species (Table 133). Rare species, both federally listed threatened and endangered (T&E) and SCC, are more abundant in the OFT Landscapes compared to the Designated OG Network (Table 133).

**Table 133. Rare Species Occurrences within the Designated OG Network and OFT Landscapes**

Rare Species Type	Alternative % Forest Occurrences that are present within Designated OG Network ( ) % Occurrences in OFT Landscapes				
	A	B	C	D	E
T&E Animals	19 (40)	16 (45)	21 (47)	17 (43)	23 (45)
T&E Plants	30 (72)	31 (94)	35 (95)	42 (93)	46 (96)
SCC Animals	21 (36)	20 (58)	24 (59)	22 (57)	27 (57)
SCC Plants	27 (49)	27 (61)	33 (65)	29 (59)	36 (61)

### Effects Common to All Alternatives

- T&E Animals:** Occurrences of T&E animals in the Designated OG Network vary from 16-23 percent with Alternatives C and E having the greatest diversity. The OFT Landscape encompass more occurrences with the least in Alternative A at 40 percent, the most in Alternative C at 47 percent.
- T&E Plants:** A moderate level of T&E plants occurs within the Designated OG Network, with a wide variance among alternatives from 30-31 percent (Alternatives A and B) to 46 percent (Alternative E). Occurrences greatly expand within the OFT Landscapes from 72 percent to nearly all occurrences in the action alternatives, varying from 93-96 percent. Alternative E has the greatest number of occurrences.
- SCC Animals:** Compared with T&E animals, the Designated OG Network would encompass a slightly higher proportion of SCC animal occurrences from 20 to 27 percent among the alternatives. While still the lowest number of occurrences in Alternative A, the proportion of occurrences would substantially increase to more than half of SCC animal occurrences in the OFT Landscapes for the action alternatives, all very similar varying from 57-59 percent.
- SCC Plants:** Compared with T&E plants, the Designated OG Network would encompass less of a proportion of SCC plants, varying amongst alternatives from 27 (A and B) to 36 (E) percent among the alternatives. The action alternatives are close to 2/3 of SCC plant occurrences in the OFT Landscapes, varying from 59-65 percent. Alternative C provides the greatest number of occurrences.

Within T&E and SCC animal and plant species, both closed canopy and edge-loving species are present within these older forests. For the fire-adapted edge species it will be important to prioritize prescribe burns to restore habitats and ensure persistence.

## Rare habitats

Rare habitats are represented within the Designated OG Networks. Precise GIS spatial dimensions are inconsistent among all the habitats. To the extent possible, the data was reviewed with aerial imagery and other background layers. Those habitats with very coarse dimensions were not incorporated into the rare habitat representation analysis within the Designated OG Network. Of the 46 rare habitats, including their subtypes, 1,285 occurrences across the Forests were analyzed. As with the rare species analysis, the analysis included points, lines, and polygons regardless of same-site locations. As such, the numbers for individual occurrences are higher than the environmental analysis completed for individual unique habitat analysis.

**Table 134. Unique Habitat Occurrences in Designated OG Network and OFT Landscapes**

	Alternative Percent of Forest Occurrences Present within Designated OG Network ( ) Percent Occurrences in OFT Landscapes				E
	A	B	C	D	
Unique Habitat (%)	47 (68)	46 (75)	58 (82)	51 (75)	55 (78)

Alternative A: Less than half of the 1,285 occurrences of rare habitats are found in the Designated OG Network (Table 134), but this amount increases to more than 2/3 for the OFT Landscapes.

Common to Action Alternatives: As shown in Table 134, more than half of unique habitats occur with the Designated OG Network for Alternatives C, D and E. For all action alternatives, at least 3/4 of rare habitats occur in the OFT Landscapes, with Alternative C having the highest at 82 percent. Therefore, most of the unique habitats would be affected by natural disturbances or activities that mimic natural disturbances. It is important that restoration of fire adapted unique habitats is implemented or continued for those habitats within the Designated OG Network or the OFT Landscape. In particular these would include low elevation rocky summits, low elevation glades, serpentine barrens, and shale slopes.

## Topographic variation and patch size

To check the resiliency of the Designated OG Network by evaluating the heterogeneity of ecozones, a sample of large, medium, and small patches was taken that was common in all the alternatives. The sample information is summarized in Table 135 below.

**Table 135. Number of Ecozones and Elevation Change by Patch Size (Sample of Patches)**

Patch Size	Sample # Selected	Number of Ecozones Range (Average)	Elevation Change Range (Average)	Acreage Range
Large	9	7-10 (8.25)	1300-3400 (2400)	3,300 -25,000
Medium	12	4-7 (5.67)	400-2400 (1250)	350-2,200
Small	11	1-4 (2.82)	150-700 (420)	25-94

In the Designated OG Network, ecosystem diversity is highest in large patch samples as shown in Table 135. Large patch samples encompass at least 60 percent of the 11 ecozones present on the Forests, and most large patch samples have more than 75 percent present in the patch. Changes in elevation are

highest within large patch samples, thus having the highest degree of geophysical and topographic diversity. In contrast, ecosystem diversity of small patch samples is limited due to the reduced range of ecozones within patches as a result of their smaller size.

All alternatives have a similar pattern with 76-83 percent of the network in large patches and about 3 to 4 percent in small patches which suggests that the Designated OG Networks proposed in the alternatives would provide ecosystem diversity and conserve biological diversity.

### Redundancy

In order to assess the spatial redundancy of patches, an analysis was completed by patch size across the two forest units and individual ranger districts for both the Designated OG Network and the OFT Landscape. This analysis has some inherent distortion, since all the districts are not evenly dispersed nor the same size in acres. And for both the network and the landscape, while the patches are denser on the Nantahala NF, particularly for the OFT Landscape, there are more acres across the Pisgah NF.

Patch size redundancy is shown in Table 136 by ranger district and alternative in four separate sections, one section for each patch size. The table includes the patches in both the Designated OG Network and the OFT Landscapes.

As shown in the table below, the OFT Landscapes versus the Designated OG Network increases the redundancy of patch sizes among all the alternatives but not always. When aggregating lands with similar management area plan components, patch sizes may increase to the next higher patch size. For example, a small patch might be included in a medium patch when lands are aggregated that have a high potential for developing old growth characteristics.

**Table 136. Number of Patches in the Designated OG Network and the OFT Landscapes by Alternative**  
The table has a section for each patch type: Large +, Large, Medium, and Small.

Ranger District	Alternative				
	# of Large + Patches in Designated OG Network ( ) # of Large + Patches in OFT Landscapes				
	A	B	C	D	E
Grandfather	0 (1)	0 (1)	0 (2)	0 (0)	0 (0)
Appalachian	0 (0)	0 (0)	0 (0)	0 (0)	0
Pisgah	1 (1)	1 (1)	1 (1)	1 (1)	1 (1)
Cheoah	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Tusquitee	0 (.5)	0 (1.5)	0 (1.5)	0 (0.5)	0 (.5)
Nantahala	0 (.5)	0 (0.5)	0 (0.5)	0 (0.5)	0 (.5)

Ranger District	Alternative				
	# of Large Patches in Designated OG Network ( ) # of Large Patches in OFT Landscapes				
	A	B	C	D	E
Grandfather	6 (7)	6 (7)	7 (7)	7 (8)	7 (9)



Ranger District	Alternative				
	# of Large Patches in Designated OG Network ( ) # of Large Patches in OFT Landscapes				
	A	B	C	D	E
Appalachian	9 (8)	9 (8)	9 (8)	9 (8)	9 (8)
Pisgah	1.5 (2.5)	1.5 (3.5)	2.5 (4.5)	1.5 (3.5)	2.5 (3.5)
Cheoah	2.75 (2.75)	2.75 (2.75)	2.75 (2.75)	2.75 (2.75)	2.75 (2.75)
Tusquitee	4.75 (4.25)	4.75 (4.25)	4.75 (3.25)	4.75 (4.25)	4.75 (4.25)
Nantahala	8 (10.5)	5 (8.5)	9 (8.5)	5 (7.5)	9 (9.5)

Ranger District	Alternative				
	# of Medium Patches in Designated OG Network ( ) # of Medium Patches in OFT Landscapes				
	A	B	C	D	E
Grandfather	17 (14)	17 (16)	43 (28)	25 (16)	20 (17)
Appalachian	12 (15)	12 (15)	24 (22)	16 (16)	19 (22)
Pisgah	10 (12)	10 (10)	14 (8)	12 (11)	10 (11)
Cheoah	11 (12)	11 (16)	17 (17)	14 (16)	9 (12)
Tusquitee	5 (7)	5 (5)	7 (7)	5 (9)	8 (12)
Nantahala	19 (18)	20 (26)	28 (30)	23 (26)	21 (29)

Ranger District	Alternative				
	# of Small Patches in Designated OG Network ( ) # of Small Patches in OFT Landscapes				
	A	B	C	D	E
Grandfather	31 (24)	31 (26)	49 (37)	32 (25)	31 (30)
Appalachian	23 (31)	23 (27)	50 (53)	30 (30)	28 (35)
Pisgah	10 (9)	10 (12)	13 (10)	13 (12)	12 (15)
Cheoah	19 (18)	19 (24)	26 (32)	26 (31)	37 (42)
Tusquitee	7 (6)	7 (13)	16 (12)	9 (14)	19 (22)
Nantahala	45 (47)	45 (50)	68 (64)	55 (48)	41 (44)

## Effects Common to All Alternatives

The Designated OG Network and OFT Landscapes are larger on the Pisgah NF than on the Nantahala NF. The Pisgah NF has more large+ and large patches, whereas the Nantahala NF has more medium and small patches. In total acreage, the Pisgah NF has over 30,000 more acres in the Designated OG Network and for some Alternatives (C and E) has more than 60,000 additional acres in the OFT Landscapes.

Differences in patch size abundance among ranger districts is due partly to their spatial configurations. The Pisgah and Grandfather Ranger Districts are lands that are mostly consolidated, which can support larger patch sizes, whereas the Appalachian Ranger District is long, linear, and has discontinuous land parcels. The largest district is the Nantahala Ranger District that supports many of the medium and smaller patches. The Tusquitee Ranger District has fewer patches which may be due to more discontinuous land boundaries and, to some extent, inaccuracies in accounting for smaller patches.

The redundancy of patch sizes across the ranger districts is somewhat consistent among the alternatives with several exceptions. In Alternative C, with the infusion of NGO inventory areas into the network, the amount of medium and small patches increases substantially, especially for the Grandfather, Appalachian, and Nantahala Ranger Districts. Alternatives D and E also have higher abundance of medium and small patches for those ranger districts due to the partial inclusion of the NGO inventory. For Alternative E, the Cheoah and Tusquitee Ranger Districts have a larger number of small and medium patches due to adjustments made to the designated old growth network in this alternative (See Appendix B). Alternatives A, C, and E also include some patches in the Cowee Mountain area which support higher amounts of large or medium patch sizes on the Nantahala Ranger District.

Refer to Appendix B for maps of each alternative as follows:

**Table 137. List of Maps by Alternative and Ranger District for Redundancy of Designated OG Network and OFT Landscapes Found in Appendix B**

Alternative	Map: Designated OG Network	Map: OFT Landscape
A	DOG N A	OFT Landscape A
B	DOG N B	OFT Landscape B
C	DOG N C	OFT Landscape C
D	DOG N D	OFT Landscape D
E	DOG N E	OFT Landscape E

## Project level actions

One of the two plan standards that differed between Alternatives B, C and D in the proposed plan was how adjustments would be made to the Designated OG Network at the project level. The standard for considering old growth characteristics at the project level varies by alternative.

The Draft Plan contains a standard for considering old growth forest at the project level for each alternative as shown in Table 138.

**Table 138. Standards for Considering Old Growth Characteristics at the Project Level**

	The project level action taken when additional old growth forest is encountered. What project level action is taken for considering old growth characteristics
<b>Alternative A</b>	<i>Existing plan direction:</i>  In each compartment containing 250 acres of national forest land, select a small patch for future old growth management. If 5 percent of the compartment acres are

	<b>The project level action taken when additional old growth forest is encountered. What project level action is taken for considering old growth characteristics</b>
	<p>already part of a large or medium patch, an additional small patch is not needed. Whenever possible, areas should incorporate some riparian habitat to enhance old growth values.</p> <p>Select the small patches prior to the first ground disturbing project of at least 5 acres proposed in the compartment.</p> <p>Select a contiguous area at least 5 percent of the size of the NF land in the compartment or at least 50 acres, whichever is greater. Management areas 14 and 18 can contribute to old growth acreage when they are included in the selected area. Compartments containing part of a large or medium patch do not need an additional small patch.</p> <p><i>The current plan is silent (and therefore unrestricted) on how existing old growth outside the designated network should be managed.</i></p>
<b>Alternative B</b>	<p><i>Proposed standard, ECO-S-27 (Alt B):</i></p> <p>During project level analysis, the designated old growth network may be adjusted at the small patch scale to include higher quality existing and future old growth forest. In deciding the best placement of newly designated patches, consider existing high-quality old growth characteristics within the Geographic Area, including management areas that may favor these conditions (such as Backcountry, Special Interest Areas, Research Natural Areas, Wilderness Study Areas, Recommended Wilderness, Congressional Designated Wilderness, and Roan Mountain MA's). Existing old growth forest that is not added to the designated old growth network will be managed consistent with the Management Area where it is found.</p>
<b>Alternative C</b>	<p><i>Proposed standard, ECO-S-27 (Alt C):</i></p> <p>During project level analysis, no new patches will be added to the designated old growth network. Existing old growth forest that is found outside the designated old growth network will be managed consistent with the Management Area where it is found.</p>
<b>Alternative D</b>	<p><i>Proposed standard, ECO-S-27 (Alt D):</i></p> <p>During project level analysis, existing old growth forest shall only be added to the designated old growth network when its inclusion contributes designated old growth acres to an ecozone, elevation or patch size of old growth that is underrepresented at the forest level and or not redundant within the designated network. Existing old growth forest that is not added to the designated old growth network will be managed consistent with the Management Area where it is found.</p>
<b>Alternative E</b>	<p><i>Plan Standard, OGN-S-02</i></p> <p>The size and configuration of the designated Old Growth Network that is defined in the Forest Plan shall be maintained through the life of this plan.</p>

**Alternative A:** The standard for Alternative A is based on a distribution requirement by watershed and compartment for developing future old growth along with patch size requirements. The current forest plan, as implemented, has added over 17,000 acres to the Designated OG Network through project

decisions with approximately 6,824 acres in small patches. Table 139 summarizes existing records for the implementation of Alternative A that has established the current Designated OG Network. Most of the large and medium patches were designated as part of the plan decision which amounts to approximately 92 percent of the current network.

**Table 139. Plan and Project Patch Designation Summary from the Existing Plan**

1994 Plan Decision	Patch Size	# Patches	Acres	
	Large	32		
	Medium	17		
Total Plan			193,724	
Project Decisions	Patch Size	# Stands	Acres	% Total Project Decision Acres
	Large	21	1,181	6.7
	Medium	112	9,773	55.0
	Small	166 (aggregated to 135 patches)	6,824	38.3
<b>Total Projects</b>			<b>17,779</b>	
<b>Grand Total</b>			<b>211,503</b>	

About 8 percent of the current network has been added during project decisions. Most of the large and medium patches allocated during projects were forest stands added to existing patches to make them larger. About 155 compartments that were examined under the current plan had stands (or portions of stands) added to the network. Future projects under Alternative A could result in the addition of small patches to other compartments where a small patch is not currently designated. This amounts to about 500 more compartments that could have designated small patches in the future. For the implementation period of 25 years, the rate of stands added to the network is approximately 7,000 acres per decade.

Four ecozones, acidic cove, rich cove mesic oak, and dry-mesic oak, are slightly underrepresented (See Representation: Ecozones and Elevations) across the Forests. Shortleaf pine is even more underrepresented by about three times less the forest average. Table 140 shows how several of these systems, rich cove, mesic oak, and shortleaf pine, have been the focus of small patch designation at the project level.

**Table 140. Ecozone Representation for All Patches by Patch Size in Designated OG Network (Alt A)**

Ecozone	Ecozone % of Total Forest	Large & Large+	Medium	Small
Spruce Fir	1.5	3.4%	0.8%	0.4%
Northern Hdwd	5.1	9.7%	5.7%	3.7%
High Elev Red Oak	3.9	7.3%	7%	4.1%
Mesic Oak	17.0	16.2%	15.4%	17.8%
Acidic Cove	23.9	20.3%	28.4%	21.3%

Ecozone	Ecozone % of Total Forest	Large & Large+	Medium	Small
Rich Cove	19.2	18.2%	12.2%	22%
Dry Mesic Oak	9.9	6.8%	10.8%	8.2%
Dry Oak	4.7	5.5%	5.5%	7.1%
Pine Oak Heath	10.0	11.4%	10.9%	11.4%
Shortleaf Pine	4.5	1.2%	3.1%	3.9%
Floodplain Forests	0.2	0.1%	0.1%	0%

This standard provides direction about where small patches are needed using compartments as the spatial identifier. Alternative A does not require additional patches when the old growth network is already met within the compartment. The treatment of old growth forest is consistently raised as an issue during project planning. The project level challenges would persist in that forest stands that may be proposed for treatments to create young forest conditions would likely be examined for existing old growth characteristics, and some stand proposals for young forest would likely be challenged. This would increase costs, timing, and uncertainty about sustaining young forest conditions. With this plan direction, there are opportunities to select the five underrepresented ecozones at the project level, although the compartment spatial scale will limit opportunities in comparison to Alternatives B and D, where selection could occur at larger spatial scales.

**Alternative B:** This alternative allows for the Designated OG Network to be “adjusted” with an emphasis of placement of existing high-quality old growth characteristics in management areas that favor those conditions. The adjustments would occur at the small patch scale within geographic areas.

Management areas that favor old growth conditions are primarily in the OFT Landscapes as described in the analyses above. The value of the OFT Landscapes is providing larger patches that have more resilience to natural disturbances. As such, stands that could be added to existing large patches could benefit the connectivity and overall integrity of those large patches. However, these actions probably would require an additional inventory of OFT Landscapes that could potentially be costly.

The same five underrepresented ecozones previously identified in the Designated OG Network for Alternative A are underrepresented in the network for Alternative B. There are many opportunities to add stands of these five ecozones to the existing Designated OG Network as shown in Table 141. To achieve forestwide representation, based on the size and representation of the Designated OG Network in Alternative B, acidic cove would have to be increased by about 6600 acres, rich cove by about 4300 acres, mesic oak by about 2400 acres, dry-mesic oak by about 5000 acres and shortleaf pine by about 6200 acres. Alternative B would enable adjustments to the network that allow for moving toward that representation.

This alternative would require looking beyond the boundaries of a project area in order to consider stands for additions to the network. Table 141 shows the amount of Matrix and Interface (MA Group 1 where treatments would most likely be proposed) versus the amount in OFT Landscapes (MA Groups 3 and 4). Because the standard encourages consideration of lands in Backcountry, Special Interest Areas, Research Natural Areas, Wilderness Study Areas, Recommended Wilderness, and Roan Mountain MA's, the designation of additional old growth patches may be most likely in these management areas. All lands in the designated wilderness are already in the Designated OG Network. Within the OFT Landscape, some older forests exist that could meet the minimum age for acquiring old growth characteristics under this planning cycle that might be the strongest candidates for addition to the

designated OG Network. However, there is not enough existing old forest in the management areas mentioned to bring all ecozones up to full representation without drawing from younger forests, or old forest allocated to Matrix and Interface.

In the absence of increasing the representation of these ecozones in the Designated OG Network, the ecozones across the forest will still achieve their desired amount of old forest, but depending on the ecozone and Tier of activity, it could take up to 100 years based on Spectrum modeling. (see Old Forest Structural Class, in the Terrestrial Ecosystem section).

**Table 141. Amount of MA Group 1 and MA Groups 3 and 4 Along With Percent in Designated OG Network by Geographic Area for Alternative B**

Geo Area	Acres Total	MA Group 1 (Acres)	% MA Group 1 in Designated OG Network (Alt B)	MA Group 3 & 4 (Acres)	% MA Group 3 & 4 in Designated OG Network (Alt B)
Bald Mtn	118,303	66,331	10.6	30,059	52.4
Black Mtn	94,625	30,236	4.1	61,469	31.4
Eastern Escarp	139,496	92,002	12.1	41,383	48.3
Fontana Lake	32,212	30,090	3.3	1,608	41.1
Great Balsam	65,878	63,146	2.5	720	89.5
Highland Dome	91,302	61,041	8.9	26,035	31.0
Hiwassee	40,845	31,116	3.0	7,646	13.8
Nantahala Gorge	22,004	8,534	9.2	10,134	64.1
Nantahala Mtns	176,113	98,586	4.1	55,397	38.2
North Slope	37,916	8,622	9.2	28,556	87.6
Pisgah Ledge	100,799	54,552	3.5	23,413	22.6
Unicoi Mtn	122,152	76,050	7.0	32,694	74.5

The standard in Alternative B clearly states that after the small patches are designated, existing old growth forest outside that network would be managed consistent with the management area where it is found, and this is intended to address the controversy of young forest creation in a progressively aging forest landscape. However, getting to the decision about what stands should be in small patches may be even more difficult than the current standard, as there is no guidance on how the network should be spatially distributed and the role that small patches would fill in the network. The adjustment of small patches throughout a geographic area could be worthwhile, especially if high quality old growth forest is found, but time consuming. Projects may take longer to analyze and approve without more explicit criteria. This alternative is likely to continue to have less acreage in the Designated OG Network over the life of the revised plan compared to the current network, because the initial network is 8,000 acres smaller.

**Alternative C:** This standard restricts any additions to the Designated OG Network but compensates that restriction by adding more than 44,000 acres of NGO inventoried old growth forests, which is an increase of approximately 21 percent above the current network.

This standard establishes the network through a forest plan decision and provides direction to manage existing old growth forest outside the network consistent with the management area. This approach has a higher degree of certainty for reaching objectives related to young forests in the plan as well as immediately establishing a broader Designated OG Network. However, if existing high-quality old growth forest is found during project level analyses that are outside the designated network, then adding to the network would not occur. Based on the size of Alternative C's Designated OG Network, acidic cove would be underrepresented by about 7,800 acres, rich cove by about 3,900 acres, mesic oak by about 1,100 acres, dry-mesic oak by about 7,700 acres, and shortleaf pine by about 7,800. Because the designated OG Network does not allow adjustments in the future, these under-represented ecozones would likely remain under-represented in the designated OG Network. Not being able to add existing high quality old growth forests to the designated OG network could result in controversy.

If a high-quality old growth patch was not added to the designated network, the effect depends on the features of the patch as well as the surrounding landscape. For example, patches could be more important to add to the designated network, if they have rare species or if they occur in fragmented portions of the landscape, or if they contribute to a large patch size.

The absence of increasing the representation of these ecozones in the Designated OG Network, the ecozones across the forest will still achieve their desired amount of old growth, but depending on the ecozone and Tier of activity, it could take up to 100 years (see Old Forest Structural Class, in the Terrestrial Ecosystem section).

**Alternative D:** This alternative allows for additions to the Designated OG Network under the condition that it contributes to underrepresented or redundant ecozones, elevation, or patch size. This alternative compensates for those restrictive conditions by increasing (by approximately 23,000 acres) the network with a portion of the NGO inventory of old growth forests. This increase is approximately 11 percent more than the current network (Alternative A).

**Table 142. Ecozone Representation for all Patches by Patch Size in Designated OG Network (Alt D)**

Ecozones	% Nantahala-Pisgah	Large	Medium	Small
Spruce-Fir	1.5%	3.5%	1.0%	0.3%
Northern Hardwood	5.1%	9.6%	8.3%	3.3%
High Elev Red Oak	3.9%	6.4%	8.0%	6.1%
Mesic Oak	17.0%	16.2%	16.0%	19.0%
Acidic Cove	23.90%	20.4%	24.7%	20.8%
Rich Cove	19.2%	17.9%	13.9%	21.0%
Dry-Mesic Oak	9.9%	7.0%	8.8%	7.3%
Dry Oak	4.7%	5.3%	5.1%	7.1%
Pine-Oak/Heath	10.0%	12.3%	11.5%	11.7%
Shortleaf Pine-Oak	4.5%	1.2%	2.5%	3.4%
Floodplain	0.2%	0.1%	0.1%	0.0%

This alternative would allow adding some stands to the network through project decisions in locations that this EIS identifies as under-represented ecozones or patches are not redundant. All five

underrepresented ecozones in the current network (shortleaf pine, acidic cove, rich cove, mesic oak, and dry-mesic oak) are also underrepresented in the network for Alternative D. Based on representation gaps found in the analysis above in Table 142, future project decisions could designate two of these ecozones, dry-mesic and shortleaf pine, by including more small patches or adding more acreage to increase the medium and large patches. Additionally, rich coves and mesic oaks could see more additions that contribute to medium and large patches, although small patches of these ecozones are sufficiently represented. And acidic cove selections could contribute to large and small patches. To achieve full representation in all ecozones above, an additional 30,000 acres could be added. In the absence of increasing the representation of these ecozones in the Designated OG Network, the ecozones across the forest will still achieve their desired amount of old growth, but depending on the ecozone and Tier of activity, it could take up to 100 years (see Old Forest Structural Class, in the Terrestrial Ecosystem section).

Note that project level representativeness and redundancy analyses would not be required to implement this standard, since this EIS analysis at the plan level is sufficient for identifying landscape scale gaps, and plan monitoring can update landscape level information.

As indicated in the redundancy analysis, Alternatives A, C and D have greater large and medium patch sizes in the Cowee Mountains. Other than Alternative C, Alternative D has similar or greater small, medium, and large patches on all the ranger districts with the exception of large patches on the Nantahala (Table 136). Alternative D would have an opportunity to increase large patches on the Nantahala Ranger District, particularly within the Cowee Mountains. This redundancy of larger patches would provide greater protection of detrimental impacts as a result of a severe disturbance, such as a tornado or large wind event.

Similar to Alternative C, this standard, compared to Alternatives A and B, provides more certainty at the plan level and less decision space at the project level. This has the potential to reduce costs and timing of projects. However, if existing high-quality old growth forest is found during project level analyses in ecozones that are already represented, then adding to the network would not occur. If a high-quality old growth patch was not added to the designated network, the effect depends on the features of the patch as well as the surrounding landscape. For example, patches could be more important to add to the designated network, if they have rare species or if they occur in fragmented portions of the landscape, or if they contribute to a large patch size.

**Alternative E:** this standard restricts any additions to the Designated OG Network but compensates that restriction by adding more than 54,000 acres to the network. This alternative also has the most large patch sizes in the Designated OG Network and would provide more resilience to natural disturbances than other alternatives (Table 129).

By enlarging the network at the plan level and setting it for the life of the plan, this approach has a higher degree of certainty for reaching objectives related to young forests in the plan as well as immediately establishing a broader Designated OG Network.

If existing high-quality old growth forest is found during project level analyses, then project decisions would have the opportunity to decide what management actions could occur. If an area outside the designated network is identified as best managed for old growth characteristics, then the project can manage for those conditions, but the area will not be added to the forestwide designated network.

The plan monitoring program will monitor whether we are moving toward our desired conditions for old growth forest on the landscape and may make recommendations for changes needed in the next planning cycle.



If a high-quality old growth patch is not added to the designated network, the effect on the old growth characteristics depends on project decision for managing in that area, which would be determined in subsequent, project specific NEPA.

### Cumulative Effects: All Lands

Across the broader Southern Appalachians, continued development on private lands will result in loss of older forests toward more young forest conditions. Discussed above, under all forest plan alternatives, the Nantahala and Pisgah NFs are aging into the old forest successional classes. The Nantahala and Pisgah NFs are part of a broader network of connected landscapes within the ecoregion, and the Forests are a hub of above-average connectedness relative to regional scale patterns (see "Climate Change" section). This connectedness contributes to an old growth network that extends beyond National Forest lands.

An analysis of lands adjacent to the OFT Landscapes was completed by incorporating lands from seven land trusts, one biological foundation, four NC agencies, and three USFS units with designated wilderness and inventory roadless areas. Incorporating an all lands analysis of other public and private lands that would likely trend toward old forest conditions further increases the Nantahala and Pisgah NFs' connected landscape size by more than 155,000 acres. The increase is even greater when examining near lands trending toward old forest such as the 500,000-acre Great Smoky Mountains NP, the 5,000 acre Grandfather Mountain Park, the 2,000 acre Needmore Game Lands, as well as various dispersed smaller tracts.

**Table 143. All Lands Analysis by Patch Size by Alternative**

Size Class	Alternative Acres ( ) # of Patches				
Ac (# patches)	A	B	C	D	E
Large +	109,498 (6)	250,244 (8)	303,088 (10)	197,537 (6)	195,222 (6)
Large	251,215 (37)	221,893 (33)	236,300 (34)	270,496 (36)	280,874 (39)
Medium	32,117 (80)	36,014 (88)	45,914 (112)	39,905 (96)	51,179 (104)
Small	6,095 (137)	6,513 (151)	8,022 (208)	6,800 (161)	7653 (190)
Total	479,925 (242)	514,664 (280)	593,324 (364)	514,738 (299)	534,928 (339)_
compared to OFT	126,252 (-9)	126,313 (+2)	149,398 (+5)	149,646 (+9)	152,566 (+8)

By analyzing adjacent and nearby public and private lands, it is possible to determine how the Nantahala and Pisgah NFs provide varying old growth forest patches within the existing Southern Appalachians landscape, primarily in western NC. For all alternatives, the all-lands analysis shows greatly increasing older forested patch acreages as well as the number of larger patches adjacent to the Forests (108). The increase in acreage is similar for Alternatives A and B, around 126,000, as well as for Alternatives C and D, with an increase of around 149,000 acres. Alternative E had the largest increase around 152,000 acres.

The total change in patch number compared to the OFT Landscape varies among the alternatives from a decrease of nine in Alternative A to an increase in nine in Alternative D. All alternatives increase in the largest patch size, with Alternative C having the most at 10. Alternative C includes a range of over 50,000 to almost 200,000 more acres within this patch size compared to the other alternatives. The number of large patches is similar across Alternatives A, C, and D, while Alternative B decreases in comparison to

the OFT Landscape. Alternative E has the largest acreage in this patch size. For all the alternatives, these larger sizes and greater acres within the all lands landscape provide for a greater buffering capacity for any natural disturbance event impacting the landscape. Of the two combined larger sizes, Alternatives B, D, and E vary slightly, about 8,000 acres in size, while Alternative E has three to four more patches. However, Alternative C includes more than 63,000 acres compared to the other three action alternatives.

These separate old forest patches are connected to each other with the most continuous connector being the Appalachian Trail (AT) which traverses south in the Nantahala NF through the Great Smoky Mountains National Park and along the boundary of the Cherokee and Pisgah NFs. Also, the wild and scenic corridors connect small watersheds. To some extent the Blue Ridge Parkway is a long connecting corridor linking the Grandfather Ranger District with the Pisgah and Nantahala Ranger Districts ending up within the Great Smoky Mountain National Park. While most of this national park is trending toward old forest, it is also a heavily trafficked road corridor that provides habitat for many weedy species including various invasive non-native plants.

**Table 144. All Lands Analysis by Patch Size Numbers by Alternative, Patch Sizes Connecting to the Appalachian Trail or in (Parentheses) to Different Wild and Scenic Corridors**

Patch Size	Alternatives				
	Alt A	Alt B	Alt C	Alt D	Alt E
Large+	2 (0)	2 (0)	2 (1)	2 (0)	2 (0)
Large	8 (2)	8 (3)	8 (2)	8 (3)	8 (4)
Medium	6 (0)	9 (1)	12 (4)	9 (1)	9 (2)
Small	8 (2)	8 (1)	9 (0)	8 (1)	8 (0)
Total patches connecting	24 (4)	27 (5)	31 (7)	27 (5)	27 (6)

Alternative A has the least number of patches connecting to the AT as well as the three wild and scenic corridors (Table 144). Alternatives B and D do not vary, having three more medium patches than Alternative A connecting to the AT as well as one more medium and large patches connecting to a wild and scenic corridor. Alternative E varies slightly with 1 more large, 1 more medium, and 1 less small patch connecting to a wild and scenic corridor. In comparison, Alternative C has the most connections with an increase of four compared to Alternatives B, D and E and seven compared to Alternative A. This increase is primarily small patches but also includes one medium patch. Alternative C is the only alternative with a very large patch that connects to a wild and scenic corridor.

For a broader explanation of how lands in the 18 county region are trending toward old forest vs young forest, see the Forest Structure section's cumulative effects above.

### 3.3.8 Fire

#### Affected Environment

##### Historical context

Over the millennia preceding European occupation, much of the vegetation in the eastern United States evolved under a regime of frequent fire with lightning-or human-caused fires maintaining forests and open woodlands with grassy understories. Sediment records from the Nantahala National Forest indicate that for the last 4000 years, fire was ubiquitous across the landscape at levels high enough to support fire adapted community types dominated by American chestnut, upland oaks, and yellow pines (Delcourt and Delcourt 1997). Eyewitness accounts by early European explorers corroborate the physical record with descriptions of open woodlands and even prairie openings across the mountains. This open

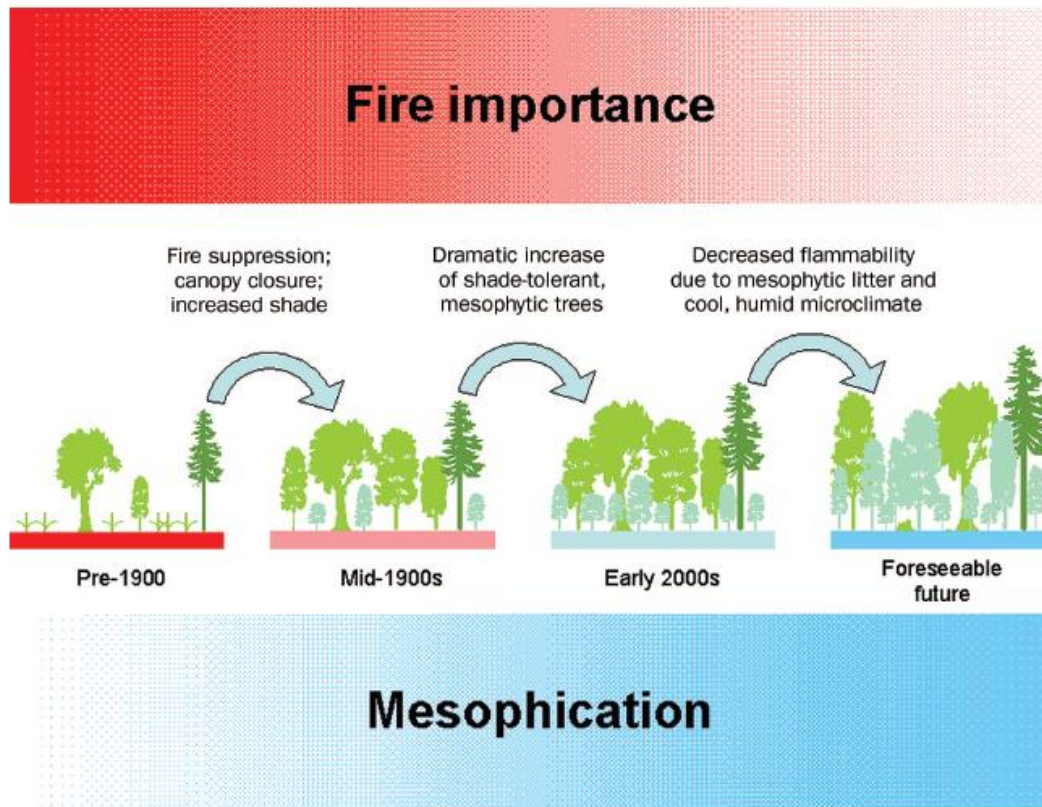
structure would have been promoted by recurrent, low-intensity fires that discouraged woody regeneration but may not have killed overstory trees. Fires ignited by lightning were supplemented by Native American burning (DeVivo 1991).

Both lightning and humans started fire, but anthropogenic fire may have been nearly gone from the landscape for as long as a century before Europeans resettled the mountains. Early European explorers in the 16<sup>th</sup> and 17<sup>th</sup> centuries brought with them disease and war, which profoundly diminished Native American populations and hence their effects on the landscape. Over this span of time, trees would have replaced grasses, and open forest canopies would have disappeared from most valleys and slopes. Fire-intolerant species gradually gained a foothold across even the most fire-prone topographic positions. Settlers moving in during this time would have assumed the forests had always been dense (Denevan 1992). Many early settlers to the mountains, however, arrived from the British Isles, where fire was still being used to manipulate the landscape (Johnson and Hale 2002). Those families eventually reinvigorated the tradition of burning the woods and brought fire back to the mountains by the 1700s and 1800s. Fire history studies indicate that at least some southern Appalachian oak and pine forests burned as often as every 3-7 years before the fire exclusion era of the 20<sup>th</sup> century (Aldrich et al. 2010; Flatley et al. 2013; Flatley et al. 2015). These fires overwhelmingly occurred outside of the lightning season, indicating that they were set by humans.

The mountains continued to be settled, and large-scale land use and vegetation manipulation expanded into the late 1800s and 1900s (see Yarnell 1998). Fire regimes changed once again with the introduction of industrial logging and access by the railroads. Trees were felled by the train-load and the logs transported out, leaving logging slash across thousands of acres. Fires were ignited by people as well as log trains, but these fires were high intensity and high severity, consuming fallen tree branches and any residual vegetation. Remaining trees would have been scarred and damaged, thus decreasing their value as a commodity, and soils eroded, leading to sedimentation in the waterways. Regrowth would have been minimal in areas with damaged soils and frequent fires. Thus, fire came to be viewed as the enemy, and the government discouraged the use of fire for any reason.

Fire prevention and suppression efforts were extremely successful. In fact, dendrochronology studies consistently illustrate the “20<sup>th</sup> century curl” where evidence of fire in the tree ring history ceases (see Lafon et al. 2017). Typically this occurred by the mid-1900s. Whereas the oldest generations of mountain families still retain memories of their grandparents burning the woods, few of today’s landowners use fire for land management. Consequently, today’s forests tend to look different than those from historic times. Canopy and midstory layers are denser; however, the most fire-adapted, sun-loving species that were common across historic landscapes are now uncommon. The ground layer is often depauperate, with few non-woody species such as grasses or forbs. Seedling trees, the next generation of the overstory, consist as predominantly non-fire adapted species contributing to natural communities for which there is no historical analog.

As fire exclusion endures, the forests will continue to change via the process of mesophication (Nowacki and Abrams 2008). As fire-adapted species decline, they are replaced by species that otherwise would be killed by fire, such as tulip poplar, red maple, and black birch. Environmental conditions shift to the detriment of species which need open conditions and sunlight to germinate and compete successfully and whose leaf litter provides fuel to carry fire. Replacement species tend to impede fire spread, because their leaves lay flat, hold moisture, and decay rapidly unlike oak leaves which decay slowly and remain curled, allowing the surface fuels to dry out and ignite. The mesophytic leaf litter layer is not conducive to burning and, hence, the decline in burnability continues with continued influences on the vegetation until the landscape reaches a point of no return with little opportunity to get fire back on the landscape (See Figure 111 from Nowacki and Abrams 2008).



**Figure 111.**Temporal changes in fire importance (fire frequency and severity) and mesophication (development of cool, moist understory conditions) for oak-pine ecosystems in the eastern United States. Olive green trees represent oaks, dark green trees represent pines, and aquamarine trees represent mesophytic species (e.g., sugar maple) (Source: Nowacki and Abrams 2008)

### Fire management today

In the past 25 years or so, land managers have recognized the role of fire in the maintenance of structure and species composition that had been on the landscape for thousands of years. Therefore, in recent decades, land management agencies including USFS have increased their use of prescribed fire (also known as controlled burning) for both ecosystem restoration as well as for the complimentary objective of fuel reduction to reduce the risk of wildfire. Prescribed fire is an intentional, human-initiated fire, or more specifically “a wildland fire originating from a planned ignition to meet specific objectives identified in a written, approved, prescribed fire plan for which NEPA requirements (where applicable) have been met prior to ignition” (Guidance for Implementation of Federal Wildland Fire Management Policy (GIFWFMP), 2009). Prescribed fire can be contrasted with wildfire, which includes all “unplanned ignitions of a wildland fire (such as a fire caused by lightning, volcanoes, unauthorized and accidental human-caused fires) and escaped prescribed fires” (GIFWFMP 2009).

The following two tables display the number and cause of wildfires on the forest in recent years and total fires and acreage annually.

**Table 145. Number and Cause of Wildfires on the Nantahala and Pisgah National Forest from 2001-2017**

Cause Class	Number of Fires	Percent of Fires
1 - Lightning	111	8%
2 - Equipment Use	40	3%
3 - Smoking	27	2%
4 - Campfire	107	7%
5 - Debris Burning	517	35%
6 - Railroad	33	2%
7 - Arson	367	25%
8 - Children	21	1%
9 - Miscellaneous	257	17%
Total Fires (2001-2017)	1,480	

**Table 146. Number of Wildfires and Acreage Burned on the Nantahala and Pisgah National Forests Annually Between 2001 and 2017**

Year	Wildfires	Acres
2001	141	5,198
2002	67	1,233
2003	39	196
2004	81	1,392
2005	63	819
2006	95	1,275
2007	159	12,619
2008	115	4,336
2009	73	1,631
2010	78	1,572
2011	75	477
2012	75	1,413
2013	35	639
2014	89	1,642
2015	80	4,033
2016	148	50,580
2017	68	9,692
Average	87	5,809

Lightning-caused wildland fires still contribute to ecosystem maintenance of the southern Appalachians (Cohen et. al 2007). Managers determine whether each fire can be managed in a way that will help meet forest goals and objectives. Even so, within the Nantahala and Pisgah NFs, lightning causes less than 10 percent of reported wildfires (<https://famt.nwcg.gov/applications/FireStat>). This is due to several reasons. Lightning fires tend to ignite under weather conditions that, ironically, discourage fire growth (i.e., rainstorms). In addition, thick, woody vegetation, which is found across much of the landscape, hampers wind and increases humidity within the forest, and there is a lack of fine fuels such as grasses, all of which impede the spread of natural fires. Roads and developed landscapes also tend to prevent fire spread. Because of these changes to fuels and environmental conditions, lightning fires in most years rarely contribute much acreage to the area burned by wildfires. Contemporary fires have been documented to smolder for a month or longer (see examples in Cohen et. al 2007), and some cover great expanses; however, these examples are uncommon under today's circumstances. Some lightning fires do ignite during periods of low precipitation, high winds, and/or droughty conditions and spread rapidly, causing wildfire suppression concerns (e.g., 2016). Researchers note that lightning alone could not have maintained open woodlands and grasslands to the extent described by historic documents and physical evidence; natural fires were supplemented by Native American burning.

Both lightning and human-caused wildfires can pose a hazard to human communities and structures. Wildfires often occur near human communities and under hazardous conditions which pose risks to firefighters and the public. Wildfires also can negatively impact resources. The Forest Service recognizes that vegetation and fire do not acknowledge ownership boundaries, nor does any single land management agency have enough resources to meet its wildland fire goals and objectives. Agencies must work together across landscapes to manage fire. The NFs in NC work within the context of the National Cohesive Wildland Fire Management Strategy (Cohesive Strategy 2011), a strategic push to work collaboratively among all stakeholders and across all landscapes using best science to make meaningful progress toward three goals:

1. Resilient landscapes
2. Fire-adapted communities
3. Safe and effective wildfire response

The Cohesive Strategy vision for the next century is to safely and effectively extinguish fire, when needed; use fire where allowable; manage our natural resources; and, as a nation, live with wildland fire.

### **Prescribed burn program**

Over the past 12 years the focus of the Nantahala and Pisgah NFs prescribed fire program has been to address hazardous fuels. Fuel treatment for reduction of wildfire hazards can be accomplished by prescribed fire and mechanical treatment. With both methods available fuels are altered by consumption or removal. Mechanical treatments rearrange fuels in that trees and shrubs may be cut down, chipped, or otherwise affected. They also can be utilized for ecosystem restoration with the removal of undesirable individuals or species, thus increasing opportunities for desirable species to expand. However, mechanical treatments do not replace all the benefits of fire. On average, non-harvest mechanical treatments like mastication are substantially more expensive, per acre, than prescribed burns.

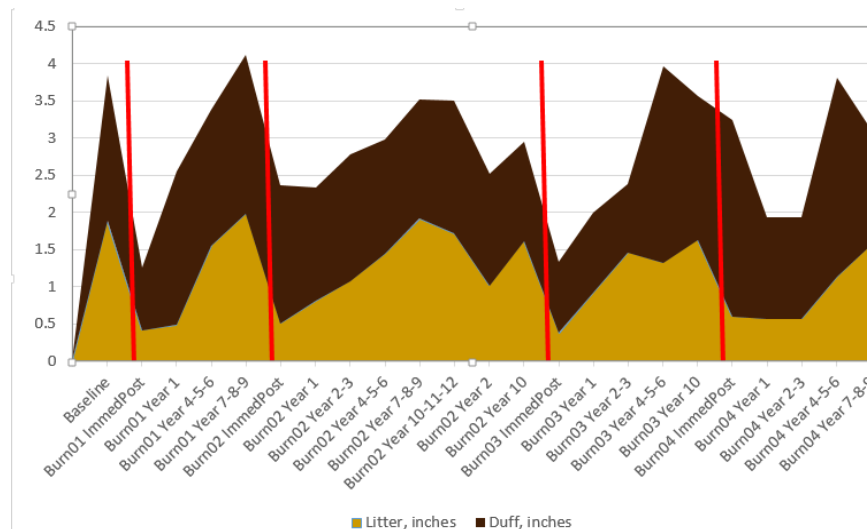
Additionally, over the past few years prescribed fire, particularly through a program called Collaborative Forest Landscape Restoration Program (CFLRP), has increasingly been used to restore fire-adapted ecosystems, especially on the Grandfather Ranger District and CFLRP has demonstrated that both ecological restoration of fire-adapted systems and fuel reduction for community protection are complimentary for selected areas on the NP.

The current NP prescribed fire program covers approximately 59,700 acres in various burn blocks, with approximately 7,500 acres of prescribed fire ignited annually. About 140 prescribed burns have occurred over the 12 years on the 59,700 acres, and about 50 percent of those acres have burned at least twice during this time frame. Repeated burning of the same acreage is important, because it takes multiple ignitions first to restore and then to maintain fire-adapted systems that historically burned every five to seven years. Leaf litter falls every autumn, so burning to reduce hazardous fuels theoretically could be done almost yearly. Not all leaf litter or duff is consumed in any one fire (Buchanan 2019, unpublished data). Including repeated burns on the same acres, the amount of activity has been approximately 94,000 acres of controlled burning over the past 12 years (Table 147).

**Table 147. Amount of Burning Activity Over 12 Years (2007-2018) (Source: FACTS)**

Nantahala	Pisgah	Total
56,267 acres	38,408 acres	94,315 acres
99 prescribed burns	42 prescribed buns	141 prescribed burns

(Note: Acreage includes areas that have burned more than once during this period, so the acreage is “activity” over 12 years, not the actual “unique ground” area.)



**Figure 112. Cherokee NF response of litter and duff layers following prescribed fire (red lines). Note that while monitoring plots in this dataset are permanent and re-measured over time, the sample size of any given sample event varies. (Source: Beth Buchanan, unpublished data)**

The amount of prescribed fire applied to the landscape each year depends on several factors. The first is prevalence of vegetation adapted to short fire return intervals. Also, each management area’s goals and objectives help determine appropriate fire levels: some areas support controlled burning to a greater extent than others. A third factor influencing the fire program, in both the short and long-term, is weather. Prescribed fires are ignited only under a discrete set of variables including humidity, temperature, fuel moisture, wind speed and direction, and other influences on fire behavior. On average, the Nantahala and Pisgah NFs have approximately 70 days available each year which match the parameters defined in burn prescriptions (Jackson, 2018). The fourth major factor is the level of resources. Each burn prescription includes the number of personnel required to attend a burn. This number is dependent on the complexity of the burn, which is based on acreage, weather parameters, topography, fuel loading, values at risk, etc. (USDA, 2009). Finally, budget and competing priorities influence the number of personnel available on any given day and therefore how much prescribed burning can be accomplished.

Nantahala and Pisgah NFs conduct prescribed burns in burn blocks (also known as burn units). Burn block sizes vary greatly. Table 148 shows the number of burn blocks by size category and the acreages of multiple burns over 12 years. Currently, there are 141 burn blocks with nearly ¾ of them less than 500 acres in size. However, most of the controlled burning activity (approximately 80 percent) occurs on block sizes greater than 500 acres. Larger burn units are often favored because of contiguous target vegetation and the ability to use natural fire breaks.

**Table 148. Existing Burn Block Sizes and Activity from 2007-2018 (#burns/total acreage per size class)**

Block Size (acres)	Nantahala	Pisgah	Total
>2000	0	3/13688	3/13688
1000-2000	10/19928	6/13691	16/33619
500-1000	18/21791	6/5663	24/27454
100-500	36/12963	11/4600	47/17563
< 100	35/1585	16/406	51/1991

Prescribed fire, especially dormant season burns, often will not significantly change the structure of mature, closed-canopy forests. Beginning in the fire exclusion and suppression era, fire-intolerant, shade-tolerant species quickly captured resources and space, and now these species make up a large percent of the midstory and overstory. Currently, prescribed fire-induced mortality occurs mainly in trees <5" at diameter at breast height (DBH) (Waldrop, et al. 1992). Therefore, restoration success will be heightened when silvicultural treatments are combined with fire to alter structure and reduce density.

Silvicultural treatments also can reduce the risk of wildfires. Biomass removal, whether logs are being harvested or smaller density trees and shrubs are felled, decreases available fuels and/or alters structure. The felling of flammable shrubs, for example, lowers the depth of the fuel bed and reduces flame lengths: fire control is simpler when flames are lower.

### Fire regimes on the Nantahala and Pisgah NFs

Given that fire is a primary disturbance agent across the forest, understanding the Nantahala and Pisgah NFs fire regimes is central to understanding the Natural Range of Variation (NRV)<sup>31</sup> as it relates composition, structure, and pattern in various ecozones. Natural disturbances such as fire have measurable patterns related to the type, frequency, intensity, and spatial scale of each disturbance.

A fire regime is defined by frequency and severity. Fire frequency is the average number of years between fires; severity describes the effect of the fire on the dominant overstory vegetation. Fire regimes have been divided into five categories, depending on typical frequency and severity (Schmidt et al 2002) (Table 149). In this document, fire-adapted vegetation refers to those community types or species that have evolved to survive and reproduce in a short-return-interval regime: a system expected to be affected by fire one-to-many times every 35 years or so.

Fire Regime Group I includes communities that depend on short return interval, low or mixed severity fires, in which more than 70 percent of the timber basal area and more than 90 percent of the canopy cover of the overstory vegetation survives (Schmidt et al 2002). Appalachian oak and yellow pine-

<sup>31</sup> This revised plan framework rests on the assumption that ecosystems are most resilient when they have high ecological integrity, which is characterized by having composition, structure, function, and species' population and community dynamics that occur within an appropriate range of variability, or Natural Range of Variation (NRV). The ability of an ecosystem to absorb and recover from disturbances, such as fire, without drastic alteration of its inherent function is central to the concept of NRV. The past range of variability serves as a reference for functional and sustainable systems that are complex and adaptive in the context of global change.



dominated communities fall into Fire Regime Group I and are considered fire-adapted. Early research (e.g., Waldrop and Brose 1999) into southern Appalachian Table Mountain pine communities suggested that the pines required severe, infrequent fires to reproduce, their seeds within serotinous cones opening after the fires. However, later research (Brose and Waldrop 2006, Waldrop et al. 2006) including dendrochronology studies (see Lafon et al. 2017) show that Table Mountain and pitch pine communities historically encountered mostly mixed or low severity regimes (placing them into Fire Regime Group I), with some but not all the mature trees succumbing to fire.

Fire Regime Group II includes communities that depend on short return interval, high severity fires, often considered stand-replacement fires. These fires kill at least 80 percent of the basal area or more than 90 percent of the overstory canopy cover (which can be trees, shrubs, or grass). These stand replacement effects are not common, although they do occasionally occur in pockets.

Community types that are associated with Fire Regime Groups III, IV, and V are not the focus of fire management on the Nantahala and Pisgah NFs, even if they fall within designated prescribed burn blocks. These communities include spruce-fir, northern hardwood, acidic cove, rich cove, and floodplain forests. These communities tend to be within the natural range of variability with regard to fire regimes. While fire may move naturally into these areas, they are not intentionally ignited during a prescribed burn.

**Table 149: Historic Natural Fire Regime Groups (from Schmidt et al. 2002)**

Fire Regime	Description
I	0-35 year frequency, low-to-mixed severity
II	0-35 year frequency, high severity
III	35-100+ year frequency, high severity
IV	35-100+ year frequency, high severity
V	200+ year frequency, high severity

Simon (2011) modeled potential natural vegetation (PNV) in Western North Carolina under historic disturbance regimes which indicate how much of the landscape is adapted to short fire return intervals (referred to as fire-adapted and defined as at least one fire per 35 years). About 53 percent of the Nantahala and Pisgah NF PNV maps as oak- or yellow pine-dominated vegetation, all of which falls into Fire Regime Group I. It is in these areas that restoration using fire would be appropriate. Again, in most other forested community types, prescribed fire would not be a primary management tool, as the fire return intervals in these types are expected to exceed 35 years. The amount of oak and yellow pine vegetation types varies by district, from nearly 3/4 of the Grandfather RD to less than half of the Nantahala and Pisgah RDs (Table 150).

**Table 150. Acres of Fire-Adapted Forest by District**

District	Yellow Pine Types, Acres	Oak Types, Acres	Percent of Ranger District that is Fire-Adapted
Grandfather	53,541	79,800	70%
Cheoah	20,647	51,252	59%
Tusquitee	23,295	67,409	57%
Appalachian	41,595	42,083	52%
Nantahala	8,993	90,720	40%
Pisgah	1,190	61,696	40%
All Districts	149,261	392,960	53%

Although all the oak and yellow pine communities in Western North Carolina are adapted to frequent fire, the average historic return interval varies among community types, with some historically seeing fire several times a decade and others only once every 20 to 30 years. In addition, understory species may require more or less frequent fire to promote healthy populations. Consequently, some communities have missed many fire intervals during the period of fire exclusion.

**Table 151. Modeled Fire Return Interval for Maintenance of Vegetation Structure and Composition, by Ecozone**

Ecozone	Maintenance Return Interval	Fire Adapted Rating
Shortleaf Pine	3-7	Very High
Pine-Oak/Heath	3-7	Very High
Dry Oak	7-12	High
Dry-Mesic Oak	15-20	High
High Elevation Red Oak	20-25	Moderately High
Mesic Oak	23-27	Moderately High

The NP NFs completed a vegetation analysis using Simon's (2011) potential natural vegetation models to determine the amount and locations of national forest that is fire-adapted. First, Simon's fire-adapted ecozones were subdivided with regard to how often they need fire to maintain structure. These divisions were rated as very high, high, or moderately high. Next, modelers divided the landscape by identifying existing burn units then compartmentalizing the remaining land into potential burn units. All units were then ranked based on size, acres of fire-adapted vegetation and rating, presence of fire-adapted rare species, and other ecological values. It must be noted that when delineating potential additional burn units, this process did not take into consideration *feasibility* of the potential burn units, including logistics, amount of fireline needed, distance to private property, or likelihood of required weather conditions (e.g., wind direction), all of which affect the likelihood of a burn.

Results from this analysis identify burn units as very high, high, or moderately high priority for fire need. The total acreage of burn units that rate as very high, high and moderately high fire adapted classes is approximately 263,000 acres (Table 152). Within these burn units, approximately 193,000 acres are fire adapted, and roughly 70,000 acres are interspersed non-fire adapted. These other acres would not be targeted for burning though they are found within burn units. Approximately 14 percent of the priority fire adapted areas (26,890 acres) are in current burn blocks.

**Table 152. Amount of Ecological Fire Adapted Priorities by Category**

Eco Priority	Community Types Included	Acres	Percent of NP NF	Acres in Current Burn Blocks
Very High	Shortleaf Pine; Pine-Oak/Heath	47,105	18%	8,086
High	Dry Oak; Dry Mesic Oak	113,252	43%	11,143
Moderately High	High Elevation Red Oak; Mesic Oak	103,154	39%	7,661
Total	Empty cell	263,511	100%	26,890

## Wildfire

A wildfire is an *unplanned* ignition of a wildland fire (or an escaped prescribed fire). The wildfire category includes unplanned fires that are human-caused and also those that are naturally ignited by lightning (IGIFWFMP 2009). Homes, businesses, and infrastructure in the wildland-urban interface all can be damaged or destroyed by wildfire. The areas which are most-highly fire adapted are not necessarily easily accessible for implementation, nor are they necessarily areas which pose the highest wildfire risk to the public. The Southern Wildfire Risk Assessment (SWRA) model identifies areas of the Nantahala and Pisgah NFs most prone to wildfire in relation to human resources at risk. Smoke-sensitive individuals (including those in schools, nursing homes, and hospitals) can be negatively impacted by fire, even at a great distance from the flames.

USFS firefighters respond to wildfire ignitions on national forest land as well as wildfires within the reciprocal zone which would threaten national forest land. The reciprocal area includes the area within 1.5 miles of national forest per the Master Cooperative Agreement with NC Forest Service. In general, there are 30-50 wildfire starts on the national forest annually. The reciprocal work agreement in some years doubles the number of wildfires that NP firefighters respond to, although most wildfires on adjacent private lands are usually smaller in size (< 5 ac). In 2016, the number of wildfire responses was almost double the surrounding years, and acreage increased nearly 10-fold. Contributing factors were extreme drought, which was promoted and supported by a La Nina weather signature and resulting rainfall deficits for the majority of the calendar year (Konrad and Knox, no date).

**Table 153. Wildfire History (2013-2017)**

Calendar Year	# Wildfires on NFS Lands	Nantahala and Pisgah Acres	# of Wildfires > 500ac	# of Wildfires < 500ac	# Wildfire Responses in the Reciprocal Zone	Total # Wildfires Including Reciprocal Zone
2017	46	8,611	3	43	47	93
2016	100	49,437	12	88	88	188
2015	35	2953	3	32	67	102
2014	50	1535	1	49	86	136
2013	30	4850	2	28	33	63
<b>Total</b>	261	67,386	21	240	321	582

Source: FireStat/Dispatch logs

USFS hazardous fuels appropriations language dictates where funds are to be spent (Radeloff et al. 2005):

“FS’s hazardous fuels appropriation . . . (is) used for fuel reduction projects, or treatments, on federal lands and in high-priority areas in the wildland-urban interface, the area where structures are intermingled with—or adjacent to—vegetated wildlands such as forests or rangelands.”

Agencies can rate areas with regard to fuel treatment value, as well as determine which potential wildfire locations may most-negatively impact human resources in order to mitigate the fuels before a wildfire ignites. The Southern Wildfire Risk Assessment (SWRA) provides a consistent, comparable set of scientific results to be used as a foundation for wildfire mitigation and prevention planning in the

southern states. SWRA's SouthWRAP program (Southern Wildfire Risk Assessment Portal) can be used to help prioritize areas where tactical analyses, community interaction and education, or mitigation treatments might be necessary to reduce risk from wildfires.

One SouthWRAP product is the Wildland Urban Interface Risk Index which estimates risks of wildfire across any given landscape. The SouthWRAP risk ratings estimate the risks to people and their properties, particularly structures. As such, risk ratings tend to be high when closer to structures and lower when farther away. Therefore, risk ratings for national forests tend to be generally low because of greater distances from the forests to homes and structures but higher close to the boundaries with private lands where distances to homes and structures are closer to the forests. A process to categorize these higher risk lands on the NP using SouthWRAP data is described in Appendix B.

To better understand how well the current burn blocks target areas of risk from wildfire, we re-categorized risk ratings for the NP and the number of current burn blocks for each risk rating (Table 154). More than half of the NP is in a moderate risk category, which is consistent with greater distances to homes and structures. Roughly 24 percent of the NP is in a higher risk category (moderately high to very high), or approximately 1/4 of the NP is closer to homes or structures that could pose significant risks from uncontrolled wildfire. Approximately 19 percent of the higher risk rated lands are in the current burn blocks.

**Table 154. Amounts of Community Protection Risk Ratings**

<b>Community Risk</b>	<b>Acres of NP NF</b>	<b>Percent of NP NF</b>	<b>Acres in Current Burn Blocks</b>	<b>Percent of Current Burn Blocks</b>
<b>Very High</b>	4,467	0.4%	38	0.1%
<b>High</b>	58,513	5.6%	2,476	4.1%
<b>Moderately High</b>	181,334	17.4%	8,624	14.5%
<b>Moderate</b>	601,819	57.7%	42,578	71.5%
<b>Low</b>	196,930	18.9%	5,858	9.8%
<b>Total</b>	1,043,063	100.0%	59,574	100%

Where the ecological fire adapted priority areas and high community risk rated areas overlap, there is the greatest potential for mutual benefits of ecosystem restoration and community protection. However, areas with very high risk for community protection may be the most difficult to treat using prescribed fire. Building fireline across long distances is cost-prohibitive, and, also, slope angles and nearby vegetation structure may not be conducive to containment of the fire.

## **Environmental Consequences**

Using the above information as context for the current prescribed fire program on the Nantahala and Pisgah, as well as the needs for fire related to ecosystem restoration and reducing the risk of fire on communities, each alternative was analyzed to determine how the proposed management area allocation might affect fire management. While prescribed fire is permitted in most management areas (all but Research Natural Areas), there are other management-area-specific constraints, such as a reduced road network in Backcountry, or additional time for planning and implementing activities in designated Wilderness areas, that have the potential to impact implementation of a successful prescribed burn program. Assumptions and steps for this analysis process are described below and further detailed in Appendix B.

### Alternative A — No Action: Current Plan

In Alternative A prescribed burning rates would continue at current levels (approximately 7,500 acres per year). Alternative A assumes that the amount of current burning and the established burn blocks are static with little to no expansion. Areas that are seeing a return to a more natural fire regime would continue on that trajectory.

About 60 percent of current burn blocks are in management areas that are suited for a wide range of conditions and management options, which means that they are most flexible in accommodating prescribed burning. In addition, Backcountry and 4C Wildlife, where lands are managed for a more narrow set of conditions but allow for controlled burning, make up another 26 percent. These two management areas are limited, however, by the amount of access for fire control lines. The remaining 14 percent of burn block acreage is scattered across other MAs, except virtually no acres fall in Special Interest Areas, Existing Wilderness, or Wilderness Study Areas.

**Table 155. Alternative A, Management Areas and Acres in Burn Blocks**

Management Areas	MA Number	Number of Acres Burned	Percent
Back Country	5	9,122	15.3%
Wilderness Study Areas	6	3	0.004%
Wilderness	7	13	0.021%
Experimental Forests	8	73	0.1%
Cradle of Forestry	11	1,145	1.9%
Developed Recreation	12	193	0.3%
Special Interest Areas	13	3	0.0%
Appalachian Trail	14	408	0.7%
Wild & Scenic	15	307	0.5%
Administrative Sites	16	47	0.1%
Balds	17	566	0.9%
Sustained Timber	1b	4,484	7.5%
Timber Visual	2a	2,439	4.1%
Visual Roaded	2c	2,085	3.5%
Sustained Yield	3b	15,875	26.6%
Timber Wildlife Visual	4a	6,169	10.3%
Wildlife	4c	6,767	11.3%
Timber Wildlife	4d	6,985	11.7%
No assigned management area (recently acquired)	U-New	2,983	5.0%
Total Acres	Empty cell	59,666 acres	100.0%

The majority of the fire-adapted forest, which would not be added to the burn program, would become more departed from the historic natural range of variation with increasingly less ecologically-appropriate composition and structure. Stocking rates would remain high or increase. Shade-tolerant species such as red maple, eastern white pine, and rhododendron would benefit. Because the leaf litter of red maple and other fire-intolerant species tend not to carry fire (Nowacki and Abrams 2008), the forests will become more fire-proof, making areas less disposed to fire under most conditions, including low-intensity prescribed fire. As ecologically inappropriate species begin to dominate the landscape, forests would be less likely to tolerate drought and temperature extremes. With high competition from resources, trees will be more stressed, and insect and disease outbreaks may become more common, potentially killing large stands of trees. Current threats include southern pine beetle and emerald ash borer. Even as the fuel bed flammability changes, some fuel components may increase. If large numbers of trees die, the potential for high severity wildfire will increase when the snags and logs dry out and become available fuels. Additionally, rhododendron under the right environmental circumstances becomes available live fuel.

In terms of fuel, fire exclusion affects fire risk both positively and negatively. The lack of fire would allow the continued expansion of flammable shrubs in the understory. Standing dead trees would potentially alter future fire regimes, with fire moving from the ground's surface through the shrub layer and into the canopy where wind can carry embers from some species longer distances. Large woody fuels on the ground can promote smoldering fires and subsequent increased and prolonged smoke production. Conversely, in those areas where the forest composition is moving toward non-fire-adapted species, fire risk may be lowered under most conditions (Nowacki and Abrams 2008). These non-fire-adapted species, such as red maple, tend not to carry fire; and hence while fire risk is reduced, the opportunity for restoration is diminished as well.

Presently, about 244,000 acres are in wildfire risk categories of moderately high to very high, with about 6 percent of current burn block acreage in these areas. In the wildland-urban interface, the increase in dead trees and live fuels, such as rhododendron, could increase the risk of wildfire spread from or into national forest.

Because only about 10 percent of existing burn blocks fall into the ecological priority management areas, the maximum restoration/maintenance potential of high priority fire adapted ecosystems is very low.

### **Effects of Alternatives B, C, and D**

Alternatives B, C, and D have identical fire program objectives, and the prescribed burning levels would not differ from one another. Prescribed burns would be planned, scheduled, and executed to manage vegetation, restore and maintain fire-adapted ecosystems and species, create desired wildlife habitat conditions, promote herbaceous ground cover to help control erosion, and modify fuel loads to reduce wildfire intensity (FR-DC-05). Normally, multiple burn objectives are compatible, and they are defined in each burn plan.

WUI areas would be managed to protect human life, enhance protection of nearby homes and improvements, and provide an area where firefighters can safely conduct tactical operations (FR-DC-04). All of the Nantahala and Pisgah NFs are found within the wildland-urban interface (WUI), defined as an area where communities and homes are next to or within fire-prone natural areas (Andreu and Hermansen-Baez 2008). National Forest Lands adjacent to homes and infrastructure can pose a greater risk of wildfire impact to private property. As noted above in Affected Environment, about one-fourth of the NP is in a moderately high, high, or very high-risk category. Approximately 19 percent of these lands are in the current burn blocks, but all burn units regardless of proximity to private property are currently managed to reduce fuels.

Where higher risks to private property overlap with fire-adapted vegetation communities, prescribed fire would provide added ecological benefits. More than 67,000 acres of moderate-high to very high ecologically prioritized acres overlap with moderately high/high/very high community protection acres. Because of logistical issues, such as the need for extensive fireline, burning along the border with private property is often cost prohibitive. In some cases, however, North Carolina Forest Service or USFS is able to enter into agreements with the private landowners which allow agencies to conduct joint controlled burns with the landowners, thus decreasing the need for firelines.

**Table 156. Acres of Overlap Between Areas that Pose a Greater Risk to Communities and Areas that Need Fire for Ecological Benefit.**

Community Protection Risk Rating (Acres)	Ecological Priority Class (Acres)			
	Very High	High	Moderate	Total
Very High	191	419	251	861
High	9,640	20,534	20,294	50,468
Moderately High	3,759	5,806	6,516	16,081
Total	13,590	26,759	27,061	67,410

In Alternatives B, C and D, the prescribed fire program is analyzed at two acreage levels. At Tier 1, which assumes funding levels similar to current levels, between 6,500 and 10,000 acres would be prescribed-burned per year. At Tier 2, which assumes additional resources such as additional partner capacity or increased budget, the forest would plan to burn up to 20,000 acres per year. Regardless of tier, current burn blocks that have been burned multiple times over the past 12 years under the current plan would be maintained and would continue to see changed conditions through management. Current burn blocks with single burns would be evaluated for re-entry based on site-specific needs including their ranking for ecological and fuel reduction risk. Managers may opt to cease burning in some units in order to re-focus on higher-priority units. In order to accomplish the Tier 2 level of burning, the current burn season would need to be expanded. The ability for the Nantahala and Pisgah NFs to reach Tier 2 levels of management will rely heavily on the Cohesive Strategy principles of working collaboratively with other agencies to achieve goals.

In order to meet a threshold of acres restored, prescribed burn units are designed to be larger than the target communities found within them. Because of heavily dissected topography, burn units often encompass many vegetation types, some of which are not fire-adapted, in order to ensure safety of firefighters and promote successful burns that can be contained within the unit. As such, burn unit boundaries are designed to minimize the creation of firelines with commensurate ground disturbance. Roads, trails, and natural firebreaks, such as streams, are used as boundaries, and temporary or permanent firelines are created as necessary following forestwide direction for soil and water management. Burn units are designed to maximize the target vegetation, and the non-target communities are not intentionally burned; fire is not forced into these areas.

Even though many community types are usually found within a burn unit, similar types are found adjacent to one another. For example, shortleaf pine and pine-oak heath communities (both considered “very high” priority communities for restoration) normally grade into dry oak and dry-mesic oak communities (considered “high” priority communities). As such, to implement Objective ECO-O-06, shortleaf pine and pine–oak heath would be targeted at the rate of 2000 to 3000 acres per decade. New burn blocks to accomplish this objective have been estimated to be approximately 5,700 to 7,000 acres

due to using natural firebreaks and existing roads or trails. Although these new burn blocks are designed to target the restoration of pine ecozones, some dry oak and dry-mesic oak ecozones would likely occur and have been estimated at amounts that would meet the objective of 1,200 to 1,900 acres per decade for those oak ecozones. Also, the new burn blocks would require prescribed fire three times within a decade. This much prescribed fire would increase the plan and implemented program at least 1,500 to 2,500 acres per year above current averages.

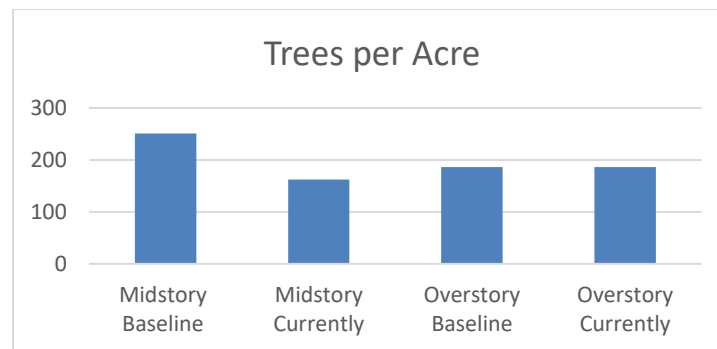
The burn program is also analyzed at a Tier 2 level of approximately 20,000 acres of prescribed fire annually. Emphasis in Tier 2 would be on restoring fire-adapted ecozones, and across ecozones where reducing fuel loads will improve public safety on adjacent private lands. This doubling of acres is above current fiscal capacity, and attainment depends on external funding and resources.

At least 30 percent of the prescribed burn acres would fall in Backcountry, Matrix, or Interface Management Areas. In order to meet Tier 2 levels of burning, burn units likely would be larger, encompassing more acres per burn. To date the Forests have had only three burns in twelve years that have been greater than 2,000 acres in size; most larger burns would be approximately 1,000 to 2,000 acres in size.

Regardless of level of burning (Tier 1 or Tier 2), the draft plan calls for the expansion of open forest woodlands and young forest conditions, which are two types of forest structure that are historically common but currently lacking on the forest. Prescribed fire alone may not accomplish these objectives.

ECO-O-04 calls for providing 1,500 to 4,000 acres of open forest woodlands conditions. While fire is more likely to kill red maple and other fire-sensitive species, it is difficult to create open conditions while selectively retaining certain trees (Buchanan, 2019, unpublished data). Some open woodland conditions would be achieved in pine and dry oak types by attaining objective ECO-O-06 (above). The open forest woodland objective is intended to augment ECO-O-06 by emphasizing the dry-mesic oak and mesic oak types. Dry-mesic and mesic oaks would require some mechanical treatment, usually a thin and two burns to create open forest woodland conditions, which would require approximately 300 to 800 acres per year dedicated to creating or maintaining open woodlands. However, attainment of open woodland condition would likely take more than one decade. Current burn blocks would be used as much as possible to attain the open forest woodland objective, potentially shortening the time frame. About 50 percent would be located in NCWRC Wildlife Active Management focal areas (as stated in the objective). Approximately half of the eco-priority areas (141,000 ac) overlap with NCWRC focal areas, so there are many opportunities to provide woodlands in the focal areas.

The information from neighboring forests below demonstrates the challenge of using fire to create open forest woodlands.



**Figure 113. Trees per acre**

\*On the Cherokee NF, midstory (2-6" DBH) tree density has decreased over time but overstory tree density (>=6" DBH) has remained about the same.



On the George Washington-Jefferson NFs, the open forest woodland condition has been achieved in only 5-9 percent of the burn units, with very high variability (Lorber et. al 2018).

ECO-O-02 calls for providing up to 37,000 acres of young forest conditions by increasing new young forest conditions up to 32,250 acres and using more focused use of prescribed fire to generate young forest conditions. Creating scattered young forest with stand replacement fire could be used in the Backcountry, where harvest activities are restricted or not likely to occur. Current burn blocks would be used as much as possible. Approximately 20-30 percent would be in Backcountry and similar management areas. Burn blocks would be selected for the characteristics for hot fires to develop gaps of young forest and then burned continuously on a cycle to maintain the gaps in early seral conditions.

Looking to other forests as an indication of what could occur during implementation, the George Washington-Jefferson (GWJ) NFs created gaps from 5-17 percent of burn blocks (in units larger than 250 acres), but results were highly variable, with some units moving to young forest across more than 50 percent of the area (Lorber 2018). The GWJ NFs' objectives were to create young forest, but under alternate conditions where tree mortality was not promoted, the opening of the canopy (by killing trees) is much less likely. The Cherokee NF, for example, has seen only a slight decrease in trees >2" DBH, particularly trees >6" or greater at DBH. The Nantahala and Pisgah NF are more mesic than both the GWJ NF and the Cherokee NF, therefore the analysis assumed that the forest would see slightly less prescribed fire acres resulting in young forest, but the Spectrum vegetation model did not include a quantified amount for Alternatives B, C and D.

Accomplishments would depend not just on funding and resources but also on the number of available burn days as well as physiological conditions of the vegetation. North Carolina Smoke Management Program Guidelines (2016) constrain the amount of burn days based on acceptable atmospheric conditions. These guidelines are part of North Carolina's effort to control PM2.5 (particulate matter of 2.5 microns in diameter or less), the primary health hazard concern from smoke emissions from prescribed burns, and are intended to be used by burn managers to mitigate smoke from prescribed burns so that the PM2.5 standards, established in National Ambient Air Quality Standards (NAAQS) by the Clean Air Act, are not exceeded. Burning is not likely on Category 1 days, because the smoke dispersal is not sufficient. The best opportunities for smoke dispersal occur on Category 4 and Category 5 days. The majority of Category 4 and 5 days fall within the Autumn season (Jackson, unpublished data). However, during Autumn, the physiological condition of the canopy vegetation affects the ability to contain the fire. During active leaf-drop, leaves fall on fire lines and remove the physical barrier of mineral soil, hence increasing the chances of fire escaping the burn unit. Therefore, most prescribed burns during Autumn must be completed once leaves have fallen, which significantly shortens the window of opportunity in this season.

**Table 157. Distribution of Potential Burn Days Based on Weather**

Season	Category Day 1	Category Day 2	Category Day 3	Category Day 4	Category Day 5	Season Total	% Season
Spring (Feb-April)	1.9	2.9	3.1	7.2	7.8	22.8	24.77%
Summer (May-July)	1.1	1.4	1.0	1.3	0.4	5.2	5.62%
Autumn (August-Oct)	13.1	6.8	5.8	7.4	4.2	37.3	40.97%
Winter	8.9	3.8	5.5	9.8	2.8	30.8	34.20%

Season	Category Day 1	Category Day 2	Category Day 3	Category Day 4	Category Day 5	Season Total	% Season
(Nov-Dec)							

Atmospheric conditions are most amenable for prescribed burning on Category 4 and Category 5 days. Mean number of days for each Category Day vary by season. Category Days are based upon the North Carolina Smoke Management Guidelines, 2016.

### Effects of Alternative E

The effects of Alternative E are similar to the effects of Alternatives B, C and D with the following exceptions. Alternative E Tier 1 objective for prescribed fire increased up to 20,000 acres/year, and for Tier 2 increase is up to 45,000 acres/year (ECO-O-06). Most of these acreages are targeted for open canopy woodlands in fire adapted ecological priority areas. The objective for open canopy woodlands (ECO-O-05) was reframed specifically to activities of thin and burn, which creates woodland at a faster pace. Thin and burn for Tier 1 is 300-600 acres/year and Tier 2 is 600-900 acres/year.

The effects of Alternative E (Tier 1) is similar to Alternatives B,C, and D (Tier 2) with up to approximately 20,000 acres/year of prescribed fire. New burn blocks would be required up to about 7,000 acres. Due to the amount of prescribed fire and more focus on thin and burn prescriptions, the amount of open canopy woodlands is expected to increase up to approximately 20,000 acres over 20 years. Alternative E goes further than Alternatives B, C, and D to estimate the quantity of acres that would result in young forest conditions from prescribed fire. This was quantified using Spectrum vegetation modeling for this alternative. About 24 -40 acres/year would result in young forest conditions over the next 20 years, and occur mostly in Backcountry management areas.

The effects of Alternative E (Tier 2) would require about 11,000 acres of new burn blocks due to the increase of prescribed fire up to 45,000 acres per year. With the expansion of the prescribed fire program, along with higher amount of thin and burn prescriptions, the amount of sustained open canopy woodland is estimated to be approximately 36,000 acres over 20 years. About 100-140 acres/year would result in young forest conditions over the next 20 years, and occur mostly in Backcountry management areas.

### Effects of Management Area Locations Among the Action Alternatives

Locations of priority burning areas would differ among alternatives because of the different management area allocations. To examine differences among the action alternatives due to management area locations, this evaluation uses management area (MA) groups as described in the “Terrestrial Ecosystem” section of this DEIS. These groups are summarized as follows:

**MA Group 1: *Matrix and Interface.*** In this MA group, a full range of potential burn block sizes would accommodate the expansion of the prescribed fire program. This MA group is suited for a wide range of conditions and management with the greatest amount of roaded access and the most flexibility for creating firelines and mechanical fuel treatment. The greatest amount of fire management is expected to occur in the Matrix, where the most acres would be managed annually. Active management in Interface would have the same tools available as in Matrix, but the total number of acres treated in Interface would be substantially less, and treatments would be designed with consideration of high concentration of forest users and heavy public use.

**MA Group 2: *Ecological Interest Areas; Appalachian Trail Corridor; National Scenic Byways; Heritage Corridors; Wild & Scenic Rivers; Experimental Forests; and Cradle of Forestry in America.*** In this management area group, fire management is allowed consistent with the desired conditions of the management area but is expected to be less active than Group 1 with fewer tools available. For example, in the Ecological Interest Areas MA, timber harvesting and prescribed fire could be used to restore community composition, while in the Cradle of Forestry, silvicultural tools can only be used to benefit

historical and educational purposes. Road building is also limited to specific circumstances that are compatible with the unique features of the management areas. As a result, active management in this group is a moderate to low level of activity compared to MA Group 1.

**MA Group 3:** *Backcountry; Special Interest Areas; Roan Mountain.* MA Group 3 involves primarily passive management where natural processes such as floods, storms, insects, disease, and fire shape the landscape. Prescribed fire is assumed to be the primary method of active restoration, occurring over large landscapes where possible. Generally, this MA group is less accessible with fewer roads. Prescribed burns in Backcountry, in particular, would tend to be larger, generally more than 500 acres, and extending to existing natural and human firebreaks due to limitations on new mechanical firelines. Large burns require more planning and mitigation and hence may not be as feasible. Additionally, mechanical fuel treatments would be limited.

**MA Group 4:** *Congressionally Designated Wilderness; Recommended Wilderness and Wilderness Study Areas; Research Natural Areas.* MA Group 4 is dominated by passive management except for minor instances where active management using prescribed burning would be desired for specific fire-adapted restoration priorities (Linville Gorge Wilderness). Fire in wilderness is desired to create more natural conditions, particularly where conditions have departed because of fire exclusion. Management of fire in wilderness is intended to permit lightning fires to play, as nearly as possible, their natural ecological role in wilderness and to reduce risks and impacts within and outside of wilderness to an acceptable level. Although it is possible to employ active management methods in this group, the tools that would be used are severely restricted, such as restrictions on motorized equipment. In order to include a portion of a designated wilderness area within a burn unit, containment lines would need to be established in these areas, but fewer options to build or hold lines will be available. As a result, fires may burn longer, and more resources may be needed on foot or aerial resources, increasing the expense of the burn. Additionally, fires that burn longer may introduce challenges in meeting smoke management guidelines over longer durations. Wilderness designation also results in strict constraints on burn objectives. For the reasons described, it is assumed that lands in this MA group would have the lowest priority for fire management.

To evaluate MA groups on prescribed fire priorities, a composite map (Figure 114) was developed that incorporated the high priorities for both ecological restoration and maintenance as well as community protection. This includes high priorities for about 196,000 acres (ecological restoration), 177,000 acres (community protection), and 67,000 acres (overlapping eco-restoration and community protection sites). Taken together, approximately 440,000 acres of the Nantahala & Pisgah NFs comprise the high priority areas for prescribed fire.

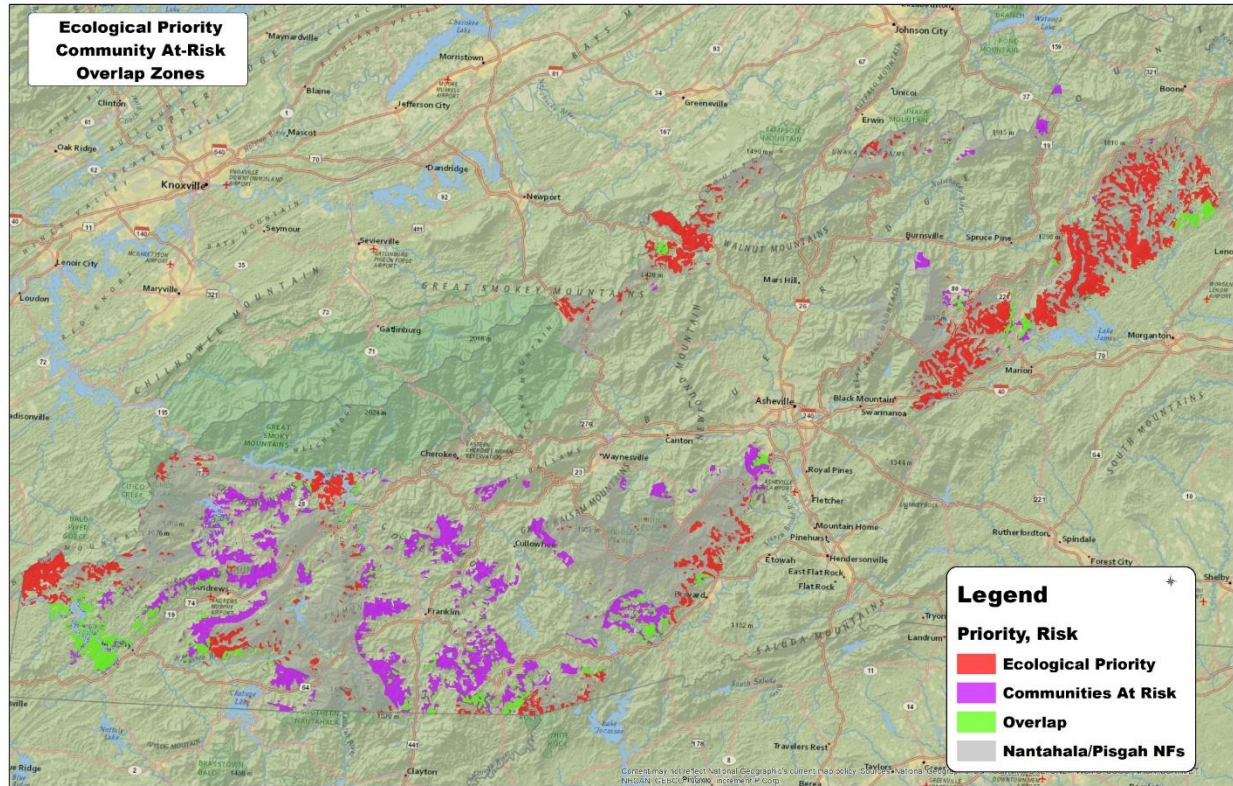


Figure 114. Ecological priority community at-risk overlap zones

The amounts in each management area group by action alternative is shown in Table 158.

**Table 158. Composite of High Priorities for Ecological Restoration and Community Protection by Management Area Group (Acres)**

MA Group	Alt B	Alt C	Alt D	Alt E
Group 1	30,9428	266,677	311,400	307,416
Group 2	30,088	54,708	37,699	37,813
Group 3	48,821	96,488	56,888	65,023
Group 4	51,756	22,207	34,106	29,954
<b>Totals</b>	<b>Alt B 440,093</b>	<b>Alt C 440,080</b>	<b>Alt D 440,093</b>	<b>Alt E 440,026</b>

Opportunities for ecological restoration and community protection using the prescribed fire program are similar among the alternatives. Alternatives B, D and E are the most similar with comparable amounts of MA Groups 1 and 2, but with Alternative C having the least in MA Group 4 would allow opportunities for more burn blocks in priority areas than those other alternatives as well as having ample opportunities for larger landscape burns with a relatively high amount of MA Group 3. Among the action alternatives, Alternative C would likely have the least opportunities for developing new, smaller burn blocks but has opportunities for larger landscape-scale burns which could restore and maintain fire-adapted ecozones where large burn blocks are feasible.

## Cumulative Effects

### Common to all alternatives

The cumulative effects analysis considers all lands across Western North Carolina for the next 50 years.

While Western North Carolina (defined by the 18 westernmost counties) is also dominated by private ownership (Fox et al. 2011), the Nantahala and Pisgah NFs make up roughly 22 percent of the land area (1,044,393 acres). Within the greater Blue Ridge Mountains section, of which WNC is a part, 67 percent of the land base is in forest condition (Keyser et al. 2014), of which 37 percent is under federal or state ownership (Keyser et al. 2014). The Nantahala and Pisgah NFs make up roughly 27 percent of the forest ownership in WNC.

As described above, USFS firefighters respond to wildfire ignitions on National Forest System land as well as wildfires within the reciprocal zone which would threaten NFS land. The reciprocal area includes the area within 1.5 miles of national forest per the Master Cooperative Agreement with NC Forest Service. The USFS will continue to work with state and other partners to respond to wildfire ignitions.

More than 4.8 million acres of Western North Carolina's forested lands are fire-adapted. Only approximately 11 percent of these acres are found on national forest (Table 159). However, more than 60 percent of the prescribed fire is conducted on USFS lands.

**Table 159. Estimated Acreage of Fire Adapted Ecozones Across Western North Carolina, Including Within Nantahala and Pisgah NFs**

Fire Adapted Ecozone	Western NC (Ac)	% of 18 Counties in Western NC	Nantahala & Pisgah (Ac)	Percent of Western NC Landbase Found Within NPNFs
Shortleaf Pine	1024127	21.7%	177270	17.3%
Pine-Oak/Heath	462165	9.8%	103187	22.3%
Dry Oak	86273	1.8%	40188	46.6%
Dry Mesic Oak	229339	4.9%	49260	21.5%
High Elevation Red Oak	305374	6.5%	103844	34.0%
Mesic Oak	383751	8.1%	46479	12.1%
Total	2491029	52.7%	520228	20.9%

Prescribed fire use is increasing across WNC and the southern Blue Ridge Mountains, which include the mountainous portions of North Carolina, South Carolina, Georgia, and Tennessee. This increase is due to the recognition of the role of fire in the restoration and maintenance of the mountains and is encouraged by the principles of the Cohesive Strategy and the partnerships of collaborations such as the Fire Learning Network (Southern Blue Ridge Fire Learning Network). Southern Blue Ridge Fire Learning Network tracks prescribed burn acreage conducted by its partners, including federal, state, and NGO land managers. Of the approximately 14,000 acres prescribed burned in 2019, about 9,000 acres were conducted by USFS and around 5,000 by NC state agencies, with the majority (about 3500 acres) conducted by NC Forest Service (unpublished data, Margit Bucher). When agreements are in place, agency personnel share resources across agency lines, and some burn units are interagency in nature. NCFS is the lead agency in conducting prescribed burns on private lands.



While the use of fire is increasing, the majority of acres will still be completed by USFS, because the agency is the largest land manager with the largest work force. The National Forest System land base is steady with the potential to increase slightly with land acquisitions. However, it is expected that over the next 50 years, private forest land will decrease in Western North Carolina and the Blue Ridge Mountain section. Contrary to other portions of the southeast, the loss of forest land in the southern Appalachians is expected to come from population growth and urbanization (Keyser et al. 2014)

### **3.3.9 Forest Health and Nonnative Invasive Species**

Healthy forests are those that are sustainable and able to maintain their organization, autonomy, and ecosystem services over time while remaining resilient to prevailing stress and disturbances. They have the physical and biotic resources to support functioning ecological systems with a diversity of native plants and animals. Native insects and pathogens are an important part of a healthy forest ecosystem, but when environmental and biological conditions lead to outbreak levels, they can cause significant impacts to forests (Liebhold and Wingfield 2014). The Forest Service uses vegetation management activities, such as timber harvest, fire, and manual and chemical treatments to actively promote forest health where unhealthy conditions develop.

A non-native invasive species is one whose introduction causes economic or environmental harm or harm to human health. Non-native invasive species have been identified as one of four critical threats to USFS ecosystems. A result of humans interacting with forest ecosystems within a globally connected society, introduced organisms are capable of creating drastic change in the composition and structure of native forest communities (Liebhold and Wingfield 2014, Fei et al. 2019). The Southern Region of the Forest Service maintains a list of species known to be invasive. The influence of invasive species is found throughout much of the Nantahala and Pisgah NFs.

While the most successful control of invasive species is preventing their arrival, many species become established and are capable of rapidly spreading (Liebhold and Kean 2018, Schoettle et al. 2019). In the absence of natural predators, non-native invasive species can rapidly increase across the landscape with little resistance beyond control and mitigation measures (Liebhold and Wingfield 2014, Schoettle et al. 2019). These species interfere with natural and managed ecosystems, degrade wildlife habitat, reduce the sustainable production of natural resource-based goods and services and increase the susceptibility of ecosystems to other disturbances such as fire (by increasing fuel loads to hazardous levels).

This section examines serious threats to forest health that require the most active prevention, suppression, or monitoring efforts, as well as strategies in the revised plan for achieving and maintaining healthy forests. The analysis of impacts to forest health is divided into three sections: damage agents of forest trees, damage agents to terrestrial and aquatic organisms and plants, and non-native invasive plants.

#### **Affected Environment**

##### **Damage agents of forest trees**

Both native and non-native insects and diseases cause above-normal mortality rates on forested lands in the United States. In many instances, the increase in damage agents can be attributed to changes in forest conditions, often a result of anthropogenic factors like suppression of fire, historical land use, and climate change. High tree mortality rates can accelerate the development of high fuel-loading in fire-dependent forests, removing important ecosystem elements, and impacting adjacent private and public property values.

Generally known for disturbances focused on species or species groups, insects and disease may affect forests at varying scales and intensity. The degree of the disturbance is generally related to the spatial arrangement of the targeted species on the landscape. When mature trees are killed, canopy gaps may

be created at the individual tree or small group scale (such as those caused by oak decline), or larger sizes and scales (such as those caused by balsam woolly adelgid, chestnut blight, hemlock woolly adelgid, or southern pine beetle). Disturbance intensity may be stand replacing (balsam woolly adelgid), mixed (chestnut blight, hemlock woolly adelgid, spongy moth (*Lymantria dispar*), or light (oak decline, elm spanworm). Insects and diseases may also affect specific ecozones. For example, Southern pine beetle is likely to occur in shortleaf pine oak and pine-oak/heath ecozones, while hemlock woolly adelgid is likely to affect acidic coves and riparian forests.

Because many insects and diseases are influenced by environmental conditions, future changes in climate can be expected to result in greater impacts from both non-native and native pests (Liebhold 2011, Vose and Elliott 2016).

### Current Trends

Pathways for introductions of pests and diseases to forest tree species are generally outside of local National Forest control. With the most important pathways being international wood movement and live plant transport (Liebhold and Wingfield 2014), historical establishment rates of 2.5 non-native forest insects or disease agents per year, and between 10 to 14 percent of pest invasions causing apparent damage (Williamson and Fitter 1996, Aukema et al. 2010), it is likely that forest health-related problems will continue to occur across the Nantahala and Pisgah NFs.

Currently, hemlock woolly adelgid, southern pine beetle, and the Slow the Spread Program (STS) for *L. dispar* are the tree related forest health impacts most managed by the National Forests in North Carolina. Additionally, the National Forest participates in the “Don’t move firewood” campaign, which emphasizes limiting the movement of firewood and associated pests across counties.

The impact of non-native pests and diseases is potentially greater in the eastern U.S., including new infestations and the spread of existing infestations to the full range of their hosts (Fei et al. 2019, Potter et al. 2019a). Up to 41 percent of the live tree biomass is currently at risk of invasion and damage within the continental U.S. (Fei et al. 2019). In the southern Appalachians, with the vast expanse of oak forests, threats that target oak tree species could potentially have a large impact in the future. Current impacts include the oak wilt pathogen and oak decline. If sudden oak death were to become established in the eastern U.S., it could also produce devastating impacts to oak forests.

There are certain invasive pests and diseases present across the Eastern U.S. and in WNC that have the potential to functionally eliminate (Potter et al. 2019b) their tree host species or cause substantial damage to forest health and productivity (Liebhold and Kean 2018, Fei et al. 2019, Potter et al. 2019b). Those tree species or groups that are limited in distribution or locally rare with low genetic variation and relatively low regeneration capacity represent some of the most sensitive species.

Table 160- Table 162 includes the most current and potential future threats to forest trees across the Nantahala and Pisgah NFs.

**Table 160. Local Non-Native Threats and Their Associated Tree Species Hosts on the Nantahala and Pisgah NFs.**

Damage Agent	Host Trees	Ecozone
Chestnut Blight ( <i>Cryphonectria parasitica</i> )	American chestnut*, American chinquapin*	All oak and coves
Dutch Elm Disease ( <i>Ophiostoma novo-ulmi</i> )	Elm (winged, American, slippery) *	Oak, floodplain, cove
Hemlock Woolly Adelgid ( <i>Adelges tsugae</i> )	Eastern <sup>β</sup> and Carolina	Cove and pine/oak



Damage Agent	Host Trees	Ecozone
- HWA	hemlocks	
Emerald Ash Borer ( <i>Agrilus planipennis</i> ) - EAB	All local ash species <sup>β</sup>	Cove, northern hardwood, high elevation red oak
Butternut Canker ( <i>Sirococcus clavigignenti-juglandacearum</i> )	Butternut <sup>β</sup>	Rich cove, floodplain
Beech Bark Disease ( <i>Cryptococcus fagisuga</i> / <i>Neonectria</i> spp)	American beech <sup>β</sup>	Cove, northern hardwood, High elevation red oak
Dogwood Anthracnose ( <i>Discula destructiva</i> )	Flowering dogwood <sup>β</sup> , American sycamore, black walnut	All except spruce/fir
Oak Wilt ( <i>Ceratocystis fackearum</i> )	Red oak group	Oak and pines
Spongy moth ( <i>Lymantria dispar</i> )	Many Hardwood Tree Species	All except spruce/fir
Balsam Woolly Adelgid ( <i>Adelges piceae</i> )	Fraser Fir	Spruce/Fir
Thousand Cankers Disease - TCD ( <i>Pityophthorus juglandis</i> / <i>Geosmithia morbida</i> )	Black walnut, butternut	Rich cove and floodplain
Phytophthora root diseases ( <i>Phytophthora</i> spp)	American Chestnut, White oak, other hardwoods	Coves, mesic and dry mesic oak
White Pine Blister Rust –WPBR ( <i>Cronartium ribicola</i> )	Eastern White Pine	All except spruce/fir
Matsucoccus scale ( <i>Matsucoccus macrocitrices</i> / <i>Caliciopsis pinea</i> )	White pine	All except spruce/fir

\*Functional extirpation has occurred    <sup>β</sup>Functional extirpation is imminent or expected

Table 160 lists several tree species that are “functionally extirpated<sup>32</sup>” or expected to be functionally extirpated from current forest communities as a result of their associated damage agent.

- American chestnut and chinquapin, mature trees, are mostly gone, and the root sprouts that do exist (plentiful on some sites) are unable to reach a size to produce viable fruit.
- Elm species (American elm, slippery and winged) have also been removed from the landscape; though on the Nantahala and Pisgah NFs, elm species were typically low in abundance.

Currently, the most active damage agents include hemlock woolly adelgid, emerald ash borer, and butternut canker, which have the potential to functionally remove eastern hemlock, ash species, and native butternut from the Nantahala and Pisgah NFs (Poland, et al. 2015). While Carolina hemlock appears to have more host resistance to hemlock woolly adelgid compared to Eastern hemlock (Mayfield, personal communication 2019), due to its limited range and small populations, it is still in an imperiled status. Other non-native damage agents, including beech bark disease and dogwood anthracnose, could likewise lead to functional extirpation of American beech and dogwood at elevations above 3,000 feet in WNC (Holzmueller, et al. 2006).

<sup>32</sup> Functional extirpation in this analysis is adapted from Potter et al. 2019 and defined as “no longer capable of providing the ecosystem services it typically provided within the ecozone(s) it evolved within.”

Many other tree species are currently being affected by non-native damage agents but are less likely to experience functional extirpation, or the end result of the agent host interaction is uncertain. These species and associated damage agents include the following:

- Oak wilt is capable of rapidly killing oaks from the red oak group but tends to occur in root graft pockets and is slow to spread (Juzwik, et al. 2011).
- Though present within the state of North Carolina in the past, *L. dispar* is not currently affecting WNC in outbreak status. The Slow the Spread program is monitoring the pest's progression, and steps to eradicate infestations will be taken as necessary. Most commonly associated with oaks, the caterpillar life stage of this invasive moth can cause individual tree mortality when populations reach outbreak status causing multiple years of defoliation. In the last three years there has been an increase in the activity of *L. dispar* on and near to the Pisgah NF.
- Balsam woolly adelgid has been impacting Fraser fir in the sky islands of WNC since the 1960s. Originally the culprit behind "fir mortality waves," it now attacks within pockets of recovering Fraser fir across the spruce fir ecozone. Fortunately, the disease progression allows some fir to reach maturity, thereby maintaining reproduction potential.
- Thousand cankers disease, which is relatively new to WNC, has the potential to impact black walnut and the already imperiled butternut. These two species exist as relatively minor components of the forest and riparian areas. The full extent of the impact is currently unknown, as the disease progress is slow and hard to detect (Newton and Fowler 2009).
- Multiple phytophthora fungal species are present within the soils of WNC, impacting American chestnut, white oaks, and other hardwoods. Though highly impactful to American chestnut, these root pathogens are less well understood in regard to their impact on white oak but may be expected to increase their potential ability to damage or kill under the wider fluctuations in precipitation patterns expected from climate change (Kolb et al. 2016, Reed et al. 2019).
- Though white pine is currently a widely distributed tree on the Nantahala and Pisgah NFs due to lack of landscape level fire, it is currently suffering from several damage agents that could result in increased mortality. White pine blister rust has been present in the mountains since the late 1940s and is typically not a widely impactful agent due to unfavorable disease progression conditions (high temps, low alternative host, dry conditions during leaf fall, etc.) (Van Arsdell 1972). A newer fungal/insect complex, Matsucoccus scale, is also found throughout the southern range of Eastern white pine and is capable of causing dieback and some mortality (Schulz, et al. 2018). White pine is also susceptible to a native root pathogen (Table 162- Annosus). With the presence of white pine blister rust, Annosus, and the scale complex, the future of white pine health is uncertain.

Table 161 identifies the current known potential forest health related damage agents. Predicting and preventing all future invasions is impossible given the rates of infestation, difficulties in detection, and globalization (Schoettle et al. 2012, Liebhold and Kean 2018, Potter et al. 2019a, Potter et al. 2019b). Table 161 lists several damage agents that have the potential to functionally extirpate their host species (sudden oak death, laurel wilt, sirex wood wasp), though their ultimate impact is still unknown and hard to anticipate.

**Table 161. Known, Potential Future Non-Native Threats and Host Trees on the Nantahala and Pisgah NFs**

Damage Agent	Host Trees	Ecozone
Sudden Oak Death	Red oak group <sup>a</sup> , Rhodo, Vaccinium	Coves, oaks, and pines

Damage Agent	Host Trees	Ecozone
(Phytophthora ramorum)	spp	
Laurel Wilt ( <i>Raffaelea lauricola</i> / <i>Xyleborus glabratus</i> )	Laurel family (sassafras)*	All except spruce/fir
Sirex woodwasp ( <i>Sirex noctilio</i> )	Many southern pine species*	Pines
Asian longhorned beetle ( <i>Anoplophora glabripennis</i> )	Maple species	All except spruce/fir
Spotted lanternfly ( <i>Lycorma delicatula</i> )	Many species ( <i>Malus</i> , <i>Prunus</i> , <i>Pinus</i> )	Most hardwood

\*Functional extirpation is suspected but not yet known.

**Table 162. Local Native Threats and Their Host Trees on the Nantahala and Pisgah NFs**

Damage Agent	Host Trees	Ecozone
Oak decline complex	N. Red, Scarlet, Black, White, Chestnut	Coves, oaks, and pines
Annosus Root Disease ( <i>Heterobasidion annosum</i> )	White Pine	All except spruce/fir
Armillaria Root Rot ( <i>Armillaria mellea</i> )	Many	All
Southern Pine Beetle ( <i>Dendroctonus frontalis</i> )	Southern Pines	Pines
Ips beetles ( <i>Ips spp</i> )	Southern Pines	Pines

The damage agents listed in Table 162 are all native to southern Appalachian forests. Having co-evolved with their hosts, they generally result in a lesser degree of mortality and are not expected to reach functional extirpation levels except in extreme circumstances. Damage agents like oak decline may become more prevalent under anticipated extreme weather patterns (e.g., boom and bust moist/dry periods), particularly where oaks are considered off-site due to past land use or changes in local conditions. Increased intensity of drought periods may make conditions ripe for aggressive outbreaks of southern pine beetle and, more atypically, Ips beetles (Kolb et al. 2016). In localized areas, especially where pine communities are small and isolated, the impacts of southern pine beetle may lead to loss of smaller communities under current disturbance patterns. Conversely, wetter periods may shift the advantage to root pathogens, making their impact more apparent on the landscape (Kolb et al. 2016, Reed et al. 2019).

Based on current and historical forest health conditions, there are at least 12 forest tree species that are already functionally extirpated or at risk of becoming functionally extirpated. These 12 tree species span eight of the 11 ecozones. When known potential future threats (Table 161) are also considered, more than 20 tree species and all ecozones (except spruce fir) have the potential to be impacted. The loss of tree species reduces functional diversity across the Nantahala and Pisgah NFs, and the effects are even more significant when a keystone species is removed from the ecosystem, such as the loss of eastern hemlock or American chestnut. American chestnut was once an overstory dominant of the forested southern Appalachians, and at the beginning of the 20<sup>th</sup> century, succumbed to the invasive chestnut blight (*Cryphonectria parasitica*). While chestnut sprouts still persist in the understory, the root pathogen *Phytophthora cinnamomic*, combined with chestnut blight, present serious obstacles to restoring

American chestnut on the forest (Wang et al. 2013). With the loss of eastern hemlock, there continues to be uncertainty regarding the species composition of the community that will replace hemlock and how that will impact the greater riparian ecosystem (i.e., rhododendron dominance, water temperature changes).

Native tree species damage agents (Table 162) typically do not act alone in the functional extirpation of a species. This analysis does not take into account the synergistic effects of multiple damage agents cumulatively impacting a forest tree species and greatly expanding the degree of impact. One example is the combination of *L. dispar*, oak decline, and the potential future sudden oak death and this combined influence on the health of red oaks in the southern Appalachians.

Though the effects of varying weather patterns associated with climate change (i.e., drought) are hard to quantify, moderate warming of winter temperatures and greater fluctuation in dry and wet periods will likely result in increased impacts from native and non-native pests (Kolb et al. 2016). The impacts will depend on the types of pest or disease, the host, and climatic conditions and can apply to many of the damage agents listed in the tables above.

Management actions can be taken to mitigate damage where it is above perceived/desired endemic levels. Within an adaptive management strategy, appropriate management actions include (Kolb et al. 2016, Guldin 2018, Halofsky et al. 2018, Schoettle et al. 2019):

- increase carbon capture,
- match species with site or those better adapted to current and future site conditions,
- harvest to reduce tree mortality and increase availability of resources,
- disrupt pheromone plumes for certain species (like bark beetles),
- increase structural and age class diversity using multi-cohort and multi-aged management,
- assist species migration,
- increase host population size (to offset losses),
- maintain a robust regeneration cycle,
- maintain genetic diversity, adaptive capacity, and population connectivity,
- utilize geographically appropriate artificial regeneration,
- apply prescribed fire where possible to maintain restored conditions (for fire adapted communities).

Adaptive management strategies related to forest health will also depend heavily on monitoring, coordination with state and federal forest health specialists, updates to science, and collaborative efforts to alter management to changing conditions. Multi-phase models like the one proposed by Schoettle et

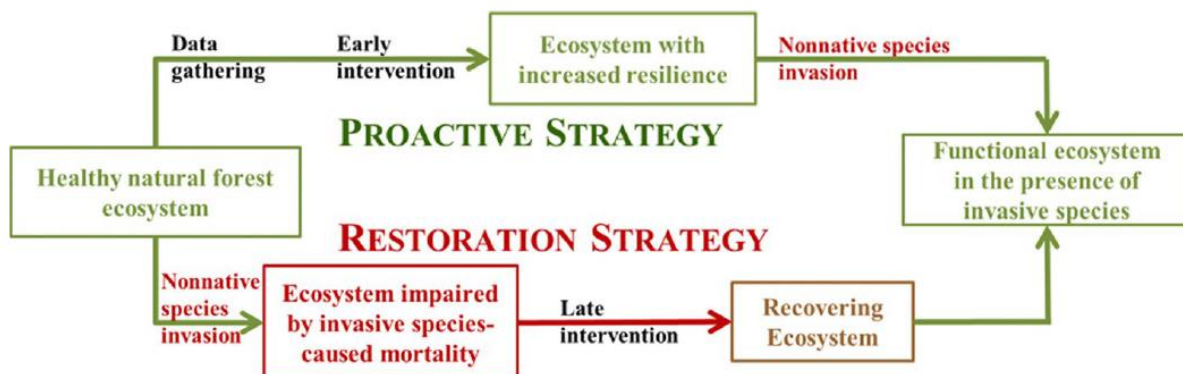


Figure 115. An adaptive framework for developing functional ecosystems in the presence of invasive species. Note where the NNIS invasion occurs on the top and bottom pathways (from Schoettle et al. 2019)

al. (2012) acknowledge that any damage agent/host interaction is variable based on a suite of factors, and, depending on the progression rate of the interaction and whether host genetic resistance is present, can be addressed either proactively (preferred) or restoratively (more common). This applies to both tree species of commercial value and ones that are not commercially valuable. Though many of our ongoing forest health management programs follow the restoration strategy flow, it may be beneficial to identify when following the proactive path in Figure 115 is a viable option. These actions are expected to improve not only native species diversity but also the resilience and/or the adaptability of ecological communities to stressors such as disease and insect outbreaks as well as extreme weather disturbances associated with climate change (Guldin 2018, Halofsky et al. 2016, Stanturf et al. 2014).

## **Environmental Consequences – Damage Agents to Forest Trees**

### **Alternative A**

The current forest plan (as amended) addresses forest health in the Forestwide General Direction section as it relates to 1) old growth forests, 2) rationale for implementing clearcutting, and 3) developed recreation areas. The concept of Integrated Pest Management is outlined in the Forestwide General Direction section in order to manage pests to achieve resource management objectives. Southern pine beetle is identified specifically with direction to manage infestations in accordance with management requirements of the Southern Pine Beetle Record of Decision. Forest health is also addressed in MA 7 (Wilderness), MA 8 (Experimental Forests), MA 9 (Roan Mountain), and MA 10 (Research Natural Areas).

### **Common to all alternatives**

In addition to language in the current forest plan, the Nantahala and Pisgah NFs have been working over the last ten years to both respond to damage agents such as hemlock woolly adelgid and develop restoration opportunities for American chestnut. Through coordination with the Southern Research Station, state and private forestry, the American Chestnut Foundation, and the Hemlock Restoration Initiative, the Forests will continue to look for opportunities to restore these species to the Forests where opportunities exist. For both species the science is rapidly changing with advances in control or improvements in the species resistance occurring regularly.

### **Common to Action Alternatives**

Within the proposed forest plan, forest health is more comprehensively integrated into all sections of the plan. There are several forestwide plan components that recognize the need to manage for and maintain acceptable levels of forest health (recreation, air, aquatic systems, terrestrial ecosystems, and climate change).

Two objectives in the proposed forest plan that are directly related to forest health are:

- FHL-O-01: Focuses on implementing current and future state and private forestry forest health protection supported programs like HWA and SPB treatments.
- FHL-O-02: Focuses on Non-native invasive species treatment objectives.

Standard FHL-S-05 requires survey and treatment of NNIS before and after vegetation management and other ground disturbing activities. Where treatments are needed, this will count toward the FHL-O-02 as described above.

The Geographic Areas section of the plan includes goals that link management actions like timber harvest, stand improvement, and restoration to improvement in forest health. Additionally, multiple management areas include desired conditions and goals that focus on maintaining or improving forest health.

The revised forest plan uses concepts including the natural range of variation, restoration of function, and adaptive capacity as guides for framing a range of structural and compositional conditions across the forest (Crow 2014, Millar 2014, Puettmann 2014). Managing toward the natural range of community conditions (as compared to current forest development trajectories) in light of changes in ecosystem drivers and disturbance patterns, should ensure maintenance of greater ecosystem diversity and productivity. Greater ecosystem diversity and productivity should result in higher adaptability to changes in disturbances and stressors that forests will face under a changing climate and the maintenance of the wide array of ecosystem services that they provide (Puettmann 2014, Stanturf 2004, Fahey et al. 2018).


### Comparison of Alternatives

As mentioned above, many forest health impacts to tree species are likely to occur regardless of what alternative is implemented. For example, emerald ash borer impacts all North American ash species larger than one inch in DBH and results in near complete mortality over several years with the fastest rates of mortality occurring in stands with low density of ash trees (Knight et al. 2013, Poland et al. 2015). Given the scattered nature of ash species in WNC, management actions taken to establish young forest structural classes that temporarily maintain ash trees under the minimum size threshold or to implement sanitation activities in advance of mortality would be implemented under all alternatives.

There is evidence that maintaining a diversity of structural conditions for different communities would increase the resilience to forest health problems (Kolb et al. 2016, Guldin 2018, Halofsky et al. 2018, Schoettle et al. 2019). Increasing the available resources (light, water, nutrients) for host species increases their ability to resist damage agents (Eastern Hemlock, McAvoy et al. 2017, Brantley et al. 2017). Furthermore, the revised forest plan desired conditions and objectives to create resilient forests, increase structural diversity, and manage toward a natural range of variation necessitates an increase in more open forests and a broad range of age classes (seral states), including an increase in younger forests and restoration to match forest community type with site types. Restoration under the proposed revised plan would also allow for older forest conditions, allowing native forest health agents (like those in Table 162) to influence forest community dynamics while giving resource managers the flexibility to address aggressive outbreaks that threaten important public investments.

In all alternatives, damage agents would be addressed through active or passive management to improve resiliency of the forest to pests. Using the MA Groups identified in the Terrestrial Ecosystems section, alternatives that offer greater opportunities to manage forest structure and composition through the creation of young forest conditions and open conditions would result in improved forest health conditions over time. Flexibility for management also provides opportunity to address forest health issues in advance of an infestation or outbreak and as new (future) issues emerge (Table 163).

**Table 163. MA Groups for Managing Forest Health**

MA Group 1	
MA Group 2	
MA Group 3	
MA Group 4	

*MA Group 1 includes Interface and Matrix MA; Group 2 includes Ecological Interest Areas, AT Corridor, Scenic Byways, Heritage Corridors, WSRs, Experimental Forests and Cradle of Forestry; MA Group 3 includes Backcountry, Special Interest Areas and Roan Mountain; and MA Group 4 includes Wilderness, Wilderness Study Areas, Recommended Wilderness, and Research Natural Areas*

Conversely, alternatives with more acres in MA Groups 3 and 4 would likely develop conditions where native (and non-native) forest damage agents would interact with maturing later structural forests. It is also worth noting from the ecological sustainability analysis that MA Groups 3 and 4 would likely have lower incidences of anthropogenic non-native species introductions (road and trail vectors of dispersion). The opposite is true in MA Groups 1 and 2, which would have more active management but also greater flexibility to treat and control damage agents as discussed above. The threat from damage agents that are mobile, like emerald ash borer and hemlock woolly adelgid, are more likely to be distributed across the landscape regardless of the management area and associated disturbance patterns (i.e., harvest openings, roads).

**Table 164. Damage Agents of Forest Trees by Ecozone (Table 160-Table 162)**

<b>Ecozones</b>	<b>Table 160</b>	<b>Table 161</b>	<b>Table 162</b>	<b>Totals</b>
<b>Spruce Fir</b>	1	0	1	2
<b>Northern Hardwoods</b>	6	3	2	11
<b>High Elevation Red Oak</b>	9	4	3	16
<b>Dry Oak</b>	7	4	3	14
<b>Dry-Mesic Oak</b>	8	4	3	15
<b>Mesic Oak</b>	8	4	3	15
<b>Acidic Cove</b>	10	4	3	17
<b>Rich Cove</b>	12	4	3	19
<b>Shortleaf Pine</b>	5	4	4	13
<b>Pine-Oak/Heath</b>	6	4	4	14
<b>Floodplain</b>	7	3	1	11

The five ecozones that have the greatest number of tree-related health impacts are high elevation red oak (HERO), dry-mesic oak, mesic oak, acidic oak, and rich cove (Table 164). Alternatives B and D have slightly more acres of these ecozones in MA Groups 1 and 2, which allow for more management opportunities to address forest health impacts (Table 165). When Alternatives B and D are compared, Alternative D has slightly more high elevation red oak ecozone acres in MA Groups 1 and 2 compared to Alternative B. Between Alternatives B and D, Alternative D allocates fewer of these ecozones in MA Group 4, where management would be most restricted, and therefore retains more tools and options to address emerging needs than Alternative B.

**Table 165. Percentage of Ecozones by Alternative and Management Area Group**

<b>Alternative B</b>	<b>Group 1</b>	<b>Group 2</b>	<b>Group 3</b>	<b>Group 4</b>
<b>HERO</b>	41%	18%	12%	29%
<b>Dry-Mesic Oak</b>	72%	7%	10%	11%
<b>Mesic Oak</b>	60%	10%	11%	19%
<b>Acidic Cove</b>	61%	10%	12%	18%
<b>Rich Cove</b>	64%	9%	11%	16%
<b>Alternative C</b>	<b>Group 1</b>	<b>Group 2</b>	<b>Group 3</b>	<b>Group 4</b>
<b>HERO</b>	26%	27%	27%	20%

<b>Dry-Mesic Oak</b>	57%	17%	21%	6%
<b>Mesic Oak</b>	49%	20%	24%	7%
<b>Acidic Cove</b>	49%	17%	24%	10%
<b>Rich Cove</b>	49%	19%	26%	6%
<b>Alternative D</b>	<b>Group 1</b>	<b>Group 2</b>	<b>Group 3</b>	<b>Group 4</b>
<b>HERO</b>	38%	25%	11%	26%
<b>Dry-Mesic Oak</b>	71%	10%	12%	7%
<b>Mesic Oak</b>	59%	14%	14%	13%
<b>Acidic Cove</b>	60%	13%	13%	14%
<b>Rich Cove</b>	63%	13%	13%	11%
<b>Alternative E</b>	<b>Group 1</b>	<b>Group 2</b>	<b>Group 3</b>	<b>Group 4</b>
<b>HERO</b>	34%	16%	27%	23%
<b>Dry-Mesic Oak</b>	72%	8%	13%	7%
<b>Mesic Oak</b>	58%	12%	19%	11%
<b>Acidic Cove</b>	60%	11%	17%	12%
<b>Rich Cove</b>	62%	11%	18%	9%

The majority of damage agents affecting forest tree species are non-native (both now and in the future), and relatively few native damage agents are considered impactful enough to warrant management response. Under all alternatives native damage agents would continue to have impacts across all ecozones but would be allowed to progress at more endemic levels in MA Groups 3 and 4, because these MAs would have less active management. Alternative C includes more acres in MA Groups 3 and 4 and therefore has a larger component of the forest that would be subject to natural processes including disturbance events such as native pests and disease.

One native damage agent worth noting individually is southern pine beetle. With the increased emphasis in the revised forest plan for restoration of southern pine species, management of southern pine beetle populations would be a priority to fully establish functioning southern pine systems. Incidentally, successful management of southern pine beetle populations aligns closely with establishing desired communities within the range of ecosystem conditions (primarily woodland density with open understory) and reintroducing fire to maintain the structure and composition (Nowak et al. 2015) necessitating more opportunities for active management. When the pine ecozones are compared by alternative across the MA groups, Alternative D has slightly more shortleaf pine in MA Groups 1 and 2 compared to Alternatives B and C, and therefore more opportunities for active management. For pine-oak/heath, Alternatives B and D include slightly more acres in MA Groups 1 and 2 compared to Alternative C.

**Table 166. Percentage of Pine Ecozones by Alternative and MA group.**

<b>Alternative B</b>	<b>Group 1</b>	<b>Group 2</b>	<b>Group 3</b>	<b>Group 4</b>
<b>Pine-Oak/Heath</b>	56%	7%	16%	21%
<b>Shortleaf Pine</b>	85%	5%	3%	7%
<b>Alternative C</b>	<b>Group 1</b>	<b>Group 2</b>	<b>Group 3</b>	<b>Group 4</b>



<b>Pine-Oak/Heath</b>	43%	13%	34%	10%
<b>Shortleaf Pine</b>	81%	11%	7%	1%
<b>Alternative D</b>	<b>Group 1</b>	<b>Group 2</b>	<b>Group 3</b>	<b>Group 4</b>
<b>Pine-Oak/Heath</b>	56%	10%	19%	15%
<b>Shortleaf Pine</b>	88%	6%	5%	1%
<b>Alternative E</b>	<b>Group 1</b>	<b>Group 2</b>	<b>Group 3</b>	<b>Group 4</b>
<b>Pine-Oak/Heath</b>	56%	9%	21%	14%
<b>Shortleaf Pine</b>	88%	6%	5%	2%

## Damage Agents of Terrestrial and Aquatic Organisms and Plants

### White-nose Syndrome

Since the arrival of White-nose syndrome (WNS) in North Carolina in 2011, bat populations have been monitored by the NCWRC, USFWS, and other partners (including the Forest Service) using four approaches: hibernacula counts, mistnetting surveys, roost surveys, and acoustic monitoring. Substantial declines of little brown, tricolored, and northern long-eared bats have been documented during this time. Many of the long term mistnetting and hibernacula monitoring sites in Western North Carolina are on or near USFS lands. Mistnetting captures are down 93 percent, 69 percent, and 85 percent for little brown, tricolored, and northern long-eared bats, respectively; and hibernacula counts are down 94 percent, 97 percent, and 100 percent for these species.

Populations of these species are now very small; however, recent surveys indicate that numbers may be stabilizing. Northern long-eared bats are federally listed as Threatened (4d), with WNS identified as the primary threat to species' persistence. Additionally, tricolored bats are proposed for federal listing for the same reason.

### Other Damage Agents to Animals

Several other threats to animals on the forest are currently being studied, and much is still unknown about the level of threat they pose to terrestrial and aquatic organisms on the Nantahala and Pisgah NFs. Current known threats include:

- **Chytridiomycosis:** caused by fungal pathogens *Batrachochytrium dendrobatidis* (Bd) and *B. salamandrivorans* (BSal): affects amphibians,
- **Ranavirus:** caused by viral pathogens of the genus *Ranavirus*: affects reptiles and amphibians,
- **Snake Fungal Disease:** caused by fungal pathogen *Ophidiomyces ophiodiicola*: affects reptiles (primarily snakes),
- **Didymo** (Rock Snot): nuisance growth of diatoms, *Didymosphenia 445 eminate*: disrupts aquatic ecosystem processes and function,
- **Whirling Disease:** caused by invasive parasite, *Myxobolus cerebralis*: affects trout (primarily rainbow trout),
- **Gill Lice:** caused by parasitic copepods of the species *Salmincola*: affects trout (primarily brook trout)

### **Damage Agents of Herbaceous Plants**

Gray's Lily (*Lilium grayi*) is a species of conservation concern that is endemic to balds, bogs, seeps, and wet meadows at mid to high elevations in North Carolina, Tennessee, and Virginia (Weakley 2015). Gray's lily is affected by a fungal phytopathogen (*Pseudocercospora inconspicua*) that results in early senescence of 59-70 percent of mature individuals and almost all juveniles (Ingram et al 2018). The fungus can affect seed capsules resulting in a reduced number of mature capsules, less seeds, and reduced viability. Recent research has indicated the fungus is also affecting the more common Turk's cap lily (*Lilium superbum*) which could be serving as reservoirs for the fungal spread (Barrett 2017). As a result of significant threats from the fungus and hybridization with Canada lily (*Lilium canadense*), the global rank for Gray's lily has been changed from G3 to G1G2, a critically imperiled designation (NatureServe 2019).

### **Environmental Consequences - Damage Agents of Terrestrial and Aquatic Organisms and Plants**

Damage agents that affect wildlife, including White-nose syndrome, fungal and viral pathogens, and parasites will continue to affect wildlife populations under all alternatives. However, most of these agents are relatively new threats. Not much is known about the distribution and potential effects of chytridiomycosis, ranavirus, snake fungal disease, didymo, whirling disease, and gill lice. Currently, these threats are still below "clinical levels" and not considered widespread. Diligent work by the Forests and many partners continue to assess the severity of these threats. White-nose syndrome is the most studied of the threats to native animals (bats) on the Forests, although its occurrence is also still being discovered across the Forests.

#### **Alternative A**

The current forest plan (Alternative A) does not address animal pests and pathogens. However, this does not prohibit proactive inventory and treatment of such threats as long as these treatments are consistent with other plan direction.

#### **Common to Action Alternatives**

The proposed revised forest plan emphasizes cooperation with partners to identify and control damage agents of terrestrial and aquatic organisms on the Nantahala and Pisgah NFs. As mentioned earlier, very little is known about most of these threats, and improved understanding is the first step in addressing the issues. This is reflected in the need for further study and documentation.

Within the proposed revised forest plan, the importance of maintaining healthy animal communities is integrated into all sections of the plan. Specifically, there are three standards addressing the mitigation of the White-nose syndrome threat to bats:

- PAD-S-10: Post and enforce the regional cave and abandoned mine closure order at all biologically significant caves and other known bat hibernacula (e.g., abandoned mines, large rock shelters, cliff faces) to control human disturbance and prevent the spread of White-nose syndrome in cave-associated bats, including, but not limited to, the federally endangered Indiana bat and threatened northern long-eared bat.
- PAD-S-11: If cave and mine closure orders are found to be ineffective at protecting hibernating bats from human disturbance, construct and maintain gates or other structures that allow for entrance and egress by bats.

- PAD-S-12: Follow all USFWS direction concerning mitigation efforts for the effects of White-nose syndrome on susceptible bat species, including decontamination protocols for people permitted to enter caves and mines for purposes identified in the closure.

### **Comparison of Alternatives**

Impacts to animal species from the pests and pathogens identified above are likely to occur regardless of what alternative is implemented. However, the proposed forest plan addresses the main threat to animal species, White-nose syndrome impacting bats, directly through plan standards to mitigate the spread of the fungus.

### **Grey's Lily**

All of the Gray's lily populations currently known on the Forests occur at Roan Mountain (Biotics 2019). The phytopathogen affecting Grey's lily would continue to impact populations at Roan Mountain under all alternatives.

The current forest plan (Alternative A) does not directly address Gray's lily but does include plan direction in the Roan Mountain MA to control insects and diseases as needed. Alternatives B, C, D, and E all include desired conditions to protect biodiversity of the area at the landscape, community, species, and genetic levels. Additionally, all action alternatives include objectives to maintain the existing grassy balds and restore 10-20 acres of grassy balds on Roan Mountain which would create more favorable conditions for Gray's lily.

Under all alternatives, the Southern Appalachian Highlands Conservancy, in partnership with the USFS and the Appalachian Trail Conservancy, would continue to provide interpretive signage at Roan Mountain that informs the public about the spread of the fungal disease and the importance of not touching the plants. The reduction of woody encroachment at Roan Mountain and continued monitoring of Grey's lily populations would provide the best opportunity to conserve this species.

### **Non-native Invasive Plant Species**

A multitude of non-native invasive plants threaten the integrity of native ecosystems and forest health on the Nantahala and Pisgah NFs. Although not addressed in the 1994 forest plan, the national forests in the Southern Region began implementing a noxious and invasive weed strategy following the signing of National Executive Order 13112 in June 1999. This order charges federal agencies with:

1. Preventing the introduction of invasive species;
2. Detecting and responding rapidly to control new invaders;
3. Monitoring;
4. Providing for restoration of native species and habitat conditions in invaded ecosystems;
5. Promoting public education on invasive species; and
6. Avoiding actions likely to cause their introduction and spread.

Public and agency awareness of the threat of non-native invasive species on forest health, biodiversity, and ecological sustainability has increased over the last 20 years. Established in 1999, the Southeast Exotic Pest Plant Council serves as an educational, advisory, and technical support council on all aspects of invasive exotic pest plant issues across the Southeast. The Chief of the Forest Service named non-native species as one of the four major threats to the National Forest System in 2006. The Forest Service updated their national strategic framework for invasive species management in 2013 (USDA Forest Service 2013). Across the Southeast, of the 380-plus recognized non-native plants in southern forests and grasslands, 53 are rated high-to-medium risk for natural communities (Wear and Greis 2012). The

Forest Service issued new invasive species management directives (Forest Service Manual 2900), effective December 5, 2011, which set forth Forest Service policy, responsibilities, and direction for the prevention, detection, control, and restoration of effects from aquatic and terrestrial invasive species (including vertebrates, invertebrates, plants, and pathogens).

The Nantahala and Pisgah NFs have identified a list of priority non-native invasive plants that pose threats to native ecosystems and rare habitats on the Forests. Plants are prioritized for treatment based on their rate of spread and threat to threatened and endangered species and rare habitats. Species with the highest treatment needs are those that rapidly spread in riparian zones, mesic, high nutrient coves, and habitat that has been affected by high severity fires. High priority species also pose a high risk to rare habitats and species. Medium priority species are those that are not as likely to invade closed canopy sites and pose less of a threat to rare habitats and species. Low priority species are those that are either not widely spread or are concentrated in small areas, and control is targeted only within the most susceptible rare habitats. Table 167 provides a list of priority species that are well-established on the Forests and have specific plan direction for treatment. This list is not comprehensive and only identifies the highest priority species at this point in time; as new NNIS are identified and become established on the Forests, they will be evaluated and treated consistent with forest plan direction.

**Table 167. Forestwide Prioritized Non-Native Invasive Plants**

Life Form	Species	Common Name	Priority
Tree	<i>Paulownia tomentosa</i>	Princess Tree	high
Tree	<i>Ailanthus altissima</i>	Tree-of-Heaven	high
Tree	<i>Albizia julibrissin</i>	Mimosa	low, targeted
Tree	<i>Elaeagnus pungens</i>	Russian Olive	low, targeted
Tree	<i>Pyrus calleryana</i>	Callery Pear	low, targeted
Shrub	<i>Rosa multiflora</i>	Multiflora Rose	high
Shrub	<i>Elaeagnus umbellata</i>	Autumn Olive	high
Shrub	<i>Spiraea japonica</i>	Japanese Spiraea	high
Shrub	<i>Reynoutria japonica</i>	Japanese Knotweed	high
Shrub	<i>Rubus phoenicolasius</i>	Wineberry	low, targeted
Shrub	<i>Mahonia bealei</i>	Leatherleaf Mahonia	low
Shrub	<i>Nandina domestica</i>	Nandina	low
Shrub	<i>Euonymus alatus</i>	Burning Bush	low, targeted
Shrub	<i>Citrus trifoliata</i>	Trifoliolate Orange	low
Shrub	<i>Lespedeza bicolor</i>	Bicolor Lespedeza	low, targeted
Shrub	<i>Lythrum salicaria</i>	Purple Loosestrife	low, targeted
Shrub	<i>Ligustrum sinense/japonica</i>	Privet	moderate
Shrub	<i>Berberis thunbergia</i>	Japanese Barberry	moderate
Shrub	<i>Buddleja davidii</i>	Butterfly-bush	low, targeted
Vine	<i>Celastrus orbiculatus</i>	Oriental Bittersweet	high
Vine	<i>Vinca minor/major</i>	Periwinkle	low
Vine	<i>Akebia quinata</i>	Five-leaf Akebia	low

Life Form	Species	Common Name	Priority
Vine	<i>Hedera helix</i>	English Ivy	low
Vine	<i>Wisteria floribunda/sinensis</i>	Japanese/Chinese Wisteria	low, targeted
Vine	<i>Glechoma hederacea</i>	Creeping Charlie	low
Vine	<i>Ampelopsis glandulosa</i>	Porcelain-berry	low, targeted
Vine	<i>Securigera varia</i>	Crown Vetch	low, targeted
Vine	<i>Pueraria montana var. lobata</i>	Kudzu	moderate
Vine	<i>Lonicera japonica</i>	Japanese Honeysuckle	moderate
Vine	<i>Dioscorea polystachya</i>	Chinese Yam	moderate
Vine	<i>Persicaria perfoliata</i>	Mile-a-minute	not on forest
Vine	<i>Clematis terniflora</i>	Sweet Autumn Clematis	low, targeted
Grass	<i>Miscanthus sinensis</i>	Chinese Silvergrass	high
Grass	<i>Arthraxon hispidus</i>	Basket Grass	low
Grass	<i>Arundo donax</i>	Giant Reed	low
Grass	<i>Lolium arundinaceum</i>	Tall Fescue	low
Grass	<i>Sorghum halapense</i>	Johnson Grass	low, targeted
Grass	<i>Microstegium vimineum</i>	Japanese Stiltgrass	low, targeted
Grass	<i>Phyllostachys aurea</i>	Golden Bamboo	low, targeted
Grass	<i>Phragmites australis</i>	Common Reed	moderate
Grass	<i>Imperata cylindrica</i>	Cogongrass	not on forest
Forb	<i>Aillaria petiolata</i>	Garlic Mustard	high
Forb	<i>Centaurea stoebe ssp. micranthos</i>	Spotted Knapweed	high
Forb	<i>Cirsium arvense</i>	Canadian thistle	high
Forb	<i>Hemerocallis fulva</i>	Daylily	low
Forb	<i>Hosta ventricosa</i>	Hosta	low
Forb	<i>Murdania keisak</i>	Asian Spiderwort	low, targeted
Forb	<i>Verbascum thapsus</i>	Mullein	low
Forb	<i>Anthriscus sylvestris ssp. sylvestris</i>	Wild Chervil	low, targeted
Forb	<i>Iris pseudoacorus</i>	Yellow Flag	low, targeted
Forb	<i>Mosla dianthera</i>	Beef Steak	low, targeted
Forb	<i>Tussilago farfara</i>	Coltsfoot	low, targeted
Forb	<i>Youngia japonica</i>	Youngia	low, targeted
Forb	<i>Ficaria verna</i>	Lesser Celandine	not on forest
Forb	<i>Heracleum mantegazzianum</i>	Giant Hogweed	not on forest

## Environmental Consequences

### Alternative A

The Nantahala and Pisgah NFs have been implementing non-native invasive plant treatments consistent with meeting the goals of Executive Orders 13112 and 13751 over the last ten years; however, Alternative A does not include plan direction to help ensure the prevention, early detection and rapid response, control and management, or rehabilitation and restoration of ecosystems degraded by non-native invasive plant species. Activities that disturb soil and increase light availability in proximity to known non-native invasive plant populations have the potential to increase the possibility for spread of these populations (Evans et al. 2006). Non-native invasive plants would continue to increase across the landscape, impacting forest and ecosystem health and composition, structure, and function. Under Alternative A, treatment of non-native invasive species populations would generally occur during implementation of vegetation management projects consistent with the 2009 Forestwide Decision on Non-native Invasive Plant Control (updated in a Supplemental Information Report in 2021). These projects would target sites where non-native invasive plants are impacting rare habitats, rare species, or natural areas, where projects are cooperatively working across multi-ownership boundaries, or where vegetation management proposals could increase existing infestations. The Forestwide Decision on Non-native Invasive Plant Control and associated environmental analysis includes a comprehensive analysis of the effects of herbicide treatments for NNIS on the Nantahala and Pisgah NFs. This decision includes specific design criteria and an implementation checklist to ensure compliance with herbicide application and Forest Plan direction.

### **Common to All Action Alternatives**

Alternatives B, C, D, and E include desired conditions, objectives, and guidelines that address the treatment of non-native invasive species to lessen the impacts from invasive species on native species and ecosystems. Plan standards and guidelines include ensuring equipment is clean and free of plant material before entering the National Forest (FHL-S-01), prohibiting the use of non-native invasive plant species in revegetation or planting efforts (FHL-S-03), and the use of integrated pest management to suppress and control invasive species outbreaks (FHL-G-01). Alternatives B, C, and D have Tier 1 objectives for annual treatment of 750 to 1,500 acres of non-native invasive plants with priority treatment at sites where invasive species are impacting rare species. The objective also includes inventorying approximately 1,000 to 2,000 acres which would help the Forests identify where new infestations are occurring and impacting ecosystems. Tier 2 objectives for Alternatives B, C, and D include control and eradication of non-native invasive plants on up to 3,000 acres annually and inventory of approximately 4,000 acres. Alternative E increases the objective for treatment of NNIS to 1,500 – 3,000 acres under Tier 1 and 3,000 – 5,000 acres under Tier 2. These increased objectives for NNIS treatment in Alternative E would allow for more treatment across the forest in high priority areas.

Through the inclusion of standards, guidelines, and objectives for the treatment of non-native invasive plant species, Alternatives B, C, D, and E include greater emphasis on the control and eradication of invasive species populations compared to Alternative A. Alternatives B, C, D, and E also include objectives for more acres of vegetation management compared to Alternative A, which would result in a greater amount of soil disturbance and potential for new invasive species infestations. Tier 2 objectives for vegetation management would disturb more acres of forest compared to Tier 1 objectives, therefore the risk of non-native invasive plants impacting forest ecosystems would be greater under Tier 2 vegetation management objectives compared to Tier 1 objectives. With the increased potential for more invasive species under Tier 2 vegetation management objectives, the Tier 2 objectives for invasive species treatment should be implemented in order to reduce the potential impacts of new invasive species infestations.

Compared to Alternative A, Alternatives B, C, D, and E place greater emphasis on the prevention and spread of non-native invasive plant infestations. As part of prevention, closed and decommissioned roads would be revegetated with native plant species. Non-native invasive species would not be used to

vegetate or revegetate roads or rights-of-way (road and utility) on the Forests under any alternative. Equipment cleaning, which prevents the introduction and spread of non-native invasive species, would be incorporated when implementing projects involving mowing or ground-disturbance, including contracts and special uses. Genetically appropriate native perennial or annual plant species would be used, preferably from local sources when seeding temporary openings (such as temporary roads, skid trails, and log landings) or when other agreements with road and utility partners are secured. Landscape-level cooperation in the form of cooperative weed management areas, though not common due to the fragmented nature of land ownership patterns, would be encouraged and considered. All these actions would help prevent some outbreaks; however, it is anticipated that there would be an increased risk of infestations with Tier 1 objectives compared to the Alternative A. Over the last five years, treatment of NNIS has ranged from 800 to 1,300 acres annually. Thus, with an increase in vegetation treatments, and new road construction and reconstruction continuing at existing levels, an increase in non-native invasive plant infestations is expected. Since the majority of vegetation management activities would occur in MA Group 1, Alternative C, with approximately 100,000 fewer acres in Group 1, would have a lower risk of non-native invasive plant spread (Table 168).

**Table 168. Approximate Acres in MA Groups by Alternative**

<b>Alternatives</b>	<b>Group 1</b>	<b>Group 2</b>	<b>Group 3</b>	<b>Group 4</b>
<b>Alternative B</b>	621,000	102,000	126,000	193,000
<b>Alternative C</b>	496,000	186,000	267,000	94,000
<b>Alternative D</b>	618,000	134,000	147,000	144,000
<b>Alternative E</b>	607,000	113,000	200,000	121,000

While Tier 2 greatly increases treatment of non-native invasive plants, the increased amount of vegetation management activities would further increase the risk of spread. It is anticipated this greater risk would further increase infestations compared to Tier 1 objectives. Tier 2 objectives for prescribed fire would also increase the amount of forest susceptible to infestations of non-native invasive species, particularly princess tree and Chinese silvergrass, which are known to invade a site after intense fire.

Alternative E objectives are at least twice as high for prescribed fire versus Alternatives B, C, and D, which would potentially result in greater amounts of ground disturbance across the forest. Tier 1 effects would be similar to Tier 2 effects for Alternatives B, C, and D. This increase also includes a prescription of creating some young forest with high intensity prescribed burns in fire adapted ecozones. A recent review of both wildfires and prescribe burns in Western NC indicates more disturbed openings within the driest fire adapted ecozones (Norman et. al. 2021). In addition, fire disturbances were found to be more prevalent within the Eastern Escarpment Geographic Area compared to the rest of the Nantahala and Pisgah NFs. While drier ecozones are less susceptible to NNIS infestations compared to more mesic ecozones, an increase in princess tree, Chinese silver grass, and tree-of-heaven is anticipated with increased prescribed fire objectives. Regardless of the higher risk across drier portions of the landscape, NNIS treatments will be prioritized in areas where NNIS are impacting rare habitats, rare species, or natural areas. It will be important to concentrate monitoring and control, of invasive plant infestations within the Eastern Escarpment. Additionally, the increased emphasis on partnerships in Alternatives B, C, D, and E will be critical to providing the necessary support to achieve Tier 2 objectives for non-native invasive treatment in areas where they are impacting rare habitats and rare species. It is anticipated that there will be small NNIS infestations that will continue to impact dry ecozones where control efforts will be difficult to achieve.

### **Cumulative Effects – All Damage Agents**

Given the wide-ranging effects of different damage agents across the southern Appalachians, mobility of many of the current damage agents across the landscape, continued sensitivity in the eastern United States to non-native introductions (Fei et al. 2019, Potter et al. 2019a), and climate change, cumulative effects of the proposed revised forest plan are similar to the alternatives discussed above. Alternatives that allow for flexibility in management of damage agents and restoration of conditions that are resilient will improve forest health goals at the landscape scale. Drivers of forest health for the southern Appalachians as a whole will depend on environmental conditions that develop as the climate changes, invasions of existing pests or introductions of new ones (likely moved anthropogenically), changes in host conditions, and population/land use trends. Though currently identified as relatively resistant to invasions at an ecological level due to low forest disturbance levels and higher levels of species diversity (Iannone III et al. 2016), as the southern Appalachians become more developed there is an increased risk from invasive species and damage agents. Land ownership patterns in the southern Appalachians also play a role in the development of forest health issues now and in the future. Efforts by the USFS to engage in all lands management may assist with controlling the movement of damage agents from adjacent private lands onto the Nantahala and Pisgah NFs. The action alternatives better enable this all lands focus to approaching forest health challenges.

The Southern Forest Futures Project conservatively estimates that the annual spread of non-native invasive plants in southern forests is 145,000 acres, accelerated by a warming climate and by increasing numbers of forest disturbances that accommodate and support growing human populations (Wear and Greis 2012). The majority of non-native invasive plants are unregulated on all but Federal lands; some continue to be sold commercially. Given the lack of adequate regulatory mechanisms, the exponential growth curve of non-native invasive plant infestations, climate change predictions, and the high costs of control, invasive plant species will increasingly threaten the composition and function of our terrestrial and aquatic ecological systems across the United States in the future.



## **3.4 Social Environment**

### **3.4.1 Lands and Special Uses**

#### **Affected Environment**

The Lands program includes land exchanges, purchases, boundary management, and other real estate type activities. Special uses include authorizations for individuals, corporations, and other government agencies to use NFS lands for multiple purposes that are determined to be in the public interest and are compatible with management direction in the forest plan.

Within the Pisgah and Nantahala NFs, there are 1,043,162 acres of NFS lands that are managed by the Forest Service. The Forests' landownership pattern can be described as large blocks of contiguous NFS lands; isolated tracts of private lands surrounded by NFS lands; isolated tracts of NFS lands surrounded by private lands; and large blocks owned by corporate landowners.

In the 1994 amendment to the forest plan, the Forests included 1,030,242 acres of NFS lands. Since then, the Forests have acquired approximately 13,000 acres of land through the Land and Water Conservation Fund, a federal land acquisition program set up to secure critical tracts of land for the benefit of all Americans. The Forests have purchased lands through the National Trails System Act to provide for the conservation and enjoyment of the nationally significant scenic, historic, natural, or cultural qualities of the areas through which national scenic trails, such as the Appalachian National Scenic Trail, may pass.

Additionally, the Forests periodically exchange lands for the mutual benefit of each party through the Weeks Law, the Federal Land and Management Policy Act, and the Federal Land Exchange Facilitation Act; and the Forests dispose of property by means of the Small Tract Act and the Forest Service Facility Realignment and Enhancement Act of 2005. Procedures for processing land acquisitions have been and will continue to be the means to acquire and maintain larger intact ecosystems or improve recreational or management access.

The Forest has approximately 4,140 miles of property boundary lines. Fifty-eight percent of these boundary lines have been painted and posted at some time. The boundary lines are maintained on a rotating basis with highest priority on high density urban interface areas. The miles of boundary lines marked or maintained varies greatly based on factors such as budget and available resources.

Special use authorizations for use of NFS land include activities such as outfitting and guiding, recreation events, communication facilities, research, photography and video productions, and utility rights-of-way. The greatest number of special use authorizations issued on the Forests are for state highway easements and for outfitting and guiding activities.

Outfitting and guiding activities include hiking, biking, rock climbing, rafting, horseback riding, and fishing, to name a few. Outfitting and guiding conducted on NFS lands has become one of the primary means for the recreating public to experience the outdoors. The trend has remained constant for outfitting and guiding proposals with hiking, biking, and backpacking being the most common. The Forests had a 44 percent increase in proposals for recreation events on the Forests from 2011 to 2012 and an additional 20 percent increase from 2012 to 2018.

The Forests administer 1,211 special use authorizations, of which 428 authorizations are categorized as recreation and 783 authorizations as lands. Recreation special uses range from authorizations for outfitting and guiding to concession campgrounds and marinas. Lands special uses range from authorizations to landowners for a driveway to communication towers, research, public road easements,

and utilities including power, phone, and gas lines. Each authorization contains terms and conditions designed to protect the public interest in accordance with applicable statutes, rules, and regulations. Periodic reviews and inspections of recreation and land uses seek to ensure that the terms and conditions are met and to identify and correct non-compliance issues.

The Forests commonly allow communities, industry, and other entities to use public lands for infrastructure including utility rights-of-way and communication facilities. The growing demand for energy has generated increased emphasis on the management of utility corridors to provide additional services and to expand or create new corridors on National Forest System lands. When new corridors are being considered, the project level effects of these corridors on forest resources are considered in detail, including, for example the potential fragmentation of the forest or spread of nonnative invasive species.

Procedures for the review and response times of special use proposals are set by policy and regulations outside the forest plan and will apply regardless of the alternative selected, as well as procedures for allocating outfitting and guiding use by conducting needs assessments and resource capacity analyses.

## **Environmental Consequences**

### **Common to all alternatives**

Criteria for landownership adjustments is consistent among all alternatives. None of the alternatives propose any site-specific changes to the existing land ownership on the Forests. No conveyances (acquisitions, disposals, or exchanges) are proposed in the forest plan. These actions would only be considered during plan implementation when an external entity presents a proposal.

There have been changes in special use policy and regulations since the 1994 plan. Some plan direction and terminology in the 1994 amended plan may no longer be consistent with current regulations and screening criteria. Current regulations would be followed under all alternatives.

Land special use requests such as new infrastructure needed for energy transmission, communications, water transmission, and other services that cannot otherwise be located on private land could not be provided or developed on lands recommended for wilderness in any alternative. This could impact public health and safety, community services, economic growth, and sustainability and result in increased impacts on private lands.

### **Differences between alternatives**

The authorization of new special uses could vary by alternative based on the management direction for the area. The most significant effect would be in Alternative B which recommends the largest amount of acres for wilderness. No new utilities or road easements (unless required by regulation or law) would be allowed in recommended wilderness, and no authorizations for commercial recreation events would be allowed in recommended wilderness areas.

The reliance on existing utility corridors and existing communication sites is included in all alternatives except for Alternative A. As a result, new corridors and communication sites would be minimized across the Forests in Alternatives B, C, D, and E.

### **Alternative A**

Priorities for acquisition of land may change over the life of the plan as resources of value are discovered and identified and additional species or conditions are found.

Under the current forest plan, an amendment is required to assign a new acquisition to a management area. Many lands that have been acquired have not implemented the plan amendment yet, and remain unassigned to a management area. NEPA projects that include unassigned parcels have to do a

concurrent forest plan amendment to assign the area a management area designation, or activities in the area have to be general enough that they could proceed under any management area on the forest.

The 1994 plan includes specific boundary management direction, but timeframes do not reflect current limitations in budget and the flexibility to determine priority work.

Special use authorizations would continue to be evaluated and issued in response to public requests for use of the Forests. No authorizations would be issued for recreation event activities within Wilderness and Wilderness Study Areas.

### **Alternatives B, C, D, and E**

Under the action alternatives, new land acquisitions are managed according to adjacent or surrounding management area direction. When not compatible with the resource values of the acquisition, or if the acquired land is not adjacent to or surrounded by existing NFS lands, a management area can be assigned based on the appropriate management area direction for the acquired lands.

Boundary management direction in the action alternatives has a greater focus on priority areas compared to Alternative A, including a LSU-DC-06 which states that "Boundary lines and property corners are easily locatable and highly visible."

Alternatives B, C, D, and E would retain much of the special uses direction from the 1994 plan and include direction to minimize new utility corridors and communication sites by co-locating or expanding existing sites. For any proposed actions, scenery management standards would require design modifications or mitigation to be utilized, to reduce scenery impacts and meet the assigned Scenery Integrity Objective (SIO). These proposed actions would also undergo project level analysis to consider associated viewpoints at all use areas, water bodies, open roads, trails, and closed roads used as trails for areas with a High, Moderate, or Low SIO and from any location within an area with a Very High SIO. In addition, all special uses would seek to blend with the natural environment by repeating elements of form, line, color, texture, pattern, and scale found within the characteristic landscape.

Alternatives B, C, D, and E include LSU-S-14 which requires equipment cleaning practices to be incorporated in special use authorizations to prevent the introduction and spread of non-native invasive plants. Population growth and popularity of the forest by tourists continues to increase pressures for recreation in a forest setting. LSU-S-05 identifies the need to address the continued increase in recreation activities. In Alternatives B, C, D, and E, project level analysis would be conducted to allocate commercial recreation use when considering significant changes to current use or demand.

Since Alternative B recommends more areas for Wilderness, in addition to a reduced ability to respond to lands special uses, there would be a reduction in opportunities for recreation special use events on the Forests. This would impact a few existing recreation events that occur in areas recommended for wilderness in Alternative B. This could result in a reduction in local tourism associated specifically with recreation special events such as endurance races that are not permitted in Recommended Wilderness. The number of outfitting and guiding participants in Recommended Wilderness Areas would be limited to 10 individuals on the same trail at the same time.

There would be no affect to existing recreation special use events in Alternatives C, D, and E, because there are no existing permitted events occurring within areas recommended for wilderness in these alternatives.

### **Cumulative Effects**

The cumulative environmental consequences are spatially bounded by an area larger than the forest proclaimed boundary within the 18-county area of Western North Carolina. This analysis of cumulative effects considers foreseeable activities over the next 10 to 15 years.

The Forests are expected to see continued population growth in communities within and surrounding the Forests that have the potential to influence landownership adjustment cases, create boundary issues, and increase the demand for special uses. This growth is expected and would add to the demand to provide land for infrastructure for community expansion. Requests for changes to existing special use authorizations for communication sites can be expected as technological advances are made. On the Forests, these sites typically occupy small areas of one to two acres.

As private property is developed, encroachment into NFS lands becomes more frequent, resulting in resource impacts and increased land survey needs. This growth would likely result in continued pressures to maintain NFS lands for recreational and open space values.

All alternatives acknowledge community needs and minimize impact to resources. These cumulative effects would be consistent across all alternatives.

### **3.4.2 Cultural Resources**

#### **Affected Environment**

The rich cultural mosaic of the Blue Ridge mountains and foothills of North Carolina has its origins in three separate continents—North America, Europe, and Africa. There are three major strands of this rich tapestry of cultural heritage, including Native American Heritage, Scots-Irish Heritage, and African Heritage. The cultural traditions of these three groups have blended into a culture unique to the Southern Appalachian Mountains. Historically, the mountains have helped to protect and nurture this cultural mosaic by providing a degree of relative isolation from the rest of the state and nation.

The USDA Forest Service's 2011 Western North Carolina Report Card on Forest Sustainability lists "cultural/spiritual values" as an indicator of socioeconomic benefits. A rating of "improving" was assigned to this indicator as "the contribution of arts and craft to the regional economy is significant and is considered an industry with a demonstrated competitive advantage relative to the rest of the State and the Nation." It is this relationship between the mountains and the communities, including their arts, crafts, music, and lifestyles, which grows the strong sense of place present in Western North Carolina. Cultural identity connections to the National Forests and Western North Carolina have been longest and strongest among Native Americans.

Similar to the historic settlement of the southern United States, the continued development of Western North Carolina was greatly influenced by a diversity of ethnic groups and religious denominations. The North Carolina mountains and foothills ring with the sounds of the fiddle, banjo, string bands, and cloggers, invoking styles that blend musical elements from multiple continents. Today, over 4,000 craftspeople live and work in Western North Carolina, where traditional and contemporary crafts flourish side-by-side and create a craft economy of more than \$206 million in the region. Visitors from all over the world come to the area in search of Native American and Appalachian crafts.

Gathering and trading of plants, lichens, and fungi from forests in the United States has been important for generations, both traditionally and economically. Local residents have collected and used food, medicinals, and craft plants for thousands of years. Along with local stone resources such as soapstone and mica, many important plants were exchanged. A few of the forest products which have been traditionally collected include ginseng, which is a valuable medicinal, as well as black cohosh and bloodroot which are often sought out for their commercial value. Galax is an evergreen ground cover harvested for use in the floral industry, and Mountain laurel, rhododendron, river cane and white oak are also used for traditional crafting. (*See Forest Botanical Product section*)

The tradition of hunting and fishing for food is also deeply rooted in these forests. With the acquisition of the Biltmore lands, the Federal government established the Pisgah National Forest and Pisgah

National Game Preserve in 1916. At that time, the Pisgah area was proposed as a game refuge for the preservation of the fauna of the mountains. The area was well stocked with game and fish, including deer, turkey, and pheasant, while the streams were stocked with rainbow and brook trout. Today, hunting and fishing are still valued, not just as part of culture, but for subsistence and a way of life. Data from big game protein harvested on public gamelands from 2015-2016 across the Nantahala and Pisgah counties shows that the hunted deer, bear, and turkey alone provided protein for more than 285,000 meals.

Places themselves have important cultural significance to people on the forest – sometimes in terms of a long-lasting spiritual connection, other times in the context of a personal experience or memory. Having the opportunity to share places with the next generation is a cultural value.

Cultural resources include the artifacts, archeological sites, and built environments created by past inhabitants, our ancestors, and those areas used or affected by them with their ways of life. The Forest Service's Heritage Program effectively identifies, considers, and manages the multitude of these resources including National Register of Historic Places properties, traditions, folkways, beliefs, Traditional Cultural Properties, and Native American Sacred Sites. The heritage program on the National Forests in North Carolina strives to provide the link between past and present cultures; to expand knowledge and understanding of the past; to share the cultural and archeological resources with the public; to actively care for the resources; to participate in ecosystem management; and to support on-the-ground project management activities.

At the time of the forest plan assessment, based on data in the National Resources Manager database, the Nantahala and Pisgah NFs currently have 3,615 recorded cultural resource sites, archeological sites, historic structures, cemeteries, and traditional cultural properties. These cultural resources were located during inventories of 85,628 acres and averaged one site recorded in every 24 acres surveyed. In addition to sites, the revised forest plan brings new recognition to congressionally designated National Historic Trails (NHTs), National Millennium Trails, and other historic routes eligible for listing on the National Register of Historic Places (NRHP). There are two NHTs located on the Nantahala and Pisgah National Forests: the American Revolution Overmountain Victory Trail and the Trail of Tears. The American Revolution Overmountain Victory Trail (OMVT) was designated in 1984. The 330-mile long OMVT route, which was used to reach Kings Mountain during the American Revolution, crosses 7.6 miles on the Appalachian and Grandfather Ranger Districts of the Pisgah National Forest. The Trail of Tears, a tribally recognized sacred site, commemorates the removal of the federally recognized tribes and the paths that 17 Cherokee detachments followed westward in 1838-1839. The National Millennium Trail Unicoi Turnpike (UT), on the Nantahala National Forest, is a commercial wagon road crossing the Southern Appalachians that was also used as part of the Trail of Tears route from North Carolina into Tennessee. Both the Trail of Tears and Unicoi Turnpike are further discussed in the Tribal Resources section.

More information about the on-the-ground location of the Trail of Tears National Historic Trail became available between the draft and final EIS, thus the location of the Heritage Corridor Management Area was adjusted to reflect this new information. For detailed information about acreage changes associated with this map correction, see EIS Appendix B.

## **Environmental Consequences**

All activities that cause ground disturbance, soil movement or mixing, compaction, deflation, and/or changes in soil moisture have the potential to adversely impact cultural resources. Activities that have the potential to impact or uncover cultural resources include skidding and yarding of timber, road and trail construction and reconstruction, road and trail use, user created trails, wildlife field construction and maintenance, disking or subsoiling, facility construction, fire-line construction, mining, unauthorized

rock hounding, unmanaged rock climbing, and dispersed camping. The repeated implementation of these activities could, over time, result in the degradation of sites, a potential reduction in the number of intact historic properties, and increased site vandalism. However, the policy common to all alternatives are designed to inventory, evaluate, and preserve significant cultural resource values through avoidance, minimization, or mitigation of negative effects of these management activities. Cultural resource surveys occur prior to planned activities so that impacts can be avoided or mitigated.

Archeological site looting and unauthorized collection of artifacts continues to be an impact to cultural resources on the Nantahala and Pisgah NFs.

Historic sites, structures, and traditional cultural properties can also be adversely affected by effects to the cultural landscape – visual or even audible intrusions. Historic structures can be adversely affected by neglect or by maintenance or repairs that do not conform to the Secretary of the Interior’s standards for historic properties. The Forest Service is legally required to consider those cultural resources that are listed in or eligible for listing in the National Register of Historic Places (historic properties) or those cultural resources that have not yet been evaluated for National Register eligibility (unevaluated cultural resources). For planned project activities, cultural resource surveys and reviews are completed prior to the action taking place and recommendations for site protection must be followed. Sites are recorded, and significant sites are recommended for avoidance.

Low intensity prescribed fires typically do not adversely affect cultural resources, as flammable historic structures and markers would be avoided during implementation. However, low intensity burns can lead to exposure of artifacts, making them susceptible to unauthorized and illegal collection and looting. This is especially true where pre-contact sites may have surface manifestations and are relatively shallow in the soil. High intensity burns also create opportunities for looting, increase the likelihood of direct adverse effects to pre-contact stone (quartzite and quartz), ceramic, and metal artifacts, and can cause increased erosion of resultant bare soils. Fire-line and dozer-line construction can affect an archaeological site’s integrity and expose artifacts through soil disturbance. Increased burn acres are often associated with increased fire-line construction which could lead to an increase in potentially adverse effects to cultural resources.

Roads and trails can directly impact cultural resource sites if their construction or use exposes artifacts to damage and/or unauthorized collection. On the positive side, roads and trails provide increased opportunities for public interpretation and scientific research of cultural resources.

Increased public access and use of National Forest System lands has the potential to affect cultural resources, particularly activities associated with motorized access and dispersed camping. With greater public use or higher concentration of use comes the potential for inadvertent discovery and compaction of archaeological sites, as well as vandalism of sites, historic buildings, and structures. On the other hand, recommending areas for wilderness designation results in restrictions on the use of mechanized equipment and motorized vehicles and therefore a lower risk of adverse effects to cultural resources.

Using mechanized timber harvesting to restore the Forests to a more natural ecological condition can potentially enhance cultural resource preservation by maintaining a forest that is less susceptible to insects and disease and therefore less tree mortality and subsequent soil disturbance caused by tip-ups when trees fall over. Restoring vegetation benefits cultural resource interpretation as well as physical site preservation. Cemeteries and archeological sites that have an open understory are less prone to tree blow down and tree tip-ups and are better preserved and protected from looting.

## **Alternative A**

Under the current forest plan, cultural resources are found within multiple management areas, and existing forestwide standards and guidelines provide for their consideration, protection, and preservation where they occur. The existing forest plan manages cultural resources through the National

Historic Preservation Act's sections 106 and 110 legal compliance requirements in reaction to proposed undertakings. This same process would be used in all plan alternatives.

The Cradle of Forestry is the one management area in the current plan that has a specific emphasis on protection of cultural resources. In contrast, all action alternatives include both the Cradle of Forestry MA as well as the Heritage Corridors MA.

There are no plan components that address looting and unauthorized collection of artifacts in Alternative A, although law enforcement activities would continue.

Alternative A includes specific open road densities by management area, and ongoing implementation estimates road construction activity levels of 1.2 miles of new system road construction, 1.9 miles of new system road on existing prisms, and 2.9 miles of temporary road construction annually to meet management and access objectives. Road construction would require a survey of cultural resources before action is taken on the ground. Unlike the action alternatives, Alternative A does not include a specific objective for road decommissioning or restoration of unauthorized roads, although current implementation averages 2.1 miles of road decommissioning annually.

Alternative A provides detailed directions for system trail construction but no direction to close unauthorized trails. Alternative A would continue to allow equestrians and mountain bikers to have unrestricted access to ride across the Forests (except in locations specifically signed as closed). While cultural resources located in recreation areas and along designated trails and roads can be monitored, signed, and protected, the impacts outside these areas are largely uncontrolled and unknown. By allowing cross-country travel for equestrians and mountain bikers in Alternative A, there is a greater potential to negatively impact cultural resources and make them accessible to looting and vandalism. As visitor use to the Nantahala and Pisgah NFs is expected to increase, so would the density of non-system trails and potential impacts to cultural resources under Alternative A.

Alternative A would maintain the existing level of access to the Forests and allow for cross country travel on horseback and bicycles. User created trails would continue to potentially impact cultural resources in certain areas. Access in the six designated wilderness areas and five Wilderness Study Areas is restricted to pedestrian use which is unlikely to adversely affect cultural resources. Concentrated camping use in wilderness areas may cause adverse effects to cultural resources.

Alternative A would call for maintaining the current amount of prescribed burning in existing burn blocks. Management impacts would continue as described above.

The average acres of mechanical treatments would stay steady under this alternative, about 800 acres annually, without a particular emphasis on maintaining cultural conditions.

### **Effects Common to All Action Alternatives**

The Heritage Corridors MA includes the Trail of Tears and the Over Mountain Victory Trail, both of which are National Historic Trails. This MA designation promotes proactive management of the corridors by prioritizing the conservation, protection, preservation, restoration, and interpretation of the area and all associated cultural resources over any other activities. The inclusion of the Heritage Corridor MA in all action alternatives would result in a greater prioritization of cultural resources in these areas compared to Alternative A. For example, it includes the following standard that would reduce the impact of soil disturbance on cultural resources: "HC-S-07: Allow no activities, including mineral collection rock hounding or mineral leasing surface occupancy, that would adversely impact tribal traditional cultural properties and ceremonial and sacred sites."

All action alternatives include a Tier 1 objective to reduce the backlog of archeological site evaluations by 60 percent and a Tier 1 objective to identify archeological sites that are at high risk from looting impacts and develop strategies for site protections and preservation.

All action alternatives include the Interface Management Area which emphasizes recreational access to the Forests along open forest roads, developed recreation areas, and national scenic trails. This management area is likely to have the highest amount of forest users and provides opportunities for cultural interpretation of the landscape. While increasing the awareness for preservation of cultural resources through interpretation is positive, high levels of use along with increasing developments can adversely impact archeological sites.

With implementation of Alternatives B, C, D, and E, bikes and horses would be limited to the existing trail system, on trails designated for those uses. This limitation would not be in place immediately following the plan decision. Rather, it would be implemented forestwide following a Forest Supervisor order once trail supply/demand issues in four geographic areas are addressed. Therefore, with implementation of Alternatives B, C, D, and E, impacts to cultural resources from recreational use off of system trails should diminish over time.

All action alternatives would increase the amount of new system road construction from the current 1.2 miles annually, which would continue under Tier 1, to another estimated 0.8-1.2 miles under Tier 2 objectives (See Transportation and Access section). Locations of potential road construction would be surveyed prior to implementation to avoid or mitigate impacts to archeological sites. The additional estimated 1.3 to 1.9 miles of roads on existing prisms would likely have minimal impact, however, these prisms may not have been surveyed in the past, so they would also require surveying.

Alternatives B, C, and D include an objective for 6,500 to 10,000 acres of annual prescribed burning which is an increase over average annual burning under Alternative A. Under Alternative E, this objective increases up to 20,000 in Tier 1. This increased amount of prescribed burning, particularly for Alternative E, would have a greater potential to impact cultural resources from prescribed burning compared to Alternative A by potentially exposing more cultural resources and making them vulnerable to erosion, collection, and looting. An increase in prescribed burning acres also has the potential for increased miles of dozer constructed fire line which could result in more impacts to cultural resources.

The action alternatives also call for an increase in mechanical timber harvest. These objectives are primarily focused on enhancing ecological conditions and forest health, although there are some specific management areas, such as the Heritage Corridor Management Area where management treatments would be designed to achieve desired cultural conditions.

To compare effects of Alternatives B, C, D, and E, an analysis examined known and potential cultural resource sites related to proposed management area allocations. For each management area that changes acreage by alternative, known recorded sites to date (2019) and probable sites based on slope and distance to water were examined. It was assumed that management areas that have more ground disturbing activities and heavy recreation use along with high site densities, known and probable, would have the most frequent potential to encounter cultural resources. This table serves as a proxy for how frequently cultural resources might be encountered when planning projects.

**Table 169. Known and Potential Cultural Resources by Management Areas that Differ by Alternative**

Management Area	Alt B Known/Potential	Alt C Known/Potential	Alt D Known/Potential	Alt E Known/Potential
Interface	457/1338	438/1109	441/1293	583/946
Matrix	2124/5848	1815/4687	2112/5698	2470/6647
Backcountry	98/1446	238/2151	98/1165	125/1667
Ecological Interest Areas	N/A	241/852	60/1279	66/960



Management Area	Alt B Known/Potential	Alt C Known/Potential	Alt D Known/Potential	Alt E Known/Potential
Recommended Wilderness	62/646	7/N/A	27/601	21/408

As described above, the policy common to all alternatives is designed to inventory, evaluate, and preserve significant cultural resource values through avoidance, minimization, or mitigation of negative effects of these management activities. Thus, cultural resource surveys occur prior to planned activities so that impacts can be avoided or mitigated. Therefore, even when cultural resources are found in projects, the effects to those resources will be avoided or mitigated.

### Alternative B

The potential for ground disturbance is the greatest in the Matrix MA because of active management such as timber harvest and road building. Compared to the other action alternatives, Alternative B has more known and potential sites in Matrix than Alternative C, and slightly more known and potential sites in Matrix than Alternative D. However, it has fewer known and potential sites in Matrix than Alternative E. Furthermore, Alt. B has the greatest amount of potential sites in Interface, where there is the strongest potential for impacts from recreation. However, Alt. E has more known cultural resource sites in interface. Therefore, Alternative B's management area allocation would have a greater potential frequency to encounter cultural resources than Alternatives C and D, but less of an impact than Alternative E.

Alternative B proposes the greatest addition to recommended wilderness and would therefore have the greatest amount of acres that are limited to non-mechanized, non-motorized access. In these locations, Alternative B would have the least potential adverse effects to cultural resources as it recommends the greatest amount of acres that restrict management activities that involve ground-disturbing activities, such as timber harvesting. Although developed recreation would be restricted in recommended wilderness, public access to these areas would still be available, and pedestrian uses of these areas are unlikely to adversely affect cultural resources.

### Alternative C

Alternative C has the fewest known and potential sites in Interface and Matrix. With the greatest amount of Backcountry MA acres of all alternatives, Alternative C would have the least opportunity for new road construction compared to Alternatives B, D, and E. With less of the Forests available for road construction, there would be less opportunity to impact cultural resources through new ground disturbance associated with road building. As a result, Alternative C's management area allocation would result in the least frequent encounters with cultural resources.

### Alternative D

Alternative D is very similar to Alternative B with slightly fewer known and potential sites in Interface and Matrix but more in Ecological Interest Area where some vegetation management and road building is permitted. There are fewer potential sites in Backcountry, which allows limited vegetation management and only temporary roads. With effects similar to what was described in Alternative B, Alternative D includes some sites in Recommended Wilderness. As a result of this management area allocation, the frequency with which Alternative D's management encounters cultural resources would be greater than Alternatives B and C but slightly less than Alternative E.

### Alternative E

Compared to the other action alternatives, Alternative E includes the most known and potential sites in Matrix, where the potential for ground disturbance is the greatest because of active management such as timber harvest and road building. Alternative E also has the most known sites in Interface.

Due to Alternative E's management area allocations, this alternative will have the greatest frequency of encountering potential and known cultural resources.

Alternative E has more prescribed burning planned than any other alternative. This increased amount of prescribed burning would have an even greater potential to impact cultural resources from prescribed burning compared to the other action alternatives. Burning more forest acres could potentially expose even more cultural resources and make them vulnerable to erosion, collection, and looting. An increase in prescribed burning acres also has the potential for increased miles of dozer constructed fire line which could result in additional impacts to cultural resources.

Road construction is emphasized in the Interface and Matrix management areas. Road construction could lead to greater impacts on cultural resources due to greater amounts of ground disturbance. Due to management area allocations, Alternative E emphasizes road construction on 58% of the forest, and prohibits road construction on 17% of the forests. This emphasis on road construction is greater than Alternative C, but slightly less than Alts. B and D.

### **Cumulative Effects**

Unlike many natural resources, cultural resources are nonrenewable. Damage to or the destruction of archaeological sites is characteristically permanent. It means the loss of information important to the understanding of the unwritten record of human history and the loss of opportunities for scientific research as well as interpretive opportunities for the public.

### 3.4.3 Tribal Resources

#### Affected Environment

The local heritage, culture, traditions, and values on lands now considered the Nantahala and Pisgah National Forests have been handed down over several generations, predating acquisition of the Forests by the United States. While many communities in WNC have a connection to the Nantahala and Pisgah, the tribal connection to these lands goes back to time immemorial.

The Federal government has a responsibility to federally recognized tribes that arises from the United States' unique legal and political relationship with tribes. It is a legally enforceable fiduciary obligation on the part of the United States to protect tribal rights, lands, assets, and resources, as well as a duty to carry out the mandates of Federal law with respect to all federally recognized tribes. This responsibility requires the Federal government to consider the best interests of the tribes in its consultation with them and when taking actions that may affect them. Laws and policies (such as but not limited to the American Indian Religious Freedom Act, Native American Graves Protection and Repatriation Act, Tribal Forest Protection Act) direct the agency to administer forest management activities and uses in a manner that is sensitive to traditional Native American beliefs and cultural practices. In meeting these responsibilities, Forest managers consult with federally recognized tribes as sovereign entities when proposed policies or management actions may affect their interests. The Nantahala and Pisgah consults with federally recognized tribes that have traditional ties to the land now administered by the Forests and conducted formal face-to-face consultation with Native American tribes concerning the development of this forest plan. The Forests use a variety of avenues to achieve meaningful consultation, with the preferred method being real-time, in-person dialogue between tribal leaders and Forest line officers.

Native American tribes associated with the plan area include federally recognized tribes with historic ties and interests in the management of the Forests. These tribes include the Eastern Band of Cherokee Indians (EBCI) in Cherokee, NC, including their Qualla Boundary adjacent to the Nantahala NF, along with interspersed tribal land parcels surrounded by NF system lands. There are more than 20 miles of shared property lines between the EBCI and the Forest Service. The EBCI has more than 56,000 acres of land in six of the 18 counties in the planning area (Clay, Cherokee, Graham, Haywood, Jackson, and Swain). The Cherokee Nation (Talequah, OK) and the United Keetoowah Band of the Cherokee Indians in Oklahoma (Talequah, OK) are two other federally recognized sovereign Cherokee tribes with interests in the Nantahala and Pisgah NFs. Additionally, the Catawba Indian Nation (Rock Hill, SC) has ties to the lands comprising the Grandfather Ranger District. The Muscogee Creek Nation (Okmulgee, OK) and Kialegee Town Creek (Wetumka, OK) have interests in the present Nantahala NF. The Shawnee Tribe (Miami, OK) has expressed interest in management of the Pisgah and Nantahala NFs as well.

The town of Cherokee, located within the Qualla Boundary, is the cultural center of the Eastern Band of Cherokee Indians. Approximately 8,000 of the 13,000 enrolled members of the tribe live within the Qualla Boundary. Other Cherokee lands in North Carolina include the 2,255-acre parcel in Graham County, home to the snowbird community, and 5,320 acres scattered throughout Cherokee County, near the old Cherokee communities of Marble, Grape Creek, and Hanging Dog. Traditional tribal uses of the Forests include the collection of medicinal plants, wild plant foods, basketry materials, and fuelwood.

Balancing the modern world with ancient traditions, the Cherokee welcome millions of visitors each year, while passing on the Cherokee language and culture. They also educate their youth to participate in the local and global economy. Cherokee, NC is also home to many traditional artisans working to preserve Native American crafts that have been passed down for generations. The traditional craft of basket

weaving is a special skill that is celebrated in order to preserve important parts of Cherokee culture. River cane and white oak are often used for baskets as are vines of all kinds. In addition, the Cherokee have a long tradition of using plants for food and healing. Some of the plants used by Cherokee healers include blackberry, black gum, hummingbird blossoms, cattail, greenbrier, mint, mullein, sumac, wild ginger, wild rose, yarrow, and yellow dock (Eastern Band of Cherokee 2013).

There are no existing applicable Native American Treaty rights in the Plan area; however, tribal rights based upon Federal laws and regulations do exist pertaining to the previously mentioned areas and activities. The Nantahala and Pisgah NFs personnel conducted formal face-to-face consultation with Native American tribes concerning the development of this forest plan.

The Forest Service manages a great diversity of landscapes and sites that are culturally important and are held sacred by federally recognized tribes. Specific locations and information about traditional uses on the Forests are often held in confidence to protect these important values. To date more than 75 locations of traditional cultural properties, sacred sites, and areas with historic ties to the EBCI and other Cherokee tribes have been identified. More than 15 of these are located on the Pisgah NF, while the remaining are located on the Nantahala NF. These areas range in size from a couple of acres to areas encompassing several thousand acres. The Forest has also issued a special use authorization to the Eastern Band of Cherokee Indians for the Snowbird Youth Center.

There are two heritage corridors that cross the National Forests that are of particular interest to tribes. The Trail of Tears National Historic Trails (TOT) was originally established in 1987 and later extended by Congress in 2008 to include portions in North Carolina. This path is a tribally recognized sacred site that commemorates the removal of the federally recognized tribes and the paths that 17 Cherokee detachments followed westward in 1838-1839. The TOT is a total of 5,045 miles in length including 40.9 miles crossing the Nantahala National Forest along six connecting routes on the Cheoah, Nantahala, and Tusquitee Ranger Districts. A second trail, the National Millennial Trail Unicoi Turnpike (UT) is a commercial wagon road crossing the Southern Appalachians that was also used as part of the TOT route from North Carolina into Tennessee, across the Nantahala National Forest. The turnpike road was completed in 1816 as a commercial route across the Cherokee Nation from the head of navigation on the Savannah River in Georgia to the Little Tennessee River near Maryville, Tennessee. The TOT and UT routes often overlap. Tribes are consulted prior to planning any activities within a distance of ½ mile<sup>33</sup> on either side of the Trail of Tears and Unicoi Turnpike, specifically alerting them if a proposed undertaking is within the mile wide trail corridor.

More information about the on-the-ground location of the Trail of Tears National Historic Trail became available between the draft and final EIS, thus the location of the Heritage Corridor Management Area was adjusted to reflect this new information. For detailed information about acreage changes associated with this map correction, see EIS Appendix B.

## **Environmental Consequences**

### **All Alternatives**

All alternatives provide direction that requires continued Forest Service dialogue and consultation with tribes about forest management, the effects of proposed undertakings, and the identification of historic places including traditional cultural properties.

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<sup>33</sup> The one mile wide corridor (1/2 mile on either side of the Trail) was decided upon to meet the guidelines developed for National Historic Trail corridor widths in the absence of knowing all exact on-the-ground trail locations and associated sites. Tribes expressed a need for a one-mile-wide corridor as needed for protection of tribal and cultural resources of the Trail of Tears and Unicoi Turnpike Sacred Site.

All alternatives provide for continued free access to the Nantahala and Pisgah NFs by native peoples for collection of plants and other forest products and the use of special places for gathering and ceremonies.

### **Alternative A – No Action**

The 1994 plan direction on tribal resources is out of date and does not address all current tribal resource management topics. The 1994 plan is explicit about protecting heritage resources, maintaining the rights of tribes to access and use the forest, and requirements for consultation and maintaining confidentiality. However, this outdated direction combines tribal interests and cultural interests together, is not inclusive of all the tribal resources we manage for today, and does not acknowledge all of the federally recognized tribes that the Nantahala and Pisgah are currently partnering and consulting with. The 1994 plan provides little direction or narrative about tribes and their interests. Since 1994, several laws, executive orders, and policy direction pertinent to tribal outreach and relations have been established. Although the 1994 plan is out of date and in need of revision, the Nantahala and Pisgah NFs has sustained a tribal relations and consultation program not specified by the 1994 plan as part of its heritage program. This ensures that all laws, regulations, and policies are being followed and tribal rights and interests are maintained under Alternative A.

As a result of the current plan's outdated language, the Nantahala and Pisgah approach for managing tribal resources on the Forests is not as clear to forest managers, tribes, or the general public as it could be. This alternative does not clarify the values and uses that are important to tribes or outline methods to meet shared goals. Nor does it incorporate the latest thinking and opportunities and goals that have developed through recent consultation and coordination.

### **Action Alternatives**

All action alternatives include plan direction that has a greater recognition of tribal resources than the current plan. Within the forestwide desired conditions, the plan articulates that “[t]ribes and tribal members are partners in managing the National Forests and its resources” (TR-DC-02) and that “Native American tribes and members retain a connection to the land that fosters both their traditional and contemporary cultural uses of the Forests. The Forests foster connections between displaced tribal members and their ancestral homelands” (TR-DC-01). This foundational approach of working with tribes as partners and fostering tribal connection to the land through both traditional and contemporary uses is supported throughout the rest of the plan direction. Additional desired conditions clarify the Forest Service intent to maintain and protect tribal values and uses, such as resources are not depleted and sacred plants and trees are managed, restored or re-established (TR-DC-04); the collection of plants and foods for tribal uses is valued (TR-DC-05); traditional ecological knowledge is incorporated (TR-DC-06); access for individual and group tribal uses is available (TR-DC-08); the Forests provide a setting for the education of tribal youth (TR-DC-11); all sacred objects, funerary, and objects of cultural patrimony are repatriated (TR-DC-12); and the Forest Service fosters strong relationships with tribes maintained through government-to-government consultation and communication (TR-DC-10). While these actions would also occur under Alternative A, the identification of these as desired conditions in the action alternatives gives an emphasis to the management of tribal resources that is more explicit and clear to all forest managers and the public compared to the 1994 plan.

The action alternatives provide specific objectives that involve working with tribes during plan implementation, including a complete tribal communication plan to identify contacts and respective responsibilities, a memorandum of understanding clarifying roles and authorities (TR-O-01), and developing a tribal partnership for restoration (TR-O-02). Fulfilling these objectives would advance tribal interests for strong relationships and effective communication while also advancing forest restoration through methods that meet tribal interests.

The standards and guidelines of the action alternatives ensure sustained appropriate access and uses for tribes. One standard adds a consultation requirement to “Manage areas with significant tribal traditions and cultural properties or sacred sites (that are identified in consultation with tribes) to preserve and restore their inherent cultural values. Formal tribal consultation is completed prior to any management decisions and activities within these areas” (TR-S-05). These areas, which are scattered across the forest, are not identified within the plan itself for confidentiality purposes but are known to forest tribal relations specialists so that this information can be considered as the forest develops projects and activities. This additional certainty of consultation in these areas helps ensure that the design of activities is compatible with tribal resources.

The management approaches in the action alternatives reflect important aspects of relationships and coordination between tribes and the Forest Service using ideas that arose during consultation. The management approaches reflect a commitment on behalf of the Forest Service to provide training to Forest Service employees about the trust responsibilities federal agencies have for tribes and the specific ways in which the Nantahala and Pisgah NFs honor and implement those responsibilities. Other management approaches include creating opportunities to allow displaced tribal members to visit their ancestral homelands to learn and share about their heritage; fostering opportunities to engage tribal members in management of forest resources such as volunteering, tribal agreements, training; and translating interpretation, education materials, and maps into native languages when possible. All of these activities would strengthen the ability of the Forests to serve tribal goals while managing forest resources. The action alternatives present increased opportunities for tribal partnerships, tribal youth education, and use of Traditional Ecological Knowledge (TEK) to benefit tribal resources.

Beyond the forestwide plan direction discussed above, the Geographic Areas chapter of all action alternatives further emphasizes historic and contemporary resources that are important to tribes. In each of the 12 geographic areas, the description in the Connecting People to the Land subsection reflects on tribal history in each area and identifies historical towns that occurred within the Forests. The Geographic Area chapter also identifies goals related to specific portions of the Forests where working with tribes is a focus, such as this goal for the Bald Mountains geographic area: “Partner with Cherokee tribes to preserve traditional and ceremonial areas and restore high elevation balds to enhance traditional special uses” (BAM-GLS-13) or this one for the Nantahala Gorge geographic area “Partner with tribes and the National Park Service to manage the Trail of Tears corridor and restore traditional plant species important for tribal traditions, culture, and arts” (NG-GLS-14). These goals will be used to support projects that contribute to tribal resources.

All action alternatives contain a new management area – the Heritage Corridor Management Area - which was designed around the Trail of Tears National Historic Trail and the Unicoi Turnpike. While all activities and projects proposed within a half mile of the trail require consultation, this management area establishes additional constraints on projects and activities within 1500 feet<sup>34</sup> of each side of the trail. Standards in this section include: “Projects are designed to avoid, minimize, mitigate, or remove negative effects on the trails, sacred sites, and potentially significant cultural resources...” (HC-S-02) and “New activities that result in ground disturbance shall require tribal consultation and consultation with the State Historic Preservation Office under the National Historic Preservation Act. Prior to ground

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<sup>34</sup> This corridor width of 1500 feet is a default width to be used until the more precise location of the trail corridor is determined from the Cultural Landscape Inventory of the Trail. The 1,500 feet wide corridor was developed based upon National Historic Trail (NHT) guidelines that suggest a 200 – 300 meter [600 – 900 feet] buffer (either side) of a NHT be used to complete a Cultural Landscape Inventory. This direction when compared with the known locations of the Trail of Tears and Unicoi Turnpike and associated sites as well as their topographic conditions and view sheds on the Nantahala National Forest resulted in a designated buffer of 750’ either side. Field visits with tribal members led to agreement as this would be the best way to proceed.

disturbance, land transfer projects, or management activities, cultural resource inventories shall be completed using the latest protocols” (HC-S-5). A guideline clarifies that “Unless necessary to protect or benefit cultural or natural resources, roads and trails should not be maintained or reconstructed outside of their existing prism, and existing utilities (powerlines, pipelines, etc.), trenches, crossings, and prescribed fire lines shall be utilized rather than disturbing new ground,” (HC-G-2) and a standard states “Existing roads and facilities such as powerlines, roads, wildlife openings, recreational residences, marinas, and their associated structures shall be maintained in a way that does not result in adverse effects to the trail” (HC-S-03). There are also standards and guidelines for timber harvest that are compatible with tribal values, wildfire management, scenery, restrictions on mineral collection and leasing, and standards on interpretation and confidentiality. Notably, there is an opportunity to make exceptions to the standards in this section without requiring a forest plan amendment if the exception is made to address tribal interests, human health and safety, or emerging resource needs following consultation with tribes, NPS, ACHP and SHPO (HC-S-10). Collectively, these standards provide a clearer picture to forest managers and tribes of the types of activities that can or cannot proceed within the Trail of Tears and Unicoi Turnpike corridors and the parameters for completing these activities. This additional clarity would provide additional protection to these resources, reducing the risk of accidental damage and aiding communication between the Forest Service and tribes.

Finally, the action alternatives also respond to tribal interests through the revised plan’s emphasis on restoration of vegetation and wildlife habitats and use of prescribed fire. This intentional focus toward restoring ecosystems could enhance the availability of plants that are valued or collected by Native Americans for traditional uses. Increased fire presence may also increase the abundance of some forest products collected by Native Americans. For example, restoration of river cane is important to the tribes. It is a traditional plant and used for basket making. White oak is another traditional species of tribal interest for restoration. Stream restoration projects, including the removal of dams and other structures to improve water quality and restore native fisheries, also benefits tribes. Plan direction in many of the ecological resource sections is compatible with desired conditions expressed by tribes for sustaining healthy forest ecosystems, plants, wildlife, air, and water.

A new forestwide standard (REC-S-11) will limit equestrian and bicycle use to NFS trails designated or managed for those uses, and on open or gated NFS roads. This new standard will decrease the potential impact to tribal resources that are located off-trail by reducing the potential for unmanaged recreational contact with these resources and reducing both accidental damage to resources and potential for looting. This standard is in addition to existing direction that limits off-highway vehicle (OHV) use to designated trails.

## **Alternative E**

Alternative E, the preferred action alternative, includes new and modified plan components that will further promote shared land stewardship, traditional ecological knowledge, and collaborative research and project design. These plan components were modified after the DEIS was released with input from federally recognized tribes. Within the forestwide Tribal Resources section, a new desired condition states “[l]ands are guided by shared stewardship, including tribal and Forest Service lands and resources, to support healthy and resilient forests that benefit tribal communities and the public.” A new objective was added for research collaboration with tribes and the Southern Research Station: “Tier 1: During the planning period, work with tribes and the Southern Research Station to identify research locations and collaboratively study sustainable plant harvesting, artisan resource management, and the use of traditional ecological knowledge” (TR-O-03). The plan was updated to clarify the intent for early engagement with tribes during project development: “Development of integrated landscape projects should seek early input from Federally Recognized Tribes and explore opportunities to reflect Traditional Ecological Knowledge in project design” (TR-G-03). New management approaches will lead forest managers to utilize collaborative and shared stewardship authorities to conduct work that benefits tribal

and NFS lands and involve both natural resources staff and the tribal historic preservation office during tribal coordination to support regular interdisciplinary involvement in project design. All of these plan language changes have a positive impact on the management of tribal resources.

### **Cumulative Effects**

The area of cumulative effects for tribal resources and relations includes the 18-county area of Western North Carolina over a timeframe including the past 10 years through the next 15 years. The Native Americans that have inhabited this region and tribes that have ties to the land view its entirety as a landscape of continuing traditional and cultural importance. Places of historical, traditional, and cultural significance to the tribes, whether or not they are identified as traditional cultural properties, and traditional forest product collection areas, are located across these landscapes. Many of these important areas are located on non-tribal lands, particularly in the mountains within the Nantahala and Pisgah NFs.

Across this overall cultural landscape, there has been a trend toward the degradation of places of traditional cultural importance. As with cultural resource sites, many of which are ancestral homes of tribal members, losses of traditional use areas and places of traditional importance has been high in urbanized areas and on adjacent and surrounding developed non-FS lands. Access has been limited over decades, and the modification of cultural landscapes has been increasing. Tribal members are concerned about the cumulative adverse effects to traditional lands and resources in Western NC, and management direction in the revised forest plan will ensure that tribal values and uses are protected on National Forest System lands.

Additionally, as other national forests are updating forest plans to clarify management direction for the Trail of Tears, those forests can use the plan direction from the Nantahala and Pisgah National Forests as a starting point to work from, increasing the potential for clear direction across National Forest System lands.

### **3.4.4 Recreation**

#### **Affected Environment**

The U.S. Forest Service provides the greatest diversity of outdoor recreation opportunities in the world, connecting people with nature in an unmatched variety of settings and activities. Through this connection, recreation is a portal for understanding and caring for natural resources, renewing body and spirit, passing pastimes and values to future generations, and inspiring passion for the land and its resources. Outdoor recreation also contributes to the economic vitality of communities near forest lands, where recreationists may eat, stay the night, stock up on supplies, sightsee, or enjoy other community resources.

The Nantahala and Pisgah NFs are among the most visited forests in the country and provide visitors with opportunities for a wide range of recreational activities and experiences, both developed and dispersed. Activities across the more than 1 million acres include birding, boating, canoeing, camping, fishing, hunting, climbing, hiking, horseback riding, mountain biking, picnicking, and many others. There are numerous rivers providing whitewater rafting and kayaking; mountain biking and equestrian trails; and hundreds of miles of hiking trails. Some trails are recognized by Congress with national designations, including the Appalachian National Scenic Trail, Trail of Tears and Overmountain Victory National Historic Trails, and several National Recreation Trails.

Many visitors to the Nantahala and Pisgah NFs are local; however, many also visit from neighboring states, including Alabama, Georgia, Tennessee, Virginia, and West Virginia. The largest cities within a two hour driving radius include Atlanta, Knoxville, Chattanooga, Charlotte, and Winston-Salem. In addition,



Asheville, NC, the Blue Ridge Parkway, and Great Smoky Mountains National Park draw national and international visitors.

The USDA Forest Service's National Visitor Use Monitoring program reported that during the fiscal year 2018 (October 1, 2017 through September 30, 2018) the total estimated annual visitation to the Pisgah and Nantahala National Forests was 5.1 million with 102,000 estimated visits to designated wildernesses. The following table shows data from FY2013 and FY2018 NVUM surveys.

**Table 170. Overview of Visitation to the Nantahala and Pisgah National Forests**

Visit Type	Estimated FY2013 Visits	Estimated FY2018 Visits
Day Use /Developed Site visits	2,040,000	2,083,000
Overnight Use/ Developed Site visits	163,000	186,000
General forest visits	3,093,000	4,928,000
Designated Wilderness visits	136,000	102,000
<b>Total Estimated Site Visits*</b>	<b>5,432,000</b>	<b>7,298,000</b>
<b>Total Estimated National Forest Visits **</b>	<b>4,037,000</b>	<b>5,155,000</b>

Source: USFS National Visitor Use Monitoring. \*A site visit is the entry of one person onto a National Forest site or area to participate in Recreation activities for an unspecified period of time. \*\*A National Forest Visit is Defined as the entry of one person upon a national forest to participate in recreation activities for an unspecified period of time. A National Forest Visit can be composed of multiple Site Visits.

Results of NVUM surveys also showed 70% of visitors interviewed cited recreation as the primary purpose of their visit, and that the Forests serve a mostly local client base. However, approximately 30% of visitors traveled more than 200 miles to visit the Nantahala and Pisgah NFs. Visitors participated in a variety of recreation activities and utilized all types of facilities provided and trails designated for specific uses. The following table shows the percentage of participation in activities for the 2013 and 2018 NVUM surveys.

**Table 171. Activity Participation of Visitors to the Nantahala and Pisgah NFs**

Activity	Percent Participation per 2013 NVUM	Percent Participation per 2018 NVUM
Hiking/Walking	60.4	54.8
Viewing Natural Features	50.9	53.4
Relaxing	22.9	28.6
Viewing Wildlife	23.9	13.5
Other Non- motorized	2.9	12.3
Driving for Pleasure	29	12.1
Bicycling	6.2	11.7
Picnicking	11.7	10.1
Some Other Activities	0.8	5.7
Nature Study	n/a**	4.6
Nature Center Activities	14.5	4.2
Fishing	5.1	4.1

Activity	Percent Participation per 2013 NVUM	Percent Participation per 2018 NVUM
Non-motorized Water Activities	1.2	3.8
Developed Camping	3.7	2.9
Gathering Forest Products	1.1	1.4
Visiting Historic Sites	4.9	1.1
Hunting	4.4	1.1
Backpacking	0.0*	1.1
Motorized Water Activities	1.5	0.6
Horseback Riding	0.0*	0.6
Primitive Camping	1.3	0.5
Resort Use	0.2	0.3
Other Motorized Activity	0.1	0.3
Motorized Trail Activity	3.2	0.1
OHV Use	2.9	n/a**
No Activity Reported	0.0*	0.0*

\*Percent participation of those interviewed. This does not mean that these activities are not occurring on the Forests; it simply means that no one was interviewed that was participating in these activities.

\*\*Interview questions or terminology related to these activities were changed from 2013 to 2018.

## Dispersed Recreation

Dispersed recreation are those uses which occur outside of developed recreation settings. They may occur in Primitive, Semi-Primitive, or Roaded Natural ROS settings. There are many types of dispersed recreation that occur on the Nantahala and Pisgah NFs, including hunting, fishing, primitive camping, backpacking, paddling, rock hounding, motorized and non-motorized trail uses, etc.

The most popular types of dispersed recreation opportunities available to Nantahala and Pisgah National Forest visitors are discussed below.

### Dispersed camping

There many dispersed campsites spread across the Forests. Most of these identified dispersed campsites have been modified with defined use-areas surfaced with gravel and basic amenities intended to improve resource protection and sanitation. Site features may include rock barriers, steel fire rings, lantern posts, and, in some cases, vault toilets.

Primitive and Semi-Primitive Non-Motorized ROS settings for backcountry camping/backpacking opportunities are also available throughout backcountry management areas, Wilderness Study Areas, recommended wilderness, and designated wilderness. Combined, these Primitive and Semi-Primitive Non-Motorized opportunities total approximately 209,750 acres of the Nantahala and Pisgah NFs.

### Non-motorized trails

Nearly 1,500 miles of trails for hiking, mountain biking, and equestrian use provide access into both national forests. Among these are eight national recreation trails, a national scenic trail, and a national historic trail. The Appalachian National Scenic Trail, Bartram National Recreation Trail, NC Mountains-to-Sea National Recreation Trail, Art Loeb National Recreation Trail, Foothills National Recreation Trail, Rim Trail, and Benton Mackaye Trail offer long-distance hiking/backpacking opportunities. Trail-side camping is available at 22 shelters along the Appalachian National Scenic Trail, Art Loeb National Recreation Trail,

and other trails. Additionally, there are dozens of trailheads within the Nantahala and Pisgah NFs to accommodate parking and provide information for each of these trail uses. The following tables show the mileage, location, and use-type for all non-motorized trails on the Nantahala and Pisgah NFs.

**Table 172. Non-motorized Trail Mileage by Ranger District and National Forest**

Non-Motorized Trail Miles by Use-Type					
Forest/District	Total	Hike	Horse/Hik	Bike/Hik	Horse/Bike/Hi
<b>Nantahala NF Totals</b>	<b>648</b>	<b>467</b>	<b>75</b>	<b>30</b>	<b>76</b>
Cheoah RD	243	182	0	5	56
Nantahala RD	286	225	37	4	20
Tusquitee RD	119	60	38	21	0
<b>Pisgah NF Totals</b>	<b>851</b>	<b>542</b>	<b>47</b>	<b>165</b>	<b>97</b>
Appalachian RD	292	232	38	15	7
Grandfather RD	219	152	3	51	13
Pisgah RD	340	158	6	99	77
<b>Total Non-Motorized</b>	<b>1,499</b>	<b>1,009</b>	<b>122</b>	<b>195</b>	<b>173</b>

**Table 173. Non-motorized Trail Mileage by Geographic Area**

Non-Motorized Trail Miles by Use-Type					
Geographic Area	Total Mileage	Hike Only	Horse/Hike	Bike/Hike	Horse/Bike/Hike
Bald Mountains	216	182	19	15	0
Black Mountains	138	84	19	15	20
Eastern Escarpment	158	118	3	37	0
Fontana Lake	85	27	0	3	55
Great Balsam	17	17	0	0	0
Highland Domes	89	64	2	3	20
Hiwassee	30	10	0	20	0
Nantahala Gorge	32	31	0	1	0
Nantahala Mountains	245	172	73	0	0
North Slope	62	55	6	0	1
Pisgah Ledge	277	102	0	99	76
Unicoi Mountains	150	147	0	2	1
<b>Total Non-Motorized Trail Miles</b>	<b>1,499</b>	<b>1,009</b>	<b>122</b>	<b>195</b>	<b>173</b>

### Motorized trails

Two off-highway vehicle (OHV) trail complexes on the Forests provide motorized trail access: Brown Mountain OHV Trail Complex on the Pisgah NF and Wayehutta OHV Trail Complex on the Nantahala NF. Both accommodate wheeled vehicles less than 60" wide. In addition, two trails in the Brown Mountain complex accommodate full-sized 4WD vehicles. A segment of motorized trail on the Pisgah Ranger District, Ivester Gap Trail, is open to street-legal high-clearance vehicles on a seasonal basis for access to berry picking areas.

**Table 174. Motorized Trail Mileage**

<b>Motorized Trail</b>	<b>Miles</b>	<b>Geographic Area</b>	<b>District</b>
<b>Brown Mountain OHV Trail Complex</b>	<b>32</b>	Eastern	Grandfather
Motorcycle	6		
Motorcycle/ATV/UTV	21		
Motorcycle/ATV/UTV/Full Size 4WD	5		
<b>Wayehutta OHV Trail Complex Total</b>	<b>22</b>	Great Balsam	Nantahala
Motorcycle/ATV/UTV	22		
<b>Ivestor Gap Trail (High Clearance)</b>	<b>2</b>	Pisgah Ledge	Pisgah
<b>Total Motorized Trail Miles</b>	<b>56</b>		

### **Hunting, fishing, and trapping**

Hunting, fishing, and trapping are allowed across most of the Nantahala and Pisgah NFs. The US Forest Service manages wildlife habitats and protects water quality in the national forests, while the NC Wildlife Resources Commission manages the wildlife and regulates hunting and fishing. Anglers and hunters are required to have the appropriate NC hunting or fishing licenses to participate in these activities. All National Forest System lands in NC are considered game lands under state regulations. Motorized hunter and angler access is available on open National Forest roads and motorized trails, while non-motorized access is available throughout National Forest game lands including wilderness, recommended wilderness, and backcountry. In addition to big game species including black bear, and wild turkey, many people hunt small game species in NC such as rabbits and squirrels as well as quail and grouse. Each year, approximately 150,000 sportsmen and sportswomen take more than 1.0 million trips afield in pursuit of resident small game species (USFWS, Survey of Hunting and Fishing).

### **Climbing and similar activities**

Climbing opportunities on the Nantahala and Pisgah NFs offer a wide range of options, levels of commitment, and rock types. Whiteside Mountain, Big Green Mountain, Cedar Rock, Looking Glass Rock, Lost Cove Cliffs, and Linville Gorge are highly visited climbing locations which provide opportunities ranging from bouldering to single-pitch and multi-pitch climbs.

### **Rock hounding and gold panning**

Rock hounding is primarily done as a dispersed recreation activity at old mine sites and mineral outcrops. Popular rock hounding areas include the Ray Mine, Buck Creek, Walker Creek Kyanite Prospect, and Grimshawe Sapphire Mine. The Forest's creeks and streambeds provide the greatest opportunities for recreational gold panning. Mineral collection is restricted to loose material on the surface, and use of mechanized equipment or any method resulting in significant ground or stream disturbance is prohibited.

### **Wildlife viewing and nature study**

The mountains of Western NC offer unique habitats for plants and animals and popular locales for viewing birds and other wildlife and studying nature. Studying the diverse natural world is another favorite pastime for visitors to the Nantahala and Pisgah NFs and includes wildflower pilgrimages, fall color tours, and many other activities.

## **Sightseeing and driving for pleasure**

The Nantahala and Pisgah National Forests have three national or Forest Service designated scenic byways which are open year-round to accommodate driving for pleasure. These include Mountain Waters Forest Service Scenic Byway, Cherohala Skyway National Scenic Byway, and Forest Heritage National Scenic Byway (a portion of which is a designated Forest Service Scenic Byway). Additionally, the Blue Ridge Parkway, which is managed by the National Park Service, provides 113 miles of scenic driving opportunities, showcasing views of the Nantahala and Pisgah NFs. In addition, there are 12 State Scenic Byways which pass through the National Forests. Many of these scenic byways offer roadside parking, scenic overlooks, interpretative wayside exhibits, picnic areas, and/or trailheads with short loop hikes. Driving for pleasure is also possible on National Forest System roads which are open to public use seasonally or year-round.

## **Water-Based Recreation**

Water-based recreation on the Nantahala and Pisgah NFs includes activities such as whitewater paddling, tubing, fishing, visiting waterfalls, swimming, and boating.

Whitewater paddling is popular in Western NC with numerous creeks and rivers providing for a diversity of paddling experiences. Forest Service facilities are located on the Cheoah, French Broad, Nantahala, and Nolichucky Rivers, with trailhead access to the upper reaches of Chattooga Wild and Scenic River. Additionally, several rivers offer outfitter-guide services.

Rivers and creeks on the Forests where water-based recreation is popular include the Davidson River, North Fork French Broad River, North and South Mills Rivers, Little Tennessee River, Tuckasegee River, Cullasaja River, Whitewater River, Thompson River, Catawba River, Linville River, Pigeon River, Laurel River, South Toe River, Hiwassee River, Santeetlah Creek, Fires Creek, Horsepasture Wild and Scenic River, and Wilson Creek Wild and Scenic River among others. Some of these offer developed access sites and facilities with parking lots, restrooms, picnic tables, and/or fishing piers. Sliding Rock on Looking Glass Creek on the Pisgah NF is a popular recreation site where visitors swim and slide on a gently sloping rock; this site has a large parking lot, restrooms, and a lifeguard station.

## **Wild and scenic rivers**

There are three congressionally designated Wild and Scenic Rivers wholly or partly within the boundaries of the Nantahala and Pisgah NFs. Chattooga Wild and Scenic River originates in the mountains of Western NC and runs a total of 59 miles through North Carolina, South Carolina, and Georgia, with 9.8 miles on the Nantahala NF. Horsepasture Wild and Scenic River on the Nantahala NF is the shortest of the three with a total length of four miles, with one and three quarters of a mile travelling through the Forest. The river contains five major waterfalls within two miles. River access is available via Rainbow Falls trail out of Gorges State Park. Wilson Creek Wild and Scenic River, on the Pisgah NF, is a total of 23 miles in length, offers developed access facilities, and is popular with swimmers and fishermen.

## **Waterfalls**

More than 44 named waterfalls on the Nantahala and Pisgah NFs attract visitors to admire their beauty. Some, such as Bridal Veil Falls, can be viewed from state highways; and others, like Dry Falls, Looking Glass Falls, and Whitewater Falls, offer wide hardened trails, handrails, uniform stairs, and resting benches. Several can be viewed from short easy hiking trails, while others require a hike of several miles into designated wilderness, wilderness study areas, or backcountry.

## Lakes/Reservoirs

The larger lakes adjacent to the Nantahala NF are reservoirs managed for hydroelectric power generation and recreation. These include Chatuge, Hiwassee, Appalachia, Santeetlah, Fontana, Cheoah, Calderwood, and Nantahala Lake. While these reservoirs are not owned or managed by the Forest Service, some have shoreline developed recreation facilities on National Forest lands such as boat launches, swimming beaches, picnic areas, fishing piers, and campgrounds. Some privately owned marinas are operated through special use permits with the Forest Service.

Several small mountain lakes/reservoirs which are on National Forest System lands include Balsam, Cherokee, and Cliffside Lake, managed by the Nantahala NF, and Lake Powhatan managed by the Pisgah NF. These lakes provide non-motorized water-based recreation experiences. Forest Service facilities at these lakes may include picnic areas, swimming beaches, fishing piers, campgrounds, and other amenities. For example, Balsam Lake Lodge, with accommodations for 20 people, provides direct access to Balsam Lake; while Lake Powhatan is part of a large recreation complex and campground.

## Developed Recreation

More than 280 developed recreation sites on the Nantahala and Pisgah National Forests serve as destinations or hubs from which to access trails, rivers, and other dispersed recreation opportunities. Development Scale (DS) is a measure of the level of development at sites like campgrounds, picnic areas, and trailheads. The DS of recreation sites ranges from 0 to 5, with Level 0 having little or no improvements; DS 1 including sites with minimal improvements, such as defined parking and signage; and Level 5 being the most highly developed sites with restrooms and drinking water. The DS of recreation sites is consistent with desired ROS settings. Sites of DS 1 or 2 have improvements to ensure resource protection from recreation impacts, where DS 3-5 site amenities add a level of visitor comfort and convenience. The types of recreation sites and distribution across ranger districts are shown in the following table. (Note: Minimally developed DS 0-1 sites are not included in the table.)

**Table 175. Quantity of Developed Recreation Sites by Type and Ranger District**

Site Type	Nantahala NF			Pisgah NF			Totals
	Cheoah District	Tusquitee District	Nantahala District	Appalachian District	Grandfather District	Pisgah District	
Boating Site	8	4	5	2	0	0	19
Campground	4	1	2	3	2	4	16
Roadside/Hunt Camp	5	1	6	0	2	9	23
Group Camp	1	0	2	1	0	3	7
Horse Camp	0	1	2	1	0	2	6
Cabin/Lookout/Lodge	3	0	1	0	0	0	4
Fishing Site	1	1	0	2	1	0	5
Information Site	0	0	1	0	0	2	3
Interpretive Site	0	0	2	0	1	2	5
Observation Site	2	0	9	1	2	1	15
Picnic Site	2	3	8	6	3	9	31
Swim Site	1	1	1	0	0	2	5

Site Type	Nantahala NF			Pisgah NF			Totals
	Cheoah District	Tusquitee District	Nantahala District	Appalachian District	Grandfather District	Pisgah District	
Target Range	1	1	2	0	0	0	4
Non-motorized Trail head	8	2	17	9	10	17	63
OHV Trail head	0	0	1	0	1	0	2
Visitor Center	0	0	0	0	1	2	3

**Table 176. Quantity of Developed Recreation Sites by Type and Geographic Area**

Site Type	Bald Mtns	Black Mtns	E. Escarp.	Fontana Lake	Great Balsam	Highland Domes	Hiwassee	Nant. Gorge	Nant. Mtns	North Slope	Pisgah Ledge	Unicoi Mtns	Totals
Boating Site	2	0	0	8	0	0	4	5	0	0	0	0	19
Campground	1	3	1	3	0	1	1	0	1	1	3	1	16
Roadside/ Hunt Camp	0	0	2	3	0	5	0	0	2	1	8	2	23
Group Camp	0	1	0	0	0	0	0	0	2	0	3	1	7
Horse Camp	1	0	0	0	0	0	0	0	3	0	2	0	6
Cabin/Lodge/ Lookout	1	0	0	0	1	0	0	0	0	0	0	2	4
Fishing Site	1	0	1	1	0	0	0	2	0	0	0	0	5
Info. Site	0	0	0	0	0	0	0	0	1	0	2	0	3
Interp. Site	0	0	1	0	1	0	0	0	1	0	2	0	5
Obsv. Site	0	0	2	1	0	6	0	3	1	0	1	1	15
Picnic Site	4	3	1	2	1	2	2	2	3	1	10	0	31
Swim Site	0	0	0	1	0	1	1	0	0	0	2	0	5
Target Range	0	0	0	0	1	0	1	0	1	0	0	1	4
Non-motor TH	5	7	7	3	0	8	2	2	7	2	15	5	63
OHV TH	0	0	1	0	1	0	0	0	0	0	0	0	2
Visitor Center	0	0	1	0	0	0	0	0	0	0	2	0	3

## Camping

Nantahala and Pisgah NFs offer a variety of camping options, including large, developed campgrounds with showers and electrical hook-ups. Concession-operated camping/day use facilities include a range of large campgrounds, group camps, and associated small campgrounds and day use areas.

## Sustainable Recreation

With the launch of the USFS initiative titled *A Framework for Sustainable Recreation* in 2010, an agency-wide emphasis was placed on managing recreation to meet the environmental, social, and economic needs of present and future generations. An analogy of a three-leg stool has been used to describe the interdependence of environmental, social, and economic sustainability, where each “leg” must be stable for the whole to be functional. Environmental sustainability refers to recreation opportunities which are designed and managed to complement natural and cultural resource management objectives and minimize impacts to these resources. Social sustainability ensures a range of recreation opportunities and settings are available to provide a variety of visitor experiences with a high degree of satisfaction and minimal conflict. Economic sustainability is two-tiered: the first tier being the ability to continue or expand economic benefits that National Forest recreation provides to communities; and the second tier being the financial foundation required to manage the recreation resource. Financial sustainability (or capability) considers all means by which environmental and social sustainability may be achieved, including allocated funding, fee revenue, grants, partnerships, and volunteers.

Ensuring a sustainable recreation program for the future has been a key issue in the development of the forest plan.

Given the volume of Pisgah and Nantahala NF visitors, recreation use on the Forests causes environmental (ecological and cultural) resource impacts that must be mitigated with proper design and maintenance. On recreation sites and trails, regular maintenance is essential to minimize impacts to natural and cultural resources, especially aquatic habitats and potential sedimentation. Some existing recreation sites and trails may require relocation to reduce resource impacts or possibly be decommissioned. Outside of locations managed for recreation, unmanaged recreation causes resource impacts as well. For example, users make and sometimes illegally manage their own trails off of the designated system. Many of these unauthorized trails do not meet USFS design standards, are steep and unmaintainable, follow creek channels, threaten cultural resource sites, or traverse sensitive habitats. If left unmanaged, these trails can result in stream sedimentation, aquatic and terrestrial habitat destruction, or degradation of cultural resources. These impacts must be mitigated, and unauthorized trails should be obliterated or analyzed for potential addition to the trail system and properly maintained.

Over the last several years, US Forest Service Southern Region budget allocations for facilities have decreased by more than half, and recreation operations and trail maintenance budgets have declined as well. Meanwhile, the agency workforce has also been reduced. Costs to maintain recreation facilities and trails continues to rise, as routine trail maintenance is deferred and aging buildings and utility systems suffer failures. These trends have contributed to the inability to update or replace aging facilities and an increase in deferred maintenance backlogs.

At the same time, the desires of recreationists have evolved too. Fewer people want unmanaged trails, poorly maintained picnic areas, campsites without modern conveniences, or older facilities. Instead, trends show visitors prefer developed sites with an abundance of updated infrastructure and technology or backcountry experiences where they can find solitude from the hustle and bustle of everyday life. Population growth and increased visitation to public lands are resulting in more recreation demands over time. The Forest Service continually has requests for more miles of trails even though the current trail system is not well maintained or even sustainable in some cases. Users want assurance of continued



access to their favorite places. Sometimes the interest of user groups that desire to use the same space in different ways can collide, causing undesirable user conflict.

These environmental, social, and economic challenges, if left unmanaged, can negatively affect visitor experiences, damage natural and cultural resources, and further strain the recreation resources themselves. In the past the Forest Service has tried to keep pace with the growing demand for recreation by providing more opportunities without much focus on whether those settings and opportunities could be sustained over the long term. Although the Forest Service has invested millions of dollars in recreation, the Forests cannot afford to replace or update aging facilities, relocate poorly designed trails, or maintain underutilized picnic areas, campgrounds, or other developed recreation sites. Even if budgets did increase, it would be unrealistic to expect the Forests to meet the desires of all users in all locations. Instead, the Forest Service must work with the public to choose recreation investments wisely and develop partnerships for shared stewardship. Done well, a sustainable recreation program would improve recreation resources and visitor experience, generate economic growth to support local communities and improve quality of life, and engage the public to forge partnerships and promote shared stewardship through collaboration.

Given the above circumstances, action alternatives propose a strong emphasis on sustainable recreation, and each action alternative offers different approaches for managing a sustainable trail system. In fact, collaborative planning for trail system improvements had already occurred in the 2011-13 Nantahala and Pisgah NF Trail Strategy, where trail condition assessments were conducted and numerous public meetings were held to hear recreation user perspectives on successes, failures, and needed improvements for sustainable trail management. Conducting public meetings and developing a Trail Strategy was part of the USFS Southern Region guidance on sustainable recreation, and this public engagement played an important role in drafting the assessment and need for change and was the basis of many proposed Plan components for dispersed recreation.

## **Recreational Access**

Access to the forest has been identified as an issue that is integral to the management of the Forests for both ecological and recreation resources. The road and trail systems provide varying levels of recreational access and a diversity of experiences. Open roads provide motorized access, while most closed system roads provide access for hikers, mountain bikers, equestrians, and hunters on foot. There is general disagreement about the use of road building to access un-roaded parts of the forest, when new trails should be added to the designated system, and how many miles of roads and trails are needed to provide ample access and opportunity to different recreation interests. Many recreation users, including hunters, had voiced their preferences for trail access during the Nantahala and Pisgah NF Trail Strategy, and many suggested improvements have been implemented; although user dissatisfaction persists with bicycle and equestrian trail opportunities in some locations.

## **Environmental Consequences**

### ***Sustainable Recreation***

#### **Common to all alternatives**

Under all alternatives the Nantahala and Pisgah NFs will be implementing collaborative recreation planning with stakeholders to develop a strategic guidance and a shared vision, similar to what was done for trails in the Trail Strategy. The Forests' developed recreation sites will be prioritized and operated to a facility condition index of 90 percent or greater. Among the non-priority sites, there will likely be additional funding needed to accomplish the same standards. With the focus of using appropriated funding on priority sites, there is potential that areas not fully supported by partners or fee collections will experience reduced services, closure, or decommissioning in order to achieve fiscal capability. The goal of maintaining and operating sites to a National Quality Standard is to improve

visitor satisfaction. Although these actions are not specifically identified in Alternative A, public engagement is a goal, and collaboration on sustainable recreation is also included in the USFS Southern Region guidance for sustainable recreation which would be implemented under any alternative.

### **Alternative A**

Under the current forest plan, the Nantahala and Pisgah NFs have been challenged with aging infrastructure and deferred maintenance, while visitation to the Forests has increased. The Forest Service continues to rely on volunteers and partners to support the recreation program for trail maintenance, shooting range assistance, river corridor management, etc. While the number of available volunteers has increased, agency capacity to train and coordinate them continues to decline. However, the trend of engaging volunteers, partners, and service programs to improve sustainable recreation is a successful, even essential, model for future of recreation management within the Nantahala and Pisgah NF.

The aging and sometimes outdated infrastructure presents many challenges when combined with workforce capacity limitations and reduced ability to provide needed improvements to maintain visitor satisfaction. Correcting health and safety issues or severe resource impacts are commonly the priority projects. Changing recreation trends and increased use has occurred more rapidly than the ability to replace or update facilities, maintain trails, or meet visitor demand; and visitor satisfaction has suffered.

Alternative A includes a forest goal to keep the public involved in open and honest dialogue and involve interested and affected people in the full process of making decisions about common resources, ensuring that everyone has access to information and facilitating conversations among interested parties and enlist them in collaborative problem solving.

The dispersed recreation component of the program relies heavily on volunteers and partners which are coordinated by Forest Service staff; however, effective coordination is often a challenge. Sustainable management of NFS trails is also made more difficult by the increasingly high volume of use. The 2013 Nantahala and Pisgah NF Trail Strategy collaboratively identified needs and desires of trail users and managers and has resulted in completion of many priority projects. Project implementation has been facilitated with support from volunteers, partners, service program participants, and in some cases, utilized fee revenue and grants. These efforts would continue under Alternative A.

### *Trail Sustainability*

In Alternative A, general direction for trails management in the current plan states:

Item #1 - Design and manage the trail system to complement forestwide and management area objectives, provide a variety of opportunities, accommodate the intended type and level of use, and require minimal maintenance. Coordinate trail management with other resource management to retain usability of trails.

Item #2 - Allow hiking use on all trails. Allow other trail uses only when compatible with management area objectives, design, and physical condition of the trail, and the trail is designated for non-hiking uses.

Item #6 - Design, build, and maintain trails for their intended use and desired experience level.

Under this general direction there is a forestwide emphasis on ensuring trails are designed and managed to accommodate their intended use while considering physical limitations, the appropriate level of use, and potential impacts to other resources (environmental sustainability); providing a range of trail opportunities and experiences for visitor enjoyment (social sustainability); and on designing and managing trails for minimal maintenance (financial sustainability). Although the terminologies used in contemporary sustainable recreation management and those used in the 1987 Plan (as amended in

1994) are different, the intent of environmental, social, and economic/financial sustainability is evident in the current plan.

However, Alternative A falls short on providing management direction which is consistent with current agency goals and vision described in *A Framework for Sustainable Recreation* or direction contained in Forest Service Manual 2350, Handbook 2309, technical guides, or the USFS Southern Region guidance for sustainable recreation. Simply stated, trail management direction of Alternative A is outdated and does not reflect contemporary sustainable recreation concepts, account for changing uses, or for the increased volume of use being experienced in recent years. For example, Alternative A has no direction to limit expansion of the trail system based on social and financial sustainability, nor does it restrict mountain biking or equestrian use to trails designated for those specific uses (environmental and social sustainability), nor incorporate other measures to reduce unauthorized trails (environmental and financial sustainability).

While the volume of trail use has grown over the last 15 years, agency workforce and fiscal capabilities have declined. These changing social conditions described above, in conjunction with reduced agency capacity and the current plan's minimalistic approach to sustainable trail management, may have contributed to a proliferation of unauthorized (user-created) trails. Sustainable trails management of Alternative A is inadequate for moving the Forest toward an environmentally, socially, and financially sustainable trail system.

#### **Common to all action alternatives**

Alternatives B, C, D, and E all include geographic areas as part of the revised plan as a way of identifying goals and emphasizing priorities on distinct landscapes across the forest. There are twelve geographic areas which are divided by landscape features and defined by landscape or scenic character, types and concentration of recreation use, and sense of place. Sense of place is the cultural and physical attributes of an area that provide meaning or value to communities and visitors; it characterizes the connection people have with specific landscapes. The experience visitors have is based upon the sense of place they feel while they are recreating with a given set of expectations. Generally speaking, the combination of a recreation setting and activity (opportunity) creates an experience. Each of the geographic areas identified in the forest plan have defined goals that highlight key recreation activities and settings that guide recreation management within geographic areas to provide a range of recreation experiences.

Alternatives B, C, D, and E also include the Interface Management Area which is defined as areas with the most concentrated recreation use on the Forests. It includes developed and dispersed recreation sites, trail heads, scenic overlooks, waterfalls, National Recreation Trails, etc. The Interface Management Area includes access corridors and recreation hubs areas where the public accesses the forest and recreates. While recreation on the Forests is not confined to the Interface, this management area includes places where the public first engages with the national forest and also includes the majority of developed recreation infrastructure. Plan components for the Interface MA emphasize scenic values to retain desired landscape or scenic characteristics and settings for the recreation experiences (INT-DC-01, INT-DC-10, INT-DC-11).

Interface Management Area, and its associated Plan components, provides an opportunity to emphasize recreation settings and prioritize facility maintenance in those places which are highly valued by recreation users. Compared to Alternative A, which manages and maintains developed recreation areas to enhance activities associated with the forest environment, alternatives B, C, D, and E focus on the whole recreation corridor in Interface MA to enhance the visitor experience. Ultimately, the inclusion of Geographic Area goals and the Interface MA will highlight recreation opportunities and settings to increase the quality of visitor experiences.

All alternatives provide plan components for recreation that emphasize moving toward a more environmentally, socially, and economically/financially sustainable recreation program; however, the action alternatives place greater emphasis on collaborating with stakeholders and local communities to develop a strategic guidance and a shared vision for sustainable developed recreation for the future within five years (REC-O-01). The action alternatives recognize the role of forest recreation to the local economy and include a desired condition that “recreation activities across the Forests contribute to the sustainability of the social and economic values of local communities through jobs and income in the local economy, community stability or growth, and the quality of lifestyles in the area” (REC-DC-11). Plan components in the action alternatives also seek to reduce user conflicts which helps to achieve desired conditions related to user satisfaction and safety. As a result of the objection process, management approaches were added to Alternative E Modified that provide guidance in managing equestrian campgrounds, educating non-equestrian users about the facility designed use, and providing information on equine behavior and user safety around horses and pack stock.

Plan components common to Alternatives B, C, D, E and E Modified include development of a climbing strategy or climbing management plan (REC-O-9) which was requested by the climbing community in the assessment phase of Plan revision; these alternatives also require development of an operations and maintenance guide for dispersed campsites (REC-O-10). These are changes from alternative A which does not include plan language for a climbing strategy, nor a maintenance guide for dispersed campsites. This emphasis on sustainable recreation and collaboration with the public is expected to improve the condition of recreation sites and trails, and ultimately lead to improved visitor satisfaction over the long-term. Additionally, the action alternatives include plan direction (REC-S-03) to limit the use of surface penetrating tools for non-commercial mineral collection to designated sites. This is expected to minimize impacts to ecological and cultural resources, thus improving ecological sustainability.

#### *Trail Sustainability*

Alternatives B, C, D, E and E Modified have many Plan components in common which are intended to move the Nantahala and Pisgah NF trail system toward environmental, social, and economic/financial sustainability. The following paragraphs highlight key Desired Conditions, Objectives, Standards, Guidelines and Management Approaches related to trail sustainability which are not included in Alternative A (although the intent may be similar to the current Plan General Direction in some instances). Alternative E Modified adds clarification to Alt. E Plan direction for sustainable trail management based on Objector comments, particularly related to collaborative trail planning to address supply/demand issues for equestrian and mountain bike trails in certain geographic areas, and triggers for implementation of a potential forest supervisor order restricting those users to designated system trails.

Within the forestwide section, Plan direction articulates desired conditions for a trail system that is environmentally, socially, and economically/financially sustainable; provides high-quality recreation experiences across a range of settings for each use-type (REC-DC-22); and ensures trail-use occurs within the ability of the land to support it, with high visitor satisfaction, minimal conflict between users, and without impacts to ecologically and culturally sensitive areas. (REC-DC-21). Multiple plan components address the types of trails available on the forest, including nationally designated trails that sustain values for which they were designated (REC-DC-31) and short connector trails that enhance loop opportunities and provide connections to communities and other public lands (REC-DC-25). A forestwide management approach and the goals and descriptions in the geographic area chapter recognize places of special recreational significance and management needs to protect unique recreation settings and opportunities.

Plan components of action alternatives address many strategies to improve trail sustainability. The desired conditions clarify that unsustainable trails are transitioned to a sustainable condition utilizing

state-of-the-art trail design principles or are decommissioned and rehabilitated (REC-DC-23) and unauthorized trails are closed and rehabilitated to prevent erosion and restore vegetation or are improved to meet trail standards and added as a National Forest System (NFS) trail through a collaborative planning process (REC-DC-24). A standard (REC-S-08) directs that if unacceptable damage to natural or cultural resources is occurring or safety issues are identified on a section of trail, FS managers must temporarily mitigate impacts, or close that section of trail until proper planning and implementation can occur to correct issues, relocate, or decommission the trail. Objectives include completion of Trail Management Objectives (TMOs) for all Nantahala and Pisgah National Forest system trails within three years and to schedule trail maintenance tasks according to frequencies identified in the TMO (REC-O-04), and increase trail miles meeting National Quality Standards over the life of the Plan (REC-O-06).

Other Plan components direct that the Forest Service will design, build, and maintain trails for their intended use and improve existing NFS trails to conform with agency design parameters (REC-S-13); similar direction is provided for trailheads (REC-DC-29). Management approaches outline that the priority of trail improvement or relocation projects shall be given to those trails with user safety or resource damage issues, recurring user conflicts, or needs identified through a trail strategy or other collaborative process.

For non-motorized trails, action alternatives differ in their approach to when new trail miles can be added, and this is further addressed below.

For motorized trails, standards in all action alternatives clarify that new motorized OHV trail miles shall only be developed to mitigate safety issues or resource damage within existing OHV trail systems (REC-S-16), although an exception is allowed for electronic bicycle trails. A management approach explains that emphasis is placed on maintaining existing motorized trails to standard rather than creating new motorized trails. Trail improvements, relocation, and/or short connectors within an existing motorized trail system may be constructed to more effectively address resource concerns or improve alignment for sustainability.

Standards define that bicycle, equestrian, OHV, and electronic-bicycle trail use occurs only on NFS trails designated for those uses or NFS roads where those uses are not in violation of regulation. However, timing of implementation differs for REC-S-11 under Alternative E, which is further clarified in Alternative E Modified (see details below).

- REC-S-10** Hiking (foot travel, pedestrian) is allowed anywhere on the forest, unless the area or route is closed by Forest Supervisor order.
- REC-S-11** Equestrian (horse, stock, pack and saddle) and bicycle use is only allowed on NFS trails designated for those uses, and on open or gated system roads; unless the road is closed to those uses by Forest Supervisor order. Equestrian use is allowed for big game retrieval in hunting seasons identified by the State.
- REC-S-12** Motorized trail use (Off-Highway Vehicles), including electronic-bicycle use, is only allowed on NFS trails and roads designated or managed for that use as identified on published Motor Vehicle Use Maps, within the season of operation, and in compliance with any use fees that may exist.

A footnote to REC-S-11 which was updated in Alternative E Modified says the standard will be implemented forestwide through a forest supervisor order after collaborative trail planning identified in Objective REC-O 07(a) and associated Geographic Area Goals have been completed. The referenced geographic area goals were also updated to clarify that metrics for achieving the goals will be determined through the collaborative process.

Guidelines clarify that mixed use non-motorized trails should be accompanied by educational efforts to reduce user conflicts, and that all user groups should be encouraged to share responsibility and work together in supporting the trails (REC-G-06), while motorized trails should not have mixed use with equestrians, and bicycles or hiking is not encouraged (REC-G-07). A standard (REC-S-17) explains that designation of trails for use of electronic-bicycles shall only be done following the latest agency guidance and site-specific analysis supporting sustainable trail use. Similarly, all agency guidance would be followed for any new emerging recreation uses.

The action alternatives are clear that a sustainable trail system depends on the help of partners, clarifying that partner organizations and communities are involved in sustainable trail planning and management efforts (REC-DC-28). The objective to increase trail miles meeting National Quality Standards (REC-O-06) moves from 50 percent in Tier 1, to 60 percent in Tier 2. However, Tier 2 relies on an increase in workforce capacity or partner engagement. Another objective states that eliminating at least 10 percent of off-highway vehicle trail deferred maintenance will be accomplished primarily through volunteers, fee revenue, and grants (REC-O-05). A management approach prioritizes new trail construction when the trail has an agreement for long-term trail maintenance responsibilities signed with a partner organization; which includes compliance reviews and provisions to consider the trail(s) for decommissioning if partner maintenance responsibilities are not fulfilled. Another calls for collaboration with affected groups prior to re-designating hike-only trails to allow bicycle, electronic bicycle, or equestrian use.

Collectively, these Plan components, which are common to each action alternative, are designed to implement sustainable trail management consistent with current agency goals, visions, policies, and technical guides. Overall direction is to manage trails to minimize ecological and cultural resource impacts (environmental sustainability); to plan trail actions collaboratively and provide for a range of experiences with minimal user conflict, high visitor satisfaction, and quality information delivery (social sustainability); and to provide for economic benefits of surrounding communities, and utilize a variety of partnerships and funding sources for trail planning, construction, improvement, and maintenance (economic/financial sustainability).

Moving toward a more sustainable trail system would generally be viewed positively by most national forest visitors. However, these alternatives also contain direction which may result in a notable change in trail management and visitor experience; and may not be viewed favorably by some visitors as compared to Alternative A.

REC-DC-26 and REC-S-11 establish a desired condition and standard to limit equestrian and bicycle use to NF system trails designated and managed specifically for those uses; although Alternative E defers implementation of REC-S-11 until certain conditions are met (which is further clarified in Alt. E Mod). Alternative A does not limit these uses to NF system trails, but Forest Supervisor closure orders 09-01-2004, 07-01-04 and 01-05-2004 have prohibitions on equestrian and/or bicycle use on certain trails, roads, and areas. These closure orders have been in place for many years and have a similar effect to the proposed direction, but are applied at a limited scale. The proposed direction in all alternatives would apply Forest-wide. When visitors ride horses or bicycles on hiking trails, it can create user conflict and unsatisfying experiences for the hiker, or cause damage to other resources. The same can be true for bicycles on horse/hike trails, or horses on bike/hike trails. Depending on the circumstance, these potentially incompatible uses and unexpected encounters may also present a visitor safety issue.

However, the primary purpose for including these Plan components is to reduce occurrences of unauthorized and unmaintainable (user-created) trails. Agency policy in Forest Service Manual 2350.3 (7) states “Do not maintain unauthorized trails.” Therefore, it is a violation of Forest Service policy for agency employees, partners, volunteers, or contractors to maintain any unauthorized trail. Additionally, the general public is prohibited from “damaging any natural feature or other property of the United

States” per Federal Regulation 36 CFR 261.9(a). There are many other federal regulations which may be violated by constructing unauthorized trails, cutting vegetation, or damaging natural or cultural resources.

When riders leave a NF system trail to access a creek, shortcut a switchback, make a new loop, or create a high-challenge downhill run, they leave a noticeable track which is followed by others. Even if visitors are not digging new tread or clearing vegetation to create an unauthorized trail, their repetitive use can create a trail which will be used again by other riders. These unauthorized routes are shared through social media, web-based mapping services, group rides, word of mouth, etc. and become more evident with each use. Some visitors may become confused as to which route is the system trail and which is an unauthorized trail, and inadvertently contribute to the resource damage (and potentially get lost) by choosing the unauthorized trails. An analysis of GPS data from personal fitness tracking devices which is uploaded and displayed on a variety of social media websites shows a vast network of unauthorized (user-created) trails across the Nantahala and Pisgah NFs. Some of these websites show “heat maps” which generally indicate a route’s volume of repetitive use; more frequently used routes are more intensely colored on the map. When data of frequently used unauthorized trails is compared to GIS data of NF system trails, the extent of off trail use is very apparent and concerning to resource managers. Visits to these locations often reveal excessively steep routes, extensive damage to terrestrial habitats, uncontrolled erosion, and impacts to aquatic habitats from stream sedimentation. In some circumstances there have been impacts to cultural resource sites. Not only do these trails cause resource damage, but repairing unauthorized trail damage diverts agency efforts and funding away from maintaining NF system trails. With limited workforce capacity and financial resources for NF system trail maintenance, the proliferation of unauthorized trails has a significant effect on the agency’s ability to move toward a sustainable trail system.

Under the current Plan direction (Alternative A) the proliferation of unauthorized trails is not addressed. Direction under the action alternatives seeks to prevent unauthorized trail creation and use by equestrian and bicycle riders with REC-DC-26, REC-S-11, and through visitor education identified in REC-DC-30. This new restriction may negatively affect the riding experience for some equestrian and bicycle users, but would have an overall positive effect of improved NF system trail condition and visitor experience for the majority of compliant trail riders.

#### *Climbing and Similar Activities*

The action alternatives provide plan direction about recreational climbing and similar activities. This section describes some plan language differences between Alternatives B/C/D and Alternative E (and Alt. E Modified), but the effect of plan direction is consistent among all action alternatives.

All action alternatives contain an objective to develop a climbing management plan. The establishment of a climbing management plan was originally suggested by public comments during the Assessment phase of plan development. The Forest Service incorporated this idea as a forestwide objective rather than add site-specific information throughout the plan, because although climbing and similar activities are identified as recreation opportunities for certain geographic areas, a forest plan does not typically contain guidance for site-specific management or detailed inventories of climbing routes; that level of detail is more appropriate in a forest climbing management plan. Based on comments between draft and final, this objective was revised in Alternative E (and Alt. E Modified) to provide additional detail of who should be involved in this effort and the resulting outcomes. This climbing management plan would utilize information provided by users, such as inventories of climbing routes, access trails, staging areas, etc. to develop area-specific management direction following the latest agency policy on climbing and similar activities. The climbing management plan would provide more detailed information such as how to improve the climber experience, identify access trails suitable for addition to the system, explore climber education opportunities, identify site-specific resource protection measures and potential

closures, and develop monitoring protocols, while increasing knowledge transfer between the Forest Service and climbing community.

All action alternatives contain several components designed to protect ecological and cultural resources, as well as wilderness values, from impacts associated with climbing and similar recreational uses forestwide. Plan direction ensures protection of peregrine falcon nesting sites (PAD-S-05) and this standard was revised in Alternative E Modified along with the addition of a management approach to emphasize collaboration with the climbing community in determining the need for closures at active nesting sites. Alternative E also restricts recreation use in unique habitats like rocky summits; or on National Register of Historic Places eligible sites; or unevaluated, or sacred cultural resource sites (REC-S-19). Based on public comments, Alternative E revised this standard to be implemented as interim protection until the forest climbing management plan is completed per objective REC-S-09, direction which was retained in Alternative E Modified. After completion of a climbing management plan, site-specific resource protection needs would be identified, along with protocol for implementing closure orders and monitoring. Therefore, the broad-brush restrictions of standard REC-S-19 (a) and (b) would no longer apply once site-specific protection measures and associated closure orders are in place. This could result in an increase in climbing opportunities, since restrictions will only affect certain climbing routes or areas. The climbing management plan would also address the issue of adopting sustainable climbing access trails as National Forest system trails so they can be properly maintained.

Other proposed plan direction in all alternatives relates to climbing in designated wilderness and placement of fixed anchors. Alternatives B, C, and D standard CDW-S-05 identifies that climbing is allowed in designated wilderness where there is no resource damage occurring and where not prohibited by Forest Supervisor's order. It also requires line officer approval for the installation or replacement of fixed anchors in designated wilderness. In Alternative E, the standard was revised to remove references of specific use types and was expanded to clarify that approval for placement of fixed anchors is solely for the purpose of ensuring resource protection and consistency with wilderness values. This direction was also repeated in Recommended Wilderness standard RW-S-13 in Alternative E and retained in Alternative E Modified.

Although the wording CDW-S-05 and other plan components was updated in Alternative E for clarity and consistency with planning directives, the associated effects are the same for all action alternatives. Compared to Alternative A, this plan direction should improve knowledge exchange between the climbing community and the Forest Service, benefiting the climbing experience and ensuring protection of ecological and cultural resources.

## **Alternative B**

### *Trail Sustainability*

Additional measures to promote sustainable trail management are incorporated into Alternative B (with variations in Alternative C and D). These Plan components identify conditions which must be met before constructing new trails, in order to achieve sustainability. Many resource managers pose the question, "Why build more trails if the existing trails can't be adequately maintained?" This is a valid point, but rather than proposing a moratorium on new trail construction or an overall cap in trail miles, these standards provide guidance as to when new trail construction is appropriate.

**REC-S-14** New trail construction or adoption of unauthorized routes as NFS trails shall only be allowed if all of the following conditions are met:

1. Trail layout incorporates the most current design principles, minimizes adverse impacts to natural and cultural resources, and does not increase user conflict.



2. The proposed trail is found to be ecologically, socially, and financially sustainable;<sup>35</sup> and the project has been approved by the Forest Supervisor.

This standard is similar to General Direction in Alternative A, but goes a step further to require implementation of contemporary trail design principles, minimal resource impacts or user conflicts, and full consideration of the three aspects of sustainable recreation. Forest Service policy already identifies the Forest Supervisor as the responsible official and decision maker on new trail construction, but this is included to emphasize the point. This standard does not place any limitations or cap on overall trail miles on the Nantahala and Pisgah NFs.

### **Alternative C**

#### *Trail Sustainability*

Additional measures to promote sustainable trails management are incorporated into Alternative C (with variations in Alternative B and D). These Plan components identify conditions which must be met before constructing new trails, in order to achieve sustainability. These standards provide guidance as to when new trail construction is appropriate.

**REC-S-14** New trail construction or adoption of unauthorized routes as NFS trails shall only be allowed if all of the following conditions are met:

1. ...same as 1 above in Alternative B...
2. ...same as 2 above in Alternative B...
3. The need for a new trail has been identified through a collaborative planning process or trail strategy.
3. Within the Geographic Area, new trail mileage will be offset by a comparable length of existing NFS trail decommissioning

These Standards are similar to Alternative B, but also require a collaborative planning process to promote partner involvement and improve the social sustainability of the proposed project. This alternative requires an offset of decommissioned miles within the Geographic Area, which in essence caps the overall trail system mileage at its current levels.

### **Alternative D**

#### *Trail Sustainability*

Additional measures to promote sustainable trails management are incorporated into Alternative D (with variations in Alternative B and C). These Plan components identify conditions which must be met before constructing new trails, in order to achieve sustainability. These Plan components provide guidance as to when new trail construction is appropriate.

**REC-O-07** Tier 1: Within three years, establish a "Trail Bank" that can be used to add new sustainable trail miles to the trail system for hiking, cycling, and pack and saddle uses. The Trail Bank will begin with a seed of 30 miles. Additional miles will be credited to the Trail Bank when existing NFS trails are decommissioned and rehabilitated. Trail Bank credits can then be used, but not exceeded, when constructing new sustainable trails or

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<sup>35</sup> Financial sustainability could include consideration of available allocated funding, fee revenue, grants, endowments, volunteerism or other partnerships for long-term maintenance of the new trail(s). On partner-proposed new trail projects, an agreement for long-term maintenance should be developed; including compliance reviews and provisions to consider the trail(s) for decommissioning if maintenance responsibilities are not fulfilled or accommodated by other means.

adopting unauthorized routes as NFS trails. The Trail Bank system will also have provisions for the Forest Supervisor to increase or decrease trail mile credits based on periodic reviews of trail program needs and limitations, and changing trail-use trends within a Geographic Area. Use of Trail Bank credits will focus on improving ecological, social, and financial sustainability of the Nantahala and Pisgah NF trail system by conducting critical analysis of new trail proposals, increasing the percentage of NFS trails meeting National Quality Standards, reducing the occurrence of unauthorized routes, and providing desired user experiences.

**REC-S-14** New trail construction or adoption of unauthorized routes as NFS trails shall only be allowed if all of the following conditions 1 through 4 are met, and at least one of the conditions in 5a through 5c is met:

1. ...same as 1 above in Alternatives B and C...
2. ...same as 2 above in Alternatives B and C...
3. ...same as 3 above in Alternative C...
4. There are available miles in the Trail Bank, once established.
5. Within a Geographic Area
  - a. At least 50% of existing non-motorized NFS trails meet National Quality Standards; or
  - b. Trails of the proposed use-type are underrepresented; or
  - c. Until establishment of the Trail Bank, new trail mileage will be offset by a comparable length of existing NFS trail decommissioning.

Required direction of REC-S-14 items 1 and 2 is unchanged from Alternative B and C; and item 3 is the same as in Alternative C. However, Alternative D offers additional flexibility to construct new trail with direction in items 4 and 5, through the implementation of a “Trail Bank” established by Objective. This “Trail Bank” concept allows credits for decommissioned trail miles, which can be exchanged for new NF system trail miles. There is a “seed” of 30 miles credited in the Trail Bank, which would potentially increase the Forest’s overall mileage, but the Objective provides for an increase or decrease in available Trail Bank credits based on a Forest Supervisor’s review. This approach requires detailed consideration of sustainability for proposed trails, collaborative planning, and resource protection. It also promotes visitor safety and minimizing user conflict, encouraging an increase in trail miles meeting standards, and places a flexible limit on potential expansion of the Nantahala and Pisgah NF trail system. This hybrid approach strikes a balance between what is essentially a “no-net-gain” in trail miles requirement of Alternative C, and the potentially unlimited trail system expansion allowed in Alternative B.

Under Alternatives, B, C, and D, the approach for building new trails is distinct from trail relocations. In REC-S-15 a standard common to these alternatives clarifies that:

**REC-S-15** Relocation of unsustainable NFS trails to mitigate resource damage, safety issues, or user conflicts does not require a match in decommissioned trail miles, understanding the length of relocated and decommissioned trail segments may differ. Abandoned trail segments shall be decommissioned and rehabilitated to prevent continued resource damage, and the relocated trail segment shall adhere to conditions of REC-S-14 items 1 and 2.

This standard allows trails needing relocation to mitigate resource damage, safety issues, or user conflicts to be addressed without the constraints of new trail construction in Alternatives C and D, even if there is a net increase in trail miles. This standard is slightly different in Alternative E.

## Alternative E and Alternative E Modified

### *Trail Sustainability*

There were many public comments received on the draft plan regarding sustainable trail management and the various conditions for new trail construction proposed in Alternative B, C, and D. While there was general support for focusing on the development of new trails, there was concern about requiring an offset of decommissioned miles that would essentially cap the trail system mileage (Alternative C) and about the logistics associated with administering a trail bank of miles (Alternative D). Commenters also voiced concern with an immediate implementation of restrictions for bicycle and equestrian users to stay on system trails and how effective the current system trails would be in accommodating increasing use in some locations.

To address these concerns, a suite of adjustments were made to plan language in Alternative E:

- The standard on new trail construction (REC-S-14) and construction of trail relocations (REC-S-15) were adjusted to read:

- REC-S-14** New trail construction, or adoption of unauthorized routes as system trails, must meet conditions 1-3 below. See exceptions for trail relocation and connectors in REC-S-15.
1. Proposed trails have been identified through collaborative trail planning between the Forest Service and interested stakeholders, such as recreation users, volunteer or partner organizations, user councils, community organizations, special use permit holders, state, or local governments, etc.
  2. (a) One or more volunteer or partner organizations commit to long-term maintenance of proposed trails through an agreement; or
    - (b) Proposed trails resolve critical health and safety needs or supply/demand issues identified in geographic area goals; or
    - (c) New trail mileage will be offset by a comparable length of existing system trail decommissioning or unauthorized route closure of at least twice the length.
  3. Proposed trails are found to be ecologically, socially, and financially sustainable and must utilize current trail design principles, avoid adverse impacts to natural and cultural resources, and not create user conflicts.

- REC-S-15** Relocation of unsustainable system trails regardless of length, or construction of new connector trails of less than 0.5 miles to create loop opportunities, are not subject to REC-S-14 conditions 1 and 2 but must conform to condition 3. Relocated trails or trail segments may be longer than those being replaced, potentially resulting in a net increase of system trail miles. Abandoned trail segments shall be decommissioned to prevent continued resource damage and discourage use, unless sustainability can be addressed by repairs and changing designated use to hike-only.

- A goal was added in four geographic areas (Bald Mountains, Black Mountains, Eastern Escarpment, and Highland Domes) to address known supply/demand issues for equestrian and/or bicycle trail opportunities through collaborative trail planning.
- The objective REC-O-07 was modified and split into two parts. Part (a) states that collaborative trail planning to address equestrian and/or bicycle trail supply/demand issues in specified geographic areas needs to begin within five years. Part (b) states that collaborative trail planning

should occur forestwide every five to seven years, building on the Nantahala and Pisgah National Forest Trail Strategy.

- Language was added to the standard REC-S-11 that restricts equestrian (horse, stock, pack and saddle) and bicycle use to system trails, clarifying that this standard would be implemented forestwide through a Forest Supervisor order after the above objective REC-O-07(a) has been achieved.
- A management approach suggesting tools that can be used to accomplish objective REC-O-07(b) was also added to identify specific issues that could be addressed in the collaborative trail planning process and clarifying that this could take multiple forms.

As part of the objection process, Alternative E Modified added further clarity to REC-O-07(a), associated geographic area goals, and the footnote to REC-S-11 which identifies when a forest supervisor order for implementation of standard will occur. Those changes include the following direction in the final Plan:

- REC-O-07(a) Tier 1:

Within five years, begin collaborative trail planning to address equestrian and/or bicycle trail supply/demand issues to meet associated Goals in Bald Mountains, Black Mountains, Eastern Escarpment, and Highland Domes Geographic Areas. (Also see: Geographic Area Goals BAM-GLS-10, BLM-GLS-09, EE-GLS-09 and HD-GLS-13.)

- Geographic Area Goals BAM-GLS-10, BLM-GLS-09, EE-GLS-09 and HD-GLS-13:

Address supply/demand issues for equestrian and/or bicycle trail opportunities within the geographic area through collaborative trail planning to identify metrics for achieving this goal, appropriate trail mileage for each use-type, new trail locations utilizing sustainable trail design principles, potential adoption of unauthorized routes, sources of construction funding, and long-term maintenance commitments by volunteer and/or partner organizations.

- Footnote to REC-O-07(a) and REC-S-11:

Standard REC-S-11 will be implemented forestwide through a Forest Supervisor order after collaborative trail planning identified in Objective REC-O-07(a) has been achieved and associated Geographic Area Goals have been completed.

All together, these adjusted plan components require implementation of contemporary trail design principles, minimal resource impacts or user conflicts, and full consideration of the three aspects of sustainable recreation (ecological, social, and economic). This set of directions is more explicit than the other alternatives in that there are some known locations where the trail system does not meet the demand and takes steps to address the issue collaboratively. By clarifying that these supply and demand issues will be addressed prior to completing a closure order to restrict equestrian and bicycle use to system trails, this alternative clarifies that restrictions to the trail system will not immediately begin with the signing of the plan. This will provide an opportunity to make needed adjustments to the trail system while also expressing the Forest's commitment to addressing the proliferation of unauthorized trails over the long term. The effects of keeping equestrian and bicycle use on designated system trails and closed roads is a positive effect described in several sections of the EIS, benefiting water, soils, cultural resources, and plant and animal diversity. Although this direction will ultimately limit where horses and cyclists can ride, objective REC-O-07(a) and standard REC-S-11 ensure the availability of hundreds of miles of system trails and closed system roads will be available for equestrian and bicycle use. Additionally, recurring collaborative trail planning for all non-motorized user groups is directed in objective REC-O-07(b), which will help to ensure a broad range of dispersed recreation opportunities are

available for all trail users, visitor satisfaction is improved, user conflicts are reduced, and the trail system continues moving toward a more sustainable condition.

#### *Recreation Opportunity Spectrum Settings*

The Recreation Opportunity Spectrum (ROS) provides managers a way to classify a range of recreation settings in which recreation opportunities (activities) occur. The unique combinations of recreation settings and opportunities provide for a broad range of visitor experiences across Geographic Areas. For example, mountain biking on single-track trails in a Semi-Primitive Non-Motorized setting of backcountry is a different experience than biking on paved pathways in the Rural setting of a developed campground, or a Roaded Natural setting on a forest development road. The unique geological and ecological characteristics of each Geographic Area further diversifies the range of potential recreation experiences. The ROS settings are classified into several categories: Primitive, Semi-Primitive Non-Motorized, Semi-Primitive Motorized, Roaded Natural, Rural, and Urban.

In Alternative A, the desired ROS settings were assigned by management area but were not mapped where multiple settings were identified within a management area. In Alternatives B, C, and D, a similar approach was used where the desired recreation settings were identified by management area and largely based on the ROS inventory. Acreage calculations for these alternatives considered both the inventoried ROS settings and management area mapping. The Primitive ROS setting was expanded to management area boundaries where managed for wilderness character or characteristics<sup>36</sup>.

In Alternative E, the desired ROS settings were mapped in a GIS layer, available in the project record. The Alternative E desired ROS settings map was developed by combining the ROS inventory with management areas, and expanding Primitive settings to boundaries of designated wilderness, recommended wilderness, WSA, and WSR corridors classified as Wild. Lands within the remaining management areas were assigned desired ROS settings spatially based on a variety of considerations, including area characteristics, recreation opportunities, concentrated use areas, and other resource management objectives. A major part of those considerations were the inventoried ROS settings, which provided a spatial representation of remoteness, proximity to roads, and locations of other developed features. The process of developing the desired ROS settings map was also based on public comment and planning team input. The percentage of acres in Table 177 for each recreation setting is based on the desired ROS settings map (GIS layer).

In all action alternatives, the Nantahala and Pisgah NFs contain the following desired recreation settings:

- Primitive
- Semi-Primitive Non-Motorized
- Semi-Primitive Motorized
- Roaded Natural
- Rural

Table 177 compares the percentage of acres in each ROS setting by alternative. Although the methods of calculation vary for Alternative A and the action alternatives because of the source data; but calculation methods attempt to provide the most accurate comparison possible. Alternatives A-D have no acres in Rural ROS setting because the ROS inventory used for analysis did not identify acres in this setting. However, the desired ROS map developed for Alternative E does have acres in the Rural ROS

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<sup>36</sup> The Primitive ROS setting represents the desired condition for designated wilderness, recommended wilderness, Wilderness Study Areas, and Wild and Scenic Rivers with wild classification, rather than the existing inventory of Primitive ROS.

setting, which is shown in the table. For Alternative E, Table 178 identifies acres of each ROS setting by management area based on the desired ROS map developed between the draft and final Plan. The percentage of acres in each ROS setting do not change for Alternative E Modified.

**Table 177. Comparison of ROS Settings Acres by Alternative**

Recreation Opportunity Spectrum Settings (% of total acres)					
Alternative	Primitive*	Semi-Primitive Non-Motorized	Semi-Primitive Motorized	Roaded Natural	Rural
Alt A	6%	19%	18%	57%	0
Alt B	19%	17%	14%	50%	0
Alt C	9%	30%	13%	48%	0
Alt D	14%	20%	15%	51%	0
Alt E**	12%	20%	39%	29%	1%

\* The Primitive ROS setting represents the desired condition for designated wilderness, recommended wilderness, Wilderness Study Areas, and Wild and Scenic Rivers with wild classification, rather than the existing inventory of Primitive ROS.

\*\*Desired ROS settings for the final Plan (Alternative E and Alternative E Modified).

**Table 178. Alt. E and Alt. E Modified Desired ROS Setting acres per Management Area**

Recreation Opportunity Spectrum Setting Acres					
Management Area	Primitive	Semi-Primitive Non-Motorized	Semi-Primitive Motorized	Roaded Natural	Rural
Interface	0	5,071	17,761	37,687	5,373
Matrix*	0	0	356,795	184,514	102
Backcountry	0	132,005	0	0	0
Ecological Interest Area	0	15,127	5,221	3,345	0
Special Interest Area	0	17,124	10,039	18,494	106
Research Natural Area	0	1,487	0	0	0
Experimental Forest	0	0	0	13,512	0
Appalachian National Scenic Trail**	0	26,233	9,656	12,128	135
Scenic Byways	0	0	0	19,171	2,521
Heritage Corridors	0	1,167	2,095	5,172	89
WSR***	1,951	2,287	0	2,170	0

Recreation Opportunity Spectrum Setting Acres					
Management Area	Primitive	Semi-Primitive Non-Motorized	Semi-Primitive Motorized	Roaded Natural	Rural
Wilderness	66,393	0	0	0	0
Recommended Wilderness & WSA****	53023	0	0	0	0
Roan Mountain	0	7,332	542	1,233	210
Cradle of Forestry	0	0	0	5,951	130

\*Inventoried SPNM acres in Matrix will be managed as a desired ROS setting of SPM.

\*\*Where the ANST passes through or is adjacent to designated wilderness, recommended wilderness, Roan Mountain or Experimental Forest management areas, acres for ROS settings are included in those respective management areas. Therefore, no Primitive ROS acres are identified for the ANST Corridor management area.

\*\*\*Where WSR boundaries overlap designated wilderness or recommended wilderness, Primitive ROS acres for those Wild classified segments are reflected in the respective management areas.

\*\*\*\*Primitive ROS acres for recommended wilderness and non-recommended WSA are combined, because all WSAs are managed to maintain wilderness characteristics regardless of recommendation for designation.

Compared to Alternative A, all action alternatives manage more of the Forests for Primitive ROS and less of the forest as Roaded Natural. This is due to the new areas recommended for wilderness under the action alternatives, but also because RNAs and WSAs are managed to have a SPNM setting in Alternative A compared to Primitive ROS under the action alternatives. While these areas do not currently have motorized recreational use, the increased amount of Primitive ROS in the action alternatives would result in fewer future opportunities for motorized access on these portions of the Forests.

Alternative B has the largest number of acres managed for Primitive ROS because it includes the largest amount of wilderness recommendations of all alternatives. Alternative C has the greatest amount of lands managed for SPNM ROS because it includes the greatest amount of backcountry of all alternatives.

Alternative E acreage for Primitive and SPNM ROS settings are generally in the middle of acreage ranges of other alternatives, because it was designed to strike a balance between lands managed for wilderness or backcountry recreation, and other lands identified for active management. This alternative has the greatest acres in SPM settings and the lowest in Roaded Natural settings of any alternative. This is because approximately half of the Forest was allocated to Matrix management area where the majority of gated NFS roads exist and where potential new road construction is most likely to occur. The SPM settings of Matrix primarily contain the gated system roads, while the Roaded Natural settings are associated with open roads. By contrast, Interface has the highest acreage of Roaded Natural settings because of its focus on visitor access via open roads. Differences in ROS settings for Alternative E as compared to other alternatives are also affected by the more detailed consideration of areas through mapping the desired ROS settings.

### *Recreation Experiences*

Alternative A includes plan language to “Provide a social setting for outdoor recreation opportunities that range from primitive to developed. Provide for a variety of recreation activities appropriate to these settings and the forest environment. To provide all recreation visitors to the national forest the opportunity to participate in activities and programs and use facilities to the highest level of access practical.” (Forest Goal 8, 1994 Amendment)

While visitors can expect the ability to participate in the same dispersed recreation activities available under Alternative A, the action alternatives seek to recognize and manage for a broad range of recreation opportunities within different settings offered in geographic areas, which ensures a variety of visitor experiences for dispersed recreation. When combined with sustainable trail management direction of the action alternatives, overall visitor experience of trail users would be improved over Alternative A.

Additionally, the action alternatives focus on sustainable recreation in ways that may result in decommissioning underutilized and unsustainable recreation sites. This may impact visitors that utilize the less popular recreation facilities, as resources are focused on more highly used and sustainable priority sites. The Geographic Area chapter included in Alternatives B, C, D and E outlines specific opportunities for connecting people to the land that will be managed for in the future. In this way, the action alternatives are clearer than the current Plan about providing a range of recreation opportunities, settings, and experiences; and how they are distributed and prioritized across the forest.

With the proposed allocation of lands to new management areas under the action alternatives, there may be a difference in how people use the forest. If an area that is currently managed as backcountry changes to Recommended Wilderness then there would be additional restrictions on the use of motorized equipment or mechanized transport such as bicycles.

Alternatives B, D and E propose an increase in the number and acres of Recommended Wilderness, which are managed for a Desired Condition of Primitive ROS. These areas are characterized by an essentially unmodified natural environment where interaction between users is very low and evidence of other users is minimal. In these areas, visitors have opportunities to engage in primitive and unconfined recreation activities in settings that provide opportunities for solitude; and where visitors can practice self-reliance through application of outdoor skills in an environment that offers a high degree of challenge and risk. Alternative B would provide the greatest opportunity for visitors to experience Primitive recreation settings, Alternatives D and E would provide a moderate amount of acres, and Alternatives A and C would provide the fewest acres managed for Primitive ROS settings. It should be noted that Alternative C also allocates the most acreage to Backcountry management, which offers a similar Semi-Primitive Non-Motorized recreation setting, while Alternatives D and E strike a balance between Primitive and SPNM settings. Additional consideration of the effects of wilderness recommendation are described in section 3.4.7.

The allocation of lands to different management areas could impact the recreation experiences because of the management activities that are likely to occur within the management area. The greatest impact to dispersed recreation from management actions such as timber harvest and prescribed fire would be in the Matrix Management Area and the effects would depend on the proximity and magnitude of the activity. Timber management creates short-term impacts to recreation when travel routes are used to access timber sale units or to haul out timber from log landings. Sites, trails, or trailheads may be closed temporarily to keep recreationists away from any hazards associated with the timber operation and noise from logging equipment and trucks may be heard in vicinity around the management activities. In many parts of the Nantahala and Pisgah NFs, recreationists have increased access to the forest because of NF system roads used for timber management, many of which are available for hiking, bicycling, hiking, and hunting. Timber management impacts the short-term character of the area, which affects the recreation experience in different ways. There are impacts to the scenery where activities are seen from trails, roads, and recreation sites; effects may range from changes in tree density or creation of openings in the forest, to terrain-altering construction of roads or landings. For Alternative E, Matrix management area consists entirely of ROS settings associated with open or closed roads and various degrees of motorized use; this is also true for Interface with the exception of a few isolated parcels of SPNM primarily on shorelines and islands in area reservoirs.



All action alternatives include objectives for an increased pace and scale of ecological restoration on the forest. This increases the potential for forest users to see and hear active management activities. These impacts would be mitigated to varying degrees depending on the management area. The Matrix MA would have the greatest impact from management activities while Backcountry, Recommended Wilderness and Wilderness would have little or no impacts from vegetation management. Alternatives B, D and E have approximately the same amount of acres in the Matrix MA, and Alternative C has approximately 120,000 acres less in the Matrix MA.

Management that changes the structure of the forest vegetation by creating openings or thinning the understory would create more early successional habitat that is favored by many wildlife. Forest openings provide increased opportunities for wildlife viewing and hunting, both of which are popular forms of recreation on the Nantahala and Pisgah NFs. While all action alternatives include the same objectives for early successional wildlife habitat, the distribution of where this occurs across the forest differs by alternative. Because Alternatives B, D and E have more acres in the Matrix MA compared to Alternative C, timber harvest and the resulting early successional habitat would be distributed across a larger portion of the landscape.

All action alternatives also include plan components that emphasize providing open forest woodland conditions and day lighting of roads. This provides benefits to wildlife that prefer early successional habitat as well as improves road conditions and wildlife viewing opportunities.

#### *Recreational Access*

Although many opportunities for recreational access to the Forest exist in all alternatives, management of the NF road and trail systems vary between Alternative A and the action alternatives. Some of those variations and their effects are discussed in the Dispersed Recreation and Trail Sustainability sections above. An analysis of NF system road access and allowed uses are contained below and in Transportation and Access section. Each management area has different allowances or restrictions on new road building, so when the size and configuration of management areas varies between alternatives, there are variations in the total amount of the forest that is accessible to new road building in each alternative.

Alternative A does not specifically restrict off-trail bicycle and equestrian use. Alternatives B, C and D restrict bicycle and equestrian use to NF system trails and roads designated for those respective uses, and Alternative E will pursue a closure order to restricts equestrian and bicycle use to system trails after the above objective REC-O-07(a) has been achieved, which was further clarified in Alternative E Modified. Motorized trail use for off-highway vehicles is restricted to NF system trails designated for that use in all alternatives. Additional differences in management of the non-motorized trail system are described above under Trail Sustainability.

In the action alternatives, there is no net decrease in miles of open roads in the Interface and Matrix management areas over the life of the plan. Most of the developed and dispersed recreation sites as well as National Recreation Trails are in the Interface Management Area, which is relatively consistent in size across all action alternatives. In Alternative A, recreational access to the forest is distributed across multiple management areas with Backcountry, Wilderness, and Wilderness Study Areas being some of the least accessible parts of the forest and generally exclude motorized use. Alternatives B, D, E and E Modified have approximately the same amount of the Forest in the Matrix MA which allows for motorized access via open roads and non-motorized access via closed (gated) roads.

**Table 179. Miles of Road (Open and Closed) Within Matrix and Interface MAs**

Alt B		Alt C		Alt D		Alt E and E Mod	
Acres	Road miles	Acres	Road miles	Acres	Road miles	Acres	Road miles

Matrix	554,128	1,444	441,014	1,211	551,412	1,439	542,865	1,304
Interface	67,145	387	55,207 <sup>1</sup>	359	66,984	385	65,893	292
<b>Total</b>	<b>621,273</b>	<b>1,831</b>	<b>496,221</b>	<b>1,570</b>	<b>618,396</b>	<b>1,824</b>	<b>608,758</b>	<b>1,596</b>

<sup>1</sup>Interface acres appear less in Alt C because of more restrictive management areas that overlap acres in this alternative.

In all action alternatives, objective TA-O-06 provides opportunities for increasing the mileage of seasonally open roads in the Interface and Matrix management areas by 5-10 percent over the life of the plan, prioritizing recreational access, such as hunting and fishing. This objective would increase the motorized access to parts of the forest that would otherwise be accessible only by hiking, biking, or horse.

### Cumulative Effects

Overall demand for outdoor recreation opportunities in the Southeast, and the settings that provide them, is increasing at a rate at least equal to population growth. Total non-Federal forest land area is expected to change with continuing conversions from forests and farmlands to cities and suburbs. Currently, more than 30 percent of total land area in the Southeast is non-Federal forest, or 1.66 acres per person. By 2060, non-Federal forest is predicted to decline to 0.95 acre per person, or 57 percent of the 2010 level. The projected decline is greater for the South than the Nation because of population growth and increased development (The Southern Forest Futures Project: summary report, Wear and Greis 2012).

The general trend on private lands surrounding the Nantahala and Pisgah NFs is the gradual loss of preferred settings for nature-based recreation. Private lands are not expected to increase the supply for the settings preferred by outdoor recreationists for their activities, therefore recreation demand on national forest system lands is expected to increase.

Regardless of the alternative selected, the increased recreation demand will continue to increase and effects such as user conflicts and resource impacts will be more extensive in alternative A which does not emphasize sustainable recreation as much as the action alternatives. Also, it is unknown if future Forest Service budgets will be able to support the recreation staff, law enforcement, and facilities (whether for developed or dispersed settings) called for by increased recreation demand. This is particularly important for high maintenance and operational cost facilities or trail systems where on-going maintenance and on-the-ground personnel are needed. Implementation of a sustainable recreation program in the face of increasing demand is dependent on effective relationships with local communities and partners to provide quality recreation experiences over the life of the plan and beyond.

All action alternatives place an emphasis on sustainable recreation and increased collaboration with recreation users. This approach to recreation management reflects decades of recreation research and development of new concepts in how to engage the public and improve visitor experiences while protecting natural and cultural resources, and exploring non-traditional ways of accomplishing these goals. With implementation of the preferred alternative the Forest will be well positioned to move toward a more sustainable recreation program even with projections of increased visitation and the uncertainty of emerging trends in recreation uses and equipment.

### 3.4.5 Scenery

#### Affected Environment

The Forests contain picturesque mountains, valleys, and rivers of great scenic beauty, with the majority of these Forests providing natural-appearing landscapes. Scenic landscapes are important to the quality of life, culture, and economies of Western North Carolina. Combined, the Nantahala and Pisgah NFs receive approximately 5.2 million visits annually. The National Visitor Use Monitoring (NVUM) program

shows that over half of visitors to the Nantahala and Pisgah NFs engage in viewing scenery. The Nantahala and Pisgah NFs also provide much of the scenic backdrop for the Blue Ridge Parkway, a national park which receives approximately 13 million visits each year. The primary activity for 91% of these visitors (approximately 11.8 million) is viewing scenery. Highly valued scenic landscapes on these Forests also include lands visible from heavily used state and Forest Service roads and national scenic byways; state parks and Forest Service recreation areas; popular reservoirs and rivers; and nationally designated trails, including the Appalachian National Scenic Trail.

Over time, Forest landscapes have been shaped by natural and human forces, many of which still occur today. When viewed in the distance, forested landscapes of the southern Appalachian Mountains probably appear like a homogeneous green canopy intermittently broken by patches of open space, similar to those prior to the era of industrial logging. However, there have been dramatic changes in the appearance of these forests, and the forests we see today are very different than those of the past, especially when viewed in the foreground. For example, the loss of American Chestnut, wide-spread clearcutting prior to National Forest establishment, aggressive fire suppression efforts, infestations of invasive plants and insects, loss of Fraser Fir and Canadian and Carolina Hemlock, increased development of roads and utilities, and increased recreational demands, have shaped the area's scenery.

Conditions continuing to affect scenery on the Nantahala and Pisgah NFs vary greatly. The following describe overall conditions across the plan area.

- *Increased development of adjacent private lands*

As the population of WNC grows, the number of residences, vacation homes, businesses, and roads has increased. This residential and commercial expansion onto adjacent previously undeveloped lands creates new areas with potential views of the Nantahala and Pisgah NFs. Heightened viewer sensitivity can lead to conflicts in current management objectives and preferences of adjacent landowners. As private lands in the southern Appalachian Mountains are developed, a greater demand is placed on public lands to provide a natural-appearing scenic backdrop for tourists and recreationists.

- *Increased tourism and tourism-based commerce*

The Nantahala and Pisgah NFs are among the most visited areas in the National Forest System and also serve as a scenic backdrop for national attractions such as the Blue Ridge Parkway and Appalachian National Scenic Trail. Economic benefits of a growing tourism industry in WNC are well documented, and along with that comes a heightened sensitivity and desire for scenic quality. The Forest Service NVUM survey conducted in five-year intervals beginning in 2003 concluded that approximately 53% to 55% of national forest visitors have a concern for scenery. A similar survey of Blue Ridge Parkway visitors in 2000 indicated that 91% of its 11 million visitors that year were engaged in viewing scenery.

- *Recreation use*

Higher numbers of recreation users cause scenic impacts as trails and dispersed campsites become worn and eroded. Trails may appear rutted impacting scenic qualities of a natural appearing landscape. Dispersed camping has resulted in areas denuded of vegetation, with compacted soil, multiple fire rings, trash accumulation, and hacked-up trees.

- *Ongoing transportation initiatives*

Highway and road improvement projects can create changes in scenic qualities of national forest lands, yet there is little guidance in the current land management plan on how to address these impacts.

- *Vegetation treatments and timber harvest*

Vegetation treatments create variations in forest canopy density, while access roads and log landings alter the terrain itself. To some, these short and long-term changes to the form, line, color and texture of the characteristic landscape have no effect on their enjoyment of the national forest; to others the effects may be obtrusive.

Scenery resource management is an integrated part of ecosystem management. Project design and analysis with interdisciplinary teams ensure long-term scenic integrity is conserved, maintained, or enhanced to achieve desired conditions. The Forest Service directives (FSM 2380) clarify that the objective of visual management is to manage all National Forest System lands to attain the highest possible visual quality commensurate with other appropriate public uses, costs, and benefits. Forest lands are inventoried, evaluated, and managed to ensure the visual resources as a fully integrated part of the National Forest System land management process, where the visual resource is treated equally with other resources.

The current scenery inventory was last updated in the early 1990s and uses a methodology developed in the 1970s. The USDA handbook *National Forest Landscape Management, Volume 2: The Visual Management System* published in 1974 was superseded in 1995 by the Forest Service handbook for scenery management *Landscape Aesthetics, A Handbook for Scenery Management* (Scenery Management System handbook). This newer handbook describes an updated process for inventorying, classifying, and managing scenery with broadened consideration for constituent input, management of cultural landscapes, landscape restoration, and many other concepts which were absent or underrepresented in the “Visual Management System” used in the current plan. The Visual Management System uses variety classes, sensitivity levels and distance zones to establish visual quality objectives across the forest. This process was used in the current Nantahala and Pisgah NFs plan and is described below in order to better clarify the effect of changes between the current plan and the action alternatives.

First, landscape character types were identified and classified into variety classes. Character types are land areas having common distinguishing visual characteristics of landform, rock formations, water forms, and vegetative patterns and are used as a frame of reference in classifying scenic quality based on physical features of the landscape. The second tier of classification is variety class, which subdivides the landscape into areas of scenic importance. This is based on the premise that landscapes with more variety or diversity have a greater potential for high scenic value, although all landscapes have some scenic value.

There are three variety classes identified in the Visual Management System (VMS):

- Variety Class A – Distinctive: Areas of unusual or outstanding scenic value, not common in the landscape character type.
- Variety Class B – Common: Areas where combinations of form, line, color, and texture are repeated throughout the character type, not unusual from standpoint of scenic value.
- Variety Class C – Minimal: Areas of little change in form, line, color, or texture and contain no characteristics of Classes A or B.

In the initial scenery inventory created for the current plan, all landscapes within the character type were determined to have some degree of variety and scenic value, therefore no lands were classified as Variety Class C. Variety Class A landscapes were ultimately identified as special interest areas to be managed for their respective unique characteristics. All remaining lands were classified as Variety Class B – Common.

After determination of variety class, two other considerations affecting management of scenery were considered as directed in the VMS: Sensitivity Level and Distance Zone. Sensitivity level is a measure of viewer concern for scenic quality, and distance zone is the distance from viewer to landscape or feature being viewed. Both of these elements were identified in the initial scenery inventory for the current plan, though this was a generalized or broad-scale inventory for land management planning purposes (a more detailed assessment of these elements is typically conducted for project-level scenery analysis).

The initial scenery inventory for the current plan identified the following sensitivity levels and distance zones:

- Sensitivity Level 1 (SL1) – Highest Sensitivity: All seen areas from primary travel routes, use areas, and water bodies where at least  $\frac{1}{4}$  of visitors have a major concern for scenic quality; and secondary travel routes, use areas, and water bodies where at least  $\frac{3}{4}$  of visitors have a major concern.
- Sensitivity Level 2 (SL2) – Average Sensitivity: All seen areas from primary travel routes, use areas, and water bodies where less than  $\frac{1}{4}$  of visitors have a major concern for scenic quality; and secondary travel routes, use areas, and water bodies where at least  $\frac{1}{4}$ , but not more than  $\frac{3}{4}$ , of visitors have a major concern.
- Sensitivity Level 3 (SL3) – Lowest Sensitivity: All seen areas from secondary travel routes, use areas, and water bodies where less than  $\frac{1}{4}$  of visitors have a major concern for scenic quality.

Primary routes, use-areas, or water bodies are areas of national or regional importance, high use volume, and/or long use duration. Secondary routes, use-areas, or water bodies only have local importance, low use volume, and/or short use duration.

The last component of inventory under the VMS are distance zones which are defined as:

- Foreground Distance Zone (FG): The detailed landscape between the viewer and  $\frac{1}{4}$  to  $\frac{1}{2}$  mile in the distance.
- Middleground Distance Zone (MG): The landscape between the foreground and background located between  $\frac{1}{4}$  and  $\frac{1}{2}$  mile and 3 to 5 miles from the viewer.
- Background Distance Zone (BG): The distant part of the landscape located greater than 3 to 5 miles from the viewer.

After these three elements were classified and mapped for the Nantahala and Pisgah NFs, guidance in the VMS was used to synthesize variety classes, sensitivity levels, and distance zones into the following visual quality objectives (VQOs). The resulting inventory was then used in management area (MA) allocation during the planning process.

- Preservation VQO – Ecological changes only (no direct human-caused changes).
- Retention VQO – Provides for management activities which are not visually evident.
- Partial Retention VQO – Management activities remain visually subordinate to the characteristic landscape.
- Modification VQO – Management activities may visually dominate the original characteristic landscape but must borrow from natural form, line, color, and texture so completely that activities appear as natural occurrences.

In 1995, the USDA Forest Service released a new handbook for scenery management titled, *Landscape Aesthetics, A Handbook for Scenery Management*; which is often referred to as the “Scenery

Management System” or SMS. Direction from the Scenery Management System handbook was not incorporated into the 1994 plan. Implementation of the handbook direction was identified as a need for change in the Nantahala and Pisgah NF’s plan Assessment prepared in 2014. All of the legislative and policy references cited above are still valid, but visual resources are now referred to as scenic resources. The Scenery Management System (SMS) utilizes many of the same components as the VMS, but the terminology, inventory process, and methods of classifying inventory results were changed. Below is a crosswalk of terms (definitions of these terms remain relatively unchanged, except where noted).

**Table 180. Visual Management System to Scenery Management System Terminology Change**

<b>VMS Term</b>	<b>SMS Term</b>	<b>Definition Change</b>
Variety Class (A, B & C)	Scenic Attractiveness (A, B & C)	Minor
Sensitivity Level (1, 2 & 3)	Concern Level (1, 2 & 3)	Minor
Distance Zone (FG, MG & BG)	Distance Zone (FG, MG & BG)	Yes, See Below
Visual Quality Objective (VQO)	Scenic Integrity Objective (SIO)	Minor
Preservation (P) VQO	Very High (VH) SIO	None
Retention (R) VQO	High (H) SIO	None
Partial Retention (PR) VQO	Moderate (M) SIO	None
Modification (M) VQO	Low (M) SIO	None

Scenery Management System distance zones break at ½ mile and 4 miles, rather than relying on a variable demarcation between zones as used in VMS. SMS distance zone definitions are:

- **Foreground Distance Zone (FG):** The landscape between the viewer and ½ mile in the distance.
- **Middleground Distance Zone (MG):** The landscape between the foreground and 4 miles from the viewer.
- **Background Distance Zone (BG):** The landscape between the middleground and the horizon.

A recent amendment to agency policy changed SIO definitions slightly, but the intent in their application remains the same. The following revised definitions were incorporated into the final forest plan.

- **Very High SIO** - The landscape is intact with only minor changes from the valued attributes described in the scenic character.
- **High SIO** - Management activities are unnoticed and the landscape appears unaltered.
- **Moderate SIO** - Management activities are noticeable but are subordinate to the scenic character. The landscape appears slightly altered.
- **Low SIO** - The landscape appears altered. Management activities are evident and sometimes dominate, but are designed to blend with surroundings by repeating form, line, color, and texture of attributes described in the scenic character.

In the environmental consequences section of this analysis, note that the “no action” alternative references assigned visual quality objectives (VQO), while the action alternatives reference assigned scenic integrity objectives (SIO). This cross-referencing of terms is important when comparing VQO and SIO management area assignments and acreages in each alternative. Where critical for comparative analysis, the equivalent VQO/SIO term is displayed in parentheses for reference.

Other changes associated with scenery management are a policy amendment replacing the term “landscape character” with “scenic character”; and the use of scenic classes described in the Scenery

Management System handbook. Scenic character is a combination of the physical, biological, and cultural images that gives an area its scenic identity and contributes to its sense of place; and provides a frame of reference from which to determine scenic attractiveness and to measure scenic integrity. The existing scenic character is described for each geographic area and is also adopted as the desired scenic character for all action alternatives as identified by management area. Scenic classes are a SMS concept which classify national forest lands into classes 1-7 based on combinations of inventoried scenic attractiveness, concern level, and distance zones. The following table shows this relationship (from SMS handbook):

**Table 181. Scenic Classes for Each SA/CL/DZ Combination**

Scenic Attractiveness	Distance Zones and Concern Levels								
	FG1	MG1	BG1	FG2	MG2	BG2	FG3	MG3	BG3
<b>A</b>	1	1	1	2	2	2	2	3	3
<b>B</b>	1	2	2	2	3	4	3	5	5
<b>C</b>	1	2	3	2	4	5	5	6	7

Like VQOs under the VMS, SIOs under the SMS are used to determine the degree to which desired scenic character attributes are to remain intact. This is measured by the amount of deviation from the desired scenic character, described as the state of naturalness, or conversely the state of disturbance created by human activities or alteration. Scenic classes are spatially mapped and used in land management planning to link desired SIOs for each management area to locations on the ground. A scenic class inventory GIS layer was developed for the Nantahala and Pisgah NF and is referenced in the plan for use in project-level planning.

At the project level, scenery resource management is used to determine potential scenery impacts by analyzing contrast of proposed actions and their degree of change within the surrounding landscape in order to maintain or achieve the desired scenic character. The potential contrast is compared with desirable attributes of scenic character in elements of form, line, color, texture, and scale. Proposed actions are assessed to determine if they would be evident, subordinate, or visually dominate features, and the degree of change from the desired scenic character. If the assigned VQO/SIO cannot be achieved, design modifications or mitigation may be utilized to reduce potential scenery impacts. Scenery/visual management considers impacts from any activity that could potentially modify the landscape, including road or highway construction, utility or communication site installations, recreation or administrative developments, vegetation management projects, facility construction, etc.

The effect of changes associated with moving from VMS to SMS are described below in environmental consequences.

## Environmental Consequences

### Effects common to all alternatives

The forest contains five administratively designated Forest Scenic Areas:

- Looking Glass Rock
- Glen Falls
- John Rock
- Whitewater Falls
- Craggy Mountain (Renamed Big Ivy/Craggy Mountain Forest Scenic Area in Alt. E and E Mod)

Under all action alternatives, these areas are managed as Special Interest Areas to protect and emphasize their special characteristics, where all proposed management activities must meet Retention VQO (Alternative A) or the equivalent High SIO (Alternatives B, C, D and E). These areas are recognized as Variety Class/Scenic Attractiveness Class A landscapes. Scenic Area boundaries and acreages in the SIA management areas are the same among Alternatives A-D, but Craggy Mountain scenic area was expanded under Alternative E and again under Alternative E Modified as the Big Ivy/Craggy Mountain Forest Scenic Area (see Alt. E and Alt. E Modified effects below). The areas are not managed for timber production, but activities such as wildlife improvements, prescribed fire, trail construction, and road construction are allowed if they enhance the area's unique qualities, foster public enjoyment of the area, and are compatible with other management objectives.

Protection of scenic resources within or as seen from other highly sensitive use areas or travel routes is also a common theme among all alternatives. Views from nationally designated corridors such as the Appalachian National Scenic Trail, National Historic Trails, National Recreation Trails, National Scenic Byways, and the Blue Ridge Parkway are classified as Sensitivity Level 1 in the VQO inventory, and Concern Level 1 in the Scenic Class Inventory. Although there are subtle differences in how these areas are to be managed, the resulting assigned Visual Quality Objectives and desired Scenic Integrity Objectives are consistent among all alternatives, including Alternative E Modified in the final Plan.

### Effects of Alternative A

Under this alternative, the newly developed Scenic Class inventory would not be utilized and the Scenery Management System terminologies and definitions would not be incorporated into the plan. The current plan would continue being used which incorporates the outdated Visual Management System and has VQOs assigned in the standards for each management area.

In the current plan some management areas are assigned a single VQO for all distance zones and sensitivity levels. Others are assigned a range of VQOs, where the applicable objective is determined on a site-specific basis by distance zone and sensitivity level. The following table identifies VQOs assigned by management area, associated acres and percentage of total Nantahala and Pisgah NF acres. This data is an approximation of potentially visible national forest lands based on GIS analysis.

**Table 182. Alternative A – Assigned Visual Quality Objective Acres by Management Area**

Management Area and Management Emphasis	P VQO	R VQO	PR VQO	M VQO	Site Specific P to M VQO	Seldom Seen	No VQO
MA1B: Timber Production, Young Forest, Motorized Recreation				33,982		2,596	
MA3B: Timber Production, Young Forest, Limited Motorized Recreation				213,935		24,460	
MA4D: Timber Production, Mixed-Age Forest, Limited Motorized Recreation			101,452	48,788		7,963	
MA12: Developed Recreation					905	47	
MA16: Administrative Facilities					532	117	
MA5: Backcountry, Non-Motorized Recreation, Mature Forest		107,801				8,698	



Management Area and Management Emphasis	P VQO	R VQO	PR VQO	M VQO	Site Specific P to M VQO	Seldom Seen	No VQO
MA14: Appalachian National Scenic Trail Corridor, Non-Motorized Recreation, Scenery		16,104					
MA2A: Scenery, Motorized Recreation Access, Mixed-Age Forest, Timber Production Modified for Scenery		9,997	24,511			2,134	
MA2C: Scenery, Motorized Recreation Access, Mature Forest, No Timber Production		31,455	2,732			3,170	
MA15: Wild & Scenic Rivers					1,337	437	
MA4A: Scenery, Non-Motorized Recreation, Mixed-Age Forest, Timber Production Modified for Scenery		10,508	41,314			4,643	
MA4C: Scenery, Non-Motorized Recreation, Mature Forest, No Timber Production		153,213	12,980			15,835	
MA13: Special Interest Areas		11,654				392	
MA17: Balds					3,378	20	
MA10: Research Natural Areas	1,442					18	
MA6: Wilderness Study Areas		26,711				1,444	
MA7: Designated Wilderness	65,104						
MA7: Experimental Forests							13,253
MA9: Roan Mountain		4,925				214	
MA11: Cradle of Forestry					6,072		
Un-inventoried Lands							26,155
<b>Assigned VQO Total Acres</b>	<b>66,546</b>	<b>372,369</b>	<b>182,988</b>	<b>296,705</b>	<b>12,224</b>	<b>72,188</b>	<b>39,407</b>
<b>Percentage of Total N&amp;P NF Acres</b>	<b>6.38%</b>	<b>35.72%</b>	<b>17.55%</b>	<b>28.46%</b>	<b>1.17%</b>	<b>6.92%</b>	<b>3.78%</b>

*Management areas with scenery/visual resources as a primary emphasis*

Of the management areas identified in the previous table, several have a primary emphasis on maintaining high quality scenery. In the land management planning process, a visual resource inventory was used to identify areas of scenic value and guide management area allocation. Management area boundaries are typically mapped to include the foreground distance zone from travel-ways, use areas, and waterbodies; but they also include prominent ridgelines visible in the middleground from key observation points and travel routes. These management areas offer protection to scenic corridors such as the Blue Ridge Parkway, Forest Heritage Scenic Byway, Mountain Waters Scenic Byway, state scenic byways, highly traveled NC and US highways, and some segments of national recreation trails and national historic trails. They also include shorelines visible from many lakes and rivers. Lands visible in these management areas are assigned a Retention or Partial Retention VQO (High or Moderate SIO).

- MA 2A (36,641 ac.) - Emphasis is on providing pleasant scenery for people who experience the forest by driving (or boating) through it. These areas are intended as scenic travel-ways through the forest. Roads are generally open with the adjacent forest land managed to

provide a pleasing visual experience. Timber management is permitted but modified to meet scenery objectives.

- MA 2C (37,357 ac.) – Management direction is the same as MA 2A, except that no timber management is allowed.
- MA 4A (56,465 ac.) – Direction is to provide remote forest settings, managed for high quality scenery. The area is mostly closed to motor vehicles, and timber management activities are designed to emphasize scenic quality and wildlife habitat.
- MA 4C (182,029 ac.) – Direction is to provide remote forest settings, emphasizing visually pleasing scenery and habitats for wildlife requiring older forests. The area is mostly closed to motor vehicles, and no timber management is allowed.

Combined, MA 2A, 2C, 4A and 4C equal approximately 30% of the Nantahala and Pisgah National Forests in the current plan.

*Management areas with scenery/visual resources as a secondary emphasis*

These areas have primary management emphases related to recreation, unique ecosystems, or congressional designations, but maintaining high quality scenery and/or natural appearing forests are strongly integrated in management direction as a secondary emphasis. Timber management or certain types of development are either prohibited or limited in these management areas, and proposed actions are required to meet Preservation, Retention, or Partial Retention VQO (Very High, High, or Moderate SIO).

- MA 5 (116,499 ac.) – Direction is to manage for a backcountry recreation experience, which has little evidence of human activities and no timber management.
- MA 6 (28,156 ac.) – These congressionally designated Wilderness Study Areas are managed to maintain wilderness characteristics, including natural and undeveloped conditions.
- MA 7 (65,104 ac.) – These congressionally designated wildernesses are managed to preserve or enhance wilderness character, including natural and undeveloped conditions.
- MA 9 (5,139 ac.) – Roan Mountain is managed to maintain unique habitats, open areas, and high scenic quality.
- MA 10 (1,459 ac.) – Research Natural Areas are managed to perpetuate unique habitats as a reference ecosystem condition for research.
- MA 13 (12,047 ac.) – Special Interest Areas are managed to preserve their unique biological, geological, or scenic values, which includes five forest scenic areas.

These six management areas with a secondary emphasis on scenery/visual resources equals approximately 22% of the Nantahala and Pisgah National Forests in the current plan.

*Management areas with congressionally designated trails, rivers, and eligible wild and scenic rivers*

Congressionally designated national scenic trails and wild and scenic rivers, as well as eligible wild and scenic rivers are managed to preserve specific attributes and values identified in enabling legislation and other guiding documents. Each of these areas has a primary or secondary management emphasis to preserve scenic quality and are generally required to meet Preservation, Retention, or Partial Retention VQO (Very High, High, or Moderate SIO).

Appalachian National Scenic Trail (ANST) - Under this alternative, the ANST has a management area corridor which is a minimum of 100 feet on each side of the footpath and can extend up to ½ mile on each side, which is considered the foreground zone. The management area was mapped without aid of

computer technology and hand-drawn on 1:24,000 topographic maps estimating potential visibility based on contours. The acreage cited below is based on this past approach to management area mapping. Because of the need to field-verify visibility from the trail, the current plan standards require a more refined mapping of the visible foreground corridor on-the-ground in leaf-off season. This is done at the project level and considers vegetative screening, but the extent of locations where this analysis must occur is not reflected in the current plan. As a result, management area acreage greatly underrepresents the actual visible foreground of the ANST corridor. Implementation of projects in the current management area has proven problematic, requiring boundary adjustments at the project level that expand protections of Management Area 14 (ANST) outside the mapped management area boundary. Standards for this management area require that a Retention VQO be met for all activities throughout the area, including all national forest lands visible within the foreground of the footpath or associated facilities regardless of the management area in which it lies. Even activities proposed on lands allocated to a timber emphasis management area are required to meet the Retention VQO if found to be in the visible foreground of the ANST.

- MA 14 (16,104 ac.) – The Appalachian Trail is a congressionally designated national scenic trail, where the visible foreground corridor is managed to preserve ANST values. Timber management is not allowed.

Designated and Eligible Wild and Scenic Rivers (WSR) – Under this alternative, WSR boundaries, segment classifications, and management direction are identified in the 1986 Nantahala and Pisgah NF plan and associated Comprehensive River Management Plans (CRMP). Additional direction is found in Amendment 18, which adds Wilson Creek WSR Comprehensive River Management Plan and management area, and Amendment 22, which updates the Chattooga Wild and Scenic River CRMP direction. The current plan, as amended, has the following general direction and scenery standards.

- MA 15 (1,774 ac.) – The Chattooga River, Horsepasture River, and Wilson Creek are congressionally designated Wild and Scenic Rivers, where a mile-wide corridor is managed to maintain their Outstandingly Remarkable Values (ORV) within river segments classified as Wild, Scenic, or Recreational.
  - Scenery standards for the Chattooga WSR are to meet Retention VQO for all segment classifications, except where the corridor overlaps Ellicott Rock Wilderness, which must meet a Preservation VQO.
  - Scenery standards for Horsepasture WSR are to meet a Partial Retention VQO in the Recreational segment, and Retention VQO in the Scenic segment.
  - Scenery standards for Wilson Creek WSR are to meet a Preservation VQO in Wild segments, Retention VQO in Scenic segments and Recreational segments of Variety Class A landscapes, and Partial Retention VQO in Recreational segments of Variety Class B and C landscapes.
- Eligible wild and scenic river corridors are not allocated as separate management areas in the current plan but are embedded in other management areas. The current plan identifies 10 eligible WSR segments totaling approximately 173 miles in length for classifications of Wild, Scenic, or Recreational. Management direction is to preserve identified ORVs within ¼ mile on each side of the river segment, which is approximately 55,360 acres. There are no VQOs assigned to eligible WSR corridors in this alternative, but the current plan does have the following scenery standards for each segment classification:
  - Wild - Maintain the natural appearance and essentially primitive character of the river areas. Provide special emphasis to visual quality within the visual corridor.

- Scenic - Maintain the river and its immediate environment in a near natural appearance. Provide special emphasis to visual quality within visual corridors outside the river area.
- Recreation - Provide special emphasis to visual quality in the immediate river environment and protect the outstandingly remarkable scenic values.

These two corridor management areas with congressional designations make up approximately 2% of the Forests.

Altogether, management areas that have a primary or secondary emphasis on scenery/visual resources or congressional designation which reflect scenery values make up approximately 54% of the Nantahala and Pisgah NFs in Alternative A, excluding eligible WSR corridors which are imbedded in other MAs.

*Management areas with timber and early successional habitat as primary emphases*

Management Areas 1B, 3B and 4D of the current plan emphasize a sustainable supply of timber and creation of early successional habitat. These management areas are mostly required to meet Modification VQO (Low SIO) and make up approximately 42% of the Forests' total acreage.

However, each of these management areas has direction requiring a more stringent scenery standard of Partial Retention VQO (Moderate SIO) on lands visible from certain locations of high scenic sensitivity. The respective plan standards are:

- MA 1B & 3B (274,972 ac.): Manage to meet Partial Retention VQO for seen areas from the Appalachian Trail or Blue Ridge Parkway as determined by specific analysis.
- MA 4D (158,203 ac.): Meet Partial Retention VQO in foreground and middleground Sensitivity Level 1. (Note: Sensitivity Level 1 travel-ways, use areas, and waterbodies include any primary route/area where at least ¼ of users have a high concern for scenery; see full definition above. This would include all scenic byways, nationally designated trails, popular recreation sites, most lakes and major rivers, and many NC and US highways.)

These standards are intended to be applied in project-level scenery analysis, which among other factors considers effects of vegetative screening adjacent to the viewer or surrounding the proposed treatment area. At the plan level it is impossible to determine actual acreage affected by these standards, so a process was developed to estimate affected acres in Alternative A Management Areas 1B, 3B and 4D, and a similar standard in the Matrix management area of all action alternatives. To accomplish this, a GIS seen-area analysis was conducted using a digital elevation model and locations inventoried as Concern/Sensitivity Level 1. This "bare-ground" seen-area analysis provides an estimate of potentially visible acres required to meet these more stringent scenery standards; but since it only accounts for topographic screening, the acreage estimates are much higher than would be derived from a site-specific analysis considering vegetative screening.

**Table 183. Alternative A - Timber Emphasis MA Acres Potentially Required to Meet PR VQO**

<b>Alternative A</b>	<b>Acres</b>
Management Area 1B in Foreground of AT or BRP	1,828
Management Area 1B in Middleground of AT or BRP	8,407
Management Area 3B in Foreground of AT or BRP	18,846
Management Area 3B in Middleground of AT or BRP	59,331
Management Area 4D in Foreground, Sensitivity Level 1	26,821
Management Area 4D in Middleground, Sensitivity Level 1	74,631
<b>Total acres of MA 1B, 3B &amp; 4D in PR VQO under these</b>	<b>189,864</b>
<b>Percentage of total MA 1B, 3B &amp; 4D acres</b>	<b>44%</b>

<b>Percentage of total Nantahala and Pisgah NF acres</b>	<b>18%</b>
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When the approximately 18% of acres in Alternative A that are managed for timber and wildlife emphasis but potentially required to meet Partial Retention VQO are combined with the approximately 54% of acres managed for a primary or secondary emphasis on scenery or congressional designation which reflects scenery values, they comprise approximately 72% of the total Nantahala and Pisgah NF acres under the current plan assigned a Preservation, Retention, or Partial Retention VQO (Very High, High or Moderate SIO). Conversely, only 28% of the forests are required to meet a Modification VQO (Low SIO).

### **Effects common to all action alternatives**

Each action alternative has plan components incorporating scenery management concepts, processes, direction, and terminologies from *Landscape Aesthetics, A Handbook for Scenery Management* (aka: Scenery Management System). As part of this direction, an updated Scenic Class inventory was developed with input from Forest leadership, resource specialists, and the public. This Scenic Class inventory is a GIS layer referenced in the plan, but is not a plan component. Within the life of the plan many things could happen that change the Concern Level, Distance Zone or even Scenic Attractiveness classification on the ground; for example, new scenic byways may be designated, new or relocated trails or roads may be constructed, certain trails may gain a national designation, or a recreation site may be decommissioned. Any of these actions would dictate a change in the Scenic Class inventory. All action alternatives have plan direction allowing and providing guidance on updating the Scenic Class inventory when conditions on the ground have changed or mapping errors are identified. As an external reference, updating the Scenic Class inventory will not require a plan amendment. The Scenic Class inventory is not to be confused with desired Scenic Integrity Objectives which are plan components and cannot be changed without a plan amendment.

To understand the potential effects of scenery management plan components in this analysis, it is important to consider that a “bare ground” GIS visibility analysis at the plan level identifies the maximum potential visibility without consideration of vegetative screening. During plan implementation, the project-level scenery analysis will identify actual visibility including effects of vegetative screening. Many of the areas or acres cited in this analysis as potentially visible may actually be completely screened by vegetation from most viewpoints.

Management area allocation in the action alternatives utilized a different approach than that of Alternative A. The effects of allocation approaches on scenery management for scenic and timber emphasis management areas are described in more detail in the latter part of this analysis.

Forestwide direction in all action alternatives includes desired conditions which ensure many opportunities for viewing high quality scenery, rural/cultural sightseeing, and nature-based tourism (SC-DC-01); that scenic resources compliment recreation settings and experiences (SC-DC-02); and that high quality scenery is emphasized where viewed from popular recreation destinations while retaining the distinctive scenic character and sense of place associated with the Nantahala and Pisgah National Forests as well as the Southern Appalachian region (SC-DC-03). The geographic area descriptions and forestwide desired conditions describe Scenic Character and Scenic Integrity Objectives (SIO) identified as desired conditions in each management area.

Forestwide standards for scenery management require that proposed actions which may visually alter scenic character undergo a project-level analysis considering associated viewpoints at all use areas, water bodies, open roads, trails, and closed roads used as trails for project areas with a High, Moderate, or Low SIO and from any location within an area with a Very High SIO; and that project-level scenery analysis be done in leaf-off season or utilize a GIS visibility analysis (SC-S-01). Both the VMS and SMS direct that project-level scenery analysis be done in optimal viewing situations, such as leaf-off season in

deciduous forests or times of reduced fog or haze where those conditions are common. Standard SC-S-02 requires that proposed activities be designed to meet or exceed desired SIOs identified in each management area. Although worded slightly differently, these standards which are common to all action alternatives are very similar to general direction in Alternative A, and would have similar effects.

Another standard outlines the timeframe needed to meet SIOs (SC-S-03):

Desired Scenic Integrity Objectives must be met in the following timeframes:

1. Very High - Within one full growing season
2. High – Within two full growing seasons
3. Moderate – Within three full growing seasons
4. Low – Within four full growing seasons or as needed to achieve restoration goals

The timeframe to meet each SIO was increased in the action alternatives by one growing season as compared to respective VQOs in Alternative A.

For example, Partial Retention VQO is required to be met after two growing seasons in Alternative A, but Moderate SIO is allowed three growing seasons in the action alternatives. This translates to more flexibility for project management actions to meet the desired SIO over an extended period of time. Another difference in this standard is the allowance for management actions to meet the desired Low SIO over any timeframe needed to achieve restoration goals that move forest ecozones toward desired conditions. This open-ended duration of time would even allow forest-type replacement treatments to meet the Low SIO; effectively eliminating any scenery management constraint for forest restoration projects required to meet a Low SIO. This is much more permissive than similar direction in Alternative A.

Alternatives B, C, D, E and E Mod also include new forestwide standards intended to allow flexibility in desired SIOs for alteration of existing or construction of new recreation or administrative facilities (SC-S-05) or in situations where a compelling need or benefit related to public health and safety is essential to the project (SC-S-06). However, in each case there is additional guidance to ensure consideration of aesthetics. In SC-S-05 proposed actions must incorporate a project design which is appropriate for the desired Recreation Opportunity Spectrum (ROS) setting and consistent with guidance of the USFS Built Environment Image Guide; and in SC-S-06 project design must seek to blend activities with the natural environment by repeating elements of form, line, color, texture, pattern, and scale found in the desired Scenic Character attributes. These standards provide flexibility in scenery management at USFS developed recreation and administrative facilities or, for example, on highway safety improvement projects, communication installations needed for public safety, or implementing Federal Aviation Administration regulations for aircraft safety such as lighting requirements or runway expansion. Alternative A has no such flexibility, which could require plan amendments to implement certain proposed actions.

Several guidelines in all action alternatives (SC-G-01 through 05) direct utilization of principles in the Scenery Management System handbook and reference the Scenic Class inventory for project-level planning and analysis. There are no comparable plan components in Alternative A, but excerpts from the Visual Management System handbook and need to reference an external VQO inventory map are integrated into current plan direction and appendices. Guidelines in the action alternatives simply update processes and terminologies found in the Scenery Management System handbook. The Scenic Class inventory developed for reference during project-level planning and analysis under the action alternatives is generated from inventories of Concern Levels, Distance Zones, and Scenic Attractiveness. These are essentially the same elements used in the VQO inventory for Alternative A, but reflect current conditions on the ground as opposed to conditions that existed when the 1987 plan or 1994 amendment were developed.

Management approaches in the action alternatives offer guidance on project planning and conducting a project-level scenery analysis. These are not necessarily repeated in Alternative A but are considerations in project planning and analysis utilizing elements from both the Scenery Management System and Visual Management System handbooks and common practices used by scenery management specialists.

*Management Areas where scenic resources are emphasized*

Management area allocation in all action alternatives was designed to minimize the number of management areas in order to provide more management flexibility and simplify implementation. As a result, management area boundaries for highly sensitive scenic corridors were mapped using a slightly different protocol for the action alternatives than those used in Alternative A. The Appalachian National Scenic Trail, Blue Ridge Parkway, Forest Heritage National Scenic Byway, and Cherokee Skyway National Scenic Byway each have their own corridor management area in the action alternatives. Using a method that is consistent with neighboring forests, each of these were mapped using a GIS visibility analysis of the foreground distance zone, which is up to ½ mile from the travelway. This process minimized the size of these corridor management areas by excluding all unseen or seldom seen areas within the ½ mile corridor.

Utilizing this management area mapping protocol for the Appalachian National Scenic Trail corridor results in a larger management area in action alternatives than in Alternative A, which remedies management area mapping and project-level implementation issues associated with the current plan. As described above, the management area acreage in Alternative A greatly underrepresents the actual visible foreground of the ANST corridor. Alternative A maps a smaller area in the plan, but requires a larger area to be analyzed at the project level. Under the action alternatives, the entire potentially visible foreground zone of the ANST, side trails, vistas, and shelters have been mapped and reflected in management area boundaries. Vegetation management within the revised management area would be allowed in certain conditions where they benefit ANST values, which is consistent with management direction on adjacent forests and in the Appalachian National Scenic Trail Comprehensive Plan. This change in management area mapping and conditions for using vegetation management techniques in the ANST corridor may result in a loss of some acres for commercial timber management, but does not necessarily preclude opportunities for improving forest health, restoring desired forest conditions, treating invasive species, etc.

Forest-wide desired condition SC-DC-09 in the action alternatives states:

Management activities visible in the foreground (FG) or middleground (MG) from the Appalachian National Scenic Trail, National Historic Trails, National Recreation Trails, Blue Ridge Parkway, or National Scenic Byways meet or exceed a Moderate SIO, regardless of scenic class or management area in which the activity is proposed. In some cases, a more restrictive SIO applies if specified in management area direction.

This desired condition has a similar effect as the previously mentioned standards for Management Areas 1B, 3B and 4D of the current plan which state:

MA 1B & 3B (274,972 ac.): Manage to meet Partial Retention VQO for seen areas from the Appalachian Trail or Blue Ridge Parkway as determined by specific analysis.

MA 4D (158,203 ac.): Meet Partial Retention VQO in foreground and middleground Sensitivity Level 1.

As indicated in the analysis of Alternative A, these standards potentially require that proposed actions on approximately 18% of Nantahala and Pisgah National Forest acres meet a Partial Retention VQO (equivalent to Moderate SIO). In SC-DC-09 of the action alternatives, additional Concern Level 1 travelways are included, such as National Historic Trails, National Recreation Trails and National Scenic

Byways which would not be considered in the current plan Management Area 1B and 3B standard; although all Sensitivity Level 1 viewpoints would be considered in the Alternative A MA 4D standard. The differences in effects of these similar standards among all alternatives is negligible and range from 14.9% of Nantahala and Pisgah NF acres in Alternative C, to 20.5% in Alternative B; with Alternative A falling in the middle at 18%. Alternative D, E and E Mod have a similar number of acres affected by this standard and represent approximately 20% of total Forest acres, as compared to 18% for a similar standard in Alternative A.

**Table 184. Action Alternatives – Matrix Acres Potentially Required to Meet Moderate SIO (SC-DC-09)**

Action Alternatives	Alt. B	Alt. C	Alt. D	Alt. E (E Mod)
Matrix MA acres in FG of nationally designated trails and byways	36,737	26,850	36,438	36,324
Matrix MA acres in MG of nationally designated trails and byways	177,444	128,168	171,300	170,168 (169,694)
<b>Total Matrix MA acres in Moderate SIO under this standard</b>	<b>214,181</b>	<b>155,018</b>	<b>207,738</b>	<b>206,492 (206,018)</b>
<b>Percentage of total Matrix MA acres</b>	<b>38.7%</b>	<b>35.2%</b>	<b>37.7%</b>	<b>38.0%</b>
<b>Percentage of total N&amp;P NF acres</b>	<b>20.5%</b>	<b>14.9%</b>	<b>19.9%</b>	<b>19.8%</b>

Another consideration is that much of the 18% of NF acres in timber emphasis management areas required to meet Partial Retention VQO in Alternative A are areas that would be required to meet a Modification VQO if not visible from the ANST, BRP, or other Sensitivity Level 1 locations. But most of the 14.9% to 20.5% of NF acres affected by SC-DC-09 in the action alternatives are portions of Matrix management area inventoried as Scenic Class 1 or 2 and would be required to meet the desired High or Moderate SIO anyway. Desired condition SC-DC-09 was added as a safeguard and to emphasize the importance protecting middleground views from nationally designated travelways such as the BRP, but it is somewhat duplicative with Matrix management area desired conditions for scenery management because of the extent of inventoried Scenic Class 1 and 2. Below is the desired SIO assignment for Matrix management area common to all action alternatives:

**Table 185. Action Alternatives – Matrix MA Desired SIO Assignments (MAT-DC-14)**

Matrix Management Area					
Inventoried Scenic Class	1	2	3	4	5-7
Desired Scenic Integrity Objective	High	Moderate	Low	Low	Low

*Management areas where active forest management is emphasized*

All action alternatives contain plan components that propose an increase in vegetation management to improve forest health and resiliency by restoring appropriate ecozone and age class distributions, reducing stand density where overstocked, increasing use of prescribed fire to replicate its natural role in the ecosystem, reducing non-native invasive plant species, and providing additional early seral habitat for wildlife. Matrix and Interface management areas are where most of the active management will occur, representing approximately 48% to 60% of the Forests depending on alternative. Matrix and Interface management areas combined comprise 59.6% of Forest acres in Alternative B, 47.6% in Alternative C, 59.3% in Alternative D, and 58.4% in Alternative E and E Modified.

During plan implementation, project-level proposed actions in these management areas may include a variety of treatment tools, such as forest-type restoration requiring clearcutting and replanting, low residual basal area shelterwood harvests to reduce yellow poplar and restore mesic oak or other



ecozones, expanding or creating new wildlife fields, or using prescribed fire to reduce rhododendron and mountain laurel shrub layers to create a more open understory conducive to herbaceous plant growth.

Depending on the treatment type, its visibility from analyzed viewpoints, the size or scale of altered area, and perceived deviations to the desired Scenic Character, these treatments may be visible from analyzed viewpoints but will be designed to meet the desired SIO within the allowed timeframe. Some treatment tools like forest-type restoration or shelterwood harvest could create noticeable deviations to the desired Scenic Character for extended periods of time, but would typically be limited to those areas which are seldom seen or assigned a Low SIO; or treatments will be modified to meet a more restrictive desired SIO. Other treatments like prescribed fire have a short duration of impact to scenery and typically green-up within one growing season, so could potentially meet even the most restrictive desired SIOs.

Regardless of proposed actions and treatment types, the project-level scenery analysis will identify viewpoints and visibility, then proposed actions will be designed in coordination with a scenery management specialist to meet the desired SIO as seen from any given viewpoint associated these management areas; this is true for all action alternatives.

### Effects that vary by action alternative

As indicated above, all forestwide scenery desired conditions, standards, guidelines, and management approaches are the same among all action alternatives. This is also true for the desired SIOs identified by Scenic Class in each management area. The only variation of scenery resource management among action alternatives is the location and size of management areas. These variations are due to the management area allocation process based on alternative themes. To compare potential effects, a GIS analysis was conducted which combined the Scenic Class inventory with management area data for each alternative. Acres of desired SIOs for each management area were then tabulated for all action alternatives. A similar process was used to determine effects of Alternative A, the results of which are displayed in a previous section of this analysis. The effects of scenery management direction for action alternatives is displayed below. As an aid, a crosswalk of terms and key abbreviations is also included.

**Table 186. Crosswalk of VQOs to SIOs**

VMS Term	SMS Term
Visual Quality Objective (VQO)	Scenic Integrity Objective (SIO)
Preservation (P) VQO	Very High (VH) SIO
Retention (R) VQO	High (H) SIO
Partial Retention (PR) VQO	Moderate (M) SIO
Modification (M) VQO	Low (L) SIO

**Table 187. Alternative B - Desired SIO Acres by MA & Percent of Total N&P NF Acres**

Management Area Name	VH SIO	H SIO	M SIO	L SIO	Site Specific VH to L VQO	Seldom Seen	No SIO
Matrix		52,181	331,002	117,837		53,108	
Interface		27,033	35,754	1,540		2,818	
Backcountry		87,697					

Management Area Name	VH SIO	H SIO	M SIO	L SIO	Site Specific VH to L VQO	Seldom Seen	No SIO
Appalachian National Scenic Trail Corridor		45,290					
National Scenic Byway Corridors		23,314					
Heritage Corridors		3,644	4,235	231		416	
Wild & Scenic Rivers					5,535	714	
Special Interest Areas		13,329	13,080	670		2,296	
Ecological Interest Areas	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Research Natural Areas		1,487					
Recommended Wilderness	126,334						
Wilderness Study Areas							
Designated Wilderness	66,400						
Experimental Forests							13,131
Roan Mountain		8,729	83			422	
Cradle of Forestry					6,072		
<b>Desired SIO total ac.</b>	<b>192,734</b>	<b>262,704</b>	<b>384,154</b>	<b>120,278</b>	<b>11,607</b>	<b>59,774</b>	<b>13,131</b>
<b>Percentage of total N&amp;P NF</b>	<b>18.45%</b>	<b>25.15%</b>	<b>36.78%</b>	<b>11.52%</b>	<b>1.11%</b>	<b>5.72%</b>	<b>1.26%</b>

**Table 188. Alternative C - Desired SIO Acres by MA & Percent of Total N&P NF Acres**

Management Area Name	VH SIO	H SIO	M SIO	L SIO	Site Specific VH to L VQO	Seldom Seen	No SIO
Matrix		40,703	254,584	99,068		46,660	
Interface		20,617	30,908	1,325		2,357	
Backcountry		229,011					
Appalachian National Scenic Trail Corridor		51,663					
National Scenic Byway Corridors		20,983					
Heritage Corridors		3,644	4,235	231		416	
Wild & Scenic Rivers					5,535	714	
Special Interest Areas		12,699	11,166	616		2,575	
Ecological Interest Areas		10,459	51,818	12,745		4,536	
Research Natural Areas		1,487					
Recommended Wilderness	11,193						
Wilderness Study Areas	15,985						
Designated Wilderness	66,400						
Experimental Forests							13,131
Roan Mountain		8,729	83			422	

Management Area Name	VH SIO	H SIO	M SIO	L SIO	Site Specific VH to L VQO	Seldom Seen	No SIO
Cradle of Forestry					6,072		
<b>Desired SIO Total Acres</b>	<b>93,578</b>	<b>399,995</b>	<b>352,794</b>	<b>113,985</b>	<b>11,607</b>	<b>57,680</b>	<b>13,131</b>
<b>Percentage of Total N&amp;P NF</b>	<b>8.97%</b>	<b>38.36%</b>	<b>33.83%</b>	<b>10.93%</b>	<b>1.11%</b>	<b>5.53%</b>	<b>1.26%</b>

**Table 189. Alternative D - Desired SIO Acres by MA & Percent of Total N&P NF Acres**

Management Area Name	VH SIO	H SIO	M SIO	L SIO	Site Specific VH to L VQO	Seldom Seen	No SIO
Matrix		50,253	327,774	117,498		55,887	
Interface		26,240	35,554	2,414		2,776	
Backcountry		107,065					
Appalachian National Scenic Trail Corridor		49,899					
National Scenic Byway Corridors		23,771					
Heritage Corridors		3,644	4,235	231		416	
Wild & Scenic Rivers					5,535	714	
Special Interest Areas		13,967	13,260	672		2,673	
Ecological Interest Areas		2,179	16,864	4,731		2,233	
Research Natural Areas		1,487					
Recommended Wilderness	74,173						
Wilderness Study Areas	3,248						
Designated Wilderness	66,400						
Experimental Forests							13,131
Roan Mountain		8,729	83			422	
Cradle of Forestry					6,072		
<b>Desired SIO total ac.</b>	<b>143,821</b>	<b>287,234</b>	<b>397,770</b>	<b>125,546</b>	<b>11,607</b>	<b>65,121</b>	<b>13,131</b>
<b>Percentage of total N&amp;P NF</b>	<b>13.77%</b>	<b>27.51%</b>	<b>38.09%</b>	<b>12.02%</b>	<b>1.11%</b>	<b>6.24%</b>	<b>1.26%</b>

**Table 190. Alternative E (and E Mod) - Desired SIO Acres by MA & Percent of Total N&P NF Acres**

Management Area Name	VH SIO	H SIO	M SIO	L SIO	Site Specific VH to L VQO	Seldom Seen	No SIO
Matrix		49,569	319,431 (318,957)	116,984		56,881	
Interface		26,240	35,554 (35,320)	2,414		2,776	
Backcountry		132,295					

Management Area Name	VH SIO	H SIO	M SIO	L SIO	Site Specific VH to L VQO	Seldom Seen	No SIO
Appalachian National Scenic Trail Corridor		48,152					
National Scenic Byway Corridors		21,851					
Heritage Corridors		3,644	4,235	231		416	
Wild & Scenic Rivers					5,535	714	
Special Interest Areas		19,755 (20,463)	20,568	2063		3,538	
Ecological Interest Areas		1,982	14,120	3,860		2,233	
Research Natural Areas		1,487					
Recommended Wilderness	49,098						
Wilderness Study Areas	3,921						
Designated Wilderness	66,400						
Experimental Forests							13,133
Roan Mountain		8,729	83			422	
Cradle of Forestry					6,072		
<b>Desired SIO total ac.</b>	<b>119,419</b>	<b>313,704 (314,412)</b>	<b>393,991 (393,283)</b>	<b>125,552</b>	<b>11,607</b>	<b>66,980</b>	<b>13,133</b>
<b>Percentage of total N&amp;P NF (Alt. E Mod results in no change of percentages)</b>	<b>11%</b>	<b>30%</b>	<b>38%</b>	<b>12%</b>	<b>1%</b>	<b>6%</b>	<b>1%</b>

As previously mentioned, Alternative E expands Craggy Mountain Forest Scenic Area from the original area designated in the current plan and identified in other action alternatives; and is expanded again in Alternative E Modified. The Forest Scenic Area was increased from 1,840 acres in other alternatives to 11,501 acres in Alternative E and 11,975 acres in Alternative E Modified. The area was also renamed to the Big Ivy/Craggy Mountain Forest Scenic Area to reflect that the landscape is larger than Craggy Mountain alone. Since this Forest Scenic Area incorporates Special Interest Area acres, as well as Research Natural Area and Recommended Wilderness Area acres, the table above reflects 8,224 acres of Special Interest Area with a desired High SIO (increased to 8,698 ac. for Alt. E Mod); 3,222 Recommended Wilderness with a desired Very High SIO; and a 55 acres Research Natural Area with a desired High SIO. In total these 11,501 acres of Alt. E and 11,975 acres of Alt. E Mod in the Big Ivy/Craggy Mountain Forest Scenic Area will comprise most of the national forest lands visible from the Blue Ridge Parkway at Pinnacle Gap and Craggy Gardens. All NFS lands visible in the Foreground or Middleground from the Blue Ridge Parkway are required to meet a Moderate SIO or higher per desired condition SC-DC-09, and those lands in the Big Ivy/Craggy Mountain Forest Scenic Area would be required to meet High SIO in Scenic Class 1 per SIA-DC-06.

As indicated in the tables above, all action alternatives have a higher percentage of lands assigned a Very High SIO as compared to Alternative A acres in Preservation VQO; and Alternatives B and D have more acres of Very High SIO than Alternative C. This is because there are more acres in recommended wilderness in the action alternatives, particularly in Alternatives B, D, E and E Modified.

Alternative A has more acres of Retention VQO, because it has over 205,000 acres in management areas with a scenery emphasis (MA 2A, 2C, 4A, 4C) which does not occur in any action alternative. Alternative C has more High SIO acres due to its increased amount of Backcountry management area compared to Alternatives B, D, E and E Modified.

The action alternatives have more acres of Moderate SIO (PR VQO) and fewer acres of Low SIO than Alternative A. This is due in part to a desired Moderate SIO for Heritage Corridors, SIAs, and Ecological Interest Areas (EIAs) but is primarily because Matrix management area has a desired SIO of Moderate for Scenic Class 2. The Scenery Management System handbook classifies Middleground-Concern Level 1 (MG1), Foreground-Concern Level 2 (FG2), and Background-Concern Level 1 (BG1) as Scenic Class 2 (SC2). With the high density of Concern Level 1 and 2 travelways crisscrossing the Nantahala and Pisgah NF, it is to be expected that much of the land base would inventory as SC2. In the Scenic Class inventory approximately 50% of the Nantahala and Pisgah NF and approximately 59% of Alternative D, E and E Mod Matrix management area are classified as SC2. These high percentages of SC2 and associated Moderate SIO acres in Matrix are also explained by the fact that approximately 36% to 37% of Matrix acres are in scenery emphasis management areas in Alternative A (MA2A, 2C, 4A, 4C), which are required to meet Retention and Partial Retention VQO.

Additionally, the current plan (Alternative A) incorporated a very detailed approach to management area allocation which relied heavily on scenery and ROS inventories, open and closed road densities, and ecological resource inventories. This allocation process resulted in 21 management areas with different combinations of scenery or timber emphasis, young or old forest desired conditions, and with or without motorized recreation access. The more generalized approach to management area allocation under the action alternatives identified certain foreground corridors, concentrated recreation use areas, special interest areas, congressionally designated areas and those recommended for designation, etc., and then the balance of land generally went into Matrix. There are variations in management area allocation based on alternative themes, but in the action alternatives Matrix consists of lands that are distributed across a dozen different management areas in Alternative A. Each of the current plan management areas have unique VQO assignments for various distance zone and sensitivity level combinations, but Matrix only has three desired SIOs; and Matrix makes up 42% to 53% of the Forests depending on the alternative. This “lumping” approach to management area allocation in the action alternatives results in a loss in plan-level specificity and shifts more responsibility of identifying and managing resources to the project-level planning team. As a result, desired SIO assignments in the action alternatives are less area-specific than in the current plan and more reliant on accuracy of the Scenic Class inventory. The resulting effect is that more of the Nantahala and Pisgah NF lands are inventoried in SC2, so a larger portion of Matrix is required to meet a Moderate SIO (Partial Retention VQO) as compared to the same lands under Alternative A.

Matrix management area in the action alternatives accounts for 42% to 53% of the Nantahala and Pisgah NF land base, and approximately 37% of that is currently managed for scenery emphasis under Alternative A. However, with a desired Moderate SIO for SC2 in Matrix, these visually sensitive landscapes will continue to be managed for similar scenery objectives under all action alternatives, despite the differences in management area allocation processes. Shifts in management area allocation and desired SIOs will tend to balance each other at project-level planning and result in little to no difference in effects to management of scenic resources for any alternative, or effects to timber or wildlife resource management resulting from implementation of plan standards for scenery.

### **Alternatives C, D, E**

Alternatives C, D, and E introduce a new management area called Ecological Interest Areas (EIA). This management area emphasizes ecological restoration, which in some instances may involve vegetation treatments intended to change forest-types to restore species composition. If for example a white pine

plantation is proposed for restoration to a dry-mesic oak forest-type, it may be most efficient and successful if the white pine is harvested and replanted with a species that is dry-mesic oak species. This potentially dramatic change in scenic conditions might only meet a Low SIO and may take many seasons of growth to blend with the desired Scenic Character. The desired SIO assignments for EIA management area are intended to accommodate forest restoration activities with a Low desired SIO for SC3, and when combined with forestwide standard SC-S-03 the SIO may be met over any duration of time.

### **Cumulative Effects**

The cumulative effects analysis timeframe for scenic resources is the next 10 to 15 years and the area is the 18 counties of Western North Carolina.

Management direction for scenic resources in all action alternatives fully incorporates the most current U.S. Forest Service policy for scenery management, but this only applies to National Forest System lands. Adjacent lands of federal, state, county, or municipal ownership may or may not have regulations, policies, or management plans protecting scenic resources. Likewise, state law, county regulations, or city ordinances, codes, or zoning may or may not protect scenic resources in regard to development on private lands. However, national parks such as the Blue Ridge Parkway and Great Smoky Mountains do have management plans with direction related to scenic resources, and state parks and forests also have management direction with some degree of consideration for scenery. The greatest potential for impacts to scenery on lands adjacent to national forest is development of private lands. In most cases there is limited regulatory control of potential scenery impacts from private development, other than areas covered by the North Carolina Mountain Ridge Protection Act; although city or county ordinances may have exemptions to this law or require more restrictive measures.

Effects of ongoing developments next to National Forest System lands can sometimes have negative effects on scenic resources when viewing the continuous landscape. Forest visitors often view scenery as a continuous landscape with little discernment regarding the land ownership being viewed. Sometimes management activities occurring on ownership boundaries can be quite noticeable if the change in form, line, color, or texture of the activity follows ownership boundaries rather than a natural landscape feature. If activities on private lands are designed to lessen impacts to scenic resources, the difference between private lands and National Forest System lands are less apparent.

Developed or modified landscapes on adjacent lands within the mosaic of ownership may have adverse impacts to scenery when considered cumulatively. Because adjacent lands may have increased development and scenic impacts over time, the value of the generally undeveloped National Forest and the more natural appearing scenery found on the forest may become increasingly valued.

### **3.4.6 Transportation and Access**

Access to the Forests was identified as an issue early in the plan revision process. System roads are the primary means of motorized access to the National Forest; however, they are also a source of concern because of potential environmental effects on water quality, wildlife habitat, and the social effects on remote settings. The current road system has a backlog of maintenance needs, and there is disagreement regarding the need for road building to access unroaded parts of the Forests.

During the assessment of forest conditions and the identification of Need for Change, the following needs were identified related to roads and access:

- Manage roads given the reality of limited maintenance funds combined with the public's desire for motorized access to the Forests;
- Manage a sustainable transportation system that meets present needs while balancing economic, environmental, and social priorities without compromising the Forests' abilities,

financially or otherwise, to maintain that system in the future. Management activities include road construction and reconstruction, as well as direction for decommissioning unneeded roads, including temporary roads and roads in environmentally or geologically hazardous locations;

- Address the public's desire to access the National Forests for multiple uses.

## Affected Environment

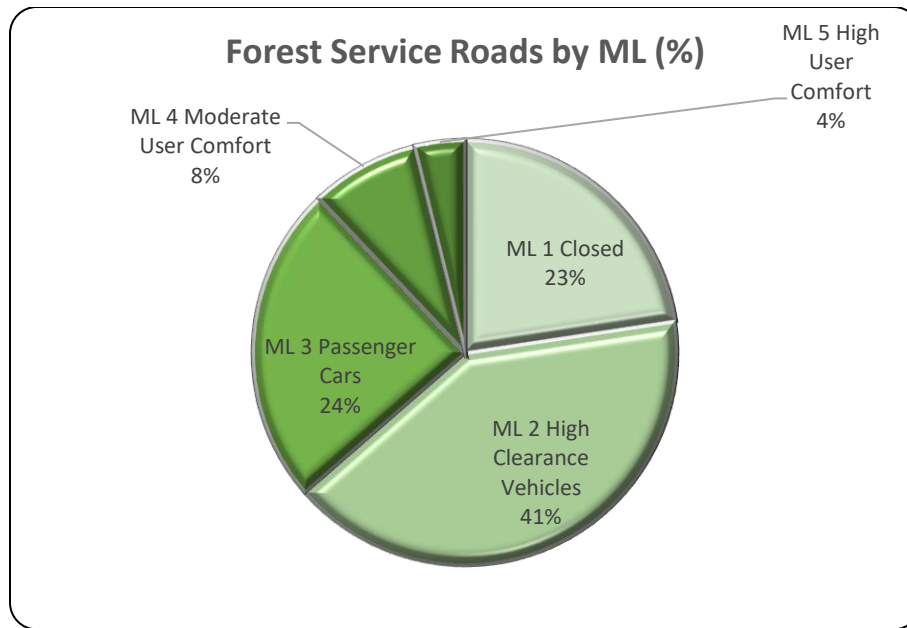
Within the Nantahala and Pisgah NFs boundary there are approximately 5,736 miles of roads, approximately 2,320 miles of which are existing National Forest System Roads (NFSR). Table 191 lists forest roads that are wholly or partially within or adjacent to NFS lands and are necessary for the protection, administration, and utilization of the NFS and the use of and development of its resources (Title 23, Section 101 of United States Code (23 U.S.C. 101). State and other federal roads on the Nantahala and Pisgah NFs total 3,379 miles. Other non-system roads include roads on private property and unauthorized roads (formerly called unclassified). Guidance for the transportation system in the current forest plan is limited to the management of roads within Forest Service jurisdiction. Table 191 summarizes the roads based on jurisdiction.

**Table 191. Roads and Trails Summary by Jurisdiction (miles)**

Jurisdiction	Nan-Pisgah Existing Conditions Boundary	
	Mileage	%
Forest Service	2,320	40.4%
Other Federal and State	3,379	58.9%
Unauthorized Non-System	37	0.7%
<b>Total – Roads</b>	<b>5,736</b>	<b>100%</b>

**Table 192 Forest Service Road Miles by Maintenance Level**

	Forest Service Road Miles by Maintenance Level (ML)					
Maintenance Level	ML 1 Closed	ML 2 High Clearance Vehicles	ML 3 Passenger Cars	ML 4 Moderate User Comfort	ML 5 High User Comfort	Total
Miles	525	951	565	191	88	2,320



**Figure 116. Miles of roads by maintenance level (percent)**

Gated Forest Service system roads are managed as either closed or restricted to protect the road prism from being degraded by vehicular traffic and to mitigate for illegal access to sensitive treatment areas. Other federal and state roads are managed as open, while non-system roads are typically managed as closed. Approximately 37 percent of system roads on the Nantahala and Pisgah NFs are maintained as open to vehicular traffic, and 22 percent are open seasonally.

Approximately 41 percent of the system roads are closed to vehicular access and are minimal standard roads designed for intermittent use. Newly constructed roads are well located on stable soils, are out-sloped, have frequent drainage dips, spot surface stabilization, vegetated cut, and fill slopes with stabilized fords at live stream crossings. Many roads are vegetated upon completion of activities in the area, and as a result, these roads require little to no maintenance between use cycles. While these roads are closed to motorized vehicular traffic, they provide non-motorized public access to the Forests which is highly valued by many forest users, including hikers, mountain bikers, and equestrians.

**Table 193. Total Nantahala and Pisgah NF Roads by Access Status (miles)**

Road System	Open		Restricted		Closed		Total miles
	Miles	Percent	Miles	Percent	Miles	Percent	
Forest Service	868	37	510	22	942	41	2,320

Forest management activities significantly affecting the transportation system are road construction, reconstruction, maintenance, and decommissioning. Road construction and reconstruction is typically related to timber harvest needs and providing adequate access on newly acquired parcels.

U.S. Forest Service road maintenance budgets historically have not been sufficient to maintain the road system to an adequate level. In recent years, large storm events have further impacted road conditions and road maintenance needs. Maintenance of the transportation system is an annual line item in the Forest Service's budgets. Traditionally, maintenance of the system roads is accomplished using project monies or receipts from the sale of Forest Service timber. Some programs that provide auxiliary funding and are coordinated through the region include the Federal Lands Transportation Program, Federal Lands



Access Program, Public Lands Highways, Federal Aid Routes, and Emergency Relief for Federally Owned Roads. Maintenance sharing is an option for distributing financial responsibility of system roads maintenance with cooperators and private users. Where applicable, cooperative agreements may alleviate a portion of the maintenance costs. Cooperative agreements define the cooperator or commercial hauler responsibilities related to the use and maintenance of system roads. In order to provide a safe and efficient transportation system that minimizes environmental impacts, new sources of funding must be identified or required maintenance must be reduced, either by reducing mileage or reducing existing maintenance levels.

## **Analysis Methods**

Changes to the forest transportation system were evaluated based on plan direction and management area allocations in each alternative that would influence future motorized access on the National Forest. Impacts on and from roads vary according to traffic use and volume, location, maintenance frequency, surfacing quality, soil type, road-surface shape, and drainage patterns, and site specific considerations will be evaluated in future project level NEPA.

This analysis assumed reduced mileage of National Forest System roads would generally equate to increased opportunity for primitive recreation and decreased motorized access and ecological impacts from roads. The ecological consequences of closing, decommissioning, and naturalizing roads generally results in increased wildlife habitat connectivity, reduced sedimentation and impacts to plants and archaeological sites, decreased vandalism and theft at archaeological sites, reduced dumping, and less noise disturbance to wildlife. The precise magnitude and location of these impacts, however, is too complex to determine at the plan scale because the effectiveness of achieving these impacts is largely dependent on site-specific situations and design features.

This analysis also assumed that roads available only for administrative use would have lower traffic volumes and correspondingly fewer impacts to ecological resources than roads that are open to the public.

## **Environmental Consequences**

### **Common to all alternatives**

In all alternatives, major roads necessary for through traffic would remain open. Roads with the highest benefits and most use are identified and prioritized, while roads with high levels of risk to safety and environmental resource damage are evaluated for closure, upgrade, conversion, or decommissioning. Most road closures would be on dead-end roads unless necessary to ensure public safety and mitigate resource damage. Specific roads designated for closure will not be identified at the plan level.

Under all alternatives, coordination, collaboration, and partnerships with other federal and state entities in the management of transportation facilities to and through the forests would continue. This is to ensure that transportation access is maintained, standards are consistent, safety issues are addressed, and efficiency is considered at all times.

### **Alternative A**

The 1987 Plan, as amended, provides guidance for what types of roads are acceptable in the various management areas, as well as road densities by management area. Road densities are highest in management areas that support timber production (MAs 1B, 2A, and 2C) and lower in management areas that emphasize non-motorized recreation use and access (MAs 4A, 4C, and 4D). Under the existing plan, management areas that do not allow for new system road construction comprise approximately 11 percent of the Forests. The remainder of the Forests have limitations on where new system road construction would occur, consistent with management area direction and forestwide standards.

Standards call for designing and constructing roads in locations where they are least likely to cause damage to natural resources with specific requirements for preventing erosion and sediment into stream channels. The current forest plan does not include plan direction or guidance for decommissioning roads.

With continued implementation of Alternative A, 6.0 total additional miles of road will likely be needed annually, including 1.2 miles of new road prism construction, 1.9 miles of existing road prism added to the system, and 2.6 miles of temporary road construction that is decommissioned after use. These numbers were calculated by looking at the ten-year period between 2001 and 2011, during which 12.5 miles of new system roads were constructed. Newly constructed roads would be better located than many existing roads, with the goals of limiting interaction with water resources, reducing the need for stream crossings, and mitigating for the impacts of erosion, sedimentation, and landslides.

Currently, road decommissioning is determined on a case-by-case basis with consideration for long-term needs of the route, the desired recreation opportunity spectrum (ROS) associated with the management area, and the need to obliterate unauthorized routes on the National Forest lands. Road decommissioning would also be expected to continue at existing rates. From 2001 to 2011, 20.7 miles of road were obliterated. Given this, about 2.1 miles of decommissioning would be expected to continue annually under continuation of Alternative A.

Currently, road maintenance activities are determined based on the maintenance level assigned to all National Forest System roads. Some roads have been closed or their use restricted to reduce the level of maintenance needed. Additionally, some maintenance has been “deferred” until it could be included within a timber sale, resulting in a backlog of deferred road maintenance activities. The general priorities identified through deferred maintenance surveys call for addressing the highest risk road segments and implementing the standard mitigation measures of the forest plan to bring the National Forest Road System in line with the Forest Plan direction and strategic intent of the road system. The two primary costs driving the deferred maintenance backlog are the cost of aggregate surface replacement and culvert replacement.

Overall, motorized access to the Forests would remain relatively consistent with existing access, and road maintenance issues would continue to persist on a transportation system that has a backlog of deferred maintenance.

### **Alternatives B, C, D, and E**

Desired conditions for transportation and access include having a sustainable, well-maintained transportation system that provides safe and efficient public access and connectivity among communities and the Forests. The transportation system reflects the expected levels of use and public desires while having minimal impacts on resources (TA-DC-01). Unneeded roads are removed from the system and decommissioned following public involvement and site-specific environmental analysis to eliminate environmental effects of the roads and achieve ecological, terrestrial, and hydrologic restoration objectives (TA-DC-07).

Roads objectives include re-evaluating and updating the Travel Analysis Report within three years of forest plan approval (TA-O-02). This Travel Analysis Report will benefit from the clearer desired conditions in the revised plan about the needs for transportation and access, and the updated allocation of lands, built on input from the plan collaborative involvement with the public. A related objective (TA-O-03) will develop and implement a forestwide road maintenance plan that prioritizes work to promote public safety, prevent erosion and sedimentation, protect water quality, and maintain access to the Forests with an emphasis on identified priority watersheds. Improvements in priority watersheds include performing road maintenance activities on 15 miles of roads that are known to be hydrologically

connected to the stream network and decommissioning unneeded roads that are adversely affecting aquatic health (WSD-O-01).

A road maintenance plan would identify maintenance activities that preserve the transportation system investment with the goal of providing the highest possible level of service with the available funding resources. Roads with the highest benefits and most use will be identified and prioritized, while roads with high levels of risk to safety and environmental resource damage would be evaluated for closure, upgrade, conversion, or decommissioning. Other outcomes of a new road maintenance plan include, but are not limited to, reduction of impacts to wildlife and their habitats; reduction in the spread of invasive plant and animal species; improved buffers between water resources and road development; redirected runoff away from water courses (filter strips); installation of more frequent cross drains and water bars when possible; and improved road layouts to include reducing the number of stream crossings needed for road development.

Road decommissioning is an activity planned for in forest objectives. Alternatives B, C and D include an objective to decommission a minimum of 50 miles of unauthorized roads and trails within priority watersheds and Inventoried Roadless Areas over the life of the plan (TA-O-04). In Alternative E, this was updated to be specific that there would be a minimum of 20 miles of unauthorized roads and 30 unauthorized trails restored to natural contours during the life of the plan (which averages out to 2 miles of roads and 3 miles of trails restored annually). Unauthorized roads are not managed as part of the forest transportation system, and while not open to motorized travel, they are often used by hikers, mountain bikers, and equestrians to access the Forests. They often contribute to erosion, sedimentation into adjacent waters, and landslides on unstable road slopes; and decommissioning these roads would improve ecological conditions by returning the area to its native state. There would be minor access impacts to the public that have historically used the unauthorized roads to access the Forests, and the objective over the entire forest (1.1 million acres) over the life of the plan would be comparatively small impact on access.

Additionally, the all action alternatives include a management approach and objective to decommission unneeded system roads and obliterate unauthorized roads in the Backcountry MA and Recommended Wilderness (TA-O-06). Existing roads in areas recommended for wilderness or allocated to the Backcountry MA are primarily closed to motorized use by the public but often used as hiking, biking, or equestrian trails.

Table 194 shows how the alternatives compare in terms of the total acreage of Backcountry and Recommended Wilderness to which this direction would apply and the associated existing road mileage in these MAs that could be affected if roads are determined to be unneeded and inconsistent with the desired conditions of the management area. While Alternative B recommends considerably more acres for wilderness, much of this area is unroaded and largely inaccessible by motorized vehicles. In contrast, the Backcountry MA in Alternative C has approximately 100 miles of existing road, some of which would be considered for decommissioning in a Tier 2 objective (TA-O-06). Alternative D has the least number of acres in Backcountry and Recommended Wilderness and the least amount of road miles that could be considered for decommissioning.

**Table 194. Miles of Road (Open and Closed) in Backcountry and Recommended Wilderness MAs, by Alternative.**

	Alt B		Alt C		Alt D		Alt E	
	Acres	Existing Road miles	Acres	Existing Road miles	Acres	Existing Road miles	Acres	Existing Road Miles
Backcountry	87,697	40	229,011	100	107,065	47	132,295	42

Recommended Wilderness <sup>1</sup>	126,334	48	27,178	6	77,421	18	49,098	9
<b>Total</b>	<b>214,031</b>	<b>88</b>	<b>256,189</b>	<b>106</b>	<b>184,486</b>	<b>65</b>	<b>181,393</b>	<b>51</b>

<sup>1</sup> This acreage includes existing Wilderness Study Areas

Collectively, the objectives described above aim to improve transportation system conditions, road maintenance, and access.

The plan does not propose road building as part of plan components, although road building may be needed to achieve other plan objectives. For this reason, the EIS considers the potential impact of road construction on several resources described in other sections of this EIS (soils, water, cultural resources, etc).

Where road construction is needed, public opinions differ about where that road building should be allowed. The action alternatives have common plan language for the transportation system but differ in terms of where that plan direction applies on the Forests (i.e., differences in management area allocation). The identification of where future roads might be needed or should be precluded was a factor considered in the allocation of management areas which varies by alternative. Under the revised plan alternatives, management areas that do not allow for new road construction comprise approximately 23 percent of the Forests' acreage for Alternative B, 14 percent for Alternative C, 19 percent for Alternative D, and 17 percent for Alternative E. The remainder of the forest has limitations on where new road construction can occur, consistent with management area direction and forestwide standards.

The Matrix and Interface MAs are generally the most roaded areas of the Forests, and it can be assumed that those are the MAs that offer the most opportunities for motorized access to the Forests, both for forest management and recreation. Interface remains relatively consistent among the action alternatives, but the amount of Matrix varies considerably between action alternatives. All action alternatives would maintain the miles of open road access in Matrix and Interface MAs with a Tier 2 objective to increase the miles of seasonally open roads by 5 to 10 percent over the life of the plan (TA-O-06). Another objective calls for daylighting between two and five miles of road annually for road maintenance or in areas where enhancing young forest habitat is prioritized (TA-O-05).

**Table 195. Miles of Road in Matrix and Interface MAs, by Alternative**

	Alt B		Alt C		Alt D		Alt E	
	Acres	Existing Road miles	Acres	Existing Road miles	Acres	Existing Road miles	Acres	Existing Road miles
Matrix	554,128	1,444	441,014	1,211	551,412	1,439	542,865	1304
Interface	67,145	387	55,207 <sup>1</sup>	359	66,984	385	65,893	292
<b>Total</b>	<b>621,273</b>	<b>1,831</b>	<b>496,221</b>	<b>1,570</b>	<b>618,396</b>	<b>1,824</b>	<b>608,758</b>	<b>1,596</b>

<sup>1</sup>Interface acres appear less in Alt C because of more restrictive management areas that overlap acres in this alternative.

Modelling projections show limited difference between action alternatives in terms of total projected road construction mileage. The primary difference between alternatives would be priorities for road construction location and road decommissioning sites based on management area direction. The Matrix and Interface MAs are the management areas most permissible in terms of new system road construction and it can be assumed that those are the management areas where most new system road construction would occur in support of management activities and providing recreational access to the Forests.

Projected miles of total road construction for the action alternatives are based on SPECTRUM modeling which estimated lands currently available and required for future vegetation management activities, the current transportation network, and operability criteria. To accomplish Tier 1 objectives, it is assumed

that current trends for transportation system management activities continue, where 6.0 total additional miles of road will likely be needed annually, including 1.2 miles of new road prism construction, 1.9 miles of existing road prism added to the system, and 2.6 miles of temporary road construction that is decommissioned after use. These roads would be constructed predominately to meet the needs of vegetation management and administrative-only use, where approximately 41 percent of all new roads added to the system will be Maintenance Level 2 and closed to the public, thereby limiting motor vehicle use, maintenance requirements, costs, and impacts to other resource areas.

To accomplish Tier 2 objectives, additional road construction could be required, as shown in Table 196, assuming consistent needs annually over the modeling time period.

**Table 196. Estimated Miles of Additional Road Construction Needed to Accomplish Tier 2 Objectives**

	Alt B	Alt C	Alt D	Alt E
Additional Total Miles of NFS Roads as New Corridor (annual)	1.1	1.2	1.0	0.8
New System Road on Existing Corridors (annual)	1.7	1.9	1.7	1.3
Additional Miles of Temporary Roads (annual)	2.6	2.9	2.6	2
<b>Total additional miles</b>	<b>5.4</b>	<b>6.0</b>	<b>5.3</b>	<b>4.1</b>

Historically, 20 percent of new system road construction occurs on new corridors, and 80 percent occurs as temporary roads or new system roads on existing corridors. Existing corridors are typically non-system, unauthorized road corridors that may have been used as temporary roads on past projects and remain on the landscape (unobliterated). Most new road mileage would consist of temporary roads not to be included in the Forest transportation atlas. All action alternatives include plan direction to remove temporary roads from service by decommissioning at the conclusion of the project. decommissioning activities would vary based on site specific needs, but could include removing drainage structures, access points, culverts, and signs, and restoring vegetation, contours, and natural drainage patterns.

Given that the revised plan does not propose road construction as part of plan components but does require decommissioning in objectives (TA-O-04 and TA-O-06), there is unlikely to be a gain in overall road miles in Alternative E, even as a result of Tier 2 objectives. The estimated miles of additional permanent roads needed to accomplish Tier 2 objectives under Alternative E (0.8 miles of new corridor plus 1.3 miles of existing corridor) is equal to the recent annual amount of road decommissioning under the current plan (2.1 miles). However, Alternative E includes more emphasis on decommissioning than the current plan, and it is unlikely that the plan will operate at maximum Tier 2 levels each year. To enable adaptive management as needed, the plan monitoring program includes a question to monitor changes to the transportation system, including miles of open, seasonally open and closed roads.

### Cumulative Effects

Based on projected population growth in Western North Carolina, it is anticipated that Forest Service roads will receive increasing use as new homes and businesses are constructed within the administrative boundary of the Nantahala and Pisgah NFs. In some instances, Forest Service roads are not designed for the increased traffic volume, but they provide important connections to state roads that support local communities and emergency services. As these impacts occur, Forest Service employees would work with state officials to address concerns on site-specific bases.

Additionally, roads managed by other federal and state jurisdictions that traverse Forest Service lands may also increase during the life of the plan. Community needs for access and safe passageway result in the need for changes to the road system managed by others, which could result in changes in access and transportation patterns on the Forests as well.

### 3.4.7 Wilderness

#### Affected Environment

##### Wilderness

Congressionally designated wilderness are areas of the National Forests specifically identified for inclusion in the National Wilderness Preservation System. There are six wildernesses on the Nantahala and Pisgah NFs that are included in the National Wilderness Preservation System, totaling approximately 66,400 acres. The six wildernesses are Ellicott Rock, Joyce Kilmer-Slickrock, Linville Gorge, Middle Prong, Shining Rock, and Southern Nantahala. Management of existing wildernesses is guided by a combination of legislation, policy, and forest plan direction.

Wilderness is comprised of large blocks of unfragmented forest designated to conserve values “where the earth and its community of life are untrammelled by man” and “generally appear to have been affected primarily by the forces of nature, with the imprint of man’s work substantially unnoticeable” (Wilderness Act 1964). These areas are managed to provide primitive and unconfined recreation or opportunities for solitude. Wilderness also provides unique educational and research opportunities and habitat for species that depend on fewer disturbances and intact forest conditions. Because of its unroaded and relatively undisturbed condition, wilderness also provides clean water for aquatic habitats and communities downstream.

Wilderness is valued by both forest users experiencing them in person, as well as individuals who never visit wilderness but are reassured that primitive areas exist and are protected from development. Managing designated wilderness to maintain or enhance wilderness character ensures these values will be preserved for future generations.

The five qualities of wilderness character are:

1. **Untrammelled** - Wilderness is essentially unhindered and free from modern human control or manipulation.
2. **Undeveloped** - Wilderness retains its primeval character and influence and is essentially without permanent improvement or modern human occupation.
3. **Natural** - Wilderness ecological systems are substantially free from the effects of modern civilization.
4. **Solitude or Primitive and Unconfined Recreation** - Wilderness provides outstanding opportunities for people to experience solitude or primitive and unconfined type of recreation, including the values of inspiration and physical and mental challenge.
5. **Other features of value** - Wilderness may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value.

The USFS National Visitor Use Monitoring program has reported that approximately three percent of visits on the Nantahala and Pisgah NFs were to designated wilderness. Recreation users desire the unique experience that is afforded by wilderness and may visit the Nantahala and Pisgah NFs specifically for these areas. Designated wildernesses provide a wide variety of visitor opportunities for exploration, solitude, risk and challenge in a natural and undeveloped environment; and for primitive and unconfined recreation in a setting characterized by predominantly unmodified landscapes with no motorized activity and limited encounters with other people. The primary recreation activities within wilderness include hiking, backpacking, horseback riding, hunting, fishing, paddling, climbing or picnicking. Some wilderness visitors use the services of an outfitter and guide operating under Forest Service special use permits.

Designated wildernesses on the Nantahala and Pisgah NFs provide large areas which are managed to maintain and enhance natural and undeveloped conditions. Many of these areas also contain designated old growth patches, US Fish and Wildlife Service critical habitat, and/or NC natural heritage natural areas, each of which is managed to be consistent with wilderness values.

Generally, motorized equipment, mechanized transport, timber harvest, building of roads or structures, and other non-conforming activities are prohibited in designated wilderness. In emergency situations involving inescapable urgency, the Forest Service has agreements with county emergency services for response protocol including appropriate use of motorized equipment and mechanized transport.

Linville Gorge, Joyce Kilmer-Slickrock, and Shining Rock Wildernesses are federally mandated Class I areas for air quality under the Clean Air Act Amendments of 1977. These areas are managed to protect the air quality related values (including visibility) and to consider, in consultation with the appropriate state or local air pollution control agencies, whether proposed increases in air pollution at electrical generating facilities or industrial facilities outside of wilderness will have an adverse impact on these values (42 U.S.C. 7475(c)). The EPA has implemented the Regional Haze Regulations (40 CFR Parts 51 and 52) to improve visibility at the Class I areas to achieve the Nation's goal of no man-made impairment to visibility at federally mandated Class I areas by 2064.

### **Wilderness Study Areas**

In addition to designated wilderness, the 1987 forest plan also includes five congressionally designated Wilderness Study Areas, three of which were recommended for wilderness designation in the 1987 forest plan (Lost Cove, Harper Creek, and Craggy Mountain WSAs). These recommendations were unchanged by the Plan's significant amendment in 1994. All Wilderness Study Areas, both those recommended and not recommended, have been managed to maintain their wilderness characteristics since designation in 1984.

Wilderness Study Areas are managed to "protect wilderness attributes" by maintaining the following wilderness characteristics:

1. The area generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable;
2. The area has outstanding opportunities for solitude or a primitive and unconfined type of recreation;
3. The area has at least five thousand acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition; and
4. The area may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value.

### **Recommended Wilderness**

Recommended wilderness areas are lands that contain wilderness characteristics (as described above) and have potential for inclusion in future wilderness designations, if Congress takes action to designate. These lands are generally free from roads and other constructed features and have high potential to provide solitude or primitive and unconfined recreation. Recommended areas are also important for species diversity, protection of threatened and endangered species, protection of watershed, scientific research, and various social values.

As part of the plan revision process, the Forest Service followed a wilderness evaluation process which includes four primary steps: inventory, evaluation, analysis, and recommendation. The inventory and evaluation processes were initiated early in plan revision and included public involvement at multiple points. These steps are fully documented in Appendix E. Fifty-two areas (362,000 acres) were included in

the initial inventory of lands that might be suitable for inclusion in the National Wilderness Preservation System and were then evaluated based on wilderness characteristics. An analysis of individual areas was completed to determine which areas, or portions of areas, would be included in an alternative analyzed in the EIS and which areas would be excluded from detailed analysis and why (Appendix E).

Twenty-four areas are included in the range of alternatives based on the evaluation of wilderness characteristics and input from public participation on the inventory and evaluation of areas. The analysis in Chapter 3 of this environmental impact statement analyzes the effects of recommending alternative combinations for wilderness, including trade-offs of managing an area as wilderness.

The recommendation for wilderness designation will be finalized in the record of decision for the revised forest plan. Future designation in the National Wilderness Preservation System can only be decided by congressional action.

## **Environmental Consequences**

### **Wilderness and WSAs**

Under all alternatives, designated wildernesses would remain the same, as only congress can add or remove lands from the National Wilderness Preservation System. Additionally, Wilderness Study Areas in North Carolina are congressionally designated; therefore, their boundaries and management will not change by alternative. However, WSAs that are recommended for wilderness designation by the Forest Service do vary by alternative.

Human use of designated wilderness is largely governed by the terms of the Wilderness Act of 1964. Project-specific proposals within designated wilderness are also evaluated through forest plan direction and minimum requirements analyses to evaluate how a proposal may affect wilderness values. Commercial uses are prohibited in designated wilderness, except for outfitter and guide services which are controlled by special use permits and associated plans of operation. General direction for wilderness management is contained in law, regulation, and agency policy and does not change based on individual forest Land Management Plans (LMP). However, management direction for specific wildernesses may differ between forest plans or alternatives. The only difference in wilderness management between alternatives is a change in group size limits from 10 to 12 people in Ellicott Rock Wilderness (see Standard CDW-S-04 in Alternatives B, C, D, and E). This change is proposed to be consistent with wilderness management of the Ellicott Rock NF on the Sumter and Chattahoochee National Forests.

### **Recommended Wilderness**

The number of areas or portions thereof recommended for wilderness designation and managed to maintain wilderness characteristics varies by alternative and was determined based on a comprehensive evaluation of wilderness characteristics and input provided by the public during the inventory and evaluation of potential additions to wilderness. Alternative A, the no-action alternative, recommends three of the currently designated Wilderness Study Areas with boundaries and acreages identified in the 1984 Wilderness legislation.

Alternative B is responsive to those individuals and groups who support the largest amount of NFS lands to be preserved as designated wilderness. This alternative recommends the greatest number of areas and greatest overall acreage for wilderness designation and includes areas having varying degrees of wilderness characteristics and strong support for wilderness recommendation from wilderness advocates. Other areas which received public support for wilderness recommendation, but lacked elements of wilderness characteristics, are identified for other management areas under this alternative. Alternative B recommends all five currently designated Wilderness Study Areas. Another aspect of this alternative is that it recommends lands adjacent to some WSAs when those lands were found to have some degree of wilderness characteristics.



Alternative C is responsive to those who are generally opposed to additional designated wilderness and may favor additional semi-primitive non-motorized recreation opportunities without the restrictions of designated wilderness or those who want expanded opportunities for active management to restore forest health, provide for wildlife habitat needs, and increase the volume and availability of timber products. This alternative includes the least amount of recommended wilderness compared to the other alternatives but has the most acres proposed for backcountry management, with many of the inventory and evaluation areas allocated as Backcountry MA. It is responsive to public comments opposing additional wilderness and also seeks to address the public desire to preserve large blocks of unroaded lands for semi-primitive non-motorized recreation without additional restrictions on mechanized transport (mountain bikes, etc.), group size, or permitting of commercial recreation special-use events. Alternative C recommends two of the five currently designated Wilderness Study Areas, Craggy Mountain and Snowbird. This alternative also allows for more areas inventoried and evaluated for potential additions to wilderness to be managed for forest restoration, timber products, wildlife habitat improvement, or gathering of non-timber forest products for commercial purposes.

Alternative D is intended to strike a balance between the public desire to actively manage and restore the forest for resiliency and biological diversity, to provide for semi-primitive non-motorized recreation settings without many of the restrictions of wilderness designation, and to preserve as recommended wilderness areas those which possess the highest degree of undeveloped and natural characteristics, opportunities for solitude or primitive and unconfined recreation, or other features of value. Many of the recommended areas in Alternative D are extensions to existing designated wilderness, which would enhance wilderness values by increasing opportunities for solitude, improving manageability, and/or preserving wilderness characteristics where they exist on NFS lands adjacent to designated wilderness. This alternative also seeks to minimize inclusion of existing non-conforming uses within recommended areas, where sustaining these existing uses would be inconsistent with wilderness values (i.e., maintained wildlife fields, highly developed trails). Alternative D recommends four of the currently designated Wilderness Study Areas, Snowbird, Craggy Mountain, Lost Cove, and Harper Creek.

Similar to Alternative D, Alternative E is intended to strike a balance between the public desire to actively manage and restore the forest for resiliency and biological diversity, to provide for semi-primitive non-motorized recreation settings without many of the restrictions of wilderness designation, and to preserve as recommended wilderness those areas which possess the highest degree of undeveloped and natural characteristics, opportunities for solitude or primitive and unconfined recreation, or other features of value. Alternative E is based on careful considerations of the public comments and the tradeoffs between managing the areas as recommended wilderness and managing them as other land allocations.

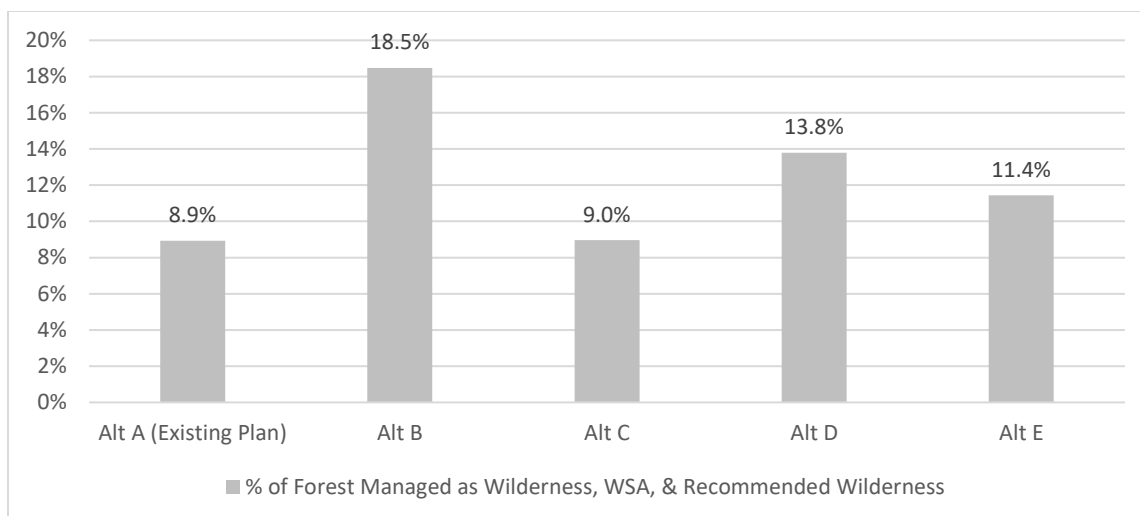
Not all lands included in the inventory and subsequent evaluation were carried forward into an alternative, and the rationale for this is provided in Appendix E. Additionally, some areas that are recommended in an alternative are smaller than the total acres initially evaluated based on the evaluation of wilderness characteristics. Table 197 shows the areas that are recommended in each alternative. Updated acreages for areas recommended in Alternative E are based on refinement of area boundaries and application of buffers along open roads.

**Table 197. Areas Recommended for Wilderness Designation by Alternative**

Area	Acres Evaluated	Alt A	Alt B	Alt C	Alt D	Alt E
Bald Mountains	11,616	0	11,794	0	0	6,319
Southern Nantahala Wilderness Ext., East	1,556	0	1,220	0	1,000	998

Area	Acres Evaluated	Alt A	Alt B	Alt C	Alt D	Alt E
Black Mountains	12,473	0	11,976	0	11,976	0
Cantrell Top	3,664	0	3,235	0	0	0
Southern Nantahala Wilderness Ext., Cherry Cove	1,159	0	1,157	0	0	0
Southern Nantahala Wilderness Ext., West	7,785	0	6,231	0	3,510	2,055
Craggy Mountain WSA	10,653	2,380	8,715	2,639	3,481	3,222
Ellicott Rock Wilderness Ext.	824	0	570	0	0	0
Harper Creek WSA	7,457	7,138	7,044	0	7,042	7,044
Joyce Kilmer-Slickrock Wilderness Ext., Deep Creek-Avey Creek (Ext. #2)	2,313	0	2,355	0	2,355	1,912
Joyce Kilmer-Slickrock Wilderness Ext., Yellowhammer Branch (Ext. #3)	1,207	0	0	0	1,272	0
Joyce Kilmer-Slickrock Wilderness Ext., Sugar Cove Branch* (Ext. #4)	326	0	326	0	326	326
Linville Gorge Wilderness Extension	2,844	0	2,920	0	0	0
Lost Cove WSA	5,934	5,708	5,706	0	5,706	5,681
Mackey Mountain	14,985	0	13,509	0	7,872	7,872
Middle Prong Wilderness Ext.	6,676	0	1,871	0	1,871	0
Overflow Creek WSA	3,901	0	3,725	0	0	0
Shining Rock Wilderness Ext., Dark Prong* (Graveyard Ridge)	2,339	0	929	0	929	939
Shining Rock Wilderness Ext., Sam Branch* (Sam Knob)	2,629	0	744	0	744	688
Snowbird WSA	11,560	0	8,481	8,481	8,481	8,335
Southern Nantahala Wilderness Ext., Central	4,298	0	2,092	0	1,660	1,052
Tusquitee Bald	29,156	0	19,230	0	15,948	0
Unicoi Mountains/Upper Bald River	8,952	0	8,413	0	0	2,655
Wesser Bald	6,642	0	4,093	0	0	0
<b>Total Acres</b>	<b>160,949</b>	<b>15,226</b>	<b>126,333</b>	<b>11,120</b>	<b>74,173</b>	<b>49,098</b>

\*Due to changes in boundary configuration for this recommended area, the geographic feature for which the original inventory and evaluation area was named is no longer relevant. This new recommended area name will be referenced in this analysis, Environmental Impact Statement, and Land Management Plan to be consistent with notable geographic features within revised area boundaries.



**Figure 117. Relative comparison of the percent of forest managed to maintain wilderness characteristics by alternative**

In response to comments received on the inventory and evaluation of areas, the following indicators were developed to demonstrate the effects of recommending wilderness:

1. Acres of recommended wilderness
2. Acres of inventoried roadless area (IRA) within recommended wilderness
3. Miles of closed system road within recommended wilderness
4. Miles of system trails managed for mechanized transport (i.e., bicycles) within recommended wilderness
5. Acres of maintained wildlife fields within recommended wilderness
6. Acres of outstanding or reserved subsurface mineral rights within recommended wilderness

These indicators are used to demonstrate differences across alternatives and are largely responsive to the issues. Alternatives are also compared in relationship to how the wilderness recommendations effect management of fire adapted ecosystems, where recommendations overlap with special interest areas and designated old growth patches, and the representation of ecozones within recommended areas.

**Table 198. Indictors for Recommended Wilderness by Alternative**

Indicators	Alt. A	Alt. B	Alt. C	Alt. D	Alt E
Acres managed as WSA and recommended wilderness	26,816 ac	126,333 ac	26,816 ac	77,373 ac	52,944 ac
Acres of recommended wilderness	15,226 ac	126,333 ac	11,120 ac	74,173 ac	49,098 ac
Acres of IRA within recommended wilderness	26,816 ac	86,529 ac	11,053 ac	65,057 ac	42,611 ac
% of recommended wilderness in IRA	100%	68%	100%	88%	87%
Miles of system road within recommended wilderness	0 mi	31 mi	3 mi	14 mi	6 mi
Miles of systems trails managed for mechanized transport	0 mi	2.5 mi	0 mi	0 mi	0 mi

Indicators	Alt. A	Alt. B	Alt. C	Alt. D	Alt E
Acres of maintained wildlife fields in recommended areas	11 ac	66 ac	2 ac	30 ac	14 ac

\*Existing information regarding reserved and outstanding mineral rights is insufficient to provide an exact acreage of current subsurface ownership.

There was general public concern regarding the loss of maintained wildlife fields and motorized access in areas that are recommended for wilderness. Additionally, mountain biking is an increasingly popular form of recreation on the Nantahala and Pisgah NFs and there is an interest in providing new bike trails in areas that allow for that type of use (outside of wilderness, WSAs, and recommended wilderness).

Many people value wilderness designations because of the assurance the designation provides for areas being managed in their natural state for future generations. Protecting water and air quality, as well as providing for recreation activities where natural conditions dominate, are among the qualities that people often attribute to wilderness. Identifying wilderness on a map can provide a destination attraction for visitors which could benefit local economies, but could also lead to increased impacts to resources such as increased erosion on authorized trails, diminished solitude, and additional agency expense to manage wilderness to standard.

Wilderness is often seen as the counterpoint to economic development of forest resources, because wilderness designation restricts land management activities and commercial uses. There have been no peer reviewed studies that have found adverse effects on regional economies due to the designation of wilderness (Hjerpe, Holmes, and White 2016). Many studies have found that, while wilderness designation requires foregoing short-term economic gains in resource extractive industries, in the long term the value afforded by wilderness for economic development of regional economies has increased (Holmes et al 2015). Many of the benefits from wilderness result in non-market values, however this does not mean there are no market benefits. For instance, there are the expenditures in local communities and businesses from those visiting wilderness areas. However, in comparing the economic trade-offs of wilderness management compared to non-wilderness management, the existence of wilderness-like experiences outside of designated wilderness areas further complicates any such trade-off analysis.

### Effects common to all alternatives

As stated above, the effects analysis included here describes the effects of recommending combinations of areas in alternative packages. Considerations related each individual area are described in Appendix E.

All Wilderness Study Areas and areas that are recommended for wilderness would be managed to maintain their wilderness characteristics. While the areas that are recommended for wilderness vary by alternative, the plan direction does not vary by alternative. Wilderness recommendation and designation would remove the potential to generate revenue from timber production, forest product sales, and other land uses which support surrounding development such as utility or transportation corridors. No new mineral claims would be filed, but valid existing claims would remain.

Existing roads within recommended areas would either continue to be maintained as linear wildlife fields or decommissioned and allowed to return to a natural state. No new wildlife fields would be created nor any timber harvest activities allowed. Many areas that are recommended for wilderness are largely unroaded and therefore have not had timber harvest activities in recent decades. Therefore, there are few acres in recommended wilderness where timber production would have been possible from existing NF system roads. Restoration activities in recommended wilderness where the outcomes protect wilderness characteristics would be allowed to continue including monitoring; relocation of animals; habitat improvements, such as removal of nonnative fish species and nonnative invasive plant species;

stream improvements; and rehabilitation of recreation impacts. However, some of these activities may not be allowed if areas are designated as wilderness by congress.

Existing NF system trails would continue to be maintained to allow for hiking and equestrian use per current trail-use designations, but mechanized transport such as bicycles or carts would be prohibited in all recommended areas (with exception of approved mobility devices for the impaired and mechanized equipment for administrative use). Commercial collection of non-timber forest products such as galax or ginseng would not be permitted; however, collection for non-commercial or tribal purposes would be allowed. Other commercial activities such as recreation special-use events would also be prohibited in areas recommended for wilderness designation.

Areas that are recommended for wilderness designation are managed to provide a primitive setting in the Recreation Opportunity Spectrum under all alternatives. The Primitive setting is characterized by large, remote, wild, and predominantly unmodified landscapes with no motorized activity and a small probability of seeing other people. Primitive settings are managed for quiet solitude away from roads, people, development, and few, if any, facilities or developments. Alternatives with greater amounts of wilderness recommendation would result in greater opportunities for primitive recreation on the Forests.

Landscape resilience, as measured by local connectedness and landscape diversity, is often used as a rationale for needing additional wilderness designations in the face of a changing climate. While designated wilderness, WSAs, and recommended wilderness would all provide for core interior forest habitat that is primarily unfragmented by NF system roads and has predominantly older aged forests, The Resilient Sites for Terrestrial Conservation Model (The Nature Conservancy) found that 86 percent of the Nantahala and Pisgah NFs has above average resiliency with the existing five designated wildernesses and management of National Forest System lands.

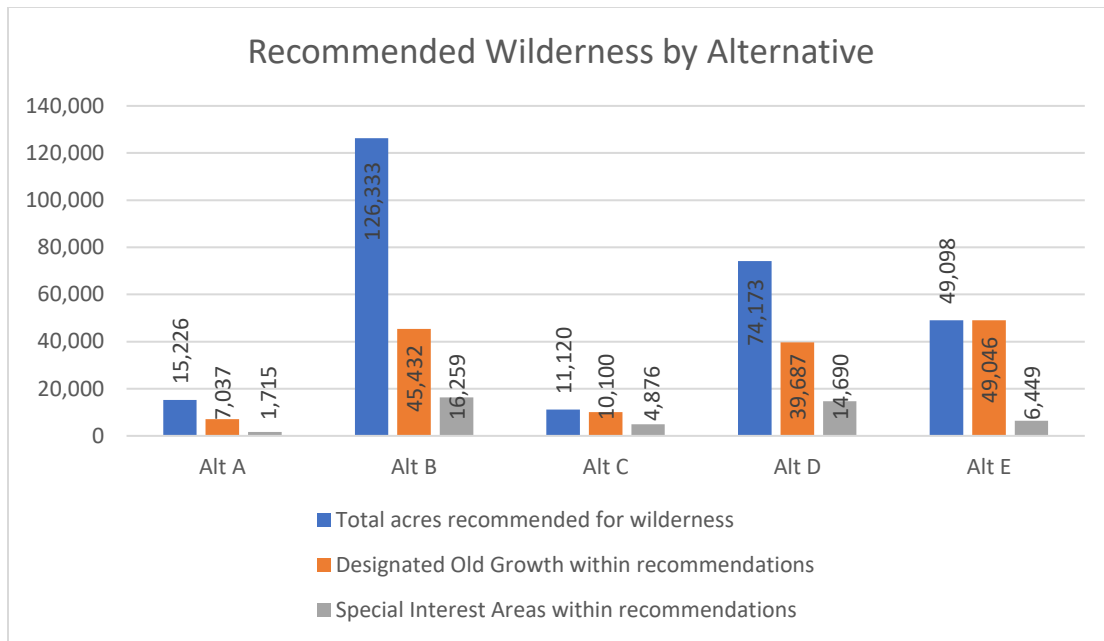
A forestwide fire prioritization model was completed to evaluate ecosystems and rare species across the Nantahala and Pisgah NFs that are the most fire adapted and the most in need of prescribed burning for either ecological restoration or community protection. The six most fire adapted ecozones modeled across the southern Appalachians are pine-oak/heath, shortleaf pine-oak, dry oak, dry-mesic oak, high elevation red oak, and mesic oak. In addition, forty-five rare species, thirty-nine plants, and six animals were modeled with the fire adapted ecosystems. Priority class ratings of very high, high, and moderately high were assigned to evaluation areas based on local expertise and concentrated class breaks (see the "Fire" section of the DEIS for more explanation on priority class ratings for fire adapted ecosystems). While the use of prescribed fire is allowed in WSAs and recommended wilderness under limited circumstances, the application of fire is more difficult when fire line construction is restricted.

The degree to which existing wildernesses on the Nantahala and Pisgah NFs represent the diversity of ecozones across the forest was evaluated as a measure of ecosystem representation and resiliency. The alternatives were compared based on how well the proposed wilderness recommendations would contribute to ecozones that are currently underrepresented in designated wilderness. The most underrepresented ecozones in existing wildernesses are rich cove, mesic oak, dry-mesic oak, pine-oak/heath, and shortleaf pine-oak (highlighted in Table 199). Ecozones that are substantially more represented in existing wildernesses compared to the overall forest composition include northern hardwood, high elevation red oak, and acidic cove. Table 199 summarizes how recommendations in each alternative contribute to the ecozones that are underrepresented in the existing designated wildernesses on the Nantahala and Pisgah NFs. Alternative B generally improves the representation of underrepresented ecozones in areas managed for wilderness character or characteristics (wilderness, WSAs, and recommended wilderness), because it recommends the largest acreage across all ecozones on the Forests.

**Table 199. Ecozone Representation in Wilderness and Recommended Wilderness**

Ecozone	Nantahala and Pisgah (%)	Existing Wilderness (%)	Existing Wilderness Plus Recommended Wilderness				
			Alt. A (%)	Alt. B (%)	Alt. C (%)	Alt. D (%)	Alt E (%)
Spruce-Fir	1.5	4.7	3.5	3.7	3.5	5.0	3.3
Northern Hardwood	5.1	10.6	11.4	9.8	11.5	11.7	10.1
High Elevation Red Oak	3.9	11.6	8.4	6.1	8.5	7.4	7.9
Acidic Cove	17.0	23.7	26.6	22.8	26.5	24.1	23.6
Rich Cove	24.0	11.8	11.8	16.8	11.9	15.3	15.4
Mesic Oak	19.2	14.9	14.2	17.3	14.2	15.9	16.2
Dry-Mesic oak	9.9	5.9	6.1	5.8	6.1	4.7	5.8
Dry Oak	4.7	6.6	6.4	4.3	6.4	4.7	5.3
Pine-Oak/Heath	10.0	9.3	10.9	11.6	10.8	10.6	11.6
Shortleaf Pine-Oak	4.5	0.7	0.6	1.7	0.6	0.5	0.6
Alluvial Forest	0.2	0.1	0.2	0.1	0.2	0.1	0.1

Alternatives were also analyzed to determine where wilderness recommendations overlap with special interest areas and designated old growth patches (Figure 118). While Alternative B recommends 50,000 acres more for wilderness than Alternative D, recommendations in Alternative D represent a similar amount of special interest areas and just 6,000 acres less of designated old growth. In Alternative E, all acres recommended for wilderness area also added to the designated old growth network. Therefore this alternative includes the most designated old growth. While there are fewer acres of Special Interest Areas within recommended wilderness for Alternative E, the SIA management area for Alternative E is approximately 10,000 acres more than Alternatives B, C or D. Regardless of whether an area is recommended for wilderness, special interest areas and designated old growth will be managed to protect their unique qualities with specific plan direction that limits timber harvesting and road building.



**Figure 118. Recommended Wilderness by Alternative**

While most of the minerals underlying the Nantahala and Pisgah NFs are federally owned, some tracts acquired by the Forest Service either had the mineral rights reserved (reserved rights), or the mineral rights were severed at the time of acquisition (outstanding rights). Whether or not these rights currently exist depend on which tracts or portions of tracts had mineral claims extinguished per the N.C. Ancient Minerals Act (N.C. Gen. Stat. § 1- 42.1 through § 1- 42.9).

Owners of reserved or outstanding mineral rights may enter upon and use as much of the surface overlying the mineral estate as is reasonably necessary to explore for, develop, extract, and process the reserved minerals, and the Forest Service cannot legally prevent mineral development where these rights may exist. Reserved or outstanding mineral rights, if any, would be further researched prior to future congressional designation of wilderness. Portions of Ellicott Rock Wilderness, Southern Nantahala Wilderness, Middle Prong Wilderness, and Shining Rock Wilderness may include areas with outstanding or reserved mineral rights.

### **Alternative A**

In Alternative A, three of the existing Wilderness Study Areas are recommended for wilderness designation. Alternative A does not propose any changes to what was recommended for wilderness in the 1987 forest plan and maintained through the 1994 amendment. National direction requires that Wilderness Study Areas and areas recommended for wilderness are not available for any use or activity that might reduce the wilderness potential of an area. Designated Wilderness Study Areas do not have any system trails that are designated for bicycle use, nor do they have trails that allow motorized use. There is approximately 0.8 miles of open NFS road in the Snowbird WSA and approximately two miles of open NFS road in the Overflow Creek WSA, both of which provide access into the areas and would remain open roads under all alternatives. Wildlife fields that are being maintained in existing WSAs would continue to be maintained under all alternatives to the extent that maintenance does not further detract from existing wilderness characteristics. Any areas designated as wilderness in the future could have final boundary adjustments to exclude features inconsistent with wilderness values, or they could be rehabilitated to restore natural conditions. Mountain biking is occurring on trails within the WSAs, particularly in Lost Cove and Harper Creek WSAs, but it is not an allowed use in these areas. Also, there would not be any opportunity for the development of bicycle trails in any WSA; unless the area is

released from wilderness study by Congress in the future. Even if released by Congress, there is no guarantee that existing area trails in WSAs would be suitable or sustainable for bicycle use. Nearby opportunities for mountain biking are available, and others are being considered outside of WSAs.

**Table 200. Wilderness Study Areas and Recommendations Under Alternative A**

Wilderness Study Area	Forest Recommendation for Wilderness Designation	Acres
Lost Cove	Yes	5,708
Harper Creek	Yes	7,138
Craggy Mountain	Yes	2,380
Overflow	No	3,200
Snowbird	No	8,390

In Alternative A the areas recommended for wilderness plus the remaining Wilderness Study Area acres and designated wilderness acres (65,400 acres) total approximately 92,215 acres; or roughly eight percent of the Nantahala and Pisgah NFs that is managed to retain wilderness character or characteristics in either designated wilderness or recommended wilderness. These acres would continue to be managed to provide a primitive recreation experience for forest users interested in experiencing quiet and solitude away from roads, people, and development.

### Alternative B

Alternative B includes the greatest amount of wilderness recommendations of all alternatives and would contribute to more than 18 percent of the forest in areas managed to maintain wilderness characteristics or character and provide a primitive recreation experience (recommended wilderness, WSAs, and designated wilderness). Twenty-three individual areas would be recommended with eleven of these being extensions to existing designated wilderness. Sixty-eight percent of the recommended acres are within inventoried roadless areas (IRAs), and there are 31 miles of closed system road distributed throughout recommended areas, ranging from maintenance level 1 (ML 1) closed roads to maintenance level 2 (ML 2) closed roads. While some of these roads are routinely maintained and used by Forest Service employees, many of the ML 1 roads are overgrown with vegetation and have minimal impact on the landscape. These roads are currently closed to public motorized use, so there would be no change in existing motorized public access if recommended for wilderness. Open roads within the Overflow and Snowbird WSAs are an exception, are cherry-stemmed out of the recommended area in all action alternatives, and would continue to be open and maintained under all alternatives. Existing roads within areas recommended for wilderness may continue to be maintained or may be decommissioned after site-specific analysis is completed. The public would continue to have the opportunity to use these roads for hiking, and equestrian access would be allowed unless decommissioned as a system road; however, bicycle use would not be allowed in any recommended areas or WSAs on or off system roads or trails.

There are approximately 2.5 miles of trails designated for mountain bike use in the Ellicott Rock Wilderness Extension, which would no longer be available for mountain bike use if the area is recommended for wilderness.

The approximately 66 acres of wildlife fields that occur within recommended areas in this alternative may continue to be maintained through regular mowing, but no expansion of wildlife fields would be allowed once the areas are recommended for wilderness.

Commercial collection of non-timber forest products is common in many areas across the forest but this alternative would result in the greatest loss of those opportunities in recommended areas, particularly in



the Black Mountains, Bald Mountain, and Mackey Mountain areas, all of which are recommended in Alternative B and are frequently used for the collection of non-timber forest products.

Approximately 30,520 acres of recommended wilderness in Alternative B has a fire priority rating of moderately high to very high with Mackey Mountain and Tusquitee Bald having the greatest amount of acres prioritized for prescribed fire. Recommending these areas for wilderness would increase the difficulty of applying prescribed fire to these ecosystems.

Alternative B has approximately 4,700 acres that may be subject to outstanding or reserved subsurface mineral rights within nine recommended wilderness areas. If these rights exist, these areas could have the potential to be explored and/or developed in the future, potentially impacting wilderness characteristics (see Minerals and Energy for more information).

### **Alternative C**

Alternative C includes the least amount of acres recommended for wilderness designation, with only two areas being recommended for wilderness. This alternative is designed to be responsive to those who are generally opposed to additional designated wilderness. Harper Creek and Lost Cove WSAs are not recommended in this alternative as a response to public comments seeking future potential for mechanized recreation opportunities (i.e., mountain biking) in these areas; and Overflow WSA is not recommended because it was evaluated as having a low degree of wilderness characteristics. Opportunities for the addition of mountain biking trails in any of the WSAs would only be allowed if an area was released from wilderness study by congressional action; however, even if released by Congress, there is no guarantee that existing area trails would be suitable or sustainable for bicycle use. Craggy Mountain and Snowbird WSAs are recommended, because they have high wilderness characteristics and public support for recommending the areas which have been managed to retain wilderness characteristics since 1984.

Alternative C would not add any additional acres that are managed for wilderness beyond the existing forest plan, because both Craggy Mountain and Snowbird are currently managed to maintain wilderness characteristics as WSAs. Approximately 9 percent of the Nantahala and Pisgah NFs would be managed to maintain wilderness characteristics or character(WSAs and designated wilderness).

There are 2.5 miles of ML 1 and 2 NFS roads in Snowbird WSA, approximately 1 mile provides motorized public access into the area that would continue to be managed as open to motorized use under this alternative. Future designation of the area as wilderness would either exclude the open road (cherry-stem the road out of the wilderness boundary) or close the road within the wilderness boundary.

There are approximately 3,800 acres in Alternative C that are ranked as high to very high in the fire prioritization model. Under Alternative C, recommending these areas for wilderness would increase the difficulty of applying prescribed fire to these ecosystems.

There are no lands with potential outstanding or reserved subsurface mineral rights that are recommended for wilderness in Alternative C.

While Alternative C provides the least amount of forest that is managed for a primitive recreational experience, this alternative provides the largest amount of Backcountry management area which provides for Semi-Primitive Non-Motorized recreation experiences in areas that are relatively unroaded and primarily shaped by natural processes.

### **Alternative D**

Alternative D recommends 16 areas for wilderness designation, nine of which are extensions to existing designated wildernesses and four of which are existing Wilderness Study Areas. The three new standalone areas that are recommended in Alternative D are Tusquitee Bald, Mackey Mountain, and

Black Mountains. Over thirteen percent of the forest would be managed to maintain wilderness characteristics or character, and provide for a primitive recreation experience (recommended wilderness, Wilderness Study Areas, and designated wilderness); approximately four percent less than Alternative B. Eighty-eight percent of the recommended areas in Alternative D are currently in Inventoried Roadless Areas (IRA), which are managed to preserve roadless character, limit most types vegetation management, and are unsuitable for timber production.

There are approximately 14 miles of closed system roads in recommended areas ranging from maintenance level 1 closed roads (ML1) to maintenance level 2 closed roads. While some of these roads are periodically maintained for administrative access, many of the ML 1 roads are overgrown with vegetation. These roads are currently closed to public motorized use, so there would be no change in existing motorized public access if recommended for wilderness. Existing roads within areas recommended for wilderness may continue to be maintained or may be decommissioned after site-specific analysis is completed. The public would continue to have the opportunity to use roads for hiking, and equestrian access would be allowed unless decommissioned as a system road; however, bicycle use would not be allowed in any recommended areas or WSAs on or off system roads or trails, and existing roads would only allow for administrative use.

There are 30 acres of maintained wildlife fields within recommended areas under Alternative D, and these could continue to be maintained until designation by Congress but could not be expanded.

Compared to Alternative B, Alternative D does not recommend any areas that have existing trails designated for mountain biking. While there is interest in allowing for mountain biking on trails in the Harper Creek and Lost Cove WSAs, this use is not currently allowed nor is there a guarantee that existing area trails would be suitable or sustainable for bicycle use if these areas were released by Congress from WSA.

Approximately 7,702 acres of recommended wilderness in Alternative D has a fire priority rating of high to very high with Mackey Mountain and Tusquitee Bald having the greatest amount of acres prioritized for prescribed fire.

Alternative D has approximately 4,100 acres that may be subject to outstanding or reserved subsurface mineral rights within recommended wilderness areas, which is slightly less than Alternative B. These areas may have the potential to be explored and/or developed in the future, potentially impacting wilderness characteristics (see Minerals and Energy for more information).

Commercial collection of non-timber forest products is common in many areas across the Forests, but this alternative would result in a loss of those opportunities in recommended areas, particularly in the Black Mountains area and Mackey Mountain, both of which are recommended in Alternative D and are frequently used for the collection of non-timber forest products.

### **Alternative E**

Alternative E recommends 14 areas for wilderness designation, eight of which are extensions to existing designated wildernesses and four of which are existing Wilderness Study Areas. The two new standalone areas that are recommended in Alternative E are Bald Mountains and Mackey Mountain. More than eleven percent of the forest would be managed to maintain wilderness characteristics or character, and provide for a primitive recreation experience (recommended wilderness, Wilderness Study Areas, and designated wilderness); approximately seven percent less than Alternative B. Eighty-seven percent of the recommended areas in Alternative E are currently in Inventoried Roadless Areas (IRA), which are managed to preserve roadless character, limit most types vegetation management, and are unsuitable for timber production.

There are approximately 5.5 miles of closed system roads in recommended areas ranging from maintenance level 1 closed roads (ML1) to maintenance level 2 closed roads. While some of these roads are periodically maintained for administrative access, many of the ML 1 roads are overgrown with vegetation. These roads are currently closed to public motorized use, so there would be no change in existing motorized public access if recommended for wilderness. Existing roads within areas recommended for wilderness may continue to be maintained or may be decommissioned after site-specific analysis is completed. The public would continue to have the opportunity to use roads for hiking, and equestrian access would be allowed unless decommissioned as a system road; however, bicycle use would not be allowed in any recommended areas or WSAs on or off system roads or trails, and existing roads would only allow for administrative use.

There are approximately 14 acres of maintained wildlife fields within recommended areas under Alternative E, and these could continue to be maintained until designation by Congress but could not be expanded.

Compared to Alternative B, Alternative E does not recommend any areas that have existing trails designated for mountain biking. While there is interest in allowing for mountain biking on trails in the Harper Creek and Lost Cove WSAs, this use is not currently allowed nor is there a guarantee that existing area trails would be suitable or sustainable for bicycle use if these areas were released by Congress from WSA designation.

Approximately 3,650 acres of recommended wilderness in Alternative E has a fire priority rating of high to very high, which is the fewest acres of any action alternative. Mackey Mountain and Unicoi Mountains have the greatest amount of acres prioritized for prescribed fire.

Alternative E has approximately 1,683 acres that may be subject to outstanding or reserved subsurface mineral rights within recommended wilderness areas, which is less than Alternatives B and D. These areas may have the potential to be explored and/or developed in the future, potentially impacting wilderness characteristics (see Minerals and Energy for more information).

Commercial collection of non-timber forest products is common in many areas across the Forests, but this alternative would result in a loss of those opportunities in recommended areas, particularly in the Mackey Mountain recommended area which is frequently used for the collection of non-timber forest products.

### **Cumulative Effects – All Alternatives**

Population growth in North Carolina is likely to increase recreational use of the Forests, including an increase in use of recommended wilderness areas. The effects of urbanization and population growth on recommended wilderness and resource conditions are likely to be gradual and extend well beyond the planning period. This growth may increase the demand and desirability for places that provide solitude and unconfined recreation. Meanwhile, increased recreational use may adversely impact wilderness characteristics, particularly the opportunity to experience solitude and natural quality.

## **3.4.8 Inventoried Roadless Areas**

### **Affected Environment**

Inventoried Roadless Areas (IRAs) are designated under the Roadless Area Conservation Rule (36 CFR Part 294 Subpart B). The Roadless Area Conservation Rule prohibits road construction or reconstruction and cutting, selling, or removing timber in IRAs unless a listed exemption applies. For example, one exemption allows the cutting, sale, or removal of generally small diameter timber when it is needed to improve threatened, endangered, proposed, or sensitive species habitat or to maintain or restore the

characteristics of ecosystem composition and structure that would be expected to occur under natural disturbance regimes.

The following values or features often characterize Inventoried Roadless Areas (RARC, Preamble, p. 3245)

1. High quality or undisturbed soil, water, and air;
2. Sources of public drinking water;
3. Diversity of plant and animal communities;
4. Habitat for threatened, endangered, proposed, candidate, and sensitive species and for those species dependent on large, undisturbed areas of land;
5. Primitive, Semi-Primitive Non-Motorized, and Semi-Primitive Motorized classes of dispersed recreation;
6. Reference landscapes;
7. Natural appearing landscapes with high scenic quality;
8. Traditional cultural properties and sacred sites;
9. Other locally identified unique characteristics.

Thirty-three areas totaling approximately 152K acres on the Nantahala and Pisgah NFs were administratively designated as Inventoried Roadless Areas in 2001. Their administrative designation was applied as a result of the adoption of the national Roadless Area Conservation Rule and thus superseded the management prescriptions that were applied in the 1987 Plan and the 1994 Forest Plan Amendment. The forest plan cannot modify Roadless Area Conservation Rule direction, and under the revised plan, these areas will be managed to retain the characteristics above. Several IRAs include roads along or within their boundaries. This is a result of lower resolution mapping at the time of the Roadless Area Conservation Rule that did not have accurate road location data.

## Environmental Consequences

### Alternative A

The 2001 Inventoried Roadless Areas are not identified in the 1987 Plan, nor are they accounted for within the existing management area designations. They appear across multiple management areas. Approximately 87 percent of inventoried roadless acreage on the Forests is within management areas currently designated as unsuitable for timber production (see Table 201 and Figure 119).

**Table 201. Inventoried Roadless Areas – Alternative A**

Inventoried Roadless Area	Acres	Forest/Ranger District	Management Area (acres)
Bald Mountain	11,244	Pisgah/Appalachian	5 (8,673), 14 (1,250), 4d (784), 2c (390), 3b (147)
Balsam Cone	10,661	Pisgah/Appalachian	4c (3,828), 13 (2,460), 5 (972), 10 (1,428), 3b (909), 4d (499), 2c (82)
Barkers Creek (Addition)	976	Nantahala/Nantahala	5 (976), 8 (7)
Bearwallow	4,116	Pisgah/Appalachian	5 (3,684), 13 (282), 2a (150)

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Inventoried Roadless Area	Acres	Forest/Ranger District	Management Area (acres)
Big Indian (Addition)	1,154	Nantahala/Nantahala	5 (1,106), 3b (48)
Boteler Peak	4,220	Nantahala/Tusquitee	5 (2,466), 4c (770), 4d (761), 1b (135), 3b (88)
Cheoah Bald	7,808	Nantahala/Cheoah	5 (5,405), 4d (2,001), 14 (357), 4c (45)
Cherry Cove (Addition)	844	Nantahala/Tusquitee	4c (844)
Chunky Gal (Addition)	3,474	Nantahala/Tusquitee	5 (2,074), 4d (891), 14 (318), 19 (138)
Craggy Mountain	2,658	Pisgah/Appalachian	6 (2658)
Deep Creek/Avery Creek	1,896	Nantahala/Cheoah	4d (1,085), 4c (757), 2a (54)
Dobson Knob	6,127	Pisgah/Grandfather	4c (4,780), 2c (577), 4d (414), 3b (356)
Graveyard Ridge (Addition)	1,973	Pisgah/Pisgah	17 (1,260), 5 (713)
Harper Creek	7,351	Pisgah/Grandfather	6 (7,351)
Jarrett Creek	7,499	Pisgah/Grandfather	5 (6,903), 2a (238), 2c (225), 4d (134)
Laurel Mountain	5,682	Pisgah/Pisgah	5 (3,175), 4d (1,312), 4a (939), 4c (256)
Linville Gorge (Addition)	2,800	Pisgah/Grandfather	4c (2,634), 3b (163)
Little Indian (Addition)	647	Nantahala/Nantahala	5 (644)
Lost Cove	5,954	Pisgah/Grandfather	6 (5,954)
Mackey Mountain	5,932	Pisgah/Grandfather	5 (5,797), 2a (101), 2c (34)
Middle Prong (Addition)	1,852	Pisgah/Pisgah	4d (1,323), 4c (528), 2c (1)
Overflow Creek	3378	Nantahala/Nantahala	6 (3,250), 8 (128)
Sam Knob (Addition)	2582	Pisgah/Pisgah	17 (1,838), 4c (723), 2c (22)
Sharptop Ridge (Addition)	594	Nantahala/Tusquitee	4d (594)
Slide Hollow	193	Pisgah/Appalachian	3b (193)
Snowbird	8,501	Nantahala/Cheoah	6 (6,501)
South Mills River	8,627	Pisgah/Pisgah	5 (6,104), 4d (2,131), 4c (311), 13 (81)
Tusquitte Bald	13,788	Nantahala/Tusquitee	5 (8,506), 4c (3,519), 2c (1,205), 4d (302), 3b (163)
Wesser Bald	4,093	Nantahala/Nantahala	5 (3,849), 14 (164), 4c (43), 4d (15)
Wilson Creek	4,989	Pisgah/Grandfather	5 (3,193), 4a (1,574), 2c (104)
Woods Mountain	9,604	Pisgah/Grandfather	5 (8,025), 3b (1,199), 2c (207), 4d (172)
Yellowhammer Branch (Addition)	1,271	Nantahala/Cheoah	5 (1,177), 4d (94)
<b>Total</b>	<b>152,488</b>		

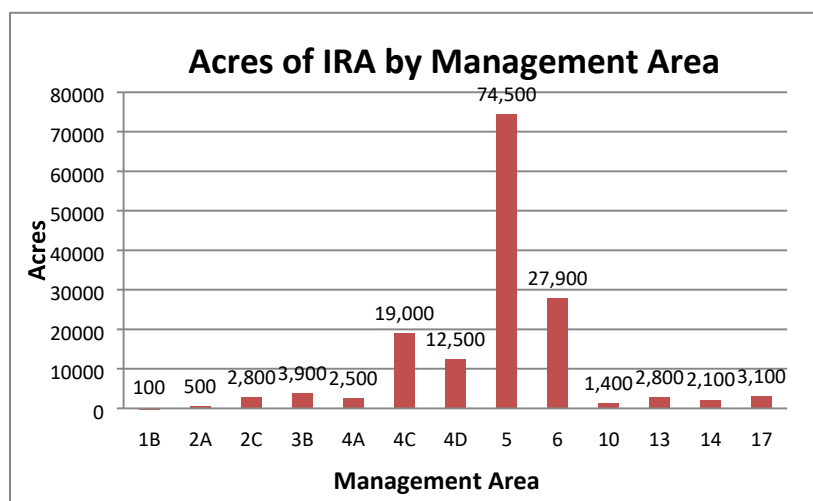


Figure 119. Acres of Inventoried Roadless Area by Management Area

When IRAs are identified in project development, interdisciplinary teams fold in the management goals and restrictions associated with managing in IRAs, modifying the design and development of the project. As part of the plan revision process, it was noted that there is a need to include plan direction for Inventoried Roadless Areas into the management area structure, so these characteristics can better be considered and designed for at the early stages of each project. These areas are not identified as lands suited for timber production.

### Alternatives B, C, D and E

In the action alternatives, the Inventoried Roadless Areas are managed as Backcountry, except where some IRAs fall within more restrictive management, such as the Appalachian Trail Corridor, Heritage Corridors, or Designated Wilderness. In addition, some IRAs are recommended for wilderness in each alternative as shown in the table below. IRA acres identified in the Interface and Matrix MAs are typically on the boundary of IRAs or include a small number of acres surrounding existing roads. Alternative E allocates the fewest amount of IRA acres to Interface and Matrix, compared to the other action alternatives.

Table 202. Distribution of Inventoried Roadless Areas by Management Area and Alternative

Management Area*	Alt B	Alt C	Alt D	Alt E
Interface	545	477	575	150
Matrix	68	49	63	110
Backcountry	58,544	112,292	72,248	96,032
Appalachian Trail Corridor	2,750	8,475	7,226	5,029
National Scenic Byways	1,442	38	1,442	14
Heritage Corridor	239	505	402	400
Wild and Scenic River Cor.	1,644	1,646	1,644	1,628
Special Interest Areas	82	80	82	84
Ecological Interest Areas	N/A	130	12	12

Management Area*	Alt B	Alt C	Alt D	Alt E
Research Natural Areas	0	1,432	0	1,428
Recommended Wilderness	86,775	11,007	65,147	42,598
Wilderness	75	75	75	53
Wilderness Study Area	0	15,959	3,247	3,855
Experimental Forest	129	129	129	130

Plan direction from for Inventoried Roadless Areas can be found in the Backcountry MA. This management direction applies whether the IRAs land in Backcountry, Interface, Matrix, or Ecological Interest Area, or any of the other management areas listed above except Wilderness, Wilderness Study Areas or recommended wilderness. IRAs in Wilderness, Wilderness Study Areas or recommended wilderness have more restrictive management that applies to road building and timber harvest activities.

IRA lands have specific plan components that recognize their roadless character, including the following desired condition, which reflects management consistent with the Roadless Area Conservation Rule:

**BAC-DC-11** Within Inventoried Roadless Areas, the undeveloped character identified in the 2001 Roadless Area Conservation Rule is retained.

Two standards (BAC-S-02) and (BAC-S-09) also ensure that timber and road construction in IRAs is consistent with the Roadless Area Conservation Rule.

**BAC-S-02** **Within Inventoried Roadless Areas** lands are not suitable for timber production. Timber may not be cut, sold, or removed except when the cutting, sale, or removal of generally small diameter timber is needed for one of the following purposes and will maintain or improve one or more of the Roadless Area characteristics. Follow the latest Forest Service policy regarding delegation of approval for the following activities:

- To improve threatened, endangered, proposed, or sensitive species habitat;
- To maintain or restore the characteristics of ecosystem composition and structure;
- The cutting, sale, or removal of timber is incidental to the implementation of a management activity not otherwise prohibited;
- The cutting, sale, or removal of timber is needed and appropriate for personal or administrative use.

**BAC-S-09** Across the Backcountry Management Area (both outside and within Inventoried Roadless Areas), permanent system roads may not be constructed or reconstructed unless one of the following conditions applies. Within Inventoried Roadless Areas, the latest Forest Service policy regarding delegation of approval of these activities must be considered:

- i. A road is needed to protect public health and safety in cases of an imminent threat of flood, fire, or other catastrophic event that, without intervention, would cause the loss of life and/or property;
- ii. A road is needed to conduct a response action under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, 1980), or the Superfund Amendments and Reauthorization Act (SARA, 1986)), or to conduct a natural resource restoration action under CERCLA, section 311 of the Clean Water Act, or the Oil Pollution Act (1990);

- iii. A road is needed pursuant to reserved or outstanding rights or as provided for by statute or treaty;
- iv. Road realignment is needed to prevent irreparable resource damage that arises from the design, location, use, or deterioration of a system road that cannot be mitigated by road maintenance. Road realignment may occur under this paragraph only if the road is deemed essential for public health and safety, public or private access, or natural resource management;
- v. Road reconstruction is needed to implement a road safety improvement project on a system road determined to be hazardous on the basis of accident experience or accident potential on that road;
- vi. The appropriate decision-maker determines that a Federal Aid Highway project, authorized pursuant to Title 23 of the United States Code, is in the public interest or is consistent with the purposes for which the land was reserved or acquired and no other reasonable and prudent alternative exists; or
- vii. A road is needed in conjunction with the continuation, extension, or renewal of a mineral lease on lands that are under lease or for a new lease issued immediately upon expiration of an existing lease. Such road construction or reconstruction must be conducted in a manner that minimizes effects on surface resources, prevents unnecessary or unreasonable surface disturbance, and complies with all applicable lease requirements, land and resource management plan direction, regulations, and laws.

As a result of these plan standards, timber activities and road construction and reconstruction would be limited to specific purposes allowed for in Inventoried Roadless Areas. As expressed in BAC-S-02, timber cutting, sale or removal is permitted in Inventoried Roadless Areas when it is incidental to the implementation of a management activity not otherwise prohibited. Examples include, but are not limited to, trail construction or maintenance; removal of hazard trees adjacent to classified roads for public health and safety reasons; fire line construction for wildland fire suppression or control of prescribed fire; survey and maintenance of property boundaries, or for road construction and reconstruction allowed by the Roadless Rule.

Additionally, most IRAs are subject to the remaining plan direction in Backcountry, which includes desired conditions to manage large blocks of remote and unroaded forest where mid to late successional communities and old growth forests predominate, and managing for a predominately Semi-primitive Non-motorized character. This would allow the retention of the nine Roadless Area characteristics.

In Alternatives B, D, and E, in locations where IRAs are recommended for wilderness, timber harvest, and road construction, or reconstruction is not allowed and management direction for other activities, such as recreation use, fire, and invasive species management would be more restrictive than in Backcountry.

As a result, the roadless characteristics of the Inventoried Roadless Areas would be maintained in all action alternatives.

### **Cumulative Effects**

The cumulative effects analysis area includes the adjoining federally managed lands, including the Cherokee NF in Virginia and the Chattahoochee-Oconee NF in Georgia. Roadless character of IRAs within the cumulative effects analysis area would be maintained or enhanced through Forest Service or other



agency regulation and policy. Other agencies and adjacent forests may also recommend portions of IRAs as wilderness resulting in cumulative effects that protect roadless character and associated benefits.

General trends on private lands surrounding the Nantahala and Pisgah NFs are increased population growth and fragmentation of forested areas. Total non-federal forest land area is expected to change with continuing conversions from forests and farmlands to cities and suburbs. Currently, more than 30 percent of total land area in the South is non-federal forest, or 1.66 acres per person. By 2060, non-federal forest is predicted to decline to 0.95 acres per person. The projected decline is greater for the South than the nation because of population growth and increased development (Wear and Greis 2012).

As non-federal forest land decreases in areas adjacent to the Nantahala and Pisgah NFs, there will be increased pressure on federal lands to provide both recreational opportunities as well as other natural resources benefits, including clean water, diverse plant and animal communities, natural appearing landscapes, etc. Inventoried Roadless Areas will continue to be managed to protect their roadless characteristics as identified in the 2001 Roadless Areas Conservation Rule but they may face increasing recreation demand as opportunities for nature-based recreation on private lands decreases.

### **3.4.9 Wild and Scenic Rivers**

#### **Affected Environment**

The Wild and Scenic Rivers Act (Public Law 90-542: 16 USC 1271-1287, October 2, 1968) and its amendments provide for the protection of selected rivers and their immediate environments. To be eligible for designation, rivers must be free-flowing and possess one or more Outstandingly Remarkable Values (ORVs), such as scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values. Designation preserves rivers in free-flowing condition, protects water quality, and protects the immediate river environments and ORVs for the benefit and enjoyment of present and future generations.

Most rivers are added to the National Wild and Scenic Rivers System (National System) through federal legislation after a study of the river's eligibility and suitability for designation. The USDA Forest Service is required to consider and evaluate rivers for potential designation on lands it manages while preparing land management plans under Section 5(d)(1) of the Wild and Scenic Rivers Act.

Rivers and stream corridors accommodate many different uses such as picnicking, fishing, day hiking, walking for pleasure, primitive camping, boating (canoeing, kayaking, rafting, tubing), swimming, and nature study. The 2000-2007 National Survey on Recreation and the Environment (USDA Forest Service 2002) interviewed more than 15,000 people to determine their participation in a variety of activities. According to the results, an estimated 76.1 million people participated in boating (including kayaking, and canoeing), and 20 million participated in rafting, tubing, or any other type of floating on flowing waters.

North Carolina currently has three designated Wild and Scenic Rivers that are managed by the USDA Forest Service. These include the Chattooga River, Horsepasture River, and Wilson Creek. Horsepasture River and Wilson Creek are located on the Pisgah NF, and the Chattooga River is located on the Nantahala, Sumter, and Chattahoochee NFs. Additionally, the 1987 Nantahala and Pisgah NFs Land and Resource Management Plan and its 1994 amendment identified 11 rivers as eligible for potential addition to the National Wild and Scenic Rivers System. One of those, Wilson Creek, was later designated; therefore, 10 eligible or suitable rivers remain from the 1987/1994 analysis. The forest plan was amended in 2004 to provide direction for the management of Wilson Creek and in 2012 to provide updated management direction for the Chattooga Wild and Scenic River.

During the Nantahala and Pisgah NFs Land and Resource Management Plan revision, all currently eligible rivers and all rivers named on a standard U. S. Geological Survey 7.5 minute USGS quadrangle map, more than 1300 in total, were reviewed by district personnel, resource specialists, and interdisciplinary team members for potential eligibility in the National System. A broad and inclusive review of potential ORVs resulted in 53 rivers with the potential for eligibility, and a more detailed review was conducted. (See Appendix F for more detailed information about the evaluation process and the review of the 53 rivers).

The proposed plan and DEIS identified 9 new eligible rivers plus 10 existing eligible rivers result in a total of 19 eligible rivers on the Nantahala and Pisgah NFs. Following the public comment period between draft and final, these rivers were reviewed again to consider any necessary changes based on comments. During this review it was found that Overflow Creek did not actually possess outstandingly remarkable values within the Forest Service segment analyzed and does not meet eligibility criteria. Furthermore, during the objection process several rivers were reevaluated based on objector comments, and a segment of the North Fork French Broad River was found to be eligible. Details of these reevaluations are documented in FEIS Appendix F. Therefore, the final plan and FEIS identify a total of 19 eligible river segments on the Nantahala and Pisgah NFs, including 10 existing eligible river segments plus 9 newly eligible river segments.

Rivers found eligible need further study to determine if they meet suitability criteria and if they should be recommended to Congress for addition to the National System. Until a final determination is made regarding suitability or non-suitability, the Forest Service is obligated to protect those qualities that make these 19 rivers eligible, until designated or released from study. Of these 19 eligible rivers, only the Nolichucky River has undergone a full suitability study resulting in a recommendation for designation.

Table 203 and Table 204 identify the designated, suitable, and eligible WSRs on the Nantahala and Pisgah National Forests. A more detailed description of each river and their potential classifications can be found in the final Plan.

**Table 203. Congressionally Designated Wild and Scenic Rivers**

River Name	Miles on N&P NF	Outstandingly Remarkable Value(s)	Classification	Status
Chattooga River*	9.7	Scenery, Recreation, Geology, Cultural/Historic, Biological	Wild, Scenic, Recreational	Designated 1974
Horsepasture River	4.2	Scenery, Recreation, Geology, Ecological/Botanical	Scenic, Recreational	Designated 1986
Wilson Creek	23.3	Scenery, Recreation, Geology, Fish, Wildlife, Ecological/Botanical, Cultural/Historic	Wild, Scenic, Recreational	Designated 2000

\*For sections within North Carolina only

**Table 204. Rivers Found to be Eligible for Inclusion as National Wild and Scenic Rivers**

River Name	Miles on N&P NF	Outstandingly Remarkable Value(s)	Preliminary Classification	Status
Big Laurel Creek*	2.8	Scenery, Recreation, Fish, Cultural/Historic	Recreational	Eligible 1987; not suitable
Cullasaja River	7.8	Scenery, Recreation, Geology, Ecological/Botanical	Recreational	Eligible 2019
Davidson River	10.9	Fish, Cultural/Historic	Recreational	Eligible 1987; not suitable

River Name	Miles on N&P NF	Outstandingly Remarkable Value(s)	Preliminary Classification	Status
East Fork Pigeon, Dark Prong & Yellowstone Prong	9.8 Total	Scenery, Fish, Wildlife, Cultural/Historic	Scenic, Wild	Eligible 1987; potentially suitable
Fires Creek	2.8	Fish	Recreational	Eligible 2019
Flat Laurel Creek	1.7	Ecological/Botanical	Recreational, Scenic	Eligible 2019
French Broad River	1.9	Scenery, Geology, Fish, Ecological/Botanical, Cultural/Historic	Scenic	Eligible 1987; not suitable
Linville River	14.0	Scenery, Geology, Fish, Wildlife, Cultural/Historic	Recreational, Scenic, Wild	Eligible 1987; potentially suitable segments
Mills River System (North Fork, South Fork, Mills)	23.1 Total	Scenery, Recreation, Fish, Wildlife, Ecological/Botanical, Cultural/Historic	Recreational, Wild	Eligible 1987; potentially suitable segments
Nantahala River (Above and below Nantahala Lake)	17.2	Scenery, Recreation, Geology, Fish, Wildlife, Ecological/Botanical, Cultural/Historic	Recreational	Eligible 1987; potentially suitable segments
Nolichucky River	6.0	Scenery, Geology, Fish,	Scenic	Suitable 1991, recommended for designation
North Fork French Broad River	3.2	Recreation	Recreational	Eligible 2022
Santeetlah Creek	12.5	Fish, Wildlife, Ecological/Botanical, Cultural/Historic	Scenic	Eligible 2019
Snowbird Creek	12.7	Scenery, Fish, Cultural/Historic	Wild, Scenic, Recreational	Eligible 1987; potentially suitable segments
South Toe River	3.7	Recreation	Recreational	Eligible 2019
Tellico River	6.0	Fish, Wildlife	Recreational	Eligible 1994
Thompson River	3.7	Scenery, Recreation	Scenic, Recreational	Eligible 2019
West Fork Pigeon River	7.0	Scenery, Recreation, Ecological/Botanical	Recreational	Eligible 2019
Whitewater River	3.6	Scenery, Recreation, Geology, Ecological/Botanical	Scenic	Eligible 2019

\*In the 1987 Plan and 1994 Amendment, a headwaters tributary to Big Laurel Creek named Puncheon Fork was also found to be eligible, but neither were found to be suitable. However, except for approximately 250 feet at its origin near Street Gap, the entire length of Puncheon Fork is on private lands. Therefore, Puncheon Fork was not carried forward as eligible from the 1994 Plan Amendment or included in the 2019 WSR eligibility evaluation.

Note: The proposed plan and Draft Environmental Impact Statement identified Overflow Creek as eligible with a scenic classification. This segment's eligibility was revisited because public comments requested this segment be classified as wild. Based on field review and specialists' input, the Forest Service determined there were no outstandingly remarkable values within this one-mile segment. Therefore, this segment is not eligible. However, during the objection process several rivers were reevaluated and North Fork French Broad River was found to be eligible and added to this list. See Appendix F for additional information.

## Environmental Consequences

All alternatives include management direction, such as desired conditions, objectives, standards, and guidelines, to ensure that proposed actions do not compromise eligibility or suitability of identified reaches to potentially be designated under the Wild and Scenic Rivers Act.

In all alternatives, the designated Wild and Scenic Rivers (Chattooga, Horsepasture, and Wilson Creek) have river corridors mapped as separate management areas that do not overlap with other management areas. All alternatives retain the ongoing management direction for these existing Wild and Scenic Rivers and continue management of the rivers for their recognized free flowing character and outstandingly remarkable values (WSR-DC-01, WSR-DC-02). Action Alternatives B, C, and D incorporate direction from Alternative A from the 2004 and 2012 amendments. The action alternatives reflect minor administrative changes in wording to bring Alternative A plan direction into the plan component framework of the 2012 planning rule, updating syntax structure for desired conditions, objectives, standards, and guidelines. The intent and implementation of the plan components will be the same under all alternatives. An example of a change is that Alternative A identifies a Visual Quality Objective for each designated river, but the revised plan uses the newer Scenery Management System; therefore, the revised plan replaces each Visual Quality Objective with the corresponding Scenic Integrity Objective. These updates in language will not result in a change of management direction. The ongoing monitoring activities along the Chattooga River are also incorporated in the monitoring program of the action alternatives.

In the action alternatives, geographic area goals will provide support for future projects in these river corridors. For example, in the Highland Domes Geographic Area, a goal to "Maintain and enhance unique tannic, sandy bottom stream habitat within Panthertown Creek, upper Chattooga River, and Savannah River watersheds to provide quality habitat for native aquatic species" (HD-GLS-07) could serve as the purpose and need for future aquatic species efforts. A goal in the Eastern Escarpment Geographic Area would support future work in Wilson Creek to "Continue working with partners to maintain a quality recreation experience, reduce erosion and sedimentation, restore aquatic organism passage, improve fisheries and reduce non-native invasive species" (EE-GLS-09).

In the action alternatives, three Chattooga River watersheds are recognized as priority watersheds: Headwaters Chattooga (6<sup>th</sup> level watershed 030601020201), Upper Chattooga River (0306001020204), and Headwaters West Fork Chattooga River (030601020202). Over the life of the plan, action plans for a selection of the priority watersheds will be developed and implemented with the intent to improve the watershed condition. Activities conducted as part of priority watershed action plans could include improving water quality and habitat conditions, restoring acres of stream ecosystem, focusing on restoring floodplain connectivity, stream channel function (for example, addition of large woody debris) and native riparian vegetation, performing road maintenance on roads hydrologically connected to the stream network, performing trail maintenance on activities within 100 feet of streams, decommissioning unneeded roads and partnering with nearby lands to accomplish shared objectives.

Under Alternative A, ten previously eligible or suitable rivers were carried forward and would continue to be managed as they are under the current Land Management Plan. In this alternative, eligible Wild and Scenic Rivers would maintain eligibility until evaluated for suitability and either designated by Congress

or released from further study. Outstandingly Remarkable Values (ORVs) and other river values associated with segment classification will be maintained within a one-quarter mile corridor on each side of an eligible river (one-half mile total). Plan direction would ensure protection of the river's ORV within this corridor. Management activities allowed within the corridor vary depending on segment classification. In Alternatives B, C, and D the newly identified eligible WSR corridors would also be managed to protect the free-flowing character, ORVs, and attributes associated with segment classifications.

In all alternatives the eligible or suitable river corridors (1/2 mile wide, approximately 1/4 mile from each river bank) are not mapped as separate management areas but overlap other management areas. Since Plan direction is to maintain free-flowing condition and ORVs consistent with potential classifications, this would supersede allocated management area direction if inconsistent with preserving WSR eligibility or suitability. Part of managing eligible and suitable river corridors is consideration of desired conditions for scenery. River segments potentially classified as Wild have a desired Scenic Integrity Objective of Very High; Scenic segments are High SIO; and Recreational segments are Moderate SIO. These desired conditions may be more restrictive than those for management areas in which the river segments lie. The types and level of development and transportation systems may also be restricted within the corridors based on river classification.

Within the corridor of a Wild classified river segment the character is primitive with little or no evidence of human activity. The area is generally inaccessible, except by trail, with limited vehicular travel within the river corridor; however, a few existing system roads may be present. Other than prescribed fires, control activities to address pest outbreaks, and the creation of trails and river access points, disturbance is primarily caused by natural processes. Activities such as new road construction, timber management or new facility construction would be heavily restricted or prohibited.

Within the corridor of a Scenic classified river segment, the character is mostly undeveloped; however, there may be occasional roads and/or bridges adjacent to or crossing the river, designated parking areas, and trailheads. The area may be accessible in places by road, and roads may occasionally reach or bridge the river. Disturbance is primarily caused by natural processes, and the landscape is mostly natural; however, both natural and human disturbance may be visible. Evidence of past or ongoing management activities, including timber harvest, is acceptable provided the forest appears natural from the riverbank.

Within the corridor of a Recreational classified river segment there may be substantial evidence of human activity, including structures. Non-motorized trails may be highly visible and be highly developed with facilities such as parking areas and restrooms. Rivers are readily accessible by roads or railroads with the existence of parallel roads or railroads on one or both banks as well as the presence of bridge crossings and other river access points. The landscape is natural; however, both natural and human disturbance may be visible. Adjacent lands may be developed for the full range of forestry uses and may show evidence of past and ongoing timber harvest.

For each potential WSR classification, the following table identifies acres of affected management areas where they overlap eligible or suitable river corridors. Acres shown for Alternative A only include river corridors and classifications from the 1987 EIS/LMP and the 1994 Amendment 5. Acreage for Alternatives B, C, D, and E include corridors of the existing and newly eligible or suitable WSR segments and classifications.

**Table 205. Overlap of Management Areas with Potential Wild and Scenic River Segments, by Classification**

Alternative A	Wild (ac.)	Scenic (ac.)	Recreational (ac.)
MA 1B – Timber/Motorized Recreation	0	0	0

<b>Alternative A</b>	<b>Wild (ac.)</b>	<b>Scenic (ac.)</b>	<b>Recreational (ac.)</b>
MA 2A – Scenery/Motorized Recreation	0	538	457
MA 2C – Scenery/Motorized Recreation	101	377	2814
MA 3B – Timber	64	741	1590
MA 4A – Scenery/Non-Motorized Recreation	6	0	227
MA 4C – Scenery/Non-Motorized Recreation	31	798	1917
MA 4D – Wildlife/Non-Motorized Recreation	262	85	2759
MA 5 - Backcountry	3921	1938	1307
MA 6 – Wilderness Study Areas	2453	294	4
MA 7 – Designated Wilderness	4697	0	137
MA 8 – Experimental Forests	0	0	0
MA 11 – Cradle of Forestry in America	0	965	0
MA 12 – Developed Recreation Sites	0	0	258
MA 13 – Special Interest Areas	0	464	627
MA 14 – Appalachian National Scenic Trail	0	0	85
MA 15 – Designated Wild & Scenic Rivers	0	0	521
MA 16 – Administrative Facilities	0	0	56
MA 17 - Balds	438	517	0
Unassigned	161	9	319

<b>Common to All Action Alternatives</b>	<b>Wild (ac.)</b>	<b>Scenic (ac.)</b>	<b>Recreational (ac.)</b>
Designated Wilderness	4691	0	1555
National Historic Trails	0	0	545
Appalachian National Scenic Trail	0	104	385
Cradle of Forestry in America	0	965	0

<b>Alternative B</b>	<b>Wild (ac.)</b>	<b>Scenic (ac.)</b>	<b>Recreational (ac.)</b>
Matrix	150	2845	6545
Interface	170	1232	3215
Backcountry	3820	2433	1444
National Scenic Byways	72	1675	1583
Special Interest Areas	55	3373	3598

<b>Alternative B</b>	<b>Wild (ac.)</b>	<b>Scenic (ac.)</b>	<b>Recreational (ac.)</b>
Recommended Wilderness	3255	550	765
Experimental Forest	0	363	0

<b>Alternative C</b>	<b>Wild (ac.)</b>	<b>Scenic (ac.)</b>	<b>Recreational (ac.)</b>
Matrix	25	1770	4367
Interface	220	674	2564
Backcountry	4775	3338	3837
National Scenic Byways	50	1118	1583
Special Interest Areas	0	3360	3484
Ecological Interest Areas	0	1526	1310
Recommended Wilderness	2453	294	4
Experimental Forest	0	363	0

<b>Alternative D</b>	<b>Wild (ac.)</b>	<b>Scenic (ac.)</b>	<b>Recreational (ac.)</b>
Matrix	153	2263	6726
Interface	170	1232	3083
Backcountry	3384	2206	1646
National Scenic Byways	22	1675	1583
Special Interest Areas	55	3373	3598
Ecological Interest Areas	484	811	0
Recommended Wilderness	3255	548	512
Experimental Forest	0	363	0

<b>Alternative E (and Alternative E Mod)</b>	<b>Wild (ac.)</b>	<b>Scenic (ac.)</b>	<b>Recreational (ac.)</b>
Matrix	74	2244	6226 (7006)
Interface	167	1212	3515 (3631)
Backcountry	3389	2710	1637
National Scenic Byways	57	1147	1583
Special Interest Areas	56	3381	3734
Ecological Interest Areas	429	705	4
Wilderness Study Area	0	89	0
Recommended Wilderness	3202	179	420

Experimental Forest	0	0	0
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Within Matrix, which emphasizes active management for timber and wildlife habitat, proposed actions that might have otherwise been allowed could need to be adjusted or foregone to ensure compatibility with WSR values, especially within segments classified as Scenic or Wild. As shown above, Alternative B, with 9,540 acres, includes the most acres where eligible or suitable river corridors overlap Matrix; Alternative D, with 9,142 acres, has fewer acres in Matrix; Alternative E and E Mod lie between Alternatives D and C; and Alternative C, with 6,162 acres, has the least. However, in all three action alternatives, most of the river corridors overlapping Matrix are associated with river segments potentially classified as Recreational. Active management for timber and wildlife habitat are generally compatible with eligible river values in corridors classified as Recreational, so the potential for forgone opportunities within Matrix would be reduced in these locations. This is also true for the corridor associated with North Fork French Broad River, which was found eligible during the objection process. Much of North Fork French Broad River corridor within Matrix is in a steep gorge and has limited road access, although NC215 passes through a portion of the corridor with an overlap of Interface management area along Forest Heritage Scenic Byway. With limited access in Matrix and a scenic byway in Interface, potential forgone opportunities in forest management associated with this newly eligible river segment, and its potential recreational classification, would be minimal.

Where eligible river corridors overlap recommended wilderness, management direction for some proposed actions may be more restrictive than management for eligible Wild and Scenic River values. For example, new roads are permitted to parallel Recreational river segments if such construction protects river values, and public use facilities such as information centers or river access developments can be developed in corridors classified as Scenic. Alternative B has 4,570 acres in recommended wilderness; Alternative D has nearly as much at 4,315 acres; Alternative E has a similar amount at 3,801 acres; and Alternative C has the fewest at 2,751 acres. However, in all three alternatives, most of the acres that would overlap recommended wilderness have a potential classification of Wild, which would have the strongest compatibility with recommended wilderness management as compared to Scenic or Recreational segments.

Within Interface, the management area that is intended to provide recreation access to heavily used areas of the forest, river segments classified as Recreational would be compatible with the management area intent. Alternative E (Alt. E Mod), with 3,515 (3631) acres, has the most acres of eligible river corridor classified as Recreational that overlaps Interface and the fewest acres in Scenic or Wild segments.

Within Backcountry, a management area with large blocks of remote and un-roaded lands managed for primitive recreation, Alternative C has the greatest overlap with eligible river corridors, exceeding Alternatives B, D and E by more than 4,000 acres each. The majority of eligible river corridors overlapping Backcountry are classified as Wild. Generally, Backcountry management would be compatible with management direction of river segments classified as Wild. However, direction for Backcountry management allows for new temporary road construction and limited vegetation management, where eligible river corridors classified as Wild would not. In the Recreational segments, accessibility may be more restricted than it would otherwise be outside of Backcountry.

Overall, there is not a single alternative where the proposed land allocation best accommodates management of potentially eligible or suitable river segments. Under all alternatives project design and implementation will have to consider compatibility of proposed actions and preservation of eligible Wild and Scenic River values for each potential classification in addition to management area direction. This may result in considering changes to activities.



## **Cumulative Effects**

The geographic extent of the cumulative effects analysis considers all of the 6<sup>th</sup> level HUC watersheds that include designated, suitable, and eligible WSR river miles.

Under all alternatives, management activities on the Forest that result from implementation of any of the alternatives would be directed to adhere to protective forest plan components that maintain river corridor conditions. Any management activities that take place within eligible and suitable wild, scenic, and recreational river corridors would be consistent with maintaining the free-flowing nature, identified outstandingly remarkable values, and water quality of river segments. For example, if invasive weeds were discovered in an eligible river corridor, action may be taken to remove the weeds to prevent further spread within the corridor.

Under all alternatives, watersheds that include the river segments provide hydrologic connectivity to activities that happen off of National Forest lands, increasing the influence of activities outside of Forest Service jurisdiction. The National Forests manage only 55% of the lands in the 6<sup>th</sup> code watersheds that include designated, eligible and suitable WSRs, plus and segments of these rivers run through private land above, below, or between segments that are adjacent to NFS lands. The amount of land within the watershed that is retained in forested condition, the intensity of the land use for urban and agricultural activities, and the use of best management practices on other lands may make a difference for retention of the outstandingly remarkable values, especially those related to fish and wildlife habitat, ecological, and botanical conditions.

Public participation in water-based recreation activities such as fishing, rafting, and kayaking will continue to increase as population and development increase throughout the state. There has been a steady increase in water-based recreation activities on rivers that flow predominantly through National Forest System lands. The effects of population growth and associated increased water-based recreation use are likely to be gradual and extend well beyond the planning period.

### **3.4.10 Timber Resources**

#### **Affected Environment**

Humans have been an integral part of the southern Appalachian landscape for approximately 12,000 years (Yarnell 1998; Barbour and Christensen 1993). Historically, Western North Carolina has seen trends in forest land utilization and conversion similar to the rest of the southeast. Since European settlement (circa 1750s) (Yarnell 1998), the natural landscape has been cleared for agriculture, homesteads, and pasture; selectively harvested for fuel wood and naval stores; harvested extensively to support the industrial revolution; burned over vast areas; subjected to wide-scale fire suppression and abandoned. By the early 20<sup>th</sup> century, an estimated 86 percent of the southern Appalachian landscape was impacted and considered young forest growth (Yarnell 1998).

Large portions of Western North Carolina became the Nantahala and Pisgah National Forests after 1916, and forests regenerated. Even though the area had been cut-over, timber harvest levels would remain high in the region up to the mid-1980s (Figure 120) due to multiple factors related to supply and demand. During the Great Depression, the Civilian Conservation Corps increased emphasis on reforestation of denuded and cut-over areas and increased fire suppression and stand improvement for regenerating forests. The world wars drove demand for timber, and national forests continued to emphasize sales to local loggers for the benefit of local economies and public relations (Yarnell 1998). In the 1960s the Appalachian Regional Commission revitalized employment programs that continued stand improvement and timber harvest to support depressed local economies. The new multiple use goals of the Forest Service, increased recreation and tourism, began to generate conflict with timber harvest (Yarnell 1998). The environmental movement of the 1970s also increased debate over even-aged management and clearcutting, which had become the standard practice in southern Appalachian National Forests, yet harvest levels remained high (Figure 120).

The 1987 Plan was authorized after steep declines in timber harvesting began in 1985 in response to concerns over issues such as clearcutting and economically efficient timber harvesting (Figure 120). The plan was reanalyzed and amended in 1994, leading to an additional but more gradual decline in harvested acres. The Indiana bat decision in the 1990s led to the lowest levels of harvest in the early 2000s. Harvests have fluctuated since 2001 with a general average of 800 to 1,000 acres harvested through 2018. Trends for the most recent decade have remained relatively steady (600 to 800 acres), with a peak of acres harvested in 2016 (1,271 acres) and a low of 318 acres in 2009. The volume produced over the last decade followed similar trends, with four times exceeding 20,000 CCF sold. The

lowest volumes occurred in 2009 and 2010 when volumes sold from the Nantahala and Pisgah NFs did not exceed 10,000 CCF.

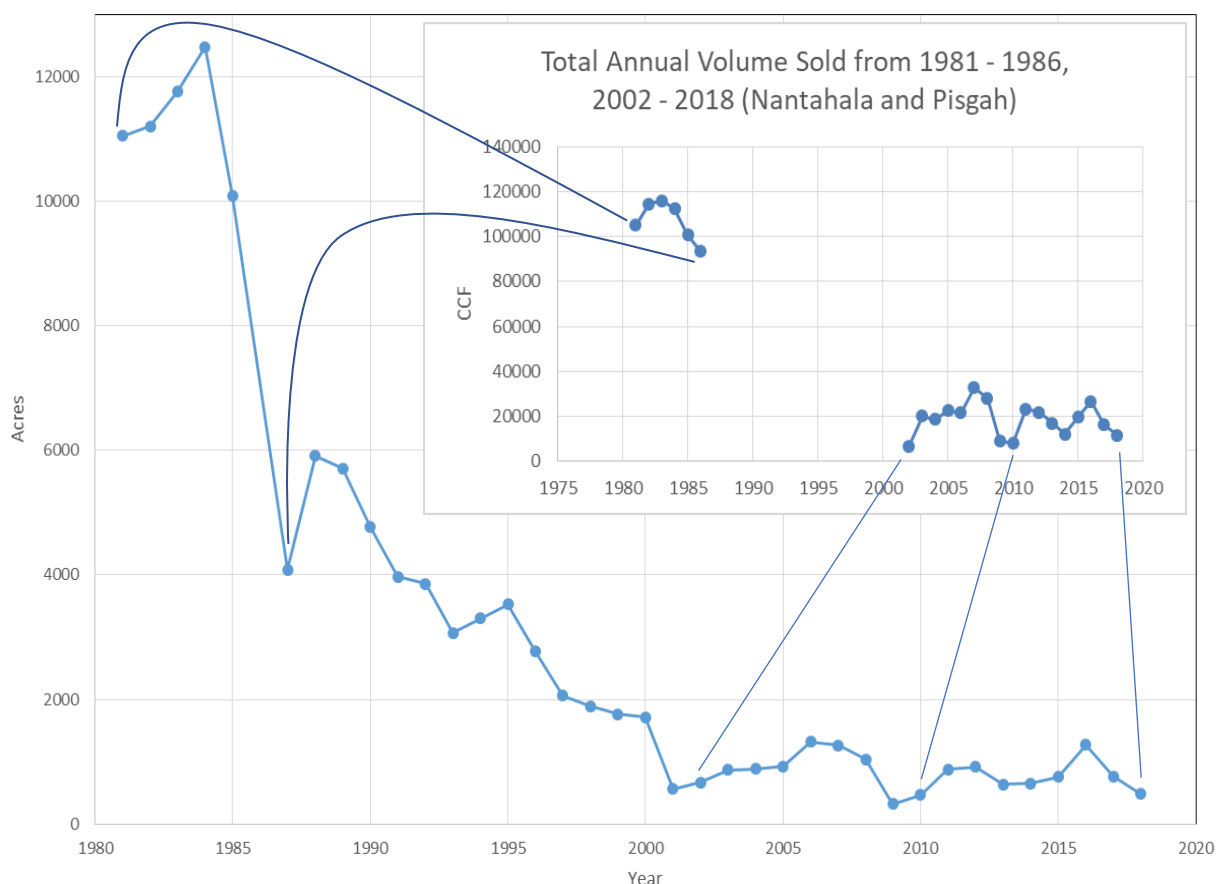


Figure 120. Nantahala and Pisgah National Forests Total Harvest Acres Sold

## Analysis methods and indicators

This analysis describes how timber resources are expected to change over time under each alternative. This section focuses primarily on the social and economic aspects of timber resources. For more understanding of changes in the ecological patterns resulting from proposed harvest activities, see the “Terrestrial Ecosystem” section instead.

The information presented in the “Environmental Consequences” section comes from several analyses completed during plan revision. Further documentation of these analyses is present in appendices and the project record. Most prominently, the Spectrum model was used to estimate harvest acres as well as volumes of wood products produced. An analysis of proposed management area designation, current road system, and Spectrum outputs provided information about lands accessed now and through the planning period as well as rough estimates of potential road building. A timber production suitability analysis was developed guided by Chapter 60 of the Land Management Planning Handbook (1909.12 Ch 60).

Vegetation management and wood products indicators described below include:

- Comparison of plan direction

- Harvest systems and methods used by alternative
- Timber calculations
  - Sustained yield
  - Quantity of wood sold
  - Lands suitable for timber production
- Land potentially impacted by timber operations
- Forest products outputs
- Species mixes

The timber calculations required for plan revision have changed in their definitions and analysis methodology between the 1982 Planning Rule that was used to develop Alternative A and the 2012 Planning Rule that was used to develop the action alternatives. As a result, a direct comparison across alternatives for sustained yield, projected timber sale quantities, and lands suitable for timber production is difficult. In each of these sections below, when Alternative A is compared to action alternatives, the data presented is described in terms of (1) differences between 1982 and 2012 requirements for these calculations (apples to oranges) or (2) what was done to present the data equally (apples to apples).

## **Environmental Consequences**

### **Comparison of plan direction**

#### **Alternative A**

Direction for timber resources in the current plan includes three overarching goals:

1. Goal 1 includes reference to “sustain(ing) ecosystems that are diverse, productive, and resilient to short-term stress and long-term change through principles of multiple-use and sustained-yield” and striving for “balance, equity, and harmony between people and the land” and “meeting this generations’ resource needs while maintaining options.”
2. Goal 2 strives to “improve the quality of life for citizens of Western North Carolina by helping to meet the basic needs of people and communities who depend on National Forest resources for water, food, fuel, shelter, livelihood, recreation, and spiritual renewal. Use resources wisely and efficiently to improve economic prosperity of local communities, the southern Appalachian region, and the nation.”
3. Goal 5 refers more directly to forest products: “Emphasize high value hardwood sawtimber. Take advantage of the forests’ capability to produce large trees of hardwood species valued for beauty and durability of this wood such as Northern red oak and black cherry. Emphasize high quality hardwood species on highly productive sites.”

The current plan also contains general direction in the Forest Wide Direction Vegetation Management Section General Direction to “Utilize all forest products from timber sale areas to the extent practicable” (III-33). This exact language is not present in the revised plan, but the concept is woven through several desired conditions described below, especially TIM – DC – 5.

#### **Common to all action alternatives**

The revised forest plan, under Terrestrial Ecosystem Desired Conditions (DC), contains a timber management practices section. Between draft and final, the timber section of the Plan was moved under its own heading, Timber Management Practices and a background discussion was added. For clarity, numbers of plan components changed because of this reorganization. To reduce confusion in reading this analysis, plan component numbers are shown for both Alternatives B/C/D, and Alternative E.

Goals described in the Alternative A discussion above were mirrored in the revised plan. Desired conditions identify lands available for timber harvest and desires that resulting products from harvests benefit local economies; connect forest outputs to WNC communities, and identify the Nantahala and Pisgah NFs as a source of high-quality products (Alternatives B/C/D ECO-DCs 13 through 15, which became TIM-DCs 2 through 4). These desired conditions address the same concepts as goals 1, 2, and 5 mentioned above.

The next set of desired conditions expand upon more contemporary issues. Alternative B/C/D's ECO-DC-16, which became Alternative E's TIM-DC-5 desire the expansion of markets for wood products not necessarily valuable currently. The desired condition identifies the interdependence on timber harvest outputs, their value, and the ability to complete expanded restoration objectives. Typical products like veneer, sawtimber, and, to a lesser degree, pulpwood generate funds that can be returned to the forest to enhance restoration efforts. As restoration increases its pace and scale, all outputs, traditional, and un-traditional products would expand. New markets and uses for products other than sawtimber and veneer would benefit the greater restoration emphasis of the plan and its impact on local economies. The greater collaborative effort that would be focused on restoration should also include development of these local markets that would utilize un-tapped portions of the restoration product stream. (Examples might include pallets, cross-laminated timbers, bark veneers, posts/poles, small diameter products, pellets, biochar, steam generation for rural communities, and other novel ideas).

Alternative B/C/D's ECO-DC-17, which became Alternative's TIM-DC-6 connects timber production, rotation ages, and sawtimber/pulpwood production with restoration and habitat desired conditions. With the increased restoration emphasis of the revised plan, timber production can be an asset to restoration. The two strategies are well aligned as many restoration goals, especially those requiring compositional restoration, are long-term and incremental in success. Restoration with a timber production objective (secondary) gives the forest manager the flexibility to plan treatments on a long-term planning horizon with scheduled inputs and investments to move a stand towards the larger restoration goal.

Alternative B/C/D's ECO-DC-18, which became Alternative's TIM-DC-7 disconnects timber harvests from production rotations yet still links them to community services and benefits. Though restoration efforts on lands unsuitable for timber production are desired in this plan, this desired condition emphasizes that there is not a connection to a rotation that would be designed to deliver a planned product output after the initial silvicultural sequence. The desired condition does however identify the opportunity for these un-scheduled restoration treatments to provide products that support communities local to the forest.

Under Community Connections (COM) in the revised forest plan, desired condition COM-DC-01 references the Forests contributing to the economic vitality of the region. This desired condition parallels, at a broader scale, desired conditions in the timber section regarding the impact the Forests have on local community vitality. This desired condition recognizes that along with recreation, culture, and traditions, the contribution of timber contributes to the wellbeing of communities surrounding the Nantahala and Pisgah NFs.

Forest wide standards and guides also reinforce the role that timber production and timber resource outputs have in relation to restoration and habitat work within the revised plan. Based on comments between draft and final, several standards and guides were changed and updated.

Alternative B/C/D's ECO-S-01 which became Alternative E's TIM-S-01 states "Timber production will not be the primary purpose." This standard complements the desired conditions in aligning the order of objectives to place timber production as secondary at best and allow restoration and habitat (when not synonymous) to be interchangeable within the primary objective position.

Alternative B/C/D's ECO-S-02 which became Alternative E's TIM-S-02 states "While timber harvest can occur on lands both suitable and not suitable for timber production." This standard has an analogue in the existing forest plan under the "Forestwide - Vegetation Management General Direction" section. Under Alternative E the language for this standard was modified to bring it more in line with the 2012 planning rule that requires timber harvest on lands not suited for timber production be done to protect multiple use values other than timber production or for salvage. Many of the sub-bullets are similar to the language in the current forest plan yet were modified to focus them on protecting other multiple resource values within the revised plan.

A sub-bullet detailing timber harvest "to restore and maintain an ecological system or habitat over time" that was added for Alternative B, C, and D was modified to read "restoring or maintaining a terrestrial or aquatic ecological system or wildlife habitat over time." This addition to the (current – Alt A) standard highlights the need for restoration and habitat of terrestrial and aquatic systems using timber harvest as a tool, not limited to lands suitable for timber production. Timber harvest was planned and modeled on unsuitable lands in all action alternatives and tiers albeit at a much lower scale than on suitable lands. This sub-bullet recognizes both the heightened importance of other resource objectives within these management areas and the greater set of limitations on designing and implementing a successful timber harvest on these areas while maintaining the overall restoration emphasis of this revised plan.

Other changes made during the development of Alternative E include the following:

TIM-S-07 subpart a: The bullet was updated to reflect current reference to the North Carolina Forest Service and their guidelines.

TIM-S-07 subpart d(i): A sentence was added to address the removal of temporary bridges used during logging operations.

TIM-S-07 subpart k: The bullet was expanded to include limited examples of temporary road or trail decommissioning techniques.

Plan standards ECO-S-08, 09, 10, 11, 12 under draft alternatives B, C, and D relating to stocking were condensed to reduce confusion regarding the forest community types and management actions that they referred to. Related stocking standards in Alternative E are TIM-S-08, 09, and 10 apply to species types or groups, planted or natural regeneration techniques, silvicultural system, and suitability of lands for timber production (or not). Where projects propose or disturbance occurs on lands not suitable for timber production, restocking levels must be assessed during the project level analysis and specified in the silvicultural prescription associated with that action. Refer to the discussion below for more information on restocking standards.

TIM-S-14 (old ECO-S-16): Several changes were made to this standard to ensure that the description of ecozones reflect the southern pine community types that may require even-aged management up to 80 acres to restore forest plan desired conditions, and to clarify the maximum size opening requirements of NFMA.

TIM-G-05 (ECO-G-05): A sentence was added to this guideline to acknowledge that managers should track development of desired species in the understory of stands they propose to regenerate.

TIM-G-06 (ECO-G-06): A sentence was added to encourage district managers utilizing stand improvement practices to utilize national database tools and surveys to track early stand development in order to maintain desired species composition after NFMA 5-year restocking requirements are met.

Management Approaches: Discussion surrounding the importance of evaluation of regeneration harvests were included in the management approaches section. The discussion clarifies the requirement that stand be stocked at the end of the NFMA 5-year requirement window but also that composition plays a more important role in the development of the regenerated community past that 5 -year window period

and through stand canopy closure, which may occur at a varying age depending on species and site productivity.

A separate management approach regarding recommended residual stocking for intermediate harvests was included, moving the idea from ECO-S-11 to this section of the forest plan. Based on responses to comments and consultation with district staff, this language was viewed more as a management approach than a standard. There is the need for increased flexibility with intermediate treatments to address desired conditions including woodlands, management in older forest for structure and forest health, where the desired residual stocking is variable. The existing forest plan did not have similar direction.

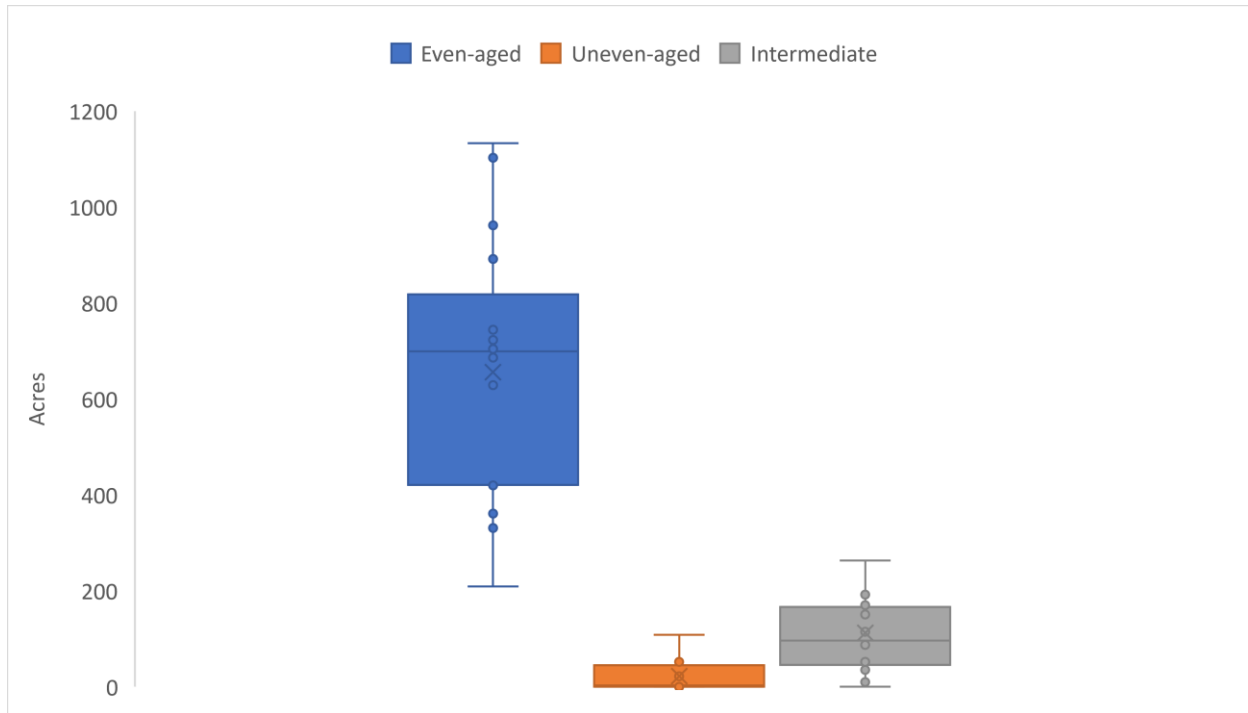
Additionally, Alternative E's plan direction includes adjusted Integrated Ecosystem and Wildlife Habitat objectives and management approaches that are described in the Terrestrial Ecosystem effects section of this EIS. These updated objectives and management approaches influenced Alternative E modeling assumptions, described in Appendix D, which impacts effects analysis in this timber resources section.

### **Harvest systems and methods used by alternative**

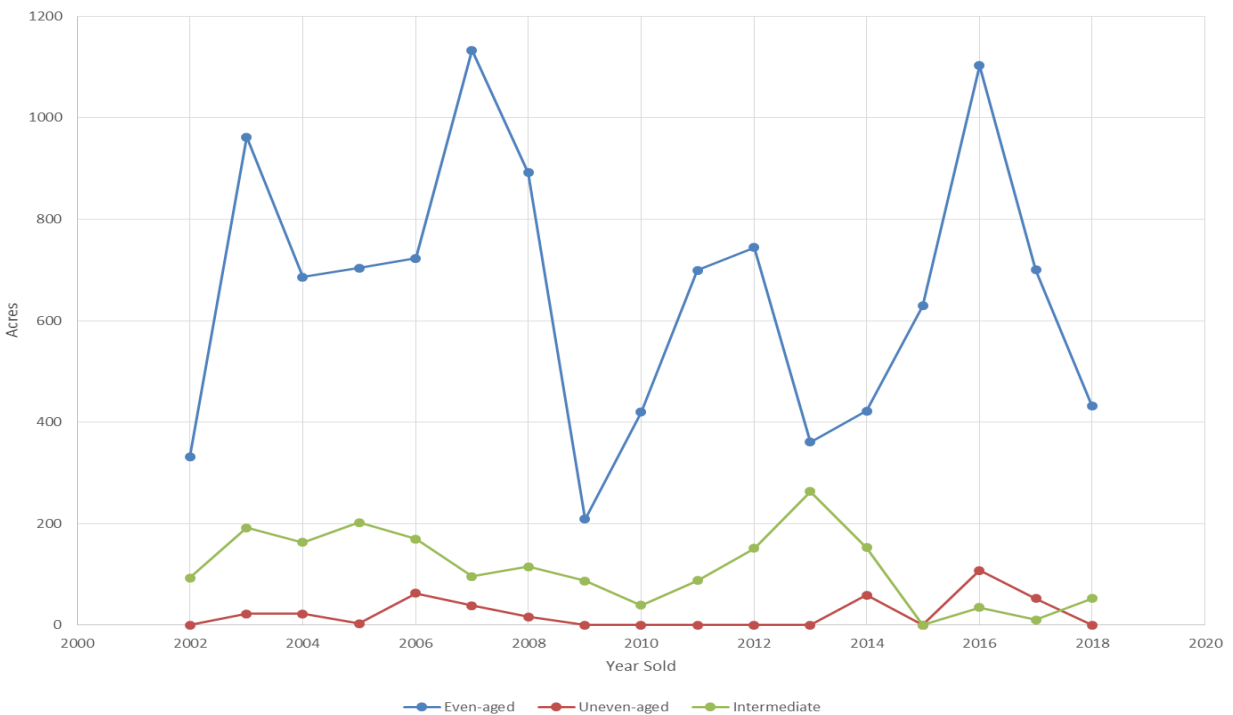
#### **Alternative A**

Under the current Nantahala and Pisgah NFs plan, the primary silvicultural systems employed have been even-aged (Figure 122). The two-aged shelterwood removal harvest has been the dominant regeneration harvest type (82 percent of even-aged harvests) and is lumped in with the even-aged systems according to 2012 planning rule definitions. When the residual basal area reserved from cutting is low, they may resemble the clearcut with reserves harvest. The remaining 18 percent of regeneration harvests are clearcuts with reserves in response to disturbance like tornado damage or wildfire and removal of plantations of white pine. In many cases, these regeneration harvests contain little to no reserve basal area. The most used uneven-aged silvicultural system is the group selection harvest. Group selection and intermediate treatments, like commercial thinning, have been utilized most years but to a much lower degree.

Under Alternative A, the even-aged regeneration harvests described above are expected to continue to dominate in silvicultural prescriptions. The current plan included an economic efficiency analysis that indicated that balanced uneven-aged management silvicultural systems like group selection were inefficient economically (FEIS LRMP 1986-2000, B-25) giving greater weight to even-aged and two-aged harvests. Past even-aged management depended on coppice regeneration of oak and other shade mid-tolerant species. Research has demonstrated that there are generally lower stump sprouting rates as trees age and increase in size, at least with the oak species (exceptions being chestnut oak and all the mesic competitors like tulip poplar and red maple) (Keyser and Zarnoch 2014). Coppice regeneration harvests may have been successful in the 1940's to 1970's, when the average stand age was younger but in more recent decades this lower sprouting effect has contributed to the development of tulip poplar dominated sites in even-aged regeneration harvests on more productive oak sites and in cove hardwoods that now contain an oak overstory due to historical land management and disturbance patterns (Elliott and Swank, 2008).



**Figure 122. Silvicultural systems employed on the Nantahala and Pisgah National Forests (2002 to 2018)**



**Figure 121. Silvicultural Systems Employed on the Nantahala and Pisgah National Forests**



### Common to all action alternatives

Within the action alternatives, the increased emphasis on restoration of all vegetative tiers of forest communities (see TIM- S -01) across the Nantahala and Pisgah NFs, would provide opportunities to include silvicultural systems that strive to restore compositional and structural complexity, increase the resilience and transition of forest communities under a climate change strategy. Future management under any of the action alternatives would employ all silvicultural systems available to meet the objectives of the forest plan, the goals of district level projects, and the collaborative efforts with partners.

With desired conditions that include increased emphasis on restoring compositional and structural restoration at multiple scales, as well as increasing or maintaining species diversity and ecosystem function towards enhanced adaptive capacity in the face of climate change, future management would need to consider employing silvicultural systems that support complexity within their design (Fahey, et al. 2018, Puttemann 2014). Examples may include (Table 206):

**Table 206. Sample Future Silvicultural Harvests Employed under the Action Alternatives for Compositional and Structural Restoration.**

Silvicultural System	Harvest	Description/Examples
Even-aged	Clearcut (w/wo reserves)	Remove a white pine plantation to begin restoration towards a desired hardwood community
Even-aged	Two-aged shelterwood (w reserves)	Create young forest where advanced desirable regeneration exists.
Retention	Variable Retention Harvest (Mitchell and Beese 2002)	Remove white pine in mixed shortleaf/hardwood to maintain biological legacies
Irregular Uneven-aged	Irregular Shelterwood (Raymond 2009)	Regeneration is desired for early age classes; need structural complexity
Balanced Uneven-aged	Group Selection	Installing groups within a cove forest dominated with tulip poplar to mimic gap formation
Multiple	Variable Density Thinning (Mitchell and Beese 2002)	Create a woodland in a dry oak community or produce horizontal diversity through skips and gaps
Multiple	Standard Thinning (multiple variants including free, low and integrated thinning, and thin/burn treatments)	Maintain healthy trees for mast production, capture mortality of short-lived oaks, reduce mesic species, establish advanced regeneration, enhance the future value of products, grow big trees faster (late successional)

To meet the revised plan's diverse set of restoration and habitat objectives, the methods used to apply treatments on the landscape may need to be expanded. The list of silvicultural options in Table 206 is not exhaustive and is under an adaptive management strategy. Some of the harvests were able to be included in the FVS and Spectrum models during plan revision. Others listed could be implemented as surrogate treatments for group selection but were not explicitly modeled.

As research updates a silvicultural system, more contemporary techniques should be considered for use. Meeting multiple objectives may require treatments that contribute to the following: managing for species diversity; preserving biological legacies, ecologic memory and niches; life boating long-lived desirable species; being mindful of mid-story and understory conditions regardless of treatment type; promoting heterogeneity in regeneration opening size and the non-regeneration matrix; and continuing

to employ adaptive management (Kern et al. 2017). Retention harvests, gap based, variable density, and irregular shelterwoods and unbalanced uneven-aged systems, all vary light levels that benefit the recruitment and establishment of persistence strategy species in the understory and should allow for more customized treatment prescriptions that reflect forest community (ecozone) variations within stand boundaries that result from topography, aspect, geology, etc. and capture opportunities and strategies that allow for resilience and transition (climate change) elements to be incorporated.

The irregular shelterwood is aligned with even-aged silvicultural systems, yet it creates a future stand with at least two age classes that bridges between even-aged and uneven-aged silvicultural systems (Raymond et al. 2009) and should not be viewed as a standard two-aged regeneration harvest, especially when the residual mature age class is grouped or clumped across the site. This type of treatment may be appropriate for developing young forest over time in stands that contain both mesic oak and cove hardwood ecozones. The flexibility in both space and time within the irregular shelterwood treatment allows several things to happen within the same stand:

- 1) Allowing for young forest creation within the currently tulip poplar dominated coves and tending of regeneration towards development of increased species diversity.
- 2) Reduction of mesophication in oak ecozones without complete removal of the overstory, which when combined with increased light levels (side lighting and reduction in canopy density) to build competitive oak advanced regeneration prior to overstory removal at a later date.

Many restoration treatments are on a continuum that requires a set of inputs to move a portion of the forest community in a desirable direction. In some cases, a single treatment may succeed in advancing an area or portion of an area (or element) toward meeting desired conditions, while at other times, multiple treatments (or entries) may be required to continue to move in the right direction. When these multiple treatments require (or can allow for) mature forest development in the interim, then rotations may be scheduled to meet multiple use benefits, including timber production, without necessarily changing the trajectory of the stand's restoration emphasis.

Typically, planned even-age treatments with a secondary objective of timber production would have reached culmination of mean annual increment (CMAI) before regeneration harvests, however under the revised forest plan there may be an increased opportunity for focused harvest of tulip popular or white pine to meet other desired conditions prior to CMAI. In these situations, they might not provide comparable economic benefit as more mature stands, but the benefits of treatment may outweigh the economic gain from waiting. For the estimated CMAI of key forest type groups, refer to the forest plan Appendix B.

#### An Oak Regeneration Example:

Restoring ecological complexity and adaptive capacity may also require alteration in the historical patterns of district project development providing more opportunistic overlap of desired conditions and objectives. For example, there continues to be a challenge across the Southern Appalachians regarding oak regeneration development. Overlapping oak management treatments where prescribed fire is desired (and operable) may increase the chance of developing advanced regeneration, may provide future creation of young forest habitat of the desired species composition, and may deliver forest products to local economies.

Broadening the scale that forest projects operate may also assist with meeting the revised forest plan management desired conditions and objectives. Per our current understanding of the oak regeneration challenge, the most successful young forest creation in oak ecozones depends on advanced, competitive regeneration. Oak seedling establishment work (see paragraph above), whether it is commercial or non-

commercial, may need to be done across larger portions of the landscape. As competitive oak develops in the understory, release of competitive oak through regeneration harvests would be implemented.

Addressing the complexity of oak restoration will require collaborative support to implement because projects will likely need to be larger than the average project size under Alternative A. These treatments would benefit from employing herbicide (to reduce sprouting), would be primarily non-commercial, where possible over as large a portion of the oak dominated landscape as practical, and would need to be rapidly responsive to acorn production which is periodic in nature.

Equally important is the monitoring of species composition within young forests and timing intermediate treatments (post-harvest site preparation, release and stand improvement treatments) to guide developing species composition towards desired future conditions. Being successful at this stage will require regular tracking (survey and observation) of stand dynamics and timely treatments to ensure that the desired species are present at the time of canopy closure and beyond.

Much of the work to ensure desirable species composition occurs in the years leading up to implementation of a regeneration harvest or around the time of canopy closure. It is most important to build the competitive presence of oak species and other persistence strategy species (see TIM-G-05) leading (4 to 10 years) into the regeneration harvest and then again (possibly repeatedly) as the young stand develops, sometimes continuing well past the stem exclusion phase of development. The standard stocking requirement born out of NFMA (FSH 1909.12 64.14) attempts to ensure stocking (stems) during the first 5 years after harvest. Historically, this was to ensure that a once forested stand that was harvested contained sufficient stems to support a future forest. On most Nantahala and Pisgah sites meeting the minimum stocking requirements in the forest plan (TIM-S-08) is highly likely. In fact, the competition for the abundant resources present by tree seedlings is so intense by the third-year post (regeneration) harvest that aggressive management of species composition is not feasible. Release treatments during this period are primarily focused on keeping the fastest growing but less desirable (due to its high abundance or sprouting ability) from overtopping the rest of the young canopy until the stand dynamics allow for the main canopy of the new cohort to begin to close. Tracking and management of composition is more feasible and impactful after this time and just before and after the canopy closes within young stands and they transition into the mid-seral state. Even in cove sites, including those dominated by mature oaks presently, due to past land use trends, even the smaller “gap” based openings contain intense levels of competition requiring timely tracking and release of the seedling of desired composition.

It is expected that many of the treatment acres associated with objective ECO-0-03 will occur prior to development of mature stem sizes at which a time application of ECO-0-04 would be more appropriate. Lack of adequate tracking of stand composition development during these key stages (and beyond) may have contributed to the development of lower species diversity stands on high productivity cove and oak sites. Collaborative efforts, especially at tier 2 objective levels will be needed to ensure desired compositional restoration goals are monitored and when needed corrective actions taken. This may include thoughtful consideration of the true desired future forest composition on productive sites moving away from the desire to manage for oak species dominance within coves where diverse cove hardwoods is a desired (and realistic) future condition.

However, given the long-term investment (and the continued scientifically experimental understanding of the oak regeneration problem) needed to develop advanced competitive oak regeneration, some stands within the oak community landscape will need to be harvested with structural goals in mind (primary objective) now, to meet vegetation structure and wildlife habitat objectives, to continue to support local economies, and to fund other restoration priorities on the forests. In these situations, there may be less opportunity to focus on the future stand’s composition (i.e., a decrease in oak composition in young forest stand). Possible locations for these structural/habitat centric types of action

are on mesic sites with already high densities of tulip poplar, on cove sites where there is currently an overabundance of oak outside the natural range of variation, or on dry sites that are natural accumulators of oak and have the greatest opportunity for oak seedlings to remain competitive after establishment.

For general estimates acres of types of harvest and management planned, please refer to Appendix B of the proposed forest plan.

## **Timber calculations**

### **Sustained yield**

Both the 1982 and the 2012 Planning Rules required identification of harvest levels that met a sustained yield. Sustained yield as defined under the National Forest Management Act (NFMA) is that “which can be removed from [a] forest annually in perpetuity on a sustained-yield basis” (NFMA at section 11, 16 USC 1611; 36 CFR 219.11(d)(6)).

The two planning rules interpret this sustained yield differently. The 1982 Planning Rule included Long-term Sustained Yield (LTSY) defined as “[t]he highest uniform wood yield from lands being managed for timber production that may be sustained under a specified management intensity consistent with multiple-use objectives” (1982 Planning Rule, Sec 219.3). The 2012 Planning Rule included a definition of Sustained Yield Limit (SYL) as “[t]he volume that could be produced in perpetuity on lands that *may be suitable* for timber production. Calculation of the limit includes volume from lands that may be deemed not suitable for timber production after further analysis during the planning process. The calculation of the SYL is not limited by land management plan desired condition, other plan components, or the planning unit's fiscal capability and organizational capacity. The SYL is not a target but is a limitation on harvest, except when the plan allows for a departure” (1909.12-2015-1, Chapter 60. Pages 7 & 8).

Key differences between the LTSY and SYL center on lands included in the calculation. The 1982 LTSY is calculated from those lands only suited to timber production. The 2012 SYL is calculated off the lands that “may be suited for timber production,” including lands that are ultimately found to not be suitable for timber production. A second, albeit related, difference is the 1982 Planning Rule’s LTSY connection to multiple use objectives and economic efficiency. In comparison, the 2012 SYL is not constrained by fiscal, organization capacity, or multiple use objectives. These differences result in a much greater number of acres being included in the SYL calculation than the LTSY calculation, which results in a higher annual sustained yield for the action alternatives when compared to Alternative A.

### **Alternative A**

Alternative A, which represents the current forest plan and was established under the 1982 Planning Rule, included a LTSY calculation of 34.5 MMBF/yr. or 6.6 MMCF /yr. This long-term sustained yield was calculated from 275,000 acres.

### **Action alternatives**

The Sustained Yield Limit (SYL), as calculated during this forest plan revision analysis, would be 45.0 MMCF/year and does not change between the four action alternatives. This sustained yield limit was calculated from approximately 700,000 acres.

### **Quantity of timber sold**

The 1982 and the 2012 Planning Rules also differ in reporting timber harvest output volumes sold during the life of the plan.

The 1982 rule defines the Allowable Sale Quantity (ASQ) as quantity of timber sold from an area of suitable land covered by the forest plan for a specified timber period. The time period is usually over a decade or as an average annual amount. The ASQ provides an upper limit on the volume of timber sold.

Under the 2012 rule, ASQ has been replaced with two more contemporary metrics that better capture the total volume of both products that meet utilization standards and those that do not. These new calculations, known as the Projected Wood Sale Quantity (PWSQ) and the Projected Timber Sale Quantity (PTSQ), are defined in Chapter 60 (FSH 1909.12).

Table 207 highlights their differences.

**Table 207. Differences Between Projected Wood Sale Quantity and Projected Timber Sale Quantity**

PWSQ	PTSQ
Includes PTSQ	Subset of the PWSQ
Includes timber and all other wood products	Meets applicable utilization standards
All lands	
Based on fiscal capability and organizational capacity	

As noted in the comparison, PWSQ includes all wood product types produced over the planning period. This includes sale of fuelwood and posts (e.g., black locust - *Robinia pseudoacacia*) for the Nantahala and Pisgah NFs. Fuelwood and posts are assumed to be a constant input over the planning period and all alternatives. The PTSQ meets local forest utilization standards (current utilization standards for the Forests are included in Appendix B to the forest plan). Both the PWSQ and PTSQ are taken from timber harvest activities modeled across all lands and are based on the fiscal and organizational capacity of the Forests.

Though the PWSQ and PTSQ are calculated across all lands, they are constrained by fiscal and organizational capacities. The 1982 ASQ is only calculated across timber suitable lands but results in a higher volume because of the lack of fiscal and organizational constraints within its calculation. In summary, the ASQ was meant to be a higher end limitation, whereas the PWSQ and PTSQ represent potential capacity.

### Alternative A

The current forest plan identified the ASQ as 65.9 MMCF for the first decade or 6.59 MMCF/year. (Amendment 5 ROD, p23, Table 2, E-Modified). This ASQ caused confusion, and it was never a target but rather an upper limit of what could be expected to be achieved.

Because the ASQ calculation was not continued in the 2012 Planning Rule, using it in this analysis provides little insight for comparing Alternative A to the action alternatives. To better facilitate direct comparison, both PWSQ and PTSQ were calculated for Alternative A using the same methods as for the action alternatives.

### Action alternatives

*November 2022 Update: Based on feedback during the objection review process, all the action alternatives were updated to align assumptions regarding commercial and non-commercial treatments in the most xeric forest types and shelterwoods designed to develop advanced competitive regeneration. In most cases this resulted in minor downward adjustments to alternatives B – D in Tier 2 (Table 208).*

Both PWSQ and PTSQ vary by alternative and the tier (1 or 2) objectives met. In the action alternatives (Table 208), PWSQ and PTSQ are both reported in millions of cubic feet (MMCF). Further detail regarding

the inputs to the PWSQ and PTSQ are included in Appendix B of the Plan, Appendix D of this EIS, and the project record.

For Alternatives B, C, and D all outputs for PWSQ and PTSQ are similar across Tier 1. All Tier 1 outputs for B, C, and D are almost double that of Alternative A (Table 208). This is a result of the increase in the Tier 1 objectives for harvest over project harvest levels in Alternative A (equivalent to the current harvest averages (last 14 years) held constant). The Tier 2 output for B, C, and D would be roughly two times the output of Tier 1 and three times the output of Alternative A.

The PWSQ and PTSQ values at Tier 1 for Alternative E falls between Alternative A and the other three action alternatives. For Tier 1, Alternative E values are around one and a half times greater than Alternative A, yet just 1 MMCF lower than the other action alternatives. Tier 2 values are still more than double Alternative E tier 1 outputs, close to or exceeding three times the values for Alternative A (PWSQ and PTSQ respectively), and approximately 1 to 1.5 MMCF lower than the other action alternatives.

In all alternatives, the estimated PWSQ and PTSQ are well below the SYL discussed above.

**Table 208. Comparison of PWSQ and PTSQ Across All Alternatives. (Figures represent the annual average of the first two decades)**

Alternative / Tier	PWSQ (MMCF)	PTSQ (MMCF)
Alternative A	3.8 PWSQ	2.1 <sup>37</sup> PTSQ
Alternative B - T1	6.1 <sub>MMCF</sub>	4.4 <sub>MMCF</sub>
T2	11.8 <sub>MMCF</sub>	10.1 <sub>MMCF</sub>
Alternative C - T1	6.2 <sub>MMCF</sub>	4.5 <sub>MMCF</sub>
T2	12.3 <sub>MMCF</sub>	10.6 <sub>MMCF</sub>
Alternative D - T1	6.1 <sub>MMCF</sub>	4.4 <sub>MMCF</sub>
T2	11.6 <sub>MMCF</sub>	9.9 <sub>MMCF</sub>
Alternative E - T1	5.0 <sub>MMCF</sub>	3.3 <sub>MMCF</sub>
T2	11.1 <sub>MMCF</sub>	9.4 <sub>MMCF</sub>

Conversion: 1 MMCF = 1,000 MCF = 10,000 CCF

### Forest land suitable for timber production

During plan implementation timber harvest would occur on both lands identified as suited for timber production as well as lands identified as not suited for production. Together, these harvesting activities provide a flow of wood products that benefit local communities consistent with desired conditions. This EIS section also includes an analysis of what is potentially accessible for timber harvest under the different alternatives (section immediately below).

On the Nantahala and Pisgah NFs, lands identified as suitable for timber production have a regularly scheduled timber harvest program that contributes to forestwide desired conditions and multiple use goals, such as providing mosaics of habitats for wildlife and plant species and contributing to the

<sup>37</sup> As a way of validating the modeled PWSQ and PTSQ for Alternative A, the actual annual outputs from 2002 to 2018 were examined (1.9 MMCF annually on average). This figure relates well to the estimated PTSQ for Alternative A, supporting continued use when compared to the action alternatives and indicating, at this time, National Forest capacities are more in line with the first tier of the alternatives.

economic sustainability of local communities by producing timber, pulp, specialty woods, and fuelwood as renewable resources.

Identification of lands as suitable for timber production does not mean those lands meet only the objective of growing trees on a rotation or that timber production has to be the primary objective. In many cases these same lands contribute to desired young forest habitat or ecological restoration as the primary objective during district resource management projects with timber production as the secondary objective (CH. 61.2). In fact, timber production has not been the primary purpose for projects or activities on the Forests in recent years. A standard in the action alternatives clarifies this by stating “Timber production will not be the primary purpose for projects and activities and shall complement the ecological restoration desired conditions and objectives” (Alternative B/C/D ECO-S-01 or Alternative E’s TIM-S-01). These lands contribute to desired young forest habitat or ecological restoration as the primary objective during district resource management projects with timber production as the secondary objective.

During Forest Plan development and revision, the 2012 Planning Rule requires the identification of lands suitable for timber production. Three definitions from Forest Service Handbook 1909.12 CH 60, which lays out the analysis process, are useful here:

1. Suitability of lands: A determination made regarding the appropriateness of various lands within a plan area for various uses or activities based on the desired conditions applicable to those lands. The terms suitable and suited and not suitable and not suited can be considered the same (CH 60.5).
2. Timber production: The purposeful growing, tending, harvesting, and regeneration of regulated crops of trees to be cut into logs, bolts, or other round sections for industrial or consumer use (CH 60.5)(36 CFR 219.19).
3. Timber harvest: The removal of trees for wood fiber use and other multiple-use purposes (36 CFR 219.19).

While timber harvest can occur on lands both suitable and not suitable for timber production, unless otherwise specified in management area direction, it can only occur on lands not suitable for timber production when it is determined that timber harvesting activities are needed for salvage or to protect multiple use values other than timber production, such as, but not limited to:

- (1) to address issues of public health or safety;
- (2) to reduce hazardous fuels and manage wildfire;
- (3) to restore or maintain a terrestrial or aquatic ecological system or wildlife habitat over time;
- (4) to restore or maintain habitat for federally threatened and endangered animals or plants and SCC;
- (5) to harvest dead or dying trees due to fire, natural disturbances, insects, and disease;
- (6) to restore or maintain recreation, scenery, or transportation management;
- (7) to accommodate special use permits and outstanding rights; or(8) for research, demonstration or education purposes.

Timber harvest is always carried out consistent with appropriate mitigations to effects to soil, watershed, fire, wildlife, recreation, and scenic and heritage resources.

The process for identification of lands as not suitable and suitable for timber production is guided by the National Forest Management Act (NFMA) and detailed in Forest Service Land Management Planning Handbook (FSH 1909.12 § 61) via a two-step approach. The process used for the Nantahala and Pisgah

Forest Plan revision is summarized here. A more detailed description of the analysis methods can be found in Appendix B.

Step 1: First, the analysis identifies lands that are not suitable for timber production based on legal and technical factors. The following four categories of lands are subtracted from the full forest acreage to identify “lands that may be suitable for timber production” (FSH 1909.12 § 61):

- Step 1 Factor 1. Lands on which timber production is prohibited or lands withdrawn from timber production (section 61.11 and 36 CFR 219.11(a)(i & ii));
- Step 1 Factor 2. Lands on which technology to harvest timber is not currently available without causing irreversible damage (section 61.12 and 36 CFR 219.11(a)(iv));
- Step 1 Factor 3. Lands on which there is no reasonable assurance that lands can be adequately restocked within five years of final regeneration harvest (section 61.13 and 36 CFR 219.11(a)(v));
- Step 1 Factor 4. Land that is not forest land (section 61.14 and 36 CFR 219.11(a)(vi)).

Forest lands that remain after this four-factor screening (Step 1) are termed “lands that may be suitable for timber production” (FSH 1909.12 § 61). This classification does not vary by forest plan alternative. These lands are not immediately available for timber production but must next be considered in Step 2 of the suitability analysis.

The starting point for Step 2 is the endpoint of Step 1.

Step 2 takes into account compatibility with desired conditions and objectives of the forest plan. During the plan revision process, the completion of Step 2 must be completed for each alternative analyzed separately.

Specific to the Nantahala Forest Plan revision, there were five additional factors associated with desired conditions and objectives subtracted from the Step 1 endpoint to account for additional lands that are not suitable for timber production.

- Step 2 Factor 1. Riparian and lake buffer zones (100-ft around lake shorelines and perennial streams, 15-ft around intermittent streams in Alternatives B-D, and 50ft around intermittent streams in Alternative E based);
- Step 2 Factor 2. Habitat designated as critical by the US Fish and Wildlife Service (Mountain Golden Heather, Spruce-fir moss spider, and Appalachian elktoe);
- Step 2 Factor 3. Ecological communities (ecozones) not economically compatible with timber production (pine oak heath, dry oak, spruce fir, floodplain, grassy bald, heath bald, and lakes);
- Step 2 Factor 4. Areas designated for management of old growth characteristics;
- Step 2 Factor 5. Lands not suited for timber production based on compatibility with desired conditions and objectives.

There were some changes to the application of these factors in the alternatives. In Alternatives B, C and D, Factor 1 included 100 ft around lake shorelines and perennial streams, and 15 ft around intermittent streams. Alternative E had modified plan direction increasing the distance of streamside zones around intermittent streams to 50 feet, so Factor 1 was modified to reflect a 50 feet distance around intermittent streams in Alternative E. Factor 2 was the same across all alternatives. Factor 3 was included during alternative A through D and dropped for Alternative E, as described further below. Factors 4 and 5



were used for all alternatives but due to changes in the location of the designated old growth network and the allocation of management areas, these factors varied across each alternative. These differences result in the final acres reported as suitable and unsuitable for timber production.

This analysis completed for the Nantahala and Pisgah Forest Plan revision utilized FsVeg, INFRA, LIDAR, Aerial Imagery, and GIS analysis to generate the estimated acres. Starting with a spatial layer of the entire Nantahala and Pisgah National Forest Ownership, individual categories that made up each factor were subtracted. Where categories or factors overlapped, they were only subtracted once. This was accomplished using the “Erase (polygon) tool” in ARC Map 10 (*ESRI software*). Methods and assumptions associated with each step are further detailed in the planning record.

Acres determined to be suitable for timber production are further reviewed in project level NEPA (ECO-S-01), because even when lands are identified as suitable for timber production at the forest plan level, at the project level, harvest may or may not be possible given the landscape, topography, access, and the constraints that contemporary harvest equipment carry to be operated safely and effectively. Therefore, these estimates are likely larger than the true number of acres that may be harvested during project level NEPA.

Though only 276,000 acres were listed as designated as suitable for timber production in the current forest plan’s Environmental Impact Statement, this analysis identified significantly more acres in the recalculation of Alternative A and each of the action alternatives using the 2012 Planning Rule process (Table 209), because the second step of the 1982 Planning Rule process differs from the 2012 Planning Rule process. The second step of the 1982 Planning Rule process removed lands that were not cost efficient in meeting forest objectives (36 CFR 219.14(c)(3)). For the Nantahala and Pisgah NFs, this step resulted in removing roughly 525,000 acres from the final suitable base. When Alternative A was recalculated using the 2012 Planning Rule process, and in all of the action alternatives, the 2012 Planning Rule different Step 2 factors 2 result in a smaller number of acres removed. Thus, Alternative A and the action alternatives result in greater suitable acres than the current plan.

The final timber suitability analysis occurred during the development of Alternative E in the spring of 2021. At the time of the final analysis, data inputs were reviewed by the forest spatial data coordinator and updated data sources were included where available. Updated layers included the land ownership data, NFS system roads, NCDOT Railroads, the NFS administrative layer, wild river segments only (vs all segments in the draft), FSveg data, bogs, rock outcrops, rare habitats, riparian and lake buffers, Lidar derived slope, the designated old growth network layer and management areas. Additionally, a change was made to step 2 of the analysis for Alternative E. While the draft EIS suitability process for Alternatives B, C and D subtracted ecozones that do not typically contain merchantable material from lands suitable for timber production, this was revisited based on public comments. Removal of ecozones that do not typically contain merchantable material is not a formal part of the suitability analysis steps outlined by Forest Service directives, and a decision was made to stick more strictly to that process. Thus, there were no suitability adjustments for individual ecozones in Alternative E.

The process changes and updated datasets resulted in several differences in the acres reported in Table 209.

**Table 209. Timber Production Suitability Classification**

Land Classification Category	Alternative A* Acres	Alternative B Acres	Alternative C Acres	Alternative D Acres	Alternative E Acres	Alternative E Modified Acres
A. Total National Forest System lands in the plan area	1,042,060				1,043,636	1,043,636

Land Classification Category	Alternative A* Acres	Alternative B Acres	Alternative C Acres	Alternative D Acres	Alternative E Acres	Alternative E Modified Acres
B. Lands not suited for timber production due to legal or technical reasons	339,014				346,045	349,741
C. Lands that <b>may be</b> suited for timber production (A-B)	703,046				697,591	693,895
D. Total lands <b>suited</b> for timber production because timber production is compatible with the desired conditions and objectives established by the plan	361,176*	405,657	458,027	409,337	459,175	458,027
E. Lands not suited for timber production because timber production is not compatible with the desired conditions and objectives established by the plan (C-D)	341,870	297,389	235,868	293,709	238,416	235,868
Total lands <b>not suited</b> for timber production (B+E)	680,884	636,403	585,609	632,723	584,461	585,609

\*Alternative A differs from the existing forest plan acres classified as suitable for timber production (275,798 acres Table E-5, Appendix E – page E-7) due to changes in the determination process under the 2012 planning rule described in the narrative.

### Land potentially impacted by timber operations (operability analysis)

The area identified as suitable for timber production is not an accurate estimate of the area in which timber will be harvested over the life of the plan. There are multiple reasons for this: 1) not all of the area identified as suitable is available and accessible for timber harvest due to current age and condition of the forest, landscape topography, and other constraints; and 2) timber harvest can occur in other areas where it is needed to create desired conditions. The plan objectives identify a much lower level of timber harvest based on these factors and are therefore a more accurate estimate of the portion of the forest that will likely be impacted by timber harvesting. This section explains in detail what lands could potentially be impacted by timber operations.

The total amount of acres suitable for timber production identifies the total number of acres on the forest that could be planned for multiple entries. Treating the full number of suitable acres could not be done, nor would it be desirable, over the 10-15 year life of the plan. Rather it would require hundreds of years. Some of the suitable acres will never be harvested due to local site conditions not accounted for in the forestwide scale of this analysis, including for example, unidentified cultural resources or right-of-way and access challenges. These local conditions are assessed at the project level and are not considered in the forest plan suitability analysis.

The total amount of acres suitable for timber production does not consider other timber harvest operations that would occur on lands that would not have regularly scheduled entries. Acres suitable for

timber production only considers those places where repeat scheduled entry is planned and does not include acres where a harvest may only be needed once or a few times until a desired condition is met and then may no longer require mechanical maintenance over this planning period (i.e., thinned woodland structure maintained with prescribed fire in the unsuited land base).

Since timber harvest occurs on both lands identified as suited for timber production, as well as lands identified as not suited for timber production, to better consider the amount of land that is likely to be harvested under multiple planning cycles, an analysis was undertaken to estimate the total amount of land base that is available and accessible for timber harvest by alternative, hereafter “operability analysis.” The operability analysis considered estimates of the current age and condition of the forest, landscape topography, existing and potential future road access, and the constraints associated with using contemporary harvest equipment. Forest level operability is programmatic and does not substitute for project level evaluation of on the ground conditions and engineering specifications for forest roads. Please refer to the project record for a detailed description of the assumptions for completion of this analysis.

The operability analysis used the existing road network as a base, but also recognized that road construction would be required to access all of the acres that the Spectrum vegetation model identified as treated acres under Tier 2. Additionally, projects from the last ten years demonstrate that some new road construction is necessary to maintain the current amount of annual acres treated (see Transportation and Access section). Therefore, given topographic and site-specific conditions that are not possible to consider accurately at this landscape scale, this operability analysis assumes that current road building levels will continue under Tier 1, and that additional permanent and temporary road construction would be needed under Tier 2, depending on alternative (see Transportation and Access section). During implementation, if an area does not have road access, access options may be pursued during district level projects.

It must be noted that the intended purpose of this estimate is to inform planning at the forest wide scale and not to predict or design harvest projects. Projects require more site-specific analysis and consideration of fine scale information about the site and forest resources.

**Table 210. Various Timber Harvest Access Constraints by Alternative (Acres)**

		Alt A	Alt B	Alt C	Alt D	Alt E
All acres available within management areas that allow timber harvest	Total acres with current access (1)	206,011	239,843	238,242	242,686	233,042
	Potential future access (road building) (2)	223,721	276,528	249,357	292,316	272,576
	<b>Total</b>	<b>429,732</b>	<b>516,371</b>	<b>487,599</b>	<b>535,002</b>	<b>505,618</b>
Acres likely to be commercially viable over the life of the revised plan within management areas that allow timber harvest*	Acres estimated to have mature and productive forests with current access (3)	97,903	111,859	111,366	113,400	107,751
	Potential future access (road building) (4)	118,217	139,121	123,728	146,686	136,770
	<b>Total</b>	<b>216,120</b>	<b>250,980</b>	<b>235,094</b>	<b>260,086</b>	<b>244,521</b>

\*Commercially viable is based on FSveg data (select age and condition classes).

In Table 210, the first two rows show the estimated acres available based on current (row 1) and potential future access (row 2) across all lands that allow for timber harvest and road building given the

assumptions discussed above. Alternatives B, C, D, and E have roughly 30,000 acres more currently accessible than Alternative A. Alternative D has the most potential future accessible acres followed by Alternatives B and E, then Alternative C, and finally Alternative A.

The second part of the analysis (rows 3 & 4) is based on estimations of currently mature forests from the Forest's FS Veg data (age and condition class). This second step attempts to best approximate the amount of all lands that allow for timber harvest and road building that would have timber size and volumes that support commercial timber harvest over the planning period. Estimated mature forest that would be currently accessible based on the analysis follows the same trends as the overall lands available in 3, rows 1 & 2 but by more than 100,000 acres lower in each alternative and more than 150,000 acres less in future access. Only slightly more than 100,000 acres would be currently accessible where mature forest conditions are available, with Alternative D having the greatest followed closely by Alternative B and C. Alternative E falls in between Alternative A and Alternative B and C. Another roughly 135,000 to 150,000 acres of currently mature forest would be available with road building in Alternatives E, B and D and around 120,000 acres in Alternatives C and A.

As a result, on a forest of just over one million acres, the total acres likely to have timber supporting potential commercial operations varies between 265,000 and 235,000 acres across the action alternatives (sum rows 3 and 4).

Of the resulting acreage above, only an estimated 107,000 to 113,000 acres that would be available if current levels of road construction are maintained across the action alternatives. To put this another way, currently about 10 percent of the forest stands could foreseeably support commercial timber operations if current levels of road construction are maintained with about 90 percent of the forest unlikely to be impacted by timber operations. Operability could increase if additional roads are added.

All of these totals are programmatic estimates, and site-specific conditions would likely further reduce the land operable for commercial timber harvest, including local topographic considerations, mitigations necessary for public health and safety, threatened and endangered species, rare ecological communities, cultural resources, scenery, and recreation. Even within Matrix where the largest amount of timber harvest operations are expected, a sizable portion of the management area could not currently be harvested.

Given these constraints, the consolidated terrestrial ecosystems objectives in the plan that would use timber harvesting (regeneration and thinning), identify roughly 22,000 acres per decade (Tier 1) or up to roughly 47,000 acres per decade (Tier 2). This equates to approximately 2.1 percent (Tier 1) to 4.5 percent (Tier 2) of the total land base over a decade being impacted by timber harvesting.

### **Forest product outputs**

With the increased emphasis on active compositional and structural restoration found within this revised forest plan, it is important to describe any expected changes in the trends of product outputs from timber harvest activities. Conceivably, with restoration desired conditions, harvest activity may need to occur on sites less commonly selected under the current forest plan and the types of harvests selected may also vary resulting in different product flows during these activities. The revised forest plan continues to include desired conditions that maintain support to local economies that depend on flows of wood products warranting the comparison described below.

Information in this section relates to the commercial timber outputs modeled in Spectrum.

*November 2022 Update: As a result of the objection review process an alternative analysis method was developed which utilized similar volume outputs from the Spectrum models as was used for the estimates of PTSQ and PWSQ in the revised plan. This results in updated numbers in table 211.*

It was assumed that up to 80% of the planned thin and burn treatments and 50% of the regeneration treatments in the xeric moisture class would be non-commercial due to the poorer site quality and potentially more remote locations of xeric site communities and are therefore not included in the calculations below. It was also assumed that 50% of the Loftis shelterwood treatments would result in future regeneration harvest volume owing to the complexity and time required to develop competitive oak regeneration (see the Oak Regeneration Example in the Harvest Systems section above). These assumptions were applied across all alternatives to develop an apples-to-apples comparison within Table 211.

These analysis assumptions assisted with modeling in the EIS, however these outputs are not a plan decision; the determination of commercial harvest of any treatment occurs during site-specific project development.

Table 211 displays the harvest outputs expected in both volume and acres, including all product groups. This table also includes a comparison of actual harvest outputs from 2002 to 2018 (*first row*) in order to validate use of the SPECTRUM model volume outputs for both Alternative A and, indirectly, the action alternatives.

**Table 211. Summary Harvest Information by Alternative and Tier\***

Tier	Alternative	MMCF/yr	ac/yr	CCF/ac
Historic	2002 - 2018	1.9	813	23
	Alt A	2.2	910	24.0
Tier 1	Alt B	3.7	1,969	18.8
	Alt C	3.6	1,824	19.8
	Alt D	3.7	1,989	18.6
	Alt E	3.8	2208	17.2
Tier 2	Alt B	9.1	4,846	18.7
	Alt C	9.5	4,610	20.7
	Alt D	9.0	4,835	18.7
	Alt E	8.5	4,727	18.0

\*Table 211 numbers are the average across the first 10 decades of the Spectrum model runs.

### Alternative A

Continuing under current management, trends in Table 211 indicate that Alternative A was constructed to be similar to the historic data. Though reported as lower in CCF/ac than the historic data, Alternative A would be within the range of per acre volume estimates calculated over the historic period (16 to 29 CCF/acre).

### Action alternatives

Spectrum model assumptions were updated in Alternative E based on public comments. Compared to Alternatives B, C and D, the regeneration harvests in Alternative E reflect a more balanced suite of regeneration treatments in cove forest types, especially in Tier 1.

**Tier 1:**

Alternatives B, C, D, and E generate slightly less than double the average annual volume of either Alternative A or the average historic value. All the action alternatives are comparable in modeled volume to each other across Tier 1. Alternative C produces the least and Alternative E producing slightly more. Alternative E likely produces more volume than the other action alternatives because of the more balanced mix of regeneration harvests in the cove forest types that includes some even-aged regeneration harvest as well as uneven-aged group selection.

**Tier 2:**

Tier 2 of the action alternatives shows a greater increase in the modeled annual volume harvested compared to current harvest levels. The differences between the four action alternatives are more noticeable in Tier 2, with Alternative E producing a slightly lower volume estimate than the other tier 2 action alternatives. Alternatives B and D are similar in estimated volume while Alternative C produces slightly more. The difference between the alternatives in Tier 2 becomes more apparent as the harvest levels are applied to more acres and management area differences become more relevant.

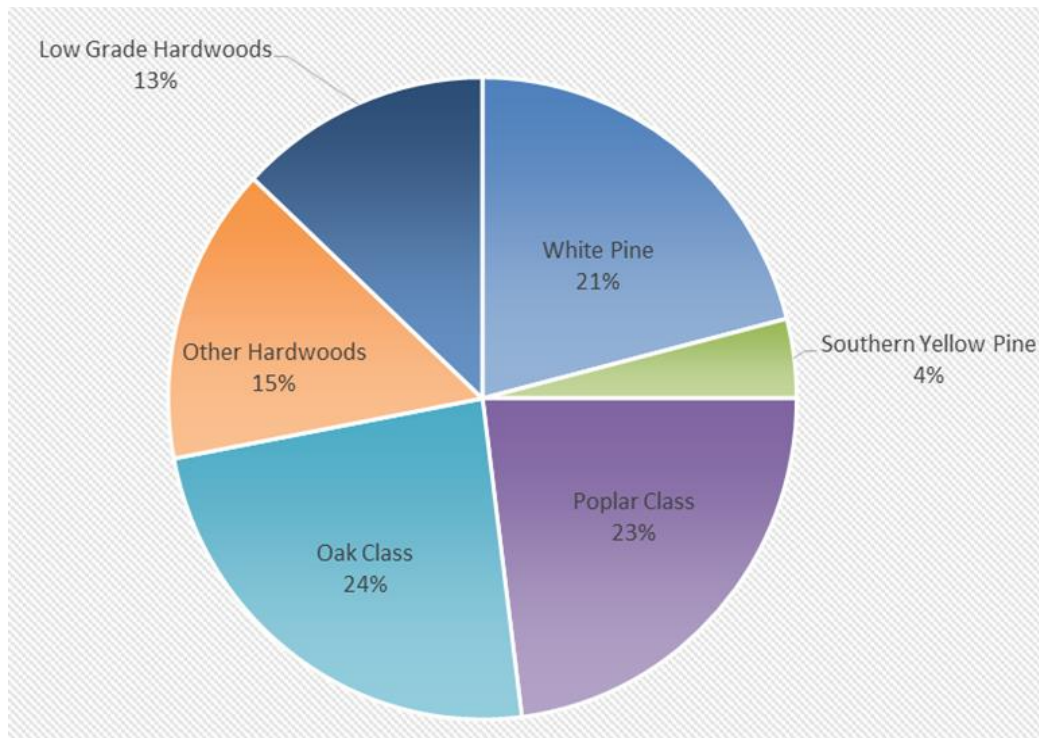
**Forest product outputs classes**

Another way of examining modeled volume outputs from the alternatives is by product class. The product class is the break-down of species type groups and size classes that the Forests use to track the value of timber sales. Appendix B of the revised forest plan provides an expanded description of product class composition. This appendix also contains a table summarizing the sawtimber, non-sawtimber, and other wood product outputs across the first two decades for all alternatives.

These findings are based on modeled outputs for the purposes of understanding effects of alternatives. These outputs will not be exact as the plan implemented, and these numbers are not a plan decision. The determination of commercial harvest of any treatment occurs during site-specific project development.

**Table 212. Estimated Product Class Distributions by Alternative & Tier as Modeled by Spectrum**

Alternative	Tier	----- Product Class -----					
		Low Grade Hardwoods	Other Hardwoods	Oak Class	Poplar Class	Southern Yellow Pine	White Pine
Alternative A	---	15%	12%	32%	25%	5%	11%
Alternative B	1	21%	22%	21%	15%	5%	16%
Alternative C	1	20%	14%	37%	11%	6%	12%
Alternative D	1	20%	14%	36%	11%	6%	13%
Alternative E	1	21%	16%	29%	22%	4%	9%
Alternative B	2	15%	12%	38%	25%	4%	6%
Alternative C	2	14%	11%	36%	29%	4%	6%
Alternative D	2	16%	12%	37%	25%	4%	6%
Alternative E	2	20%	10%	37%	22%	4%	7%



**Figure 123. Volume sold between 2002 and 2018 by product class distribution**

As with 4 in the above volume discussion, historic values were included as a way of comparison and validation of what is modeled for use in Alternative A. The volume sold, displayed proportionally by product classes between 2002 and 2018, is represented by the above pie chart (Figure 123<sup>38</sup>). For the historical data, the oak, poplar, and white pine classes each represent slightly more than a fifth of the volume sold with low-grade hardwoods, other hardwoods, and southern yellow pine classes representing approximately the other two-fifths when combined (Figure 123).

### Alternative A

The modeled Alternative A shows the product class distribution would be similar to the historical numbers (Table 212). The low-grade hardwood, other hardwood, southern yellow pine, and poplar classes occupy similar proportions of the total when compared to the historical data. Unlike the historical volume sold data, the oak class has expanded from 24 to 32 percent of the total, and the white pine class has shrunk to 11 percent of the total.

### Action Alternatives (Tier 1)

When modeled Alternative A is compared to Tier 1 of Alternatives B, C, D, and E, there are similar trends in product class distribution with several notable exceptions (Table 212). The amount of volume estimated to be in the poplar class drops from above 20 percent in Alternative A to between 15 and 11 percent. This drop may be a result of the lowered emphasis on harvesting in cove forest types/ecozones under Tier 1 for Alternatives B, C, and D. The percentage in the poplar class for Alternative E is similar to Alternative A, likely due to both the increased group selection harvesting in coves and more traditional even-aged and shelterwood harvest types modeled in coves under this alternative. The white pine

<sup>38</sup> This data was also examined by the ten-year periods of 2002 to 2012 and 2008 to 2018. Proportions of product classes were similar across the two periods. Therefore, the two time periods were represented as one for comparison with the revision alternatives. The historical values for pulpwood were assigned to their respective product classes in order to be comparable to the modeled data outputs categories.

product class distribution for Alternatives B, C, and D remains in between the percentages of historic volumes sold and the modeled Alternative A. This reflects the continued engagement in removal of white pine where it is planted in areas that would better support other forest types or where it has encroached, reaching undesirable levels due to the reduced presence of fire as a disturbance. The white pine product class is lower in Alternative E than any other alternative including Alternative A representing a modeled increase in the emphasis on management in coves and restoration of woodlands through the thin and burn prescription which is harder to implement if a desirable site is dominated by offsite white pine.

The low-grade hardwood and the other hardwood product classes increase in comparison to historic data and Alternative A. In Alternative B, these two classes have the largest increases of all the product classes, supporting the increased emphasis of harvesting in forest types/ecozones that have not been traditionally targeted for young forest creation but would be targeted under a forest plan that emphasizes restoration of young age classes and open seral states across all ecozones with departed conditions. The increase in low grade hardwoods is similarly high but not as dramatic for other hardwoods under Alternative E even though under this alternative volume estimates were reduced for those treatments on the xeric moisture class due to generally low merchantability of the timber products there. Even with the proportion reduction discussed above, the actual acres of the thin and burn treatment turn out similar in levels to the other action alternatives.

The oak product class remains similar to its range in the historic volume sold data and Alternative A, indicating the larger presence of oak forests on the landscape and each alternatives' continued interest in restoring young and open seral classes in oak dominated ecozones. It should be noted that with the decreased emphasis on harvesting in the cove forests across the action alternatives in Tier 1, the oak product class would likely contain lower value oak volumes, as the species would be harvested from sites of lower productivity and quality.

The southern yellow pine class remains the same across all alternatives in Tier 1 and the historic volume sold data. Though restoration of departed southern yellow pine communities would be an emphasis of the revised plan, many of the harvest actions taken would remove low grade hardwoods, short-lived oak, and/or white pine in favor of leaving desirable pine species to generate open and young forest conditions. Full restoration of these sites would likely take longer than the planning period.

### **Action Alternatives (Tier 2)**

Under Tier 2, the product class distributions alter somewhat under the increased harvest activity across the forest. The oak class remains roughly the same across all Alternatives when compared to Tier 1 and Alternative A. For Tier 1 and Tier 2 in all alternatives, the oak class makes up a third of the products produced. This would be a larger percentage than it has been under the historical sold volume data (Figure 123).

Under Tier 2, the poplar class for Alternatives B, C, and D also increases above the distribution it was modeled within Tier 1 and would again return to historical levels. This would likely be the case because of the increased need to harvest within the cove forests/ecozones in order to: 1) meet the higher activity levels of Tier 2 plan objectives; 2) continue to support the restoration efforts on other lower value community types; 3) reflect the location of the current Forest Service road network; and 4) return to stands previously harvested to continue silvicultural intent and improve/restore forest conditions. For Alternative E, the poplar class proportions remain the same between tiers and is similar to Alternative A. The proportion of the poplar class in Alternative E is slightly lower than the other action alternatives under the Tier 2 model runs.

Keeping in mind that the overall volume production level would increase across the action alternatives for Tier 2 (Table 211), with the increased activity, the proportion of low-grade hardwoods decreases back



to historical volume sold levels for Alternatives B, C, and D. For Alternative E, the proportion of low-grade hardwoods remains elevated above historical levels and similar to the modeled proportions in Tier 1. Alternative E estimates greater volumes of low-grade hardwoods in part due to the increased harvesting in the moderate oak forest types which tend to generate more lower graded hardwoods (e.g., as compared to the cove forest types) and the increased emphasis on compositional restoration objectives in the oak types which utilize longer harvest cycles and increased intermediate treatments to ensure competitive oak regeneration (preparatory cutting from below, reductions of mesic species, and irregular shelterwoods regeneration harvests). Counterbalancing the increased poplar class levels within Tier 2 for the action alternatives, the white pine class drops in importance proportionally from roughly 14 percent in Tier 1 to 6 percent in Tier 2. Though a drop worth noting due to the higher overall activity levels across the action alternatives in Tier 2, the volume of white pine being harvested in Tier 2 would still more than double the amount harvested under Tier 1.

The other hardwoods class remains proportionally similar across all alternatives and Tier 2 as it did in Tier 1 with the exception of Alternative B. Out of the four action alternatives, the proportion of other hardwoods in Alternative E is slightly lower. The southern yellow pine class also remains largely unchanged across all alternatives and tiers.

In summary, the overall harvest volume produced in Alternative A would increase in the Tier 1 action alternatives and then further increase in the Tier 2 action alternatives (Table 211). Though the increases would be apparent in all product classes, under the modeled Tier 1 action alternatives, at least some of the increase would be proportionally greater in the low-grade hardwood product. This would be paired by a corresponding downward shift in the proportion made up by the poplar class. In Tier 2, the demand for increased harvest activities across the forest types and ecozones results in an increase in the proportion the poplar class would occupy (when compared to Tier 1) and a decrease in the proportion of the white pine class. Through all tiers and alternatives, the proportion of the oak class and the southern yellow pine class remains relatively static.

### **Cumulative Effects**

Statewide, federal forests and timber land accounts for less than 2 percent of the ownership (Brown 2018). Within the 18-county area of Western North Carolina, the Nantahala and Pisgah NFs make up roughly 22 percent of the land area (1,044,393 acres). The ownership of Western North Carolina's timber is dominated by private ownership (Fox et al. 2011).

Sixty-seven percent of the Blue Ridge Mountains section is comprised of forests (Keyser et al. 2014). A total of 37 percent of the forest land in the Blue Ridge Mountains is under federal and state ownership (Keyser et al. 2014). The Nantahala and Pisgah NFs make up roughly 27 percent of the forest ownership in WNC. It would be expected that over the next 50 years, forest land would decrease in Western North Carolina and the Blue Ridge Mountains section. Contrary to other portions of the southeast, the loss of forest land in the southern Appalachians would be expected to come from population growth and urbanization (Keyser et al. 2014).

Growing stocks in the Blue Ridge Mountains section were close to 16 MMMBF in 2010. These stocks are forecasted to continue to increase from 2020 to 2030 as forests continue to mature and will be followed by a decrease in growing stock volumes through 2060, especially around urban areas like Asheville, NC and Knoxville, TN (Keyser et al. 2014). In comparison to the forests closer to WNC urban centers, that portion of the growing stock that is part of the National Forests in WNC would remain comparatively unchanged as the private landscape changes around it due to the small proportion of the USFS land base planned for harvesting.

**Table 213. Estimated Contribution of Nantahala and Pisgah Forests Outputs to WNC Markets**

WNC Annual Output	Alternative A	Alternative B		Alternative C		Alternative D		Alternative E	
(Fox et al. 2011)	NA	Tier 1	Tier 2	Tier 1	Tier 2	Tier 1	Tier 2	Tier 1	Tier 2
----- MMCF -----									
70.6	0.02	0.03	0.17	0.04	0.15	0.04	0.17	0.05	0.18
----- Percent of Total -----									
	0.03	0.04	0.24	0.06	0.21	0.06	0.24	0.07	0.25

From 1995 to 2007, the total average annual roundwood output of WNC was 70.6 million cubic feet (Fox et al. 2011). With the assumption that annual production of roundwood would stay roughly the same as current production, the Nantahala and Pisgah NFs would contribute a small percent to the local production (Table 213). North Carolina is currently a net importer of roundwood, even though hardwood roundwood production statewide has increased 10 percent from 2013 to 2015 (Gray et al. 2017).

Appalachian regional trends in timber harvest indicate that 74 percent of roundwood products produced in WNC are hardwood, while North Carolina as a State, overall produces much more softwood than hardwood (Gray et al. 2017). This percentage is in line with the distribution of hardwood products produced from 2002 to 2018 across the Nantahala and Pisgah NFs (75 percent). The Nantahala and Pisgah forest plan revision action alternatives would result in product class distributions with lower softwood (conifer) products than what is present historically or regionally. In Tier 1, 13 to 20 percent of the modeled product class distribution is in softwood products; in Tier 2, the proportion decreases further to nine to 11 percent.

### 3.4.11 Minerals and Energy

#### Background

##### Mineral supply

The diverse geologic setting of the Nantahala and Pisgah NFs in the mountains of Western North Carolina endows the Forests with a wide range of mineral resources. The Nantahala and Pisgah NFs rank number one among national forests east of the Mississippi in the number of different non-fuel minerals based on analysis of data in the Mineral Resources Data System (MRDS) of the U.S. Geological Survey. The North Carolina Geological Survey recognized the Nantahala and Pisgah NFs as part of the mineral endowment of Western North Carolina in comments on the draft Assessment for Forest Plan Revision, stating:

“Large portions of the Nantahala and Pisgah National Forests are underlain by a Precambrian rift basin (Coleman and Cahan, 2012). Western North Carolina has been the focus of extensive mineral exploration since the early exploration and development of the State. Ore deposit models, summarized in Cox and Singer (1992), suggest the potential for further mineral discoveries including volcanogenic massive sulfides, and precious metal vein systems.”

“Diverse other mineral commodities in the two national forests include: monazite (source of rare earth elements – see Mertie, 1975) and important industrial minerals ‘alaskite’ (quartz, mica, and feldspar), olivine, gold, diamonds, industrial garnet, building- and dimension stones (river rock and flat mylonitized stone), marble, talc, and gemstones. Other minerals summarized from the studies of F.G. Lesure and his many co-authors (see the USGS’ National Geologic Map Database) include: kyanite-sillimanite-andalusite, gold, silver, rare-earth elements, thorium, titanium and uranium, pegmatite minerals, mafic and ultramafic rock mineralization, mica along with supporting geologic and geochemical data. Talc and marble deposits occur nearby to USFS lands. Decorative stone, ‘river rock’ and ‘flagstone’ (mylonitized metamorphic rock) are present throughout Western North Carolina. Saprolite (weathered bedrock) may provide local clay. Sand and gravel may be a local source of construction aggregate.” (Reid, 2013)

The Mineral Resources Data System (MRDS) of the U.S. Geological Survey (USGS) includes more than 40 metallic and non-metallic minerals on the Nantahala and Pisgah NFs (Table 214). MRDS is a data base of mineral site records including present and past mines, prospects, and occurrences along with related geologic, commodity, and deposit information (U.S. Geological Survey 2013a). The MRDS has about 200 records of mineral sites on the Nantahala and Pisgah NFs. The large number (+40) and variety of minerals in MRDS is an indicator of significant mineral potential of the Nantahala and Pisgah NFs. Maps of the MRDS mineral sites on the Forests' six ranger districts are displayed in Appendix B of the Supplemental Report for Energy and Mineral Resources Assessment which can be found in the plan revision project record.

**Table 214. Known Hardrock Minerals on the Nantahala and Pisgah NFs Based on Mineral Resources Data System (MRDS) of the U.S. Geological Survey (2013a)**

Arsenic	Gold	Nickel	Stone, Dimension
Asbestos	Graphite*	Niobium* (Columbium)	Sulfur
Barium-Barite*	Iron	Olivine	Talc-Soapstone
Beryllium*	Kaolin	Palladium*	Tantalum*
Chromium*	Kyanite	Platinum*	Thorium
Cobalt*	Lead	Pyrite	Tin*
Copper	Magnesium*	Quartz	Titanium*
Corundum	Manganese*	Rare Earth Elements*	Vermiculite
Feldspar	Marble	Rhodium	Zinc
Fluorspar*	Mica	Silica	Zirconium*
Garnet	Molybdenum	Silver	

Source: US Forest Service GIS analysis of minerals in the USGS Mineral Resources Data System (MRDS)

\*Critical Minerals: "A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals" (U.S. Dept. of Commerce 2019).

Mineral resources are a key component of the economy in Western North Carolina including the 18 counties with the Nantahala and Pisgah National Forests. Some key facts about mineral resources in WNC include:

- Western North Carolina is the only producer of high-purity quartz in the world, amounting to 90 percent of all mined and processed quartz for use in the electronics industries. Quartzites of the Chilhowee Group in northern McDowell County have potential to be a source of high-silica material.
- North Carolina leads the nation in production of feldspar, mica, and olivine.
- North Carolina has long been famous for the variety of precious and semi-precious stones such as emeralds, rubies and sapphires (gem-quality corundum), hiddenite, garnet, and other semi-precious stones. This public participation has helped North Carolina rank first in the eastern United States in the mining and marketing of gemstones and mineral specimens.

### Mineral use

The Nantahala and Pisgah NFs use both energy and non-energy mineral resources to accomplish forest plan goals and objectives for the wide range of resource programs spread across a 1.1 million acre land base. Minerals are used for:

- Hardware: tools, equipment, computers, GPS, cell phones, vehicles, culverts, bridges, water and sewage systems, fire trucks, aircraft, electrical grid, and other infrastructure;

- Mineral supplies: gasoline, diesel, oil, chemicals, batteries, etc. to fuel, power, operate, and maintain the hardware or to conduct natural resource inventories or apply mineral-based fertilizers, fire retardants, and herbicides for invasive species control, etc.;
- Construction materials in a relatively raw form: aggregate, rip-rap, concrete, landscaping rock, building stone, etc.

The Nantahala and Pisgah NFs use mineral materials (crushed rock aggregate, rip rap, landscaping rock, etc.) to construct and maintain roads, developed recreation sites, trailheads, and other facilities. The largest use of mineral materials is road aggregate on the Forests' open roads. Traffic wears out the road surfacing aggregate, abrading and crushing the rock and turning the rock to dust that washes off or blows off the roads. New aggregate must be added to the roads periodically to maintain the road. Every year the Forests resurface a few roads with several thousand tons of aggregate. Based on an engineering compilation of aggregate use by ranger districts for FY10-12, the Forests' average annual aggregate use was about 4,000 tons per year. However, there is a backlog of many miles of roads needing resurfacing, and more may be needed annually to reduce the backlog of maintenance.

In addition to road maintenance and surface rock replacement, mineral materials in large quantities are needed to repair the roads and stream crossings damaged or destroyed by storm events, floods, road slopes failures, etc. These episodic emergencies can increase the need for mineral materials beyond the annual use for routine maintenance and surface rock replacement. The Forests use rock pits on the Forests to supply some mineral materials. However, the majority of mineral materials used by the Forests are purchased from quarries on private land.

The Massey Branch quarry within a 34.4 acre area near Robbinsville in Graham County on the Cheoah Ranger District on the Nantahala NF has been operating under a Forest Service mineral materials authorization for crushed stone and riprap.

The Johns Knob quarry on the Cheoah Ranger District was a key source of mineral materials to build the Cherohala Skyway in Graham County. After Skyway construction, the quarry remains in demand, for example, as a resource for a landslide repair on the Skyway. Other quarries that have been active in the past include O.J. Wilson quarry (2 acres), a dimension stone quarry near Unicoi in Yancey County on Appalachian Ranger District, Pisgah NF, and A. Taylor quarry (3 acres), a dimension stone quarry near Linville in Avery County on the Grandfather Ranger District, Pisgah NF.

In the late 1980s and early 1990s the Forests had a substantial program of issuing mineral material permits to the general public to obtain small amounts of building stone (similar to firewood permits). Since then the Forests have reduced this program.

The primary potential for leasable minerals on the Forests is for hardrock minerals such as olivine, mica, gemstones, gold, precious metals, rare earth elements, high-purity quartz, etc. (U.S. Geological Survey 2013; North Carolina Mountain Resources Commission 2012b; Reid, J.C. 2012, 2013), including critical minerals identified in Table 214. The portion of the Pisgah NF in the vicinity of Hot Springs has potential for geothermal resources. Potential for commercial deposits of oil and gas or coal is low (North Carolina Oil and Gas Program (a) and (b); Reid 2009; U.S. DOI, BLM 2008; Robinson, et al. 1992).

A Bureau of Land Management (BLM) hardrock mineral lease for 158 acres for olivine is in effect in the Buck Creek area of Clay County on the Tusquitee Ranger District on the Nantahala NF. No mining has been conducted on the lease, and no plan of operations to conduct mining operations has been submitted to the BLM and FS. Market conditions and other factors affect when, or if, a lessee submits a plan of operations. As long as the lease is in effect, there is the potential for exploration and development. The preference right lease was renewed in 2011 for a 10-year period and includes the right to renew for successive periods of 10 years under such terms and conditions as may be prescribed

by the Secretary of the Interior unless otherwise provided by law at the expiration of any period. The existing lease is a valid existing right that would continue until the lease is no longer in effect.

The Forests have about two hundred abandoned mine or prospect sites, primarily from historic mineral exploration and development. Some abandoned sites, such as shafts or adits, pose safety hazards. The Forest Service plans and works abate public safety hazards. Abatement measures can include installing bat gates to protect bat habitat.

### **21st century national demand**

Since the development of the 1987 forest plan, the U.S. demand for minerals has grown to include not only traditional demands for minerals but also new and emerging demands for minerals essential for high technology, computers, Internet, fiber optics, cell phones, GPS, national defense, strategic and critical minerals, nanotechnology, renewable energy (wind, solar, biomass), clean car technology, greenhouse gas reduction and carbon capture infrastructure, and other climate change mitigation and adaptation infrastructures (U.S. Geological Survey 2013; Reid, J.C. 2012, 2013; National Academy of Sciences 2007; U.S. Department of Energy 2010). Several components of clean energy technologies, including permanent magnets, batteries, and photovoltaic (PV) thin films and phosphors, depend on materials at risk of supply disruptions (U.S. DOE 2010). One of the principal causes of lag in meeting these demands is the limited amount of exploration done in the last few decades for new sources of these minerals (USGS 2014).

Other than the federal lease for olivine, the Forests have not received any recent requests for exploration of federal leasable minerals; however, the Nantahala and Pisgah NFs offer an opportunity to discover and develop new sources of supply in an economic and environmentally sensitive fashion. While historically there has not been interest in critical minerals on the Forests, in the future there may be interest in the potential for critical minerals. The critical minerals found on the Forests are of national demand, as explained in the June 4, 2019 release of “A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals” (U.S. Dept. of Commerce 2019).

### **Analysis**

The affected environment and environmental consequences sections below are organized around the following analysis topics:

- Federal leasable minerals
- Reserved and outstanding mineral rights
- Noncommercial mineral collection
- Fossil fuel consumption
- Renewable energy
- Mineral materials

### **Federal leasable minerals**

Congress established the leasable minerals program to provide domestic sources of minerals from federal lands and to generate federal revenue. The leasable minerals program administered by the Bureau of Land Management is one of the federal government’s largest sources of non-tax revenue. On NFS lands the revenue is shared with the states for distribution to the counties for schools and roads. The federal leasable minerals revenue is also distributed to the Land and Water Conservation Fund, the Reclamation Fund, and the Historic Preservation Fund.

Management of the federal leasable mineral resources on NFS lands is a shared responsibility between the U.S. Department of Interior, BLM, and the USDA Forest Service. The BLM has the authority to issue licenses, permits, and leases for exploration and development of federal leasable minerals. The Forest Service has the authority to develop a forest plan for integrated resource management to provide for ecosystem services and multiple uses, both of which include mineral resources. In order to issue licenses, permits, and leases for federal leasable minerals on National Forest System lands, BLM needs consent from the Forest Service, which would be informed by the National Environmental Policy Act process with public involvement. If the FS provides consent, it is conditioned by terms or stipulations that BLM would add to the license, permit, and lease to ensure that impacts on surface resources are mitigated and that the affected land is reclaimed.

Because of the split authorities between the BLM and the Forest Service, the Forest Service determines how much of the federal mineral estate on NFS lands is open or closed to exploration and development of federal leasable minerals. The forest plan is the foundation, because plan components directly and indirectly affect the potential consent determinations that could be made during plan implementation.

BLM is a cooperating agency in the Nantahala and Pisgah NF plan revision because the agency has legal jurisdiction over the vast federal mineral estate underlying the Nantahala and Pisgah NFs.

### **Affected Environment**

The Nantahala and Pisgah NFs are comprised of acquired NFS lands, therefore hardrock minerals such as gold, olivine, and rare earth elements are managed as leasable minerals by the BLM under Section 402 of the President's Reorganization Plan No. 2 of 1946.<sup>39</sup> The BLM must have Forest Service consent before leasing acquired NFS lands for leasable minerals. The current leasable minerals program on the Nantahala and Pisgah is very small, with one hardrock mineral lease for olivine in the Buck Creek area.

The primary potential for leasable minerals on the Forests is for hardrock minerals (such as olivine, mica, gemstones, gold, precious metals, rare earth elements, high-purity quartz, critical minerals, etc.). Prior to any leases occurring, the FS and BLM would conduct environmental analysis for proposals for prospecting or exploration activities, such as trenching and drilling, or for mineral development (including production) of a surface mine or an underground mine. The portion of the Pisgah NF in the vicinity of Hot Springs has potential for geothermal resources. There is low potential for commercial deposits of oil and gas or coal.

### **Environmental Consequences**

#### **Common to all alternatives**

The only existing mineral lease on the Forest (hardrock mineral lease for olivine in the Buck Creek area) would be managed similarly under all alternatives.

The primary potential for leasable minerals on the Forests is for hardrock minerals, including critical minerals. Due to low potential for commercial deposits of oil and gas or coal no lease activity is expected for oil, gas, or coal during the life of the plan. While the Hot Springs area has potential for the occurrence of geothermal resources, there is a low potential for commercial deposits and development on National Forest System lands.

Due to current lack of proposed new mineral leases on the Forest, the potential for leasable mineral activity (exploration and development) is greater in the mid-to-long term than the short term. Mineral

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<sup>39</sup> On lands reserved from the public domain in Western US states, these minerals would be managed under the 1872 Mining Law. Because of the addition of hardrock minerals to leasable minerals on (continued on next page) (continued from previous page) acquired lands, the scope of the mineral estate that BLM has the authority to lease (and that requires FS consent) is far greater on the Nantahala and Pisgah NFs than on western NFs.

projects have the potential to adversely impact air, soil, surface water, groundwater, terrestrial and aquatic resources, recreation, scenery, cultural and other resources. The potential environmental impacts of mineral activity that would be common to all alternatives are as described in EPA reports (U.S. EPA, 1997, 2011, and 2016). Mineral projects would have short-term and long-term effects and would involve irreversible commitments of depletable resources.

Any proposed leasable mineral activities during plan implementation would require additional project analysis of environmental effects and would involve the public in the NEPA process. The framework established by Congress for federal leasable minerals provides for environmentally responsible exploration and development and required reclamation.

When an applicant applies for a BLM authorization to explore or develop federal leasable minerals, the BLM conducts an initial review to see that the application includes required information. BLM then sends the application to the Forest Service and requests Forest Service consent to the BLM authorization requested by the applicant. In cooperation with the BLM, the Forest Service would then conduct an environmental analysis with public involvement (NEPA process) of the proposed project.

If the FS decides to consent to the BLM authorization, the consent would be conditioned by Forest Service requirements or stipulations that BLM would add to the license, permit, and lease to ensure that impacts on resources are mitigated and that the affected land is reclaimed. Even if the FS decides to consent, the BLM would make its own independent decision on whether or not to issue the authorization. If the FS decides not to consent to the BLM authorization, BLM could not issue the authorization.

The Revised Plan provides direction and enforceable standards and guidelines that would protect resources in connection with mineral development. For example, one of the standards for Federal Leasable Minerals is:

“When providing consent to the Bureau of Land Management (BLM) for leasable mineral exploration or development, the consent shall include any requirements for environmental protection. Federal leasable mineral exploration and development shall be conducted in a manner that minimizes adverse impacts to the land, air, and water, to cultural, biological, visual, minerals, and other resources, and to other land uses or users. Lease stipulations and conditions of approval for operations may include, but are not limited to, modification to proposed siting or design of facilities, timing of operations, and specification of interim and final reclamation procedures” (MIN-S-01).

In addition, forestwide standards and guidelines and management area direction of the Plan apply to all projects including commercial mineral extraction and energy development. For efficiency, the Plan does not repeat all standards and guidelines within each individual resource section.

In addition, federal laws and regulations that apply to mineral and energy development on National Forest Systems lands provide a well-established regulatory framework and enforceable requirements to protect resources. The BLM and Forest Service regulations for mineral and energy projects are more specific than the forest plan and would protect resources on NFS lands even if the Forest Plan did not exist.

The Forest Service and the BLM would use independent authorities to enforce environmental requirements related to mineral activity and would ensure reclamation consistent with laws and regulations.

Potential ground disturbance for leasable mineral activity includes access road construction, mineral exploration such as drilling and trenching, and mineral development of surface mines and underground mines. To estimate the range of potential ground disturbance of hardrock leasable mineral exploration

and development under each alternative, data was considered regarding mines permitted in the 18 counties with the Nantahala and Pisgah NFs lands (North Carolina Division of Energy, Mineral and Land Resources 2018). The current 7,005 acres of permitted mines for hardrock leasable type minerals on non-NFS lands is less than 1/5th of one percent (0.186 percent) of the 3,752,302 of non-NFS lands in the 18 counties. This analysis assumes a parallel 0.186 percent of forest lands could be disturbed in mineral development, including 0.05 percent estimated to be impacted by mineral exploration (see Appendix B for analysis assumptions). If, for whatever reason, the private sector would not initiate any proposals on the Nantahala and Pisgah NFs during the 15 years of the plan, then the lower end of potential ground disturbance would be zero acres. Table 217 shows the potentially affected acres by alternative.

All alternatives would restrict federal leasable mineral exploration and development to varying degrees and thus would affect the potential for discovery and production of mineral deposits. All alternatives would also affect the potential for leasable mineral revenues to federal, state, and local governments. Under all alternatives the private sector would initiate proposals for leasable mineral exploration or development. Under each alternative, the Forest Service has the ability to limit the number of acres that the BLM offers for lease by exercising its consent authority. The Forest Service can provide limits on the number of acres that might be disturbed by including any applicable surface disturbance restrictions as a condition of consenting to the lease.

Under all alternatives, lands designated by Congress as Wilderness would be permanently withdrawn from federal mineral leases.

Within Wilderness Study Areas, federal minerals are unavailable for leasing. These WSAs would continue to be unavailable for leasing of federal minerals until Congress makes a decision on whether or not to designate as Wilderness.

Land identified as Recommended Wilderness in an alternative would be managed in the Recommended Wilderness and Wilderness Study Areas Management Area. These lands are managed to preserve their wilderness characteristics until Congress designates them as Wilderness or releases them from further consideration. The FS is unlikely to consent to BLM to lease federal minerals in recommended wilderness. However, if an area recommended by this plan is administratively changed to no longer be recommended in the future, then mineral leases would be able to proceed at that time. As a result, the decision to recommend Wilderness would have direct effects of making the area unavailable for federal mineral leasing until Congress designates the area as Wilderness or releases them from further consideration.

Additionally, other management areas with severe restrictions on road construction would severely impact leasable mineral exploration and development.

### **Alternative A**

Under the current forest plan, the desired condition of utilization of mineral resources is provided in an environmentally sound manner. The current plan provides opportunities for leasable mineral exploration and development and thus for potential discovery and production of minerals to meet 21st century demands.

### **Action alternatives**

In the revised plan, the desired condition is to provide opportunities for minerals and energy production in an environmentally sound manner to meet current and future needs. This desired condition is similar to the desired condition for the Alternative A of the current plan.

All the action alternatives would increase the acres of potential withdrawals from mineral leasing laws (Table 215). However, only designated Wilderness areas and designated Wild and Scenic Rivers are permanently removed from leasable mineral exploration and development; therefore, the acres below



show what is possible only if all the areas recommended for Wilderness go on to be designated and all of the eligible Wild and Scenic Rivers are designated.

**Table 215. Existing and Potential Withdrawals from Mineral Leasing Laws by Alternative**

Management Area	Alt A	Alt B	Alt C	Alt D	Alt E
Wilderness	66,400	66,400	66,400	66,400	66,400
WSA Non-Recommended Wilderness	11,590	0	15,696	3,200	3,200
WSA Recommended Wilderness	15,226	26,816	11,120	23,616	23,791
Non-WSA Recommended Wilderness	0	99,517	0	50,557	25,307
Wild and Scenic Rivers and Eligible WSRs (excluding acres counted in rows shown above)	24,535	34,209	26,683	33,531	34,269
<b>Total</b>	<b>117,751</b>	<b>226,942</b>	<b>119,899</b>	<b>177,304</b>	<b>152,967</b>

Compared to no action, the action alternatives would also increase the acres of other management areas with severe restrictions on access for leasable mineral exploration and development. Indicators of severe restrictions on leasable mineral activities are management areas that do not allow, or severely restrict, new road construction. Examples of management areas with severe restrictions on road access in each alternative are displayed in Table 216.

**Table 216. Examples of Management Areas that Severely Restrict or Do Not Allow Road Construction**

Management Area	Alt. A Acres	Alt. B Acres	Alt. C Acres	Alt D. Acres	Alt E. Acres
Backcountry	116,499	87,697	229,011	107,065	132,295
Appalachian National Scenic Trail Corridor	16,104	45,290	51,663	49,899	48,152
Special Interest Areas and Ecological Interest Areas	12,047	29,376	106,612	56,579	68,119
<b>Total</b>	<b>144,650</b>	<b>162,363</b>	<b>387,286</b>	<b>213,543</b>	<b>248,566</b>

Using the data above, **Error! Reference source not found.** estimates the potential ground disturbance for leasable mineral activity by alternative, including mineral exploration such as drilling and trenching and mineral development of surface mines and underground mines (see Appendix B for more information).

**Table 217. Estimated Range of Potential Ground Disturbance for Leasable Mineral Activity During 15 Years of Revised Plan**

	Alt. A Acres	Alt. B Acres	Alt. C Acres	Alt. D Acres	Alt. E Acres
Forest total	1,042,797	1,042,797	1,042,797	1,042,797	1,043,368
Existing and potential withdrawals (as shown in Table 215, Totals )	117,751	226,942	119,899	177,304	152,967
Lands not in existing and potential withdrawals	925,046	815,855	922,898	865,493	890,401

	Alt. A Acres	Alt. B Acres	Alt. C Acres	Alt. D Acres	Alt. E Acres
Upper estimate of ground disturbance for mineral development (mines)	1,634	1,442	1,631	1,529	1,573
Upper estimate of ground disturbance for mineral exploration	86	75	85	80	82
Estimated range of potential ground disturbance of leasable mineral activity during life of Revised Plan	0 - 1,721	0 - 1,517	0 - 1776	0 - 1,610	0-1656

In summary, under any alternative, the portion of the land that may be impacted by leasable mineral activity is estimated to be less than 1800 acres, or 0.17 percent of the Forests. All of the action alternatives provide more restrictions on leasable mineral exploration and development than the current plan.

### Cumulative Effects

As mines on non-federal lands produce and draw down mineral supplies, there is a continuing need to explore and develop new mineral supplies. Proposals for new mines on NFS lands across the U.S. have faced challenging permitting processes involving the FS, BLM, and other Federal agencies such as the U.S. Fish and Wildlife Service. Even renewal of an existing lease can be challenging and time consuming.

Despite extending across 18 counties with potential for hardrock leasable minerals, the Nantahala and Pisgah NFs do not contain any hardrock leasable producing mines. All of the producing hardrock mines are on non-NFS lands. The challenges of the Federal permitting process are a key factor in the disparity in hardrock mineral production between NFS lands and non-NFS lands in the 18 counties.

In recent years proposals for new mines on non-NFS lands also face challenging permitting processes as the population has increased in rural areas. Conducting mineral exploration and development on Federal and non-Federal lands is difficult nationally, contributing to a national supply that lags behind demand.

The past and present effects of the forest plan are a lack of exploration, discovery, and production of Federal leasable minerals. Under all alternatives the potential future effects of a revised plan could range from a continued low level of exploration, discovery, and production to exploration, discovery, and production of one or more essential minerals (those minerals essential for 21st century technology, national defense, strategic and critical materials, renewable energy [wind, solar, biomass], clean car technology, greenhouse gas reduction and carbon capture, and other climate change mitigation technology). Or, given that the land base of the Nantahala and Pisgah NFs is more than one million acres, the potential future effects of a revised plan could include the discovery and production of one or more mineral deposits of regional, national, and international significance.

### Reserved and Outstanding Mineral Rights

#### Affected Environment

Most of the minerals underlying the Federal lands that make up the Nantahala and Pisgah NFs are federally owned minerals. However, some tracts acquired by the USDA Forest Service either had the mineral rights reserved (reserved mineral rights) or already had the mineral rights severed (outstanding mineral rights). These mineral rights are also called “private mineral rights,” because the tracts with reserved or outstanding mineral rights (ROR) on the Forests were acquired from private parties. These private rights are considered when allocating surface management prescriptions in order to identify potentially incompatible and conflicting land uses.

The available lands status subsurface ownership data indicates about 10 percent or less of the Nantahala and Pisgah NFs acreage is subject to reserved or outstanding mineral rights (ROR). Extensive legal research would be needed to get a better estimate of the acreage subject to ROR.

Currently the only active ROR operation is the Hewitt quarry in Swain County on the Cheoah Ranger District in the Nantahala NF. The quarry (about 25 acres) has limestone, marble, and talc.

In locations where outstanding mineral rights exist, the mineral owner has constitutionally protected rights to access the tract and explore and develop minerals. The Forest Service administers ROR operations under the terms of the deed and applicable laws.

### **Environmental Consequences**

The revised plan would have two potential effects relating to reserved and outstanding mineral rights (ROR):

1. Potential conflicts of reserved and outstanding mineral operations with national forest surface management.
2. Potential conflicts of national forest surface management with the exercise of reserved and outstanding mineral rights, such as the potential for delays or increasing the costs of private mineral right development.”

These potential effects would be strongest in those management areas where roads are prohibited or severely restricted, such as in the Backcountry Management Area or areas recommended for Wilderness. An indicator of the potential for conflict is the degree of restrictions or prohibitions that the alternatives place on roads or Federal leasable minerals. The alternatives vary in the extent to which they create potential effects on surface management and private mineral rights operations. While access to private mineral rights needs to be granted (unless a formal “taking” process is enacted where the private mineral owner is compensated for not being able to access the minerals they own), the costs to the private mineral owner of the mitigation measures associated with providing that access may increase in those areas where roads are otherwise prohibited or restricted. **Error! Reference source not found.** Table 216 displays the differences between the alternatives in those areas where roads are otherwise prohibited or restricted.

### **Common to all alternatives**

Existing reserved and outstanding operations would continue under all alternatives.

### **Alternative A**

The Forests’ GIS lands status data indicates about 10 percent of the acreage on the Nantahala and Pisgah NFs is subject to reserved and outstanding mineral rights. Table 217 shows the acres in Management Areas that would have restrictions or limitations on providing access to outstanding or reserved mineral rights by alternative, with Alternative A having the lowest number of acres in this category. In Alternative A the dual potential effects on surface management and private mineral rights operations may occur in portions of the areas shown in Table 216 and Table 217.

### **Alternatives B, C, and D**

All action alternatives increase the acres where there could be restrictions or limitations on providing access to outstanding or reserved mineral rights. The dual potential effects on surface management and private mineral rights operations are most adverse. (see Table 216 and Table 217). Table 218 below shows the areas that are recommended for Wilderness in one or more alternatives and the estimated number of acres within those recommended areas that have outstanding or reserved mineral rights. This

provides an indication of potential conflicts between managing the area to protect its “wilderness characteristics” versus allowing private mineral rights’ owners to access their minerals.

**Table 218. Recommended Wilderness Subject to Reserved and Outstanding Mineral Rights\***

<b>Recommended Wilderness Area</b>	<b>Area Acres</b>	<b>Alt. A (ac)</b>	<b>Alt. B (ac)</b>	<b>Alt. C (ac)</b>	<b>Alt. D (ac)</b>	<b>Alt. E (ac)</b>
Cherry Cove Ext A	1,157	0	83	0	0	0
Southern Nantahala Wilderness Ext., West	6,231	0	265	0	0	0
Ellicott Rock Ext.	570	0	62	0	0	0
Mackey Mtn	13,509	0	184	0	56	56
Middle Prong Ext	1,871	0	1,871	0	1,871	0
Shining Rock Ext. Dark Prong	929	0	929	0	929	939
Shining Rock Ext. Sam Branch	744	0	744	0	744	688
Tusquitee Bald	19,230	0	541	0	545	0
Wesser Bald	4,093	0	37	0	0	0
<b>Total</b>	<b>48,334</b>	<b>0</b>	<b>4,716</b>	<b>0</b>	<b>4,146</b>	<b>1,683</b>

\*This information is provided to give an indication that some areas recommended for wilderness may have a conflict between managing the area to protect wilderness values and allowing private mineral owners to access minerals. However, these area numbers are estimates, subject to verification.

### **Alternative B**

Alternative B has the most acres of recommended wilderness subject to reserved and outstanding mineral rights, including three areas with 100 percent of the acres subject to ROR (Table 218).

Compared to Alternative A, Alternative B increases the acres in MAs which prohibit or severely restrict roads, and, therefore, has potential conflicts on surface management and private mineral rights operations. The increased acres in these MAs is substantially less than the increased acres for Alternatives C, D and E (Table 216).

### **Alternative C**

Alternative C, unlike Alternatives B, D, and E, does not add acres of recommended wilderness subject to reserved and outstanding mineral rights, but does include acres that already recommended as Wilderness Study Areas (Table 218). However, Alternative C has the largest increase in acres in management areas which prohibit or severely restrict roads, and, therefore, has the potential conflicts on surface management and private mineral rights operations. The increased acres in these MAs is substantially more than the increased acres for Alternatives A, B D, or E (Table 216).

### **Alternative D**

Alternative D has the second most acres of recommended Wilderness subject to reserved and outstanding mineral rights, including three areas with 100 percent of the acres subject to ROR (Table 218).

Alternative D increases the acres in MAs which prohibit or severely restrict roads, and, therefore, has potential conflicts on surface management and private mineral rights operations. The increased acres in

these MAs are substantially more than for Alternatives A and B but substantially less than for Alternative Cs and E (Table 216).

### **Alternative E**

Alternative E has the third most acres of recommended Wilderness subject to reserved and outstanding mineral rights (Table 218).

Alternative E increases the acres in MAs which prohibit or severely restrict roads, and therefore has potential conflicts on surface management and private mineral rights operations. The increased acres in these MAs are more than for Alternatives A, B and D but less than for Alternatives C (Table 216).

## **Noncommercial Mineral Collection**

### **Affected Environment**

As the largest public land in Western North Carolina, and endowed with a rich variety of minerals, the one million acres of the Nantahala and Pisgah NFs under the current plan have a distinctive role and contribution for non-commercial mineral collecting on public land within the broader landscape in North Carolina and among the national forests in the eastern United States. The public has a long tradition of noncommercial mineral collecting at many sites on the Nantahala and Pisgah NFs, including the Ray Mine in Yancey County, Walker Creek Kyanite Prospect in Buncombe County, Grimshawe Sapphire Mine in Transylvania County, and Buck Creek/Corundum Knob Area in Clay County. The Nantahala and Pisgah NFs are famous for rockhounding opportunities for a variety of minerals, such as agate, apatite, beryl (aquamarine), corundum (ruby, sapphire), feldspar, garnet, hyalite opal, kyanite, mica, monazite, olivine, quartz, tourmaline, and zircon.

For more information on noncommercial mineral collecting as a recreation activity (including rockhounding and gold panning), see the “Recreation” section.

## **Environmental Consequences**

### **Alternative A**

Under the current plan, rockhounding and gold panning may take place on most national forest lands – provided only small quantities of material are removed for personal, non-commercial purposes. The current plan does not designate sites for non-commercial mineral collecting.

The forestwide direction for non-commercial collection of minerals (rockhounding, gold panning, etc.) in the current plan is:

1. Dispersed Recreation Management
2. Allow recreational collection of minerals where minerals are loose and free on the surface, in federal ownership, and not restricted by permit.
3. Restrict mineral collection to nonmechanical equipment with no significant ground and stream disturbance.

Ground disturbance occurs mainly in abandoned mine areas or in traditional rockhounding sites which are areas of past ground disturbance. In some cases the degree of ground disturbance results in impacts to surface resources and public safety. The Forests have guidelines to reduce impacts to surface resources and public safety.

### **Action Alternatives**

The desired condition for the action alternatives is that opportunities for rockhounding and other types of non-commercial mineral collecting (e.g., for recreational, scientific, or educational purposes) are available and managed to protect natural resources and public health and safety.

Forestwide direction includes an objective to identify areas where surface-penetrating tools can be used for non-commercial mineral collection within three years of plan approval (REC-O-02), and this standard:

- REC-S-03      Non-commercial mineral collection, such as rockhounding, gem collection, and gold panning for personal use, may take place on National Forest System lands where the activity is not restricted by mineral lease or Management Area direction. The following restrictions apply:
- i.      Following the identification of areas where surface penetrating tools can be used for non-commercial mineral collection (REC-O-02), use of surface penetrating tools for collection is only allowed in identified areas.
  - ii.     Gold panning may be used in the bed of streams provided that no digging tools, including suction dredging, beyond pans are used and aquatic habitat is not adversely impacted.
  - iii.    Any disturbance to or removal of historical or archaeological artifacts is prohibited by federal law.
  - iv.    Fossil collection shall be in accord with Forest Service Paleontological Resources regulations (36 CFR 291).
  - v.     Authorization is required for non-commercial mineral collection for research purposes.

REC-S-03 clarifies that following plan approval, noncommercial mineral collection may take place where not otherwise restricted, which is comparable to implementation under the current plan. After the objective is completed and areas where surface penetrating tools can be used are identified in project specific analysis and NEPA, then the plan supports the closure of other (non-identified) areas to surface penetrating tools. The decision on designation of these areas would be made during plan implementation. The Black Mountain Geographic Area includes a goal to direct visitors seeking opportunities for noncommercial mineral collection to the Ray Mine area. Given this, it is likely that the Ray Mine area would be one of the locations where surface penetrating tools could be used.

While there would not be an immediate effect of implementing the revised plan direction, following implementation of the objective and the designation of sites where surface penetrating tools can be used, the revised plan would restrict noncommercial mineral collection using surface penetrating tools to designated sites.

Noncommercial mineral collection is restricted in Special Interest Areas (EIA-S-08), as well as in recommended wilderness, and eligible wild and scenic rivers. Therefore, a second effect of the action alternatives would be to reduce the acres available for potential designation for non-commercial mineral collection. Compared to the current plan, the action alternatives would increase the acres of recommended Wilderness, eligible Wild and Scenic Rivers, and Special Interest Areas (SIA), and thus would decrease the acres available for potential designation for non-commercial mineral collection.

## **Fossil Fuel and Other Mineral Consumption**

### **Affected Environment**

Fossil fuel consumption is an indicator of energy use as well as the carbon footprint associated with the current forest plan. Primary uses of fossil fuels by USFS management include gasoline and diesel use for the forest fleet; operations and travel associated with timber harvest, prescribed fire, and wildfire suppression; use of aircraft in resource monitoring; and constructing, operating, and maintaining infrastructure. A much greater amount of fossil fuels is used by the public on the Forests, including the fuel associated with travel and recreation.

The Forests use energy and non-energy mineral resources to accomplish Forest Plan goals and objectives for the wide range of resource programs spread across a 1.1 million acre land base. The overwhelming majority of the tools, vehicles, equipment and energy used to manage the Forests and sustain ecosystems are made of minerals. For example, the Forests use mineral materials (crushed rock aggregate, rip rap, landscaping rock, etc.) to construct and maintain roads and developed recreation sites and to repair storm and flood damage.

### **Environmental Consequences**

NEPA requires consideration of energy use and conservation potential of various alternatives and mitigation measures at 40 CFR 1502.16 (e). The current plan and action alternatives require energy to achieve plan objectives, desired conditions, and projected effects. Fossil fuel use is expected to increase under the action alternatives, because forest objectives call for increasing management objectives across a number of resources in both Tier 1 and Tier 2. For example, action alternatives work on increasing the pace and scale of restoration using timber harvest and prescribed fire and will use more fossil fuels than Alternative A. The largest energy requirement of the Forests is by far the fossil fuel use expended by visitors to the Forests. Because recreation is a discretionary activity, the recreation part of each plan alternative has the greatest conservation potential. In contrast, forest management has much smaller energy requirements and is using energy to meet basic needs for wood, clean water, and clean air and to restore and sustain the forests which are used to meet basic needs.

The action alternatives were not designed to address conservation potential for energy requirements. As a result, the action alternatives would have the effect of increasing energy requirements to implement them.

NEPA also requires consideration of depletable resource requirements: 40 CFR 1502.16 (f). The action alternatives would increase the consumption of non-energy mineral resources to accomplish forest plan goals and objectives, such as mineral materials to maintain roads and repair storm damage. The action alternatives would have the effect of increasing depletable requirements (energy and non-energy minerals) to implement them.

### **Cumulative Effects**

The Nantahala and Pisgah NFs, like other national forests, depend on the United States maintaining and continuing the historic shift from the use of wood to the use of minerals to meet so many of society's basic needs. In the 19th century wood from eastern forests was among the most widespread and essential material, both for domestic use and industry, and provided 90 percent of the nation's energy in 1850 (MacCleery 1992). The dependence on wood to meet the needs of a growing society led conservation pioneers to predict the catastrophic loss of American forests and a "wood famine." The situation was dire on eastern forests. The escalating trend to loss of forests was broken when the United States made a historic shift from the use of wood to the use of minerals to meet basic needs. Collins and others (1997) note: "Minerals did more than replace wood. Minerals opened a whole new world of construction and architecture far beyond the limited technical capacity of wood. Minerals allowed cities to reach for the sky: to house more people on less land; to provide more working space on less land." Society's massive shift to mineral resources was the indispensable and overarching requirement in the historic restoration and sustainability of forests such as the Nantahala and Pisgah NFs, established, respectively, in 1920 and 1916.

The shift to mineral resources has resulted in significant environmental impacts including impacts to forests. For example, coal fired power plants produce emissions resulting in acidic rain that harms forests and forest soils. In the United States many of these emissions are reduced through pollution controls, such as using limestone in flue-gas desulfurization (FGD) technology. Thus, when impacts are identified, it is mineral resources and the advanced technology made possible by minerals that provides a basis for

mitigating measures to reduce impacts. Mineral-based technologies, such as renewable energy (wind, solar), clean car technology, greenhouse gas reduction and carbon capture infrastructure, are leading the way and are essential to mitigating climate change.

From the 1920s to the present, sustaining the U.S. forests, including the Nantahala and Pisgah NFs, required that mineral resources including fossil fuels be produced every year (Collins et al. 1997). The requirement for mineral production from lands outside the national forests in order to restore and sustain the Nantahala and Pisgah NFs will continue every year into the foreseeable future. Society's use of mineral resources and advanced mineral-based technology (including solar, wind, and other renewable energy technology) is an essential requirement for sustaining the Nantahala and Pisgah NFs and other national forests.

## **Renewable Energy**

### **Affected Environment**

Renewable energy includes wind, hydropower, solar, biomass, and geothermal energy. The Energy Policy Act of 2005 recognizes the Forest Service's role in meeting the renewable energy goals of the United States. Consistent with agency policies and procedures, the use and occupancy of NFS lands for alternative energy production, such as wind energy development, are appropriate and can help meet the energy needs of the United States. The state of North Carolina is aiming to generate more of its power from solar, wind, and other renewable sources. State law requires Duke Energy to get 12.5 percent of its power from solar, wind, and other renewable sources by 2021.

Currently, hydropower is the only renewable energy source being utilized in any substantial amount on the Nantahala and Pisgah NFs. The Nantahala NF has four hydroelectric dams in operation, and the Pisgah NF has none. The Nantahala Project, Duke Energy Carolinas, LLC is located in Western North Carolina on the Nantahala River and on two tributaries, Dicks Creek and White Oak Creek. This project occupies 41 acres of the Nantahala NF and generates an average of 215,159 megawatt hours (MWh) of energy annually. The Queens Creek Hydroelectric Project, Duke Energy Carolinas, LLC is located on Queens Creek, 1.5 miles upstream of its confluence with the Nantahala River, near the town of Topton, Macon County, NC. The project does not occupy any federally owned lands. The Queens Creek Project generates an average of 5,000 MWh of energy annually. The East Fork Project, Duke Energy Carolinas, LLC is located on the East Fork of the Tuckasegee River in Western North Carolina and lies within the Tuckasegee River watershed, which is a sub-basin of the Little Tennessee River. The Tuckasegee River flows through the cities of Cullowhee, Sylva, and Bryson City before it joins the Little Tennessee River almost 50 miles from its headwaters. The East Fork Project consists of three hydroelectric developments which are Tennessee Creek, Bear Creek, and Cedar Cliff. The East Fork Project generates an average of 94,710 MWh of energy annually. The Tapoco Project, Alcoa Power Generating, Inc. is located on the Little Tennessee and Cheoah Rivers in Graham and Swain Counties in North Carolina and Blount and Monroe counties in Tennessee. The project includes four developments: Santeetlah, Cheoah, Calderwood, and Chilhowee. The Tapoco Project historically has generated about 1,445,582 MWh of electricity annually.

A 2005 report by the National Renewable Energy Laboratory (NREL) and the Forest Service identified and evaluated the potential for solar and wind energy resource development on NFS lands, including the NFS lands in North Carolina (National Renewable Energy Laboratory Report 2005). The Nantahala and Pisgah NFs have potential to produce both solar power and wind power. In North Carolina the highest average annual wind speeds are along the coast or in the mountains of western NC where the Nantahala and Pisgah NFs are the largest land ownership. No special use permits for large scale wind or solar power have been issued under the current plan on the Nantahala and Pisgah NFs.

Woody biomass includes trees and woody plants, including limbs, tops, leaves, and needles that are a by-product of forest management. Woody biomass can be utilized to produce energy both on a residential



scale (firewood) and on a commercial scale. The primary obstacle to the utilization of woody biomass in western NC is the lack of biomass purchasing plants in the 18- county area of western NC. Therefore, the Nantahala and Pisgah NFs are currently not selling any woody biomass from the forest with the exception of that which is sold in the form of firewood permits.

The portion of the Pisgah NF in the vicinity of Hot Springs has potential for geothermal resources.

## Environmental Consequences

The following analysis applies to large scale renewable energy projects which can produce commercial renewable energy.

### Alternative A

Under the current plan, the four hydroelectric dams on the Nantahala NF would continue in operation. Woody biomass by firewood permits would continue to be available. Opportunities for commercial biomass as well as wind, solar, and geothermal energy projects can also be considered.

### Action alternatives

A desired condition of the action alternatives is that renewable energy opportunities, such as biomass, firewood, hydropower, geothermal, wind, and solar, are considered.

Compared to the current plan, the action alternatives would reduce the acres available to consider for renewable energy projects, because the current plan has fewer restrictions and thus more potential for large scale renewable energy projects (Table 216).

The Matrix is the most likely MA where large-scale renewable energy projects could be considered under the action alternatives. Management areas that would prohibit or severely restrict large scale renewable energy projects include Wilderness, recommended Wilderness, Backcountry, Special Interest Areas, Ecological Interest Areas, the Appalachian National Scenic Trail Corridor and Scenic Byways. Alternative C has the most acres in management areas that would prohibit or severely restrict large scale renewable energy projects and would therefore have the most adverse effect on potential commercial renewable energy projects. Alternatives B, D and E would substantial adverse effects but less than Alternative C. Alternative A would have the least adverse effect on potential commercial renewable energy projects.

In management areas, such as Matrix, where a large-scale renewable energy project is compatible with the general area desired conditions, prior to any activity, future project level NEPA analysis must consider forestwide and management area resource standards, such as those for scenery, wildlife, botany, cultural resources, recreation, or old growth forests, to evaluate the feasibility of an individual project. For example, under all action alternatives more than 70 percent of the acres in Matrix would be in Scenic Class 1 or 2 which have scenic integrity objectives of high or moderate. Meeting the Plan standards could be a challenge for large scale commercial energy projects if large areas are needed for construction or long-term infrastructure. Large scale renewable energy projects would be difficult to implement due to the totality of plan direction effects on technical or economic feasibility even in Matrix management area.

For the other management areas, large scale renewable energy projects would be unlikely based on revised plan direction. The following management areas have plan direction that may prohibit or severely restrict or not allow renewable energy projects, which would be analyzed at the project level.

**Table 219. Lands that Could Prohibit, Severely Restrict, or Not Allow Renewable Energy Projects**

Lands	Alt A Acres	Alt B Acres	Alt C Acres	Alt D Acres	Alt E Acres
Existing and Potential Withdrawals (as shown in Table	94,990	202,182	99,143	150,022	124,947

Lands	Alt A Acres	Alt B Acres	Alt C Acres	Alt D Acres	Alt E Acres
215)					
Backcountry	116,499	87,697	229,011	107,065	132,295
Special Interest Areas and Ecological Interest Areas	12,047	29,376	106,612	56,579	68,119
Appalachian National Scenic Trail Corridor	16,104	45,290	51,663	49,899	48,152
Scenic Byways	37,357	23,314	20,983	23,771	21,852
<b>Total</b>	<b>276,997</b>	<b>387,859</b>	<b>507,412</b>	<b>387,336</b>	<b>390,365</b>

In 2005, the National Renewable Energy Laboratory (NREL) and the Forest Service identified and evaluated the potential for solar and wind energy resource development on the NFS lands in North Carolina (National Renewable Energy Laboratory Report 2005). The report mapped potential areas for wind energy considering wind speeds. The report identified Wind Power Class 4 and above as high potential areas for wind energy. Acres of wind energy potential (Wind Power Class 4 and above) by MA by action alternatives are shown in Table 220. The Nantahala and Pisgah NFs have about 45,350 acres of Wind Power Class 4 and above.

**Table 220. Acres of Wind Energy Potential (Wind Power Class 4 and Above) by Action Alternatives Management Areas**

Management Area	Alt B Acres	Alt C Acres	Alt D Acres	Alt E Acres
Matrix	8,900	5,570	8,538	7,743
Interface	2,297	1,110	2,271	2,249
Backcountry	4,075	13,223	4,752	9,024
Wilderness Study Area	0	140	0	22
Wilderness	9,408	9,408	9,408	9,406
Experimental Forest	105	105	105	105
Roan Mountain	2,739	2,739	2,739	2,739
Cradle of Forestry	179	179	179	179
Appalachian National Scenic Trail Corridor	5,185	6,540	6,165	5,570
Scenic Byways	2,179	2,237	2,374	2,135
Heritage Corridors	68	68	68	68
Special Interest Area	1,381	1,512	1,760	3,048
Ecological Interest Area	0	1,652	645	505
Research Natural Area	0	313	0	313
Recommended Wilderness	8,833	553	6,342	2,232
<b>Total Acres</b>				<b>45,338</b>

Management Area	Alt B Acres	Alt C Acres	Alt D Acres	Alt E Acres
	45,348	45,350	45,348	

Under the action alternatives, 80 to 88 percent of Wind Power Class 4 and above acres would be in MAs that would not allow or would severely restrict wind turbines needed to produce commercial wind energy.

The combination and totality of revised plan standards and guidelines for all resources would also likely make large scale non-wind renewable energy projects difficult to impossible to accomplish even in the Matrix (the most likely MA for active management).

## Mineral Materials

### Affected Environment

The Nantahala and Pisgah NFs uses mineral materials (crushed rock aggregate, rip rap, landscaping rock, etc.) to construct and maintain roads, developed recreation sites, trailheads, and other facilities. The largest use of mineral materials is road aggregate on the Forests' open roads. Traffic wears out the road surfacing aggregate, abrading and crushing the rock and turning the rock to dust that washes off or blows off the roads. New aggregate must be added to the roads periodically to maintain the road. Every year the Forests resurface a few roads with several thousand tons of aggregate. Based on an engineering compilation of aggregate use by ranger districts for FY10-12, the Forests' average annual aggregate use was about 4,000 tons per year. However, there is a backlog of many miles of roads needing resurfacing, and more may be needed annually to reduce the backlog of maintenance.

In addition to road maintenance and surface rock replacement, minerals materials in large quantities are needed to repair the roads and stream crossings damaged or destroyed by storm events, floods, road slopes failures, etc. These episodic emergencies can increase the need for mineral materials beyond the annual use for routine maintenance and surface rock replacement. The Forests use rocks pits on the Forests to supply some mineral materials. However, the majority of mineral materials used by the Forests are purchased from quarries on private land.

The Massey Branch quarry within a 34.4-acre area near Robbinsville in Graham County on the Cheoah Ranger District on the Nantahala NF has been operating under a Forest Service mineral materials authorization for crushed stone and riprap.

The Johns Knob quarry on the Cheoah Ranger District was a key source of mineral materials to build the Cherohala Skyway in Graham County. After Skyway construction, the quarry remains in demand, for example, as a resource for a landslide repair on the Skyway. Other quarries that have been active in the past include O.J. Wilson quarry (2 acres), a dimension stone quarry near Unicoi in Yancey County on Appalachian Ranger District, Pisgah NF, and A. Taylor quarry (3 acres), a dimension stone quarry near Linville in Avery County on the Grandfather Ranger District, Pisgah NF.

In the late 1980s and early 1990s the Forest had a substantial program of issuing mineral material permits (similar to firewood permits) to the general public to obtain small amounts of building stone and landscaping rock. Since the 1990s the Forest has reduced this program.

### Environmental Consequences

#### Common to all alternatives

Existing mineral material permits/contracts would continue under all alternatives. Because the Forest obtains most mineral materials from private lands, the environmental consequences for these mineral materials are on private lands.

### **Alternative A**

The current plan (Alternative A) compared to the Action Alternatives (Alternatives B, C, D, and E) provides the most opportunity to 1) State and other governmental requests for mineral materials needed for public works and infrastructure projects, 2) meet Forest Service continuing demand for mineral materials to maintain roads, developed recreation sites, trailheads, and other facilities, and to repair the roads and stream crossings damaged or destroyed by storm events, floods, road slopes failures, etc., and 3) to meet non-commercial public demand for building stone, landscaping rock, and other mineral materials.

The ground disturbance of mineral material projects has the potential to adversely impact natural resources. The Forest Service regulations for mineral materials provides for environmentally responsible development and requires reclamation. The current plan (Alternative A) compared to the Action Alternatives (Alternatives B, C, D, and E) would have more potential for mineral materials operations on the Forest to adversely impact natural resources.

### **Action Alternatives**

Each Action Alternative (Alternatives B, C, D, and E) compared to the current plan substantially reduces the area available to meet demand for mineral materials. For example, the Revised Plan includes this standard for mineral materials: “Boulderfields shall not be permitted for any rock removal, unless for scientific research that would benefit management of the unique habitat.” Boulderfields contain loose rock and are a low-cost source of mineral materials compared with bedrock.

The Action Alternatives also restrict the areas potentially available to meet demand for mineral materials (Table 215 and Table 216). The Action Alternatives would increase dependence on private land sources to meet the Forest’s continuing demand for mineral materials. Because of the long haul for rock trucks to deliver mineral materials (aggregate, rip-rap, etc.) to Forest locations, the economic cost and the carbon footprint is high. The Action Alternatives would substantially reduce opportunities to use Forest rock sources to reduce the economic cost and the carbon footprint of using private land sources.

The ground disturbance of mineral material projects has the potential to adversely impact natural resources. The Forest Service regulations for mineral materials provides for environmentally responsible development and requires reclamation. Each Action Alternatives (Alternatives B, C, D, and E) compared to the current plan (Alternative A) would have less potential for mineral materials operations on the Forest to adversely impact natural resources.

## **3.4.12 Social and Economic Resources**

The mission of the Forest Service is to sustain the health, diversity, and productivity of the nation’s forests and grasslands to meet the needs of present and future generations. The Nantahala and Pisgah NFs lands both influence and are influenced by individuals nearby and nationally. The Forests contribute to sustaining the viability of national, regional, and local communities. Uses, products, services, and visitor opportunities supported by NFS lands produce benefits which contribute to the robustness and sustainability of communities, particularly local communities adjacent to NFS lands. Historically, individuals in these communities have benefited from a host of services such as recreation, scenery, enjoyment, opportunities to connect with nature, timber products, and food hunted, fished or gathered, and jobs that depend on the forest. The general public across the United States also benefits from the Forests. These benefits include clean air, clean water, conservation of forest, and habitat for aquatic species, wildlife, and threatened and endangered species. Additionally, almost all National Forest management activities have the potential to directly or indirectly affect the social and economic environment through people’s values, beliefs, and attitudes as well as the economic and social structures of communities.

The 2012 planning rule directs plans to guide management so that forests are ecologically sustainable and contribute to social and economic sustainability, as well as to have the capacity to provide people and communities with ecosystem services and multiple uses that provide a range of social, economic, and ecological benefits for the present and into the future. Specifically, plan components must include standards or guidelines to guide the plan area's contribution to social and economic sustainability, taking into account ecosystem services as well as multiple uses that contribute to local, regional, and national economies and communities in a sustainable manner. Furthermore, reasonably foreseeable risks to social benefits shall be considered when developing the forest plan.

The Forest Service manages NFS lands according to the principle of multiple use. This principle allows the agency to manage land for a variety of uses, including amenity, commodity, non-commodity, and recreation. The Multiple-Use Sustained-Yield Act (Pub. L. 104–333) formalized this management philosophy, stating that the Forest Service is to manage resources to best meet the needs of the American public, with flexibility to provide for “periodic adjustments in use to conform to changing needs and conditions” (Section 4(a) of the Act [16 U.S.C. 531]). For instance, areas suitable for timber production may contribute to the local economy by sustaining timber sector jobs and income, thereby maintaining the social fabric and lifestyles of the community. Wilderness areas may also contribute to social and economic well-being as visitors from near and far experience solitude in these locations while contributing to the local community during their visit.

This section describes the social and economic conditions of the affected environment using key indicators of social and economic sustainability; describes how key benefits of the Forest currently contribute to the social and economic sustainability of beneficiaries; and evaluates the impacts of the alternatives on the benefits the Forest provides to local residents and the general public.

### **Socioeconomic Indicators**

Social and economic sustainability is analyzed by considering the social and economic context of the forest and how the forest will contribute to people and community needs in each of the forest plan alternatives.

Social and economic characteristics of the analysis area are described by the following indicators. Many of these indicators will then be used to explain the effects of the alternative management scenarios. For example, estimates of job and income contributions to the local economy by alternative are one way to understand socioeconomic impacts of different management alternatives on the local economies surrounding the Nantahala and Pisgah NFs.

- Demographics: Population, Age
- Economy: Income, Median Earnings, Non-labor Income, Employment, Unemployment
- Public Values
- Benefits to People: Ecosystem Services

### **Affected Environment**

On a regional level, the Nantahala and Pisgah National Forests are located in the Southern Appalachian Mountains. The Southern Appalachian Mountains include seven states and 135 counties, covering approximately 37 million acres. At a more local level, Western North Carolina is known as the Mountain Region, as it includes the Appalachian Mountains, with the Great Smoky, and Blue Ridge mountain ranges. The Nantahala and Pisgah NFs are located within this area along with the Great Smoky Mountains National Park and the home of the Eastern Band of Cherokee Indians (the Cherokee Qualla Boundary). The Blue Ridge Parkway passes through the Nantahala and Pisgah NFs. The mountains, valleys, rivers, waterfalls, small towns and associated culture are such that the area is congressionally

designated as the Blue Ridge National Heritage Area. Within and across the Nantahala and Pisgah NFs there is diversity in population, economies, culture and lifestyle, amount of Forest Service lands.

The economic analysis area consists of 18 counties in Western North Carolina that are adjacent to, or in the immediate vicinity of the Nantahala and Pisgah NFs. These 18 counties are Avery, Buncombe, Burke, Caldwell, Cherokee, Clay, Graham, Haywood, Henderson, Jackson, Macon, Madison, McDowell, Mitchell, Swain, Transylvania, Watauga, and Yancey. The largest counties, in terms of land area, are Buncombe, Burke, Haywood, Macon, and Swain County all with more than 500 square miles. Cherokee, Graham, Jackson, Macon, McDowell, and Transylvania Counties, have the greatest number of National Forest System acres.

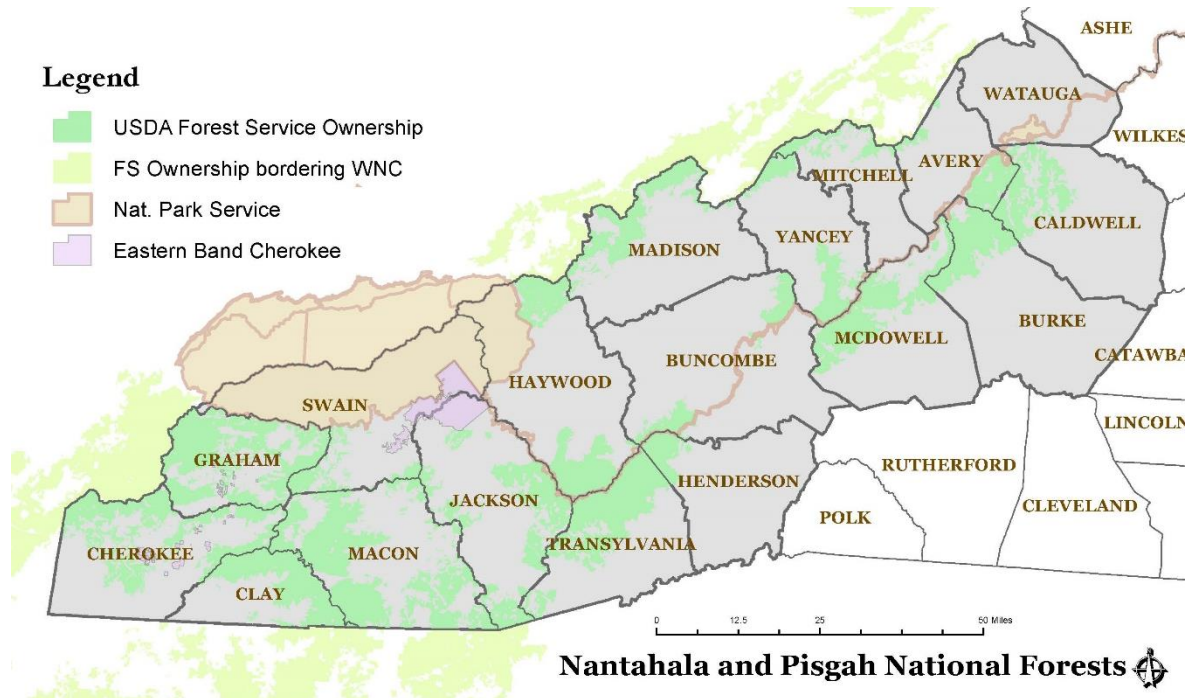


Figure 124. Economic analysis area

Very high public use, complex and highly diverse ecosystems, and a land base spread over 18 counties, which is intermingled with private property interact to form a challenging environment for managing the Nantahala and Pisgah NFs. The relationship between the geographic area and its resources and the people who live and visit is very important. For example, each county in Western North Carolina has a County Heritage Plan, which emphasizes the natural and the cultural attributes of the area and the links between them.

Western North Carolina contains few major urban centers; however, it is nestled in the southern Appalachian Mountains between Atlanta, GA; Greenville, SC; Charlotte, NC; and Knoxville, TN. The 18 county area containing the Nantahala and Pisgah NFs includes the urban population centers Asheville, Boone, Hendersonville, Waynesville, and Black Mountain. Additionally, Western North Carolina has several colleges and universities, most notably Appalachian State University in Boone, the University of North Carolina at Asheville, Western Carolina University in Cullowhee, Warren Wilson College in Swannanoa, and Brevard College in Brevard. The area is connected to other regions by two interstate highways; I-40, running from Tennessee southeast toward the Piedmont, and I-26, running north/south

through the most populated counties in the region. Largely a rural area, most of the region is connected by State highways.

The area is home to many third- and fourth-generation residents. In the recent past, the region experienced an influx of retired residents and second-home owners, both groups citing the natural beauty and cultural opportunities of the area as major reasons for their move.

Social, cultural, and economic factors have changed dramatically since the 1960s. Additionally, steady population increases since the 1960s have resulted in a change in the values and lifestyles from previous generations, especially regarding the use and preservation of natural resources. Long-time residents depended on natural resources to make a living and to provide a setting for traditional events and activities; therefore, generally favor use and conservation of natural resources. New residents, often relocating from large cities outside the region, are more inclined to see natural resources set aside and preserved for the ecological and aesthetic services they provide. This dichotomy of views continues to challenge the region to plan for and achieve sustainable outcomes.

The larger metropolitan areas have grown faster than the rural counties and these areas have been better able to withstand economic downturns as their economics became more diversified. Arts, entertainment, and recreation represent a significant growth sector in the region, with Buncombe, Watauga, Henderson, and Jackson counties being the major centers for these activities. In addition, the region is recognized for its wilderness and roadless areas which are limited resources in both the Southern Appalachians and the Eastern United States.

The cultural matrix of the analysis area has origins in Native American Cherokee Indian, Scots-Irish, and African traditions. The forest is an interwoven thread in the cultural relationship between the mountains and the communities, including their arts, crafts, music, religion, and lifestyles, contributing to the strong sense of place present in Western North Carolina.

## **Demographics**

As a whole, the population of the 18-county analysis area is somewhat older, less racially diverse, has a lower per capita income than the state as a whole. The percentage of homes that are second homes is higher in the 18-county area than in the state or nation as a whole, which in part reflects the area's history as a popular location for retirees.

Population is an important consideration in managing natural resources. In particular, population structure (size, composition, density, etc.) and population dynamics (how the structure changes over time) are essential to describing the consequences of forest management and planning on a social environment (Seesholtz et al. 2006). Population increases may lead to conflicts over land use, travel management, recreation activities, and values. These are conflicts that Forest Service managers attempt to balance when making management decisions.

Overall, the analysis area population grew an estimated 2.7 percent from 2010 to 2015, which was lower than the state average estimated population growth of 6.2 percent (U.S. Department of Commerce 2016b). Buncombe County had the largest estimated population (247,336 or 26.7 percent of total) and growth rate (6 percent) in the 18-county analysis area (total population 924,658). The majority of counties experienced population growth between 2010 and 2015, with the exception of Avery, Burke, Caldwell, Cherokee, Mitchell, and Yancey counties that experienced population declines.

Rapid population growth may signal expanding economic opportunities and/or desirable amenities within the analysis area. National Forest System lands provide natural amenities and employment opportunities for area residents. Growing populations and development will place greater demand on forest resources. Forest management can expect to be tasked with maintaining the quality of visitors'

experiences while providing forest products and cultural and recreational experiences to a greater number of people.

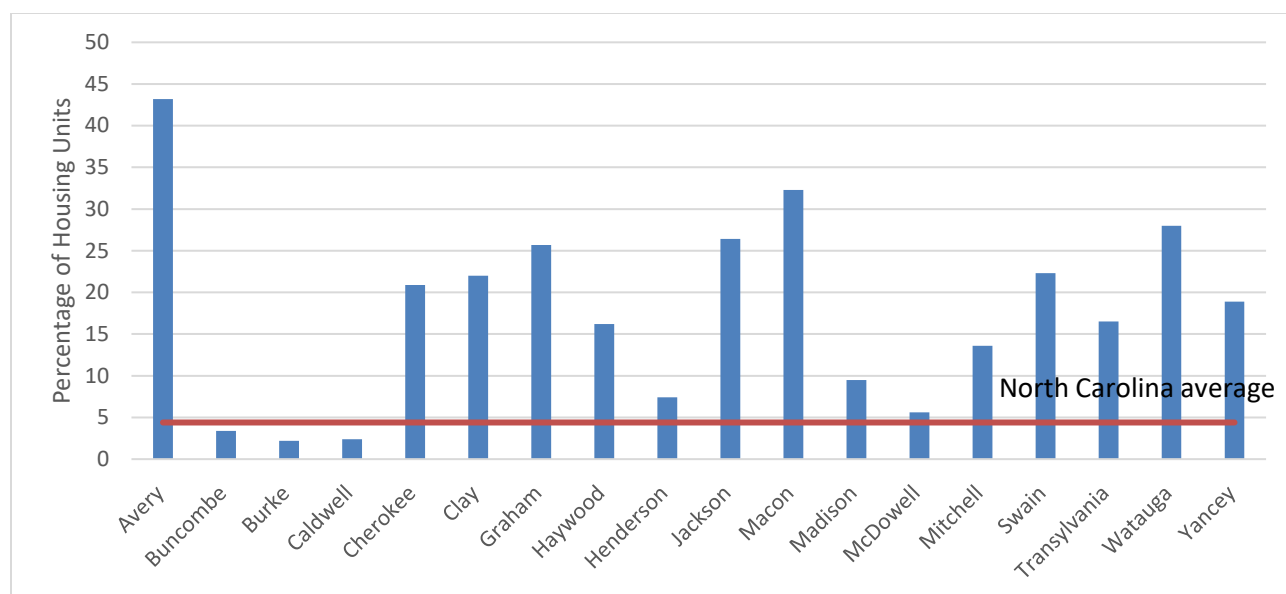
**Table 221. Population and Population Change, 2010 - 2015**

Location	2010 Population	2015 Population	% Change Pop 2000-2015	Metro/Nonmetro Status
Avery	17,951	17,695	-1.4%	Nonmetro
Buncombe	233,249	247,336	6.0%	Metro
Burke	90,557	89,548	-1.1%	Metro
Caldwell	82,162	81,758	-0.5%	Metro
Cherokee	27,317	27,092	-0.8%	Nonmetro
Clay	10,418	10,656	2.3%	Nonmetro
Graham	8,702	8,700	0.0%	Nonmetro
Haywood	58,597	59,170	1.0%	Metro
Henderson	103,881	109,719	5.6%	Metro
Jackson	39,144	40,812	4.3%	Nonmetro
Macon	33,453	33,919	1.4%	Nonmetro
Madison	20,549	21,027	2.3%	Metro
McDowell	44,593	44,961	0.8%	Nonmetro
Mitchell	15,680	15,330	-2.2%	Nonmetro
Swain	13,861	14,163	2.2%	Nonmetro
Transylvania	32,404	32,928	1.6%	Nonmetro
Watauga	49,705	52,240	5.1%	Nonmetro
Yancey	17,911	17,604	-1.7%	Nonmetro
Analysis Area	900,134	924,658	2.7%	NA
North Carolina	9,271,178	9,845,333	6.2%	NA

Source: U.S. Department of Commerce 2016b; ERS 2017

In addition to population growth, natural amenities may also drive retirement location selection and second home ownership. The analysis area saw significantly higher proportion of seasonal housing units in many of the counties (43 percent in Avery County, 32 percent in Macon County and 25 percent in Graham County, for example) relative to the state (4.4 percent) and national averages (3.5 percent).





**Figure 125. Seasonal or Occasional Use Housing (U.S. Census Bureau, 2010)**

Age data may be relevant for forest management decisions. A population's age may affect community values and uses associated with NFS lands. For example, older populations are more likely to desire easily accessible recreation opportunities. Younger populations are generally more able to participate in extreme recreation opportunities, like mountain biking or bouldering, and may demand those types of activities on the forest or indicate the need for family-friendly activities and uses, such as a trail system with ranging degrees of difficulty.

From 2010 to 2015, the percent of the total population in the analysis area 65 and over increased from 17.5 percent to 19.7 percent, whereas the increase in the state of North Carolina was from 12.6 percent to 14.2 percent (U.S. Department of Commerce 2016b). The percentage of people 65 or older is increasing more rapidly in places such as Western North Carolina because natural amenities may drive retirement location selection and second home ownership (Jaret and Baird 2013). With nearly 20 percent of the population 65 and over in 2015, planning efforts that consider how this group of the population prefers to recreate, use forest products, and access federal lands would benefit the aging population.

**Table 222. Percent of Population by Age Categories (2015)**

Location	Under 18	18 to 24	25 to 44	45 to 64	65 and over
Avery	16.0%	10.1%	25.9%	28.3%	19.7%
Buncombe	19.7%	8.5%	26.7%	27.6%	17.4%
Burke	20.5%	9.3%	23.4%	29.1%	17.7%
Caldwell	21.3%	8.3%	23.6%	29.8%	17.1%
Cherokee	18.0%	6.3%	19.3%	30.2%	26.0%
Clay	18.8%	6.7%	18.9%	28.4%	26.9%
Graham	21.4%	9.4%	19.8%	28.2%	21.2%
Haywood	18.5%	7.3%	21.8%	29.4%	23.0%

Location	Under 18	18 to 24	25 to 44	45 to 64	65 and over
Henderson	19.9%	6.6%	22.0%	27.6%	23.9%
Jackson	17.4%	18.9%	22.2%	24.8%	16.8%
Macon	18.8%	6.6%	20.3%	28.5%	26.1%
Madison	18.6%	10.7%	21.7%	29.3%	19.8%
McDowell	21.0%	7.9%	23.8%	29.2%	17.9%
Mitchell	18.7%	8.2%	21.0%	29.6%	22.4%
Swain	23.3%	7.3%	24.5%	27.0%	18.0%
Transylvania	16.9%	8.7%	18.1%	28.8%	27.6%
Watauga	13.5%	31.4%	19.2%	22.3%	13.7%
Yancey	19.2%	7.0%	22.0%	29.0%	22.8%
Analysis Area	19.2%	9.9%	23.2%	28.0%	19.7%
North Carolina	23.2%	9.9%	26.4%	26.3%	14.2%

Source: U.S. Department of Commerce 2016b

## Economy

Personal income is an indicator of the economic well-being of an area and provides a measure of all sources of income within the analysis area. High personal income may be a signal of greater job opportunities, highly skilled residents, greater economic resiliency, and well-developed infrastructure; while low personal income is often a reflection of poor economic conditions and relatively few economic opportunities available within a region. Total personal income in the analysis area was about \$33.3 billion dollars in 2015, which was 8 percent of the total personal income in North Carolina (\$415 billion) (U.S. Department of Commerce 2016a). Personal income in the analysis area has grown much less rapidly than total personal income across the state. Between 2000 and 2015, total personal income in North Carolina grew by 34.5 percent while total personal income within the analysis area grew by 20.9 percent (adjusted for inflation and reported in 2016 dollars; U.S. Department of Commerce 2016a).

Per capita personal income measures average income per person in a region. As shown by Figure 126, Buncombe and Henderson counties were the only counties with per capita income greater than the average for North Carolina. Cherokee and McDowell counties had the lowest per capita income levels, which could suggest that these areas are more dependent on public services and resources. Per capita personal income has increase between 2000 and 2015 both across the state as a whole (8.2 percent) and analysis area (6.1 percent). Although both personal income and per capita income within the analysis area have grown, they continue to grow at a slower rate than that of the state.

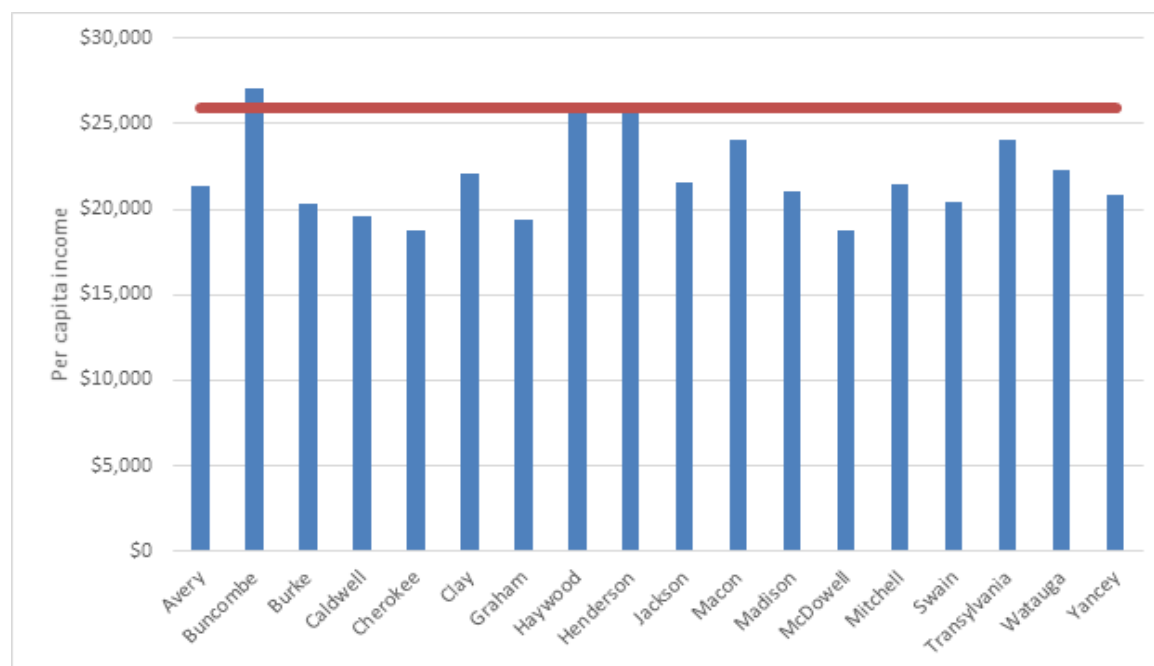


Figure 126. 2015 Per Capita Income (U.S. Department of Commerce, 2016b)

Per capita income considers all sources of income (including wages and salary payments, transfer payments, investment earnings, dividends, and rents), but offers an incomplete picture of the economic well-being of an area. Median earnings for workers consider only wage and salary earnings. Median earnings in all counties in the analysis area are below the state and national medians. Median earnings are more than 25 percent higher than per capita income in Burke, Caldwell, McDowell, Swain, and Yancey counties, which suggests that employed residents of these counties have higher incomes than individuals who do not derive income from employment (e.g., retirees). In contrast, median earnings are 40 percent lower than per capita income in Watauga County, which suggests that retirees and/or non-workers have higher incomes than workers in the county.

Table 223. Median Earnings for Workers (\$2016)

Geography	Estimate
Avery	\$21,517
Buncombe	\$27,388
Burke	\$25,833
Caldwell	\$25,802
Cherokee	\$22,419
Clay	\$22,974
Graham	\$22,699
Haywood	\$27,748
Henderson	\$27,476
Jackson	\$21,186
McDowell	\$25,525

Geography	Estimate
Macon	\$23,423
Madison	\$24,396
Mitchell	\$26,033
Swain	\$26,170
Transylvania	\$21,859
Watauga	\$13,632
Yancey	\$26,847
North Carolina	\$29,280
United States	\$31,334

Source: US Census Bureau, 2018

Both labor and non-labor income are used to understand total personal income. Non-labor income is any income derived from investments, dividends, rents, or transfer payments. In contrast, labor income is salary and wage disbursements from employment. Figure 127 displays the role of both from 2000 to 2016. During the past decade, the percentage of total income derived from non-labor sources increased in the analysis area.

This increase in non-labor income may reflect changing demographic characteristics. Because older populations rely largely on non-labor income, including rents, dividends, and transfer payments (e.g., Social Security), high percentages of non-labor income likely indicate higher concentrations of retirees. Over half of the increase in non-labor income between 2000 and 2016 is attributable to the increase in age-related transfer payments, including social security and Medicare (U.S. Department of Commerce, 2017).

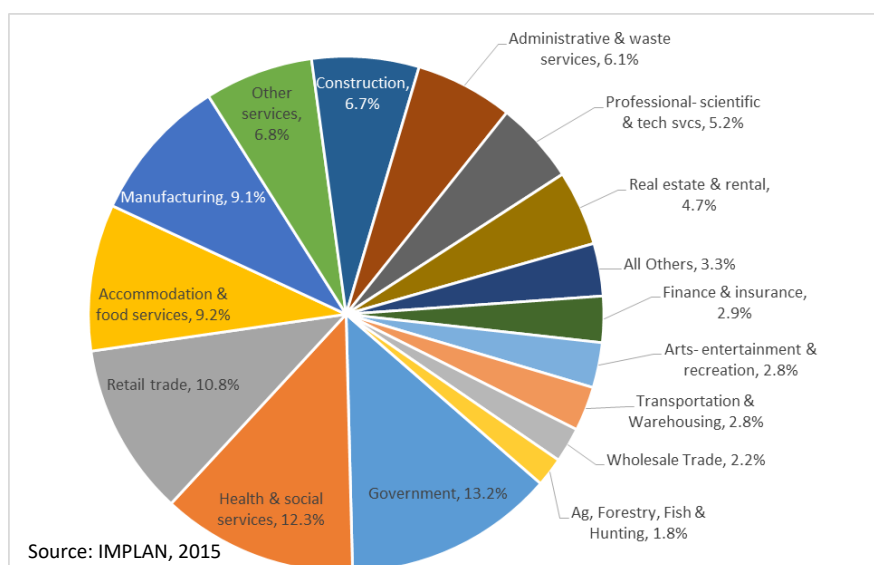
Non-labor income is not directly tied to employment; therefore, it can be more resistant to economic downturns. However, as the most recent recession demonstrated, asset markets can be quite volatile, and non-labor income that depends on investment returns may be unstable.



**Figure 127. Labor and Non-Labor Earnings in 18-County Analysis Area, 2000-2016**

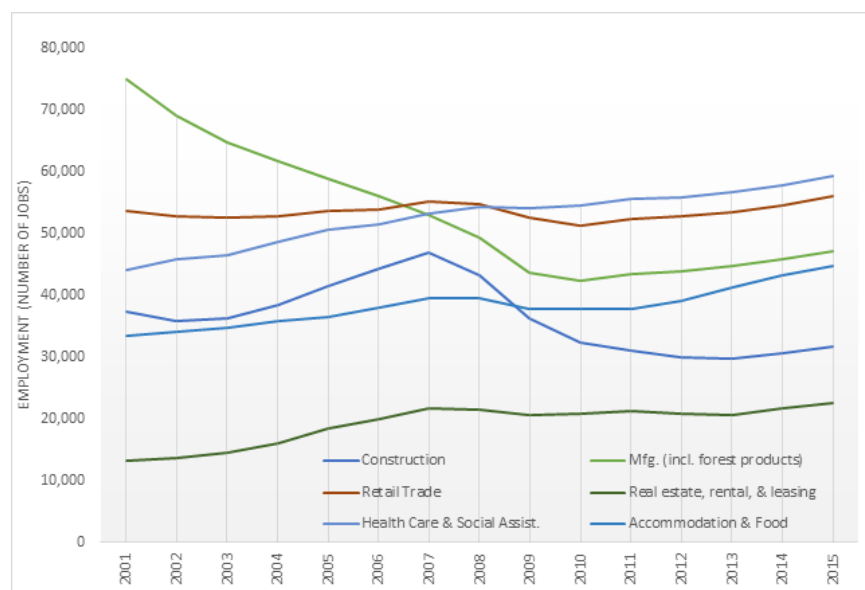
## Employment

Assessing employment by industry sector helps identify industries which are important to the local economy surrounding the national forests. Total employment in the 18-county analysis area increased from 460,777 to 491,854 jobs between 2000 and 2015 (a 6.7 percent increase). During the same time period, the total employment in North Carolina increased by 16.6 percent (U.S. Department of Commerce 2016a). Portions of the analysis area were historically resource extraction-based economies that depended on mining and timber harvest to support their communities. While some communities still depend on these sectors, the composition of the economies is changing. The distribution of employment among economic sectors is displayed in Figure 128. In 2015, the government (13.2 percent), health and social services (12.3 percent), and retail trade (10.8 percent) sectors contained the largest shares of employment in the analysis area (IMPLAN 2015). A portion of employment in many industries can be directly or indirectly attributed to the Nantahala and Pisgah NFs but not all employment is attributable; employment contributions provided by the Nantahala and Pisgah NFs are discussed below in the Economic impact analysis section.



**Figure 128. Employment by Industry in Analysis Area**

Of particular interest are the industries that could be affected by Nantahala and Pisgah NFs forest management. Construction and manufacturing employment has generally declined over the past fifteen years, whereas health care, accommodation, and real estate industries have seen overall increases in employment (U.S. Department of Commerce 2016a). Accommodation, real estate, and retail trade are often associated with tourism, which could be attributed to Nantahala and Pisgah NFs recreation opportunities.



**Figure 129. Employment trend by selected industries in analysis area (U.S. Department of Commerce 2016a)**

Though job creation is perceived as desirable, much of this growth can be attributed to growth in services-related industries, which generally pay lower wages than those in non-services sectors. Analysis area jobs in service-related sectors paid on average 31 percent less than jobs in non-services-related fields (U.S. Department of Labor 2016). Between 2001 and 2015, employment in non-services-related sectors declined by 28 percent while employment in services-related sectors increased by 27 percent (U.S. Department of Commerce 2016a). Although increases in services-related employment relative to non-services related employment may have a negative effect on wages in the region, employment in the service sector may play an important role in increasing labor participation.

The unemployment rate provides insight into the correspondence between residents' skills and employment opportunities. The "natural" rate of unemployment is said to be around 5 percent. This is the so-called "natural" rate, because this is a level that allows for movement between jobs and industries but does not signal broad economic distress. In 2016, the national unemployment rate was 4.9 percent.

The unemployment rate varied across the counties within the analysis area. Graham, Swain, and Mitchell had the highest rates of unemployment at 8.8, 6.1, and 6.1, respectively. Buncombe, Henderson, and Watauga counties had the lowest rates at 3.8, 4.2 and 4.5, respectively, in 2016. This compares to the state-wide unemployment rate of 5.1 percent.

**Table 224. Unemployment Rate, 2016**

Geography	Estimate
Avery	5.0
Buncombe	3.8
Burke	4.9
Caldwell	5.2
Cherokee	5.6
Clay	5.4
Graham	8.8

Geography	Estimate
Haywood	4.6
Henderson	4.2
Jackson	5.4
McDowell	4.8
Macon	5.4
Madison	4.9
Mitchell	6.1
Swain	6.1
Transylvania	4.9
Watauga	4.5
Yancey	5.2
North Carolina	5.1
United States	4.9

Source: Bureau of Labor Statistics, 2017.

Trends in the unemployment rate are a measure of economic resilience. Unemployment trends in the study area counties have mirrored state and national trends. There are no counties within the study area at distinct economic disadvantage to changes in the economy, although counties, such as Graham and Swain, with higher rates of unemployment are likely more vulnerable to changes in economic conditions than counties with lower rates of unemployment.

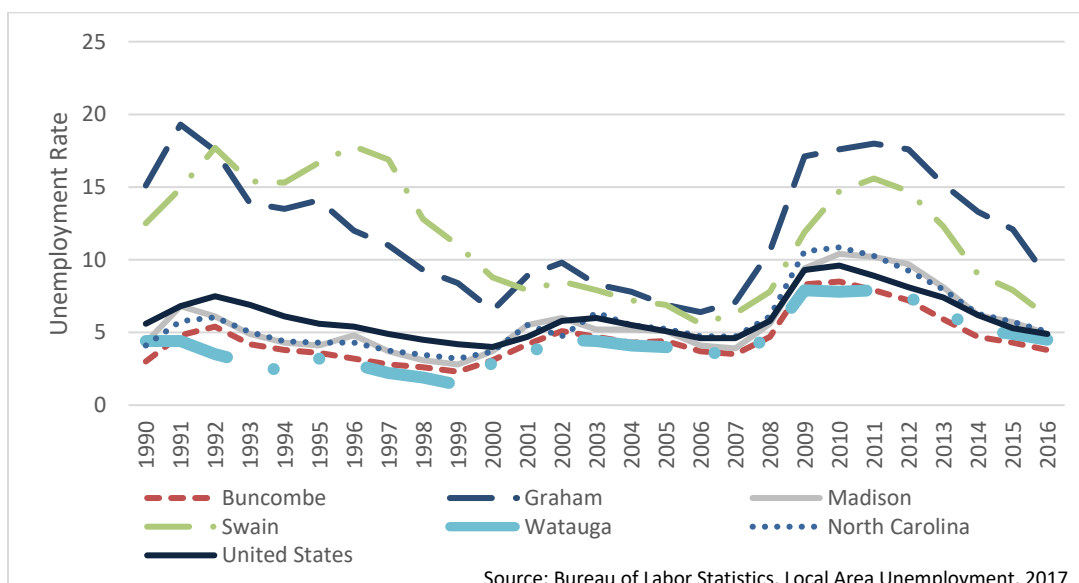


Figure 130. Unemployment rate trend, 1990-2016 (selected counties only)

## Contribution of the Nantahala and Pisgah to the broader region

The Nantahala and Pisgah National Forests make up 27 percent of all forested land in the 18-county plan area. While a high percentage of non-NFS lands across Western North Carolina are available to provide important benefits, Forest Service lands take the lead in providing forested and other natural environments available for the personal benefit of people through **recreation, spiritual use, and access** to forest products. In addition, there are national, state, county, and city parks as well as state-managed forest lands available for public use; although, many of these lands do not offer the wide range of public access and public use opportunities available on NFS land in Western North Carolina.

The WNC region is favored with abundant supplies of water and many localities depend at least in part on water coming from the NFS lands. Nantahala and Pisgah NFs supply timber to the local mills, including an element of high-quality hardwoods that may not be as available from private timberlands. Firewood, plus a wide variety of medicinal, edible, and horticultural and craft plants, is available from these National Forests by permit, whereas other public lands may not provide those benefits. The Forests contain areas of importance to members of several Native American tribes, ensuring that opportunities for traditional practices and access to sacred sites are preserved.

The Forests play an important role in sustaining the diversity of plant and animal communities present in the plan area. For example, they contain a greater proportion of high elevation forests and other high elevation ecosystems including high elevation red oak, northern hardwood, spruce-fir, and beech gap/boulder field forests and Southern Appalachian balds, than are available in the surrounding landscape. These forest communities provide habitat for many rare or uncommon species of plants and animals such as Gray's lily, spruce-fir moss spider, and Carolina northern flying squirrel. Many of the plants and animals that comprise the highly diverse Southern Appalachian ecosystems may have opportunity to thrive across the broader landscape, but those that are rare or that require special conditions may be better protected or find refuge on parts of the landscape more common within the National Forest System lands and the rare habitats found there. Additionally, as reflected by the multitude of high elevation areas, there are hundreds of miles of coldwater streams that support aquatic species of high ecological and public value, such as native brook trout.

Most of the forested land in WNC is privately owned; therefore, many residents and visitors do not have access for recreation, hunting and fishing, or forest product gathering. The Forests provide visitors and residents with that opportunity, providing access to both developed recreation areas and remote backcountry locations. The Nantahala and Pisgah NFs are among the most visited forests in the country and provide visitors with unique opportunities for a wide range of recreational activities and experiences that also provide economic support to surrounding communities.

The majority of gamelands open for hunting in WNC are located in the Nantahala and Pisgah NFs. Likewise, whitewater rafting and the economic benefits derived from outfitter guides are for the most part provided by rivers that run at least in part through NFS lands. Additionally, the preponderance of public land at the high elevations that allows for passage of the Appalachian National Scenic Trail and unobstructed views from the Blue Ridge Parkway are additional economic drivers to the local economies. These one-of-a-kind scenic attractions that are available on the Forests add to the sense of place for residents and draw tourists that contribute to local economies.

The model of a working forest is another contribution of the Nantahala and Pisgah NFs to the national context of forest management. The Pisgah NF is considered the birthplace of modern scientific forestry in North America. George Vanderbilt was the first of the large forest owners in America to adopt the practice of forestry. He hired prominent landscape architect Frederick Law Olmstead Sr. and Gifford Pinchot, who went on to become the first chief of the agency that became the U.S. Forest Service, to advise him on how to manage the property. Olmstead recommended turning the lands into a working forest managed under scientific principles common in European forestry but little used in the United



States. Pinchot's successor, Carl Schenk, established the Biltmore Forest School, the first school of forestry in the United States, in 1898. The site of the historic school is now part of the 6,540-acre Cradle of Forestry in America Historic Site which provides visitors with a glimpse of this history through its museum, events, and exhibits. After Vanderbilt's death, the National Forest Reservation Commission approved the purchase of Pisgah Forest of 86,700 acres that would become the Pisgah National Forest. When Edith Vanderbilt sold the land to the federal government, she wrote "I wish earnestly to make such a disposition of Pisgah Forest as will maintain in the fullest and most permanent way its national value as an object lesson in forestry." Maintaining the Pisgah NF with scientific forest management is a cultural value of these public lands.

## **Public values**

There is widespread support for many of the contributions provided by the forest, but maximizing multiple benefits on the same piece of ground is challenging for both managers and the capacity of the land. As more people appreciate FS resources and engage in resource uses, there is the likelihood of increased conflict due to people wanting different opportunities associated with FS resources (Brown and Reed 2000). Conflicts surrounding FS resources, resource uses, and management often stem from how individuals/groups prioritize their values—one may prioritize his/her value of recreational opportunities over another person's aesthetic value of an area.

Consideration of public values in management of the forests is important because these are public lands. Addressing or failing to address public values can affect relationships between the agency and forest stakeholders, can impact the ability to successfully implement the Plan and projects, and can cause potential impacts to communities and interest groups. Over time, values about the forest continue to develop with changing demographics, new forms of use, and new knowledge about ecology.

Public values for the Nantahala and Pisgah are as diverse as those who use and love these forests. Values have been expressed to the Forest Service during plan development, framed within thousands of written comments and personal engagement through meetings and activities. A sample of values shared with us includes: spiritual connections to nature and opportunities for renewal, the value of the forests for providing food to families, access to special places, sustaining biodiversity, harvesting and gathering locally grown forest products, preserving wild forest landscapes, providing jobs that support local industries, enhancing wildlife populations, providing opportunities for exercise and health, preserving history and historical events for society, trusting government land managers to steward the land for all Americans, working together toward shared goals, sustaining forest resources for our children and their children. These values and more are addressed throughout the revised Plan and the design of EIS alternatives.

## **Benefits to people**

As summarized in the "Contribution of the Nantahala and Pisgah to the broader region" section, the forests produce a wide range of environmental goods and services that people value. These social benefits are also known as ecosystem services, and include the following:

- Provision services, such as clean air and fresh water, energy, food, fuel, forage, wood products or fiber, and minerals
- Regulating services, such as long term storage of carbon; climate regulation; water filtration, purification, and storage; soil stabilization; flood and drought control; and disease regulation
- Supporting services, such as pollination, seed dispersal, soil formation, and nutrient cycling
- Cultural services, such as educational, aesthetic, spiritual, and cultural heritage values, recreational experiences, and tourism opportunities.

The Forest Service identified key forest benefits by reviewing public comments and attending dozens of meetings across the forest during plan development. Table 225 includes the key benefits that were identified. Many of these key benefits and their corresponding indicators are described in greater detail in the other resource sections of the EIS, identified in the table.

**Table 225. Key Benefits to People from the Nantahala and Pisgah National Forests, Alphabetical Order**

<b>Key Benefit</b>	<b>EIS Section that Describes Potential Impacts to Each Benefit</b>
Access	Roads and Transportation; Recreation
Appalachian Culture	Cultural Resources
Biological Diversity	Terrestrial and Aquatic Ecosystems and Species
Clean Air	Air Resources
Clean Water	Water Resources
Economy	Social and Economic Resources: Economy
Food (hunting, fishing, plant collection)	Terrestrial and Aquatic Ecosystems; Social and Economic Resources
Health and Well Being	Social and Economic Resources: Values
Habitat	Terrestrial and Aquatic Ecosystems and Species
Jobs	Social and Economic Resources: Economy
Recreation (including hiking, camping, hunting, fishing, family gatherings)	Recreation, Social and Economic Resources
Timber	Timber resources; Social and Economic Resources
Tourism	Social and Economic Resources: Economy
Viewing Nature	Scenery
Wildlife	Terrestrial and Aquatic Ecosystems and Species

Many of the key benefits are interrelated. Though readers will find information on these topics in other sections identified above, the following paragraphs focus on the social and economic components of these benefits.

Some goods such as timber, can easily be valued because timber can be bought and sold in markets. Other resources provided by these lands, such as recreational opportunities, ecological processes, and habitat for unique species, are harder to value through traditional means. Throughout the analysis, no attempt has been made to assign monetary values to non-market values, including ecosystem services. While not quantified, relevant non-market values and ecosystem services are represented throughout the affected environment and in other resource sections listed above.

### **Health and well-being**

One of the benefits of the Nantahala and Pisgah that was frequently expressed in Assessment meetings was of how important the national forests are to people as a place to go to relieve the stress of everyday life, thus contributing to the health and well-being of society. The presence of the Nantahala and Pisgah National Forests increase the attractiveness of local communities and regional well-being. Living in close proximity to NFS lands provides residents with greater access to open spaces, wildlands, and a wide

range of recreational opportunities. National studies have shown that while local residents may forego higher paying jobs in areas with fewer natural amenities, they gain personal enjoyment from the outdoor experiences they have on the forests. Natural amenities, often provided by public lands, have been found to influence population and employment changes in amenity rich communities (Knapp and Graves 1989; Clark and Hunter 1992; Mueser and Graves 1995; McGranahan 1999; Lewis et al. 2002; Jaret and Baird 2013).

## Recreation

The Forest Service's National Visitor Use and Monitoring survey found an estimated 5.2 million visits were made to the Nantahala and Pisgah NFs in 2018 (US Forest Service, 2020). (Note that these numbers were updated between the draft and final EIS to reflect the most recent National Visitor Use and Monitoring survey.) Recreational uses of the forests include backpacking, bicycling, camping, climbing, fishing, hiking, horseback riding, hunting, off road vehicle use, scenic driving, many water activities, and viewing nature and wildlife. Hiking/walking, viewing natural features, driving for pleasure, viewing wildlife and relaxing are the top five activities in which visitors engage. Hiking/walking is the most common main activity (the primary purpose of the forest visit), followed by viewing natural features. Many forest visitors come to enjoy the region's botanical diversity. Spring wildflowers may be seen virtually anywhere within the Nantahala and Pisgah NFs, and fall foliage from the forests' diverse hardwood is a major tourism driver.

**Table 226. Forest Activity Participation, 2018**

Activity	Percent Participation	Percent Main Activity <sup>A</sup>
Hiking / Walking	54.8	29.6
Viewing Natural Features	53.4	28.7
Relaxing	28.6	2.4
Viewing Wildlife	13.5	0.7
Other Non-motorized	12.3	5.9
Driving for Pleasure	12.1	5.1
Bicycling	11.7	10.9
Picnicking	10.1	0.6
Some Other Activity	5.7	4.2
Nature Study	4.6	0.7
Nature Center Activities	4.2	0.5
Fishing	4.1	3.4
Non-motorized Water	3.8	3.1
Developed Camping	2.9	1.9
Gathering Forest Products	1.4	0.2
Visiting Historic Sites	1.1	0.1
Hunting	1.1	1.1

<b>Activity</b>	<b>Percent Participation</b>	<b>Percent Main Activity<sup>A</sup></b>
Backpacking	1.1	0.6
Horseback Riding	0.6	0.6
Motorized Water Activities	0.6	0.1
Primitive Camping	0.5	0.2
Other Motorized Activity	0.3	0.2
Resort Use	0.3	0.1
Motorized Trail Activity	0.1	0.0

<sup>A</sup> Survey respondents were asked to select just one of their activities as their main reason for their forest visit. Some respondents selected more than one, so this column may total to more than 100 percent.

Source: USFS, 2018

The users of these forests are residents of nearby communities as well as those from more distant locations in the United States and abroad. Half of all forest visits were by those who traveled less than 50 miles to the Nantahala and Pisgah NFs. However, recreation benefits extend to people well beyond the analysis area. Forty-two percent of visitors traveled over 100 miles to recreate on the Nantahala and Pisgah NFs.

Visitors to national forests spend money on lodging, restaurants, gasoline, entry fees, and souvenirs. These purchases support employment and income in communities that surround NFS lands. Visitor spending is influenced by both the type of trip (local or non-local; day or overnight) and the type of recreation activities. The National Visitor Use and Monitoring survey collects data on visitor spending allowing estimation of economic contributions to the local economies (White, 2017). The economic contributions of recreation visitors are discussed in the Environmental Consequences section below. In addition, the Economic Assessment provides a more detailed overview of the travel and tourism contributions to western North Carolina (USFS, 2014).

Other studies of economic contribution have been completed to specifically address the economic contribution of mountain biking, paddling and climbing, for example, on the Nantahala and Pisgah NFs (Maples and Bradley 2017a, 2017b, 2017c). These studies, using a convenience sample, estimate a total of 874,231 visits by climbers, mountain bikers, and commercial and non-commercial paddlers, annually. They also present estimates of visitor spending and the related economic contributions to the local economy by this group of users. The Maples and Bradley studies have not been peer reviewed, but regardless they suggest a significant group of people who value the National Forest's ability to support diverse recreational activities, and also these users' positive impact on local economies through recreation services and tourism.

A 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, a joint effort by the U.S. Fish and Wildlife Service and the U.S. Census Bureau, indicates that in 2011, 1.6 million state resident and nonresidents 16 years old and older fished or hunted in North Carolina (U.S. Department of Interior et al., 2011). This group was comprised of 1.5 million anglers (93 percent) and 335 thousand hunters (21 percent). An estimated 2.4 million participated in wildlife-watching activities, which includes observing, feeding, and photographing wildlife. However, only 29 percent of these participated in wildlife viewing activities more than one mile from their home. Combined, an estimated \$3.3 billion is spent on wildlife recreation in North Carolina. The results of this study cannot be restricted to only National Forest visitors, however it serves to illustrate the great number of people who value the North Carolina

landscapes that support these recreational activities and the positive impact these users have on the economy of the state.

Other state-wide studies of recreation activities, for example mountain trout fishing (Responsive Management, 2015), and recreational horseback riding (American Horse Council Foundation, 2018), also estimate the signification recreation participation and associated economic contributions to the North Carolina economy. These studies do not estimate the contribution attributable directly to the Nantahala and Pisgah NFs, but again illustrate the large recreation economy of which the recreation opportunities on Nantahala and Pisgah NF land are a part.

Spending time with family was also an important benefit of the forest that was mentioned during plan development. The forest offers places for families to gather for large family reunions and gatherings that develop into family traditions. Having the opportunity to share favorite places with future generations of family is a cultural value.

A comprehensive report on recreation by Cordell (2012) indicates that demand for recreation activities has been and will continue to increase through 2060, with wildlife viewing, sightseeing, and visiting historic places increasing the most.

### **Food: Fishing, Hunting, and Plant Collecting**

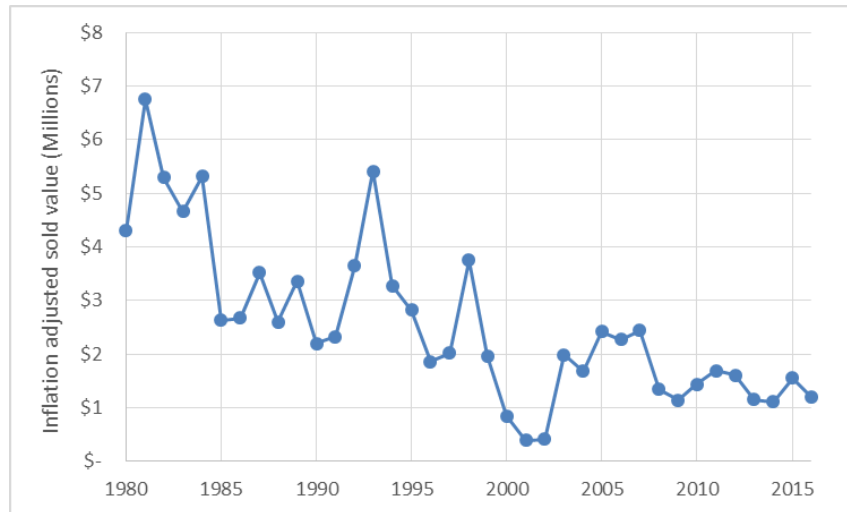
Gathering and trading of plants, lichens, and fungi from forests in the United States has been important for generations. Native Americans had well-established trade routes throughout the land for thousands of years. As other groups came to North America, trade in these products expanded to Asia and Europe, and plant collection is part of the region's cultural tradition. Plants that collected on the forest include plants used for healing and preventative medicine (such as ginseng, black cohosh, bloodroot) edibles (berries, mushrooms, ramps), florals (galax, ferns), horticulturals (tree saplings, Fraser fir seedlings and cones), crafting materials (mountain laurel rhododendron), firewood and locust posts. Permits are required for collection of most gathered forest products and collecting of some species such as ginseng is limited.

The tradition of hunting and fishing for food is also deeply rooted in these forests. With the acquisition of the Biltmore lands, the Federal government established the Pisgah National Forest and Pisgah National Game Preserve in 1916. At that time, the Pisgah area was proposed as a game refuge for the preservation of the fauna of the mountains. The area was well stocked with game and fish, including deer, turkey, and pheasant, while the streams were stocked with rainbow and brook trout. Today, hunting and fishing are still valued, not just as part of culture, but for subsistence and a way of life. Data from big game protein harvested on public gamelands from 2015-2016 across the Nantahala and Pisgah counties shows that the hunted deer, bear, and turkey alone provided protein for more than 285,000 meals.

### **Timber**

Historically, forest products were a major contribution of national forest lands. However, as seen in Figure 131, there has been a decreased supply of forest products and corresponding sold value, which has likely affected local economies that once depended on the resource to support jobs, income, and a way of life. While the Nantahala and Pisgah NFs' contributions from the timber program to the local

economy may be smaller than historically, in the context of regional and state markets, it is nevertheless important to the local timber industry.



**Figure 131. NFs in North Carolina sold value trend of forest products (U.S. Department of Agriculture 2017)**

In 2015, employment in the commercial logging sector provided about 355 jobs and the sawmills sector accounted for about 507 jobs in the analysis area, which is collectively about 0.2 percent of the total employment in the analysis area (IMPLAN 2015). While the size of the timber sector is small relative to the regional economy, jobs in resource extraction sectors continue to be important to smaller communities whose economies have historically been dependent on natural resource sectors. The average wage in natural resource extraction sectors is high compared to wages in recreation-related sectors. For example, the average wage in the sawmill sector in 2015 was about \$40,714 (IMPLAN 2015).

## Tourism

The users of these forests are residents of nearby communities as well as those from more distant locations in the United States and abroad. The majority of visitors (53 percent) to the Nantahala and Pisgah NFs traveled less than 50 miles. The top 15 most commonly reported zip codes of survey respondents are all within the 18-county analysis area. However, recreation benefits extend to people well beyond the analysis area. Thirty-eight percent of visitors traveled over 100 miles to recreate on the Nantahala and Pisgah NFs.

Visitors to national forests spend money on lodging, restaurants, gasoline, entry fees, and souvenirs. These purchases support employment and income in communities that surround NFS lands. Visitor spending is influenced by both the type of trip (local or non-local; day or overnight) and the type of recreation activities. The National Visitor Use and Monitoring survey collects data on visitor spending allowing estimation of economic contributions to the local economies. The economic contributions of recreation visitors is discussed in the environmental consequences section below. In addition, the Economic Assessment provides a more detailed overview of the travel and tourism contributions to Western North Carolina (USFS 2014).

## Wilderness

Wilderness is often seen as the counterpoint to economic development of forest resources because wilderness designation restricts land management activities and uses. There have been no peer reviewed studies that have found adverse effects on regional economies due to the designation of wilderness areas (Hjerpe, et al. 2017).

Despite the fact that Wilderness designation requires foregoing short-term economic gains in resource extractive industries, some studies have found that Wilderness has increased long-term regional economic development opportunities (Holmes et al. 2015). Amenities provided by wilderness areas, for instance, scenic values and recreational opportunities, are strong attractors to mobile entrepreneurs, professionals, and retirees. A number of studies have found that protected lands attract new residents and businesses, which contribute to economic growth (Rudзитis and Johnson 2000; Deller et al. 2001). The term amenity migrants has been coined to describe people who relocate to amenity rich regions. Amenity migrants bring with them social, human, and financial capital that are in turn are invested in community and regional markets and increase the economic base. To consider the economic benefits of wilderness, it is necessary to look beyond per unit economic impacts and consider the economic impact on overall community and regional economic development (Power 1992; Holmes et al. 2015). Communities that offer amenity values that enrich resident's quality of life and the character of the community, such as wildlife viewing opportunities, hiking, scenic views, water quality, and air quality, are competitive in attracting resource rich mobile entrepreneurs, professionals and retirees. This is one reason many rural communities see conserving amenity values as a core element of economic development strategies.

### **Other economic benefits: payments to states and counties**

The Nantahala and Pisgah NFs make payments to states and local governments through two programs. These are Federal Payments In-Lieu of Taxes (PILT) and Forest Service county payments--the Secure Rural Schools Act (SRS) or the Federal 25-Percent Fund.

Counties receive revenue sharing payments from commercial activities on Federal lands, such as oil and gas leasing and timber harvesting. For national forests, beginning in 1908 the payment was 25-percent of the moneys received annually. Since 2008 the payments are based on 25-percent of the 7-year rolling average annual receipts. These payments are commonly called 25-percent payments. However, in response to declining timber receipts, the Secure Rural Schools and Community Self-determination Act (SRS) was passed in 2000 which offered a guaranteed source of payments that was not tied to annual commercial revenue on national forests. All North Carolina counties, with the exception of Madison County, with Nantahala and Pisgah NFs lands elected to receive the Secure Rural Schools Act State Payment share in fiscal year 2017 and not the 25-percent payments. Counties could change their election between SRS and 25-percent payments if changes in revenues made it advantageous to do so. Table 227 shows the county total and per-acre revenue from Secure Rural School and 25-Percent Forest Service payments in fiscal year 2017.

**Table 227. SRS and 25-Percent Payments, FY2017**

<b>County</b>	<b>Total Payment FY17</b>	<b>Average Payment per Acre</b>
Avery	\$41,944.99	\$1.39
Buncombe	\$24,249.15	\$0.81
Burke	\$69,565.95	\$1.40
Caldwell	\$67,274.92	\$1.43
Cherokee	\$164,790.03	\$1.77
Clay	\$110,529.00	\$1.66
Graham	\$200,654.94	\$1.76

County	Total Payment FY17	Average Payment per Acre
Haywood	\$66,903.93	\$0.97
Henderson	\$18,392.96	\$0.97
Jackson	\$90,941.58	\$1.18
Macon	\$172,961.74	\$1.13
Madison <sup>a</sup>	\$11,264.31	\$0.20
McDowell	\$105,022.38	\$1.49
Mitchell	\$27,389.44	\$1.44
Swain	\$32,116.52	\$1.39
Transylvania	\$95,236.54	\$1.08
Watauga	\$518.39	\$1.33
Yancey	\$54,558.42	\$1.43
<b>Total</b>	<b>\$1,354,315.19</b>	<b>\$1.27</b>

<sup>a</sup> Madison County elected to receive the 25 percent 7 year rolling average payment and not the SRS payment.

Source: US Forest Service, 2018

Federal lands are exempt from property taxes, but counties receive payments-in-lieu-of-taxes (PILT) from federal lands in their jurisdiction. PILT payments help local governments carry out such vital services as firefighting and police protection, construction of public schools and roads, and search-and-rescue operations. The payments are made annually for tax-exempt Federal lands administered by the Bureau of Land Management, the National Park Service, the U.S. Fish and Wildlife Service (all bureaus of the Interior Department), the U.S. Forest Service, and for Federal water projects and some military installations (U.S. Department of the Interior 2016). As seen in Table 228, Cherokee, Clay, Graham, Macon, and Madison counties received all of their 2016 PILT payments as a result of the FS land in the counties (U.S. Department of the Interior 2016).

**Table 228. Payments In-Lieu of Taxes, 2016**

Location	Total Payment	FS as Percent of Total PILT Acres
Avery	\$79,904	95.2%
Buncombe	\$83,010	92.6%
Burke	\$130,622	98.3%
Caldwell	\$122,181	99.4%
Cherokee	\$241,504	100%
Clay	\$172,773	100%
Graham	\$294,950	100%
Haywood	\$340,604	52.6%



Location	Total Payment	FS as Percent of Total PILT Acres
Henderson	\$32,514	98.3%
Jackson	\$199,044	96.0%
Macon	\$341,802	100%
Madison	\$140,795	100%
McDowell	\$154,916	98.5%
Mitchell	\$51,557	97.2%
Swain	\$623,517	9.6%
Transylvania	\$214,065	98.9%
Watauga	\$24,291	4.2%
Yancey	\$100,322	98.4%
Analysis Area	\$3,348,371	77.3%

Source: U.S. Department of the Interior 2016

## Grazing

Grazing in the traditional sense as seen on western national forests does not occur in either Nantahala or Pisgah NFs. Grazing is used as a tool for maintaining Southern Appalachian balds, such as those associated with Roan Mountain. No animal unit month targets or objectives are associated with the 1987 Plan.

## Environmental Consequences

### Demographics

Under all alternatives, growing populations and development will place greater demands on public land resources and may affect the perceived aesthetics and uses associated with National Forest System lands. Public land managers can expect to be tasked with maintaining the quality of visitors' experiences while providing forest products and cultural and recreational experiences to a greater number of people.

Increased population of residential areas surrounding National Forest System lands also increases the region's need for infrastructure and may place greater pressure on the National Forest System to provide utility right-of-ways, for example, to meet the region's growing infrastructure needs. These pressures may threaten the public lands role in contributing to sense of place and the quality of life in surrounding communities (Stedman 2003). Alternatively, if future proposals are declined or routed away from the forest, then this may impact services to the surrounding communities.

### Economy

#### Economic impact analysis

Economic impact analysis estimates economic consequences of forest management actions. Estimates of employment, labor income and value added are discussed and reported below.

As this analysis was updated between the draft and final EIS, it was updated to reflect the newest round of NVUM estimates. NVUM reports an increase in total recreation visits to the Nantahala and Pisgah NFs over the previous survey round. Relative to the results reported in the DEIS there are less wildlife-

related visits and a larger portion of those visits are from local visitors. This partly drives the changes in estimated economic impacts relative to those reported in the DEIS.

This analysis was also updated to reflect information about timber processing. The DEIS assumed that only a portion of the timber harvested was processed within the 18-county analysis area. This was based on information from the USDA Forest Service Forest Inventory and Analysis Timber Product Output Database. The FEIS refines this general assumption and the results of the analysis show the impact when all timber harvested is processed within the 18-county analysis area.

Table 229 provides total employment estimates, by alternative. Recreation accounts for the majority of Nantahala and Pisgah NF-related employment under all alternatives. Changes in timber volume provide the only quantitative differences in resource outputs used for this analysis and therefore differences in estimated jobs and income across alternatives. Variation between alternatives in terms of economic consequences is small. In the DEIS, the average was reported to avoid implying the estimated differences are meaningful given actual resource use will fluctuate based on local and global market conditions. In this FEIS, Alternative E is shown separately since this is new information, however the variation between alternatives remains small. A larger estimated increase in economic impact results from the increase in estimated timber volume outputs between Tier 1 and Tier 2.

**Table 229. Total Employment Contribution by Program Area, by Alternative**

Resource Area	Total Number of Jobs Contributed <sup>C</sup>				
	Alt A: Current	Avg of Alts B, C, D, Tier 1	Avg of Alts B, C, D, Tier 2	Alt E: Tier 1	Alt E: Tier 2
Forest Service Expenditures <sup>A</sup>	445	445	445	445	445
Minerals	<1	<1	<1	<1	<1
Payments to States/Counties	114	114	114	114	114
Recreation, general (non-wildlife and fish-related) <sup>B</sup>	2,494	2,494	2,494	2,494	2,494
Recreation, wildlife and fish-related <sup>B</sup>	99	99	99	99	99
Timber	126	265	657	272	654
<b>Total Forest Management</b>	<b>3,280</b>	<b>3,419</b>	<b>3,811</b>	<b>3,425</b>	<b>3,808</b>
Percent Change from Current	---	4.2%	11.4%	4%	16%

<sup>A</sup> Forest Service expenditures is estimated based on the employment and budget of the National Forests of North Carolina, which includes Nantahala, Pisgah, Uwharrie and Croatan National Forests. Data is available at this budgeting unit.

<sup>B</sup> Recreation visits in the National Visitor Use Monitoring are distinguished by those that are Wildlife and fish-related and those that are not. Wildlife and fish-related recreation includes viewing wildlife, fishing, and hunting as the primary activity during visit.

<sup>C</sup> These estimates reflect the total job contributions. Total job contributions are the sum of direct and secondary contributions. This is discussed in the Appendix.

Source: FS estimates using IMPLAN 2016

Program area contributions map to diverse sectors of the local economy. For example, the top two sectors with the most Nantahala and Pisgah NFs recreation-related employment are retail trade, and accommodation and food services. These sectors are, in part, associated with the tourism economy, which is supported by the Nantahala and Pisgah NFs and other public and amenity providing lands in the analysis area.

Table 230. **Labor Income by Program Area, by Alternative** provides labor income estimates by alternative. As with the employment estimates, recreation and Forest Service expenditures account for the majority of Nantahala and Pisgah NFs contributions to local economic activity.

**Table 230. Labor Income by Program Area, by Alternative**

Resource Area	Thousands of 2016 dollars				
	Alt A: Current	Avg of Alts B, C, D: Tier 1	Avg of Alts B, C, D: Tier 2	Alt E: Tier 1	Alt E: Tier 2
Forest Service Expenditures <sup>A</sup>	\$27,681	\$27,681	\$27,681	\$27,681	\$27,681
Minerals	\$12	\$12	\$12	\$12	\$12
Payments to States/Counties	\$4,918	\$4,918	\$4,918	\$4,918	\$4,918
Recreation, general (non-wildlife and fish-related) <sup>B</sup>	\$68,814	\$68,814	\$68,814	\$68,814	\$68,814
Recreation, wildlife and Fish-related <sup>B</sup>	\$2,816	\$2,816	\$2,816	\$2,816	\$2,816
Timber	\$4,869	\$12,372	\$30,267	\$12,621	\$29,900
<b>Total Forest Management</b>	<b>\$109,110</b>	<b>\$116,613</b>	<b>\$134,508</b>	<b>\$116,862</b>	<b>\$134,141</b>
Percent Change from Current	---	7%	23%	7%	23%

<sup>A</sup> Forest Service expenditures is estimated based on the employment and budget of the National Forests of North Carolina, which includes Nantahala, Pisgah, Uwharrie and Croatan National Forests. Data is available at this budgeting unit.

<sup>B</sup> Wildlife and fish-related recreation includes viewing wildlife, fishing, and hunting as the primary activity during visit.

Source: FS estimates using IMPLAN 2016

The labor income data show differences in income per job by program area. For instance, recreation-related jobs provide approximately \$27,500 in labor income, on average, timber-related jobs average \$38,500 in labor income, and Forest Service expenditures provide, on average, \$62,000 in labor income per job. These findings reveal that jobs supported by Forest Service expenditures pay well compared to jobs supported by timber and recreation activities on the Nantahala and Pisgah NFs. Timber and recreation-related employment is more likely to be seasonal, which contributes to the lower earnings.

The sectors with the most Nantahala and Pisgah NFs related labor income are government, accommodation and food services, and retail trade. Many of these sectors are associated with the tourism economy.

**Table 231. Final Value Added by Program Area, by Alternative**

Resource Area	Thousands of 2016 dollars				
	Alt A: Current	Avg of Alts B, C, D: Tier 1	Avg of Alts B, C, D: Tier 2	Alternative E: Tier 1	Alternative E: Tier 2
Forest Service Expenditures <sup>A</sup>	\$33,305	\$33,305	\$33,305	\$33,305	\$33,305
Minerals	\$32	\$32	\$32	\$32	\$32

Resource Area	Thousands of 2016 dollars				
	Alt A: Current	Avg of Alts B, C, D: Tier 1	Avg of Alts B, C, D: Tier 2	Alternative E: Tier 1	Alternative E: Tier 2
Payments to States/Counties	\$6,781	\$6,781	\$6,781	\$6,781	\$6,781
Recreation, general (non-wildlife and fish-related) <sup>B</sup>	\$108,086	\$108,086	\$108,086	\$108,086	\$108,086
Recreation, wildlife and Fish-related <sup>B</sup>	\$4,414	\$4,414	\$4,414	\$4,414	\$4,414
Timber	\$7,620	\$20,505	\$50,114	\$20,938	\$49,411
Total Forest Management	\$160,237	\$173,122	\$202,731	\$173,556	\$202,028
Percent Change from Current	---	8%	27%	8%	26%

<sup>A</sup> Forest Service expenditures is estimated based on the employment and budget of the National Forests of North Carolina, which includes Nantahala, Pisgah, Uwharrie and Croatan National Forests. Data is available at this budgeting unit.

<sup>B</sup> Wildlife and fish-related recreation includes viewing wildlife, fishing, and hunting as the primary activity during visit.

Source: FS estimates using IMPLAN 2016

### Common to all alternatives

Under all alternatives, employment and labor income supported by activities on the Nantahala and Pisgah NFs account for approximately 0.5 percent of study area employment and labor income. This economic impact analysis considers only the market transactions that result from activities on the Nantahala and Pisgah NFs. Numerous non-market social and economic values are associated with the Forests and are discussed below. The value of ecosystem services, such as, clean air and water, are not captured in the economic impact analysis. Therefore, the analysis in this section should not be conflated with a representation of the total economic value of the Forest.

**Minerals:** Under all alternatives, mineral activities on the Nantahala and Pisgah NFs supports less than one job, annually. This material supports regional infrastructure (for example, aggregate replacement for roads, rip rap and other materials for flood repairs) and for local and/or regional economic development (aggregate and construction materials for residential, commercial, and public works projects, for example). Therefore, the mineral program contributes jobs, income, and raw materials to the local and national economy under all alternatives. The Minerals and Energy section of the EIS discusses current mineral use and mineral potential.

**Recreation:** An estimated 5.2 million visits were made to the Nantahala and Pisgah NFs in 2018. The expenditures of local and non-local visitors to the Nantahala and Pisgah NFs are estimated to support approximately 2,594 jobs and \$71.6 million in labor income, annually. Recreation-related employment is substantial relative to other resource areas on the Nantahala and Pisgah NFs. Recreation visitor spending is the largest single source of economic activity associated with Nantahala and Pisgah NFs management.

Nantahala and Pisgah NFs would continue to support a wide range of recreational experiences which contribute to the local quality of life and stimulate economic activity under all alternatives. Managing sustainable outdoor recreation opportunities with decreasing budgets and an increasing user population is a challenge the Forest is already confronting. All alternatives encourage collaboration with communities, tourism providers, recreation enthusiasts, and other stakeholders which is intended to

maintain recreation experiences that are economically beneficial as well as socially and ecologically sustainable in the long term. Additional recreation effects are discussed under Recreation Effects.

**Payments to States/Counties:** As noted in the section above, the Nantahala and Pisgah NFs support payments to local governments through the PILT and SRS programs. These payments would support approximately 114 jobs and \$4.9 million in labor income annually under all alternatives. PILT payments are not a function of forest management and are not expected to vary across alternatives. SRS payments are not a function of forest revenues, while 25-percent payments are. Counties that elect SRS rather than 25-percent payments would not see a change in county payments resulting from changes in timber sales under any alternatives. Seventeen counties in the 18-county analysis area elected to receive the SRS payments in 2017. The one county that has elected the 25-percent payment would be affected by the variation in forest revenues resulting from forest product removal across alternatives. In the future, counties may elect to switch payment programs should that be advantageous to them. No estimates of county payment variation are included in this analysis. PILT and SRS programs offer local economic stability in the form of jobs and labor income.

**Forest Expenditures:** National Forests of North Carolina, including Nantahala and Pisgah NFs, salary and non-salary (e.g., field and office equipment and supplies) expenditures support approximately 445 jobs and \$27.7 million in labor income in the local economy, annually. The expenditures reflect direct Forest Service employees and, indirect and secondary contributions, such as jobs created from non-salary expenditures and the multiplier from Forest Service employees living and spending salaries in the analysis area. Forest budgets may fluctuate over the life of the management plan but are not dictated by management plan or alternatives. Forest budgets are distributed by an act of Congress and therefore no variation is modeled. Forest Service employment and expenditures offers local economic stability in the form of jobs and labor income.

## **Public values**

### **Alternative A**

Alternative A would continue to implement the 1986 Forest Plan as amended. With the amendment of the 1986 Plan in 1994, there was widespread public support for the increased emphasis on ecosystem management including the designation of an old growth network balanced with direction for a range of early successional habitat across management areas. Alternative A includes special attention to visually sensitive areas and provides for a range of social settings for outdoor recreation. The plan recognizes the economic contributions to the local economies as well as the importance of rehabilitating damaged ecosystems and enhancing the diversity of plant and animal communities.

While the forest goals outlined in the 1994 amendment and direction that was included in the amended plan went a long way to meeting public interests at that time, advances in our understanding of forest management and best available science provide us with opportunities to meet the changing needs of forest ecosystems and the public that utilizes them. Public engagement during the development of the Need for Change identified interests in developing a revised plan that better meets both ecological needs as well as the increased public recreation use of the Nantahala and Pisgah NFs.

### **Common to action alternatives**

Where there is broad agreement among diverse interests, the plan direction is the same for all three action alternatives. As a result of broad agreement on many resource management topics, there are only three plan components in the plan that vary between action alternatives, including two standards and one objective (more on these differences is explained below). The remaining plan desired conditions, objectives, standards, and guidelines are consistent across action alternatives.

All action alternatives emphasize ecosystem restoration and maintenance to achieve healthy ecosystems. Healthy ecosystems are most resilient for providing the provisioning, regulating and supporting benefits that people depend on from the forest, including clean air, clean water, climate regulation, nutrient cycling, etc.

Under all action alternatives, the revised plan provides an increased emphasis on social values. The forestwide plan direction includes a new section on Community Connections, which outlines desired conditions and objectives for providing benefits to local communities, and a section on public involvement and collaboration, making a commitment to continue involving members of the public in shaping activities on the ground. For example, all action alternatives include an objective to meet with local governments once a year to understand their interests in developing projects:

**COM-O-02** Every year host a discussion at the supervisor's office with interested WNC local governments or their economic development offices to foster shared actions that support local jobs, attract tourism, and encourage coordination on public health and safety issues.

This new guideline is included in the public involvement section:

**PI-G-02** In order to encourage meaningful public participation during preparation of integrated landscape projects, the Forest Service should facilitate collaboration among state and local governments and Indian tribes and participation of interested persons, except where emergency situations warrant an expedited time frame.

This shift in plan direction compared to alternative A will ensure that projects and program management at the forest level are continually considering public interests through early public involvement.

Additionally, Alternatives B, C and D include a chapter on geographic areas, in which each section of the forest is recognized for the values it provides to the public in the context of the western NC landscape, highlighting places and uses that are important to people. Each geographic area has a section that identifies cultural history of the area, the ecological values, the ways people connect to the land, the water and watershed connections to the region, places to be managed in recognition of their unique features, and ways to work together across the Forest boundary to further shared goals. This chapter was built using public information about the places and uses that people value on the forest and shares a vision for how the forest will be managed in recognition of those interests. Geographical Areas provide direction that is consistently applied across the forest reflecting where there are some differences based on the unique sense of place (Andereck and Knopf 2007; Parker and Green 2016). As a result of using this information to develop projects and activities, the action alternatives are more effective at addressing social values than Alternative A.

Compared to Alternative A, all action alternatives include an increased pace and scale of restoration resulting in movement toward improved ecosystem conditions and ecosystem health, improved wildlife habitats, and greater wildlife abundance. Compared to Alternative A, these alternatives will result in more forest products and economic contributions to the local economies.

In response to an increased interest in recreational use of the Nantahala and Pisgah NFs, all action alternatives include the Interface management area which was designed around the places that people have heaviest use of the forest, reflecting locations of key access that will be sustained. Interface management area direction provides a focus on forest management that is consistent with a high quality recreation experience. All action alternatives have approximately the same acreage of Interface MA, except in areas where there is a more restrictive management area (i.e., Appalachian Trail, Recommended Wilderness).

With growing populations in western NC and increasing recreation on the Nantahala and Pisgah NFs, the existing trail system will increasingly be the primary way in which people reach the forest off of the system roads. Each alternative addresses increasing trail miles slightly differently, but will draw from the goals and priorities identified in the Geographic Areas to identify opportunities for sustainable trail systems. Engaging with the public, local communities, and recreation user groups will be integral in defining priorities for existing and new trails under all action alternatives.

### **Differences between action alternatives**

Where opinions differ about the values to manage for on the forest landscape, NEPA issues were identified (see section 1.6). These issues were used to address a range of options in alternatives (see section 2.1) Many of the values expressed by the public related to places on the Forest, therefore, the primary difference between action alternatives is the allocation of management areas. As a result of different management area allocations, a range of values for a single place can be considered across multiple alternatives. Alternative development took care to ensure that the design of alternatives did not polarize interests but attempted to provide advancement for multiple values within each alternative. See chapter 2 for more information.

### **Cumulative Effects – All Alternatives**

Based on trends in regional population growth and FS visitation, recreational use of Nantahala and Pisgah NFs is anticipated to increase under all alternatives. This increase was not included in the economic impact modeling because this change is not a direct result of management by the FS but suggests the recreation program will likely continue to play a role in the regional economy.

As the population ages, demand for easily accessible recreation opportunities will increase.

## **3.4.13 Environmental Justice**

Environmental justice is the fair treatment and meaningful involvement of people of all races, cultures, and incomes, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Executive Order 12898 states that “each federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations.” The emphasis of environmental justice is on health effects and/or the benefits of a healthy environment. The CEQ has interpreted health effects with a broad definition: “Such effects may include ecological, cultural, human health, economic or social impacts on minority communities, low-income communities or Indian Tribes ...when those impacts are interrelated to impacts on the natural or physical environment” (CEQ 1997).

During the scoping process for forest plan revision, environmental justice concerns that were raised include the use of national forests for traditional cultural practices and subsistence. The Nantahala and Pisgah NFs provide local residents with food, water, and forest products used for home heating and construction; and have enabled generations of local residents to subsist on low incomes through subsistence fishing, hunting, gathering, and bartering.

### **Affected Environment**

#### **Low-income populations**

Poverty is an important indicator of well-being. Individuals with low incomes are more vulnerable to a number of hardships which may negatively affect their health and well-being and they may also be more reliant on natural resources and federal lands for subsistence and access to recreation opportunities.

The U.S. Census Bureau defines low-income populations by the percentage of people living below poverty in a given area, which is consistent with the CEQ's environmental justice guidance. Statistics at the county level are compared to the state average to identify areas that are low income. As seen in Table 232, 2015 data suggests that Graham, Jackson, Swain, and Watauga counties have poverty rates (21.9, 22, 24.5, and 31.4 percent, respectively) that are about five percentage points or greater than that of North Carolina (17.4 percent) (U.S. Department of Commerce 2016b). Therefore, these counties also meet the criteria for environmental justice populations.

**Table 232. Percent of Population Below Poverty, 2015**

<b>Location</b>	<b>% People Below Poverty, 2015 data</b>
Avery	15.40%
Buncombe	15.90%
Burke	19.90%
Caldwell	19.60%
Cherokee	20.00%
Clay	21.10%
Graham	21.90%
Haywood	17.20%
Henderson	13.80%
Jackson	22.00%
Macon	19.10%
Madison	18.10%
McDowell	20.20%
Mitchell	19.50%
Swain	24.50%
Transylvania	12.60%
Watauga	31.40%
Yancey	21.70%
Analysis Area	18.30%
North Carolina	17.40%

Source: U.S. Department of Commerce 2016b

### **Minority Populations**

Minority populations as defined by Council on Environmental Quality (CEQ) guidance under the National Environmental Policy Act (CEQ 1997) include individuals in the following population groups: American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic. Minority populations are identified using the U.S. Census Population Estimates program which provides estimates for the resident population by age, sex, race, and Hispanic origin at the national, state and county scales.



Total minority population refers to that part of the total population which is not classified as Non-Hispanic White Only by the U.S. Census Bureau. By using this definition of minority population, the percentage is inclusive of Hispanics and multiple race categories and any other minority single race categories. This definition is most inclusive of populations that may be considered as a minority population under EO 12898.

U.S. Census data is used to determine whether the populations residing in the analysis area constitute an “environmental justice population” through meeting either of the following criteria:

- 1. A readily identifiable group of people living in geographic proximity with a population that is 50 percent minority. The population with a 50 percent minority may be made up of one minority or a number of different minority groups; together the sum is 50 percent.*
- 2. A minority population may be an identifiable group that has a meaningfully greater minority population than the adjacent geographic areas or may also be a geographically dispersed/transient set of individuals such as migrant workers or Native Americans (CEQ 1997).*

Identifying meaningfully greater populations means making efforts to measure the study area population in relation to the general area population. A difference of more than five percent between the analysis area and the surrounding geographic (North Carolina) area may indicate a minority population (Grinspoon et al. 2014).

As seen in Table 233, the analysis area population is predominately white. However, in 2015, Graham, Jackson, and Swain counties were estimated to have about 7.6, 8.4, and 26.1 percent of the population of American Indian descent, which is meaningfully greater than the state average of 1.1 percent (U.S. Department of Commerce 2016b). Overall, Graham, Jackson, and Swain counties meet the criteria for environmental justice populations.

**Table 233: Racial and Ethnic Composition of 2015 Population in the Analysis Area (U.S. Department of Commerce 2016b)**

Location	Hispanic or Latino	White	Black or African American	American Indian	Asian	Native Hawaiian & Other Pacific Islander	Some Other Race	Two or More Races
Avery	4.7%	87.3%	4.1%	0.5%	0.5%	0.0%	0.0%	2.9%
Buncombe	6.4%	83.8%	6.2%	0.4%	1.1%	0.0%	0.1%	2.1%
Burke	5.8%	82.3%	5.9%	0.4%	3.6%	0.0%	0.2%	1.8%
Caldwell	4.9%	88.1%	4.9%	0.4%	0.6%	0.1%	0.1%	1.0%
Cherokee	2.8%	91.6%	1.6%	1.7%	0.4%	0.0%	0.0%	1.8%
Clay	3.0%	96.0%	0.5%	0.0%	0.1%	0.0%	0.0%	0.4%
Graham	1.5%	88.0%	0.5%	7.6%	0.0%	0.0%	0.0%	2.4%
Haywood	3.6%	93.4%	0.9%	0.3%	0.5%	0.0%	0.0%	1.3%
Henderson	9.9%	83.6%	2.9%	0.3%	1.0%	0.1%	0.4%	1.8%
Jackson	5.3%	81.0%	2.2%	8.4%	0.9%	0.1%	0.2%	1.9%
Macon	6.6%	89.7%	1.1%	0.5%	0.7%	0.0%	0.1%	1.2%
Madison	2.4%	94.1%	1.9%	0.2%	0.5%	0.0%	0.1%	0.9%

Location	Hispanic or Latino	White	Black or African American	American Indian	Asian	Native Hawaiian & Other Pacific Islander	Some Other Race	Two or More Races
McDowell	5.6%	87.9%	3.8%	0.5%	0.8%	0.1%	0.4%	0.9%
Mitchell	4.6%	93.2%	0.9%	0.4%	0.3%	0.0%	0.0%	0.6%
Swain	2.4%	64.0%	1.5%	26.1%	0.5%	0.0%	0.0%	5.5%
Transylvania	3.1%	89.2%	3.8%	0.5%	0.5%	0.0%	1.3%	1.7%
Watauga	3.5%	92.1%	1.1%	0.3%	0.9%	0.0%	0.1%	2.0%
Yancey	4.7%	93.0%	1.2%	0.4%	0.2%	0.1%	0.0%	0.4%
Analysis Area	5.6%	86.3%	3.8%	1.2%	1.1%	0.0%	0.2%	1.7%
North Carolina	8.8%	64.2%	21.2%	1.1%	2.5%	0.1%	0.2%	1.9%

### Environmental justice and tribal consultation

While federally recognized tribes fall into a minority category as defined by environmental justice, and many times they may also be considered low-income, consideration of tribes within the requirements of Executive Order 12898 does not replace the agency's responsibility to conduct government-to-government consultation affecting federally recognized, State-recognized, and non-recognized tribes; individual tribal members, including those living off-reservation and Alaska Natives; and Native Hawaiians.

The Federal Government has a trust responsibility to federally recognized tribes; the Forest Service, like other federal agencies, must act consistently with the federal trust responsibility when taking actions that affect tribes. Part of this responsibility includes consulting formally with tribes and considering their interests when taking actions that may affect them or their resources. See the Tribal Resources section for more information.

Some tribes may prefer to participate only in the more formal and required consultation process and may not want to have a parallel effort with the environmental justice outreach. In some cases, the environmental justice effort will give members of a tribe living outside a reservation or maybe having disagreement or different opinions than the formal tribal government an opportunity to express their issues or concerns. It is important to identify that tribal populations exist in a study area, and to reach out to them as environmental justice populations, but also understand that such actions do not take the place of the formal government-to-government consultation that is required for federally recognized tribes.

In addition, while not classified as EJ populations, the FS has recognized a population increase in three stakeholder groups in several counties including Asians (Burke), Blacks (Buncombe, Burke, and Caldwell), and Hispanic/Latinos (Buncombe, Burke, Caldwell, Henderson, Macon, and McDowell).

### Environmental Consequences

#### Effects common to all alternatives

Although there are identified environmental justice populations in the analysis area, there were no disproportionate negative environmental or health effects to minority or low-income populations

anticipated from any alternative. Public involvement during plan revision was inclusive and provided ample opportunity for issues of environmental justice to be raised. Under all alternatives, continued management of the Nantahala and Pisgah NF's ecosystems will contribute to healthy plant, fish, and wildlife populations, contributing to the resilience of forest-dependent communities.

Following this management plan, implementing decisions and authorizing on-the-ground activities would require appropriate site-specific NEPA review in order to proceed. This would include additional evaluation to identify the location of potential environmental justice populations relative to the location of future actions and analysis to determine whether there would be disproportionately high and adverse human health or environmental effects to environmental justice populations.



## Chapter 4: Consultation and Coordination

### 4.1 List of Preparers

These specialists were integral to the analysis of this Environmental Impact Statement:

Name	Title	Educational Experience	EIS Contribution	Experience
Michelle Aldridge	Planning and NEPA Staff Officer	M.S. in Natural Resources	Team Leader	13 years
Alison Borchers	Economist	Ph.D. in Economics	Social and Economic Analysis	11 years
Sheryl Bryan	Fisheries and Wildlife Biologist	M.S. in Fisheries Science	Wildlife and Ecological Analysis Team	30 years
Beth Buchanan	Regional Fire Ecologist	M.S. in Ecology	Fire Management	23 years
Alice Cohen	Collaboration Specialist	M.A. in Teaching	Collaboration Coordinator	29 years
Tom Collins	Geologist	B.A. in Geology	Mineral Resources, Geologic Resources, Geologic Hazards	50 years
Erik Crews	Dispersed Recreation Program Manager/ Landscape Architect	Bachelor of Landscape Architecture	Recreation, Scenery, Appalachian Trail, Wilderness, Wild and Scenic Rivers	30 years
Brady Dodd	Forest Hydrologist	M.S. in Forest Resources	Hydrology and Soils	29 years
Alexa Dugan	Natural Resource Specialist (Carbon)	M.S. in Geography	Carbon Analysis	10 years
Sarah Farmer	Science Writer	Master Liberal Arts & Sciences	Communications Materials and Editing	11 years
Logan Free	Developed Recreation Program Manager	Master of Landscape Architecture (MLA)	Recreation	7 years
Ned Gardiner	NOAA (Affiliate, Contractor), Engagement Manager, U.S. Climate Resilience Toolkit	Ph.D. in Ecology	Climate Analysis	22 years
Joel Hardison	Forest Archeologist and Tribal Liaison	M.S. in Earth Sciences, Archeology emphasis	Cultural and Tribal	29 years

<b>Name</b>	<b>Title</b>	<b>Educational Experience</b>	<b>EIS Contribution</b>	<b>Experience</b>
Larry Hayden	Contractor	Master's in Forestry	Planning specialist and analyst	34 years
Bill Jackson	Air Resource Specialist (retired)	B.S in Forestry	Bill Jackson	33 years
Lisa Jennings	Grandfather District Recreation Manager	M.S. in Forestry	Climate Analysis	11 years
Gary Kauffman	Forest Botanist/Ecologist	M.S. Botany/Mycology	Botanical and Ecological Analysis Team	27 years
Chelsea Leitz	Regional Inventory and Monitoring Coordinator	M.S.in Geospatial Information Systems	GIS/AGOL, Climate analysis, monitoring	5 years
Steve Little	Forest Fire Management Officer	B.S. Conservation Law Enforcement	Fire	32 years
Heather Luczak	Environmental Coordinator	M.S. in Natural Resources Management	Environmental Coordinator, Wilderness Inventory and Evaluation	18 years
Gisele Majidi-Weese	Assistant Forest Engineer	B.S. Environmental Engineering	Roads and Transportation	11 years
Bart Matthews	GIS Program Manager	B.A. in Geography	Geospatial Analysis, Cartography	13 years
Duncan McKinley	Natural Resource Management Specialist (Carbon)	Ph.D. in Biology	Carbon Analysis	22 years
James Melonas	Forest Supervisor	M.S. in Environmental Policy	Deciding Official	16 years
Bruce Meneghin	Planning Analyst (Retired)	B.S. Natural Resource Recreation Management	Ecological Modeling	35 years
Julie Moore	Realty Specialist	H.S. Diploma	Lands and Special Uses	31 years
Amy Nathanson	Regional Planning Analyst	M.S. in Ecology	Climate Analysis	13 years
Allen Nicholas	Former Forest Supervisor (Retired)	Master's in Business Administration	Former Forest Leader	35 years
Susan Parker	Planning and Environmental Specialist	Ph.D. in Natural Resources and Recreation	Wild & Scenic Rivers, Social and Economic Resources	12 years
Eric Pullium	GIS Specialist	AAS Forest Management	Cartography	19 years
Lannette Rangel	Resource Assistant	MEM in Ecosystem Management	Response to Comments, Plan and EIS updates	1 year

<b>Name</b>	<b>Title</b>	<b>Educational Experience</b>	<b>EIS Contribution</b>	<b>Experience</b>
Jason Rodrigue	Forest Silviculturist	M.S. in Forestry	Silviculture and Ecological Analysis Team	20 years
Holly Stratton	GIS Specialist (retired)	B.S. Biology/Geography	Spatial Analysis and Cartography	32 years
Rodney Snedeker	Forest Archeologist and Tribal Liaison (retired)	B.A. Anthropology	Cultural and Tribal	38 years
Emrys Treasure	Regional Inventory, Monitoring, Assessment, and Climate Change Coordinator	B.S. in Natural Resources	Climate Analysis, Climate Analysis	17 years
Amber Vanderwolf	GIS Specialist	A.A.S. in Forest Management	Spatial Analysis and Cartography	27 years
Sarah Wiener	Research Fellow	M.S. in Forestry	Climate Analysis	8 years

## 4.2 List of Agencies, Organizations, and Persons to Whom Copies of the Statement are Sent

This environmental impact statement will be shared with the following federal agencies, federally recognized tribes, state and local governments, and organizations representing a wide range of views regarding the Forest Plan.

### Tribal Governments

Tribal Historic Preservation Office	Kialegee Tribal Town
Alabama-Coushatta Tribe of Texas	Muscogee (Creek) Nation
Alabama-Quassarte Tribal Town	Poarch Band of Creek Indians
Catawba Indian Nation	Shawnee Tribe
Cherokee Nation	Thlopthlocco Tribal Town
Coushatta Tribe of Louisiana	United Keetoowah Band of Cherokee Indians
Eastern Band of Cherokee Indians	

### Federal Government

Advisory Council on Historic Preservation, Director of Planning and Review	Chief of Naval Operations, Energy and Environmental Readiness Division
Animal and Plant Health Inspection Service, Deputy Director Program and Policy Development	U.S. Army Corps of Engineers, South Atlantic Division
Blue Ridge Parkway National Park	U.S. Environmental Protection Agency, Region 4 EIS Review Coordinator
Bureau of Land Management	Department of Energy, Director of NEPA Policy and Compliance
Great Smoky Mountains National Park	Federal Aviation Administration, Regional Director
Natural Resources Conservation Service, National Environmental Coordinator	Federal Highway Administration, Division Administrator
National Agricultural Library, Acquisitions and Serials Branch	Rural Utilities Service
National Oceanic and Atmospheric Administration, Southeast Region Habitat Conservation Division	Tennessee Valley Authority, NEPA Administration
National Oceanic and Atmosphere Administration Office of Policy and Strategic Planning	USDA Office of Civil Rights
	U.S. Coast Guard, Office of Environmental Management

### State Government

NC Department of Agriculture and Consumer Services	NC Forest Service
NC State Environmental Review Clearinghouse	NC Natural Heritage Program



NC Wildlife Resources Commission

State Historic Preservation Office

**Local Government**

Avery County	Watauga County	Town of Laurel Park
Buncombe County	Yancey County	City of Lenoir
Burke County	Town of Andrews	Town of Maggie Valley
Caldwell County	City of Asheville	City of Marion
Cherokee County	Town of Beech Mountain	Town of Marshall
Clay County	Town of Black Mountain	Town of Montreat
Graham County	Town of Blowing Rock	City of Morganton
Haywood County	Town of Boone	Town of Murphy
Henderson County	City of Brevard	Town of Robbinsville
Jackson County	Town of Bryson City	Town of Seven Devils
Macon County	Town of Burnsville	Town of Sylva
Madison County	Town of Clyde	Town of Waynesville
McDowell County	Village of Flat Rock	Town of Weaverville
Mitchell County	Town of Franklin	Town of Woodfin
Swain County	Town of Hayesville	
Transylvania County	City of Hendersonville	

**Non-Governmental Organizations**

Access Fund	Graham County Economic Development	Ruffed Grouse Society
American Whitewater		Sierra Club, Wenoca Chapter NC
Appalachian Trail Conservancy	International Mountain Bicycling Association	NC Sierra Club
Back Country Horsemen of NC	Mountain True	Southern Appalachian Mineral Society
Carolina Land and Lakes Resource Conservation and Development Council	NC Wildlife Federation	Southern Appalachian Wilderness Stewards
Carolina Mountain Club	Nantahala-Pisgah Forest Partnership	Southern Environmental Law Center
Columbia Forest Products	National Audubon of NC	Southern Off-Road Bicycling Association
Defenders of Wildlife	National Forest Foundation	
EcoForesters	National Wild Turkey Federation	The Nature Conservancy
Evergreen Paper	NC Horse Council	The Wilderness Society
Fish and Wildlife Conservation Council	Quality Deer Management Association	Trout Unlimited
	Root Cause	Wild South



## Chapter 5: Literature Cited

### Air

- Knoepp, J. D.; Vose, J. M.; Jackson, W. A.; Elliott, K. J.; and Zarnoch, S. 2016. High elevation watersheds in the southern Appalachians: Indicators of sensitivity to acidic deposition and the potential for restoration through liming. *Forest Ecology and Management*. 377: 101-117.
- Lawrence, G. B., and Huntington, T. G. 1999. Soil-Calcium Depletion Linked to Acid Rain and Forest Growth in the Eastern United States. USGS Water-Resources Investigations Report 98-4267. 12. <https://doi.org/10.3133/wri984267>
- Lawrence, G. B.; Sullivan, T. J.; Burns, D. A.; Bailey, S. A.; Cosby, B. J.; Dovciak, M.; Ewing, H. A.; McDonnell, T. C.; Minocha R.; Quant, J.; Rice, K. C.; Siemion, J.; and Weathers, K. 2015. Acidic Deposition along the Appalachian Trail Corridor and its Effects on Acid-Sensitive Terrestrial and Aquatic Resources. Results of the Appalachian Trail MEGA-Transect Atmospheric Deposition Effects Study. Natural Resource Report NPS/NRSS/ARD/NRR—2015/996. National Park Service, Fort Collins, CO.
- McDonnell, T. C.; Sullivan, T. J.; Cosby, B. J.; Jackson, W. A.; and Elliott, K. J. 2013. Effects of Climate, Land Management, and Sulfur Deposition on Soil Base Cation Supply in National Forests of the Southern Appalachian Mountains. *Water, Air, & Soil Pollution* 224, no. 10: 1–18. doi:10.1007/s11270-013-1733-8.
- McDonnell, T. C.; Sloat, M. R.; Sullivan, T. J.; Dolloff, C. A.; Hessburn P. F.; Povak, N.A.; Jackson, W. A.; and Sams, C. 2015. Downstream warming and headwater acidity may diminish coldwater habitat in Southern Appalachian Mountain streams. *PLOS One*. DOI:10.1371/journal.pone.0134757.
- McDonnell, T. C.; Sullivan, T. J. and Jackson, W. A. 2018. Atmospheric Deposition Effects Modeling for Resource Management on Southern Appalachian National Forests. Final report prepared for USDA Forest Service, Asheville, NC. E&S Environmental Chemistry, Inc., Corvallis, OR. 66 pp.
- McNulty, S. G.; Cohen, E. C.; Moore Myers, J. A.; Sullivan, T. J.; and Li, H. 2007. Estimates of Critical Acid Loads and Exceedances for Forest Soils across the Conterminous United States. *Environmental Pollution, Air Pollution and Vegetation Effects Research in National Parks and Natural Areas: Implications for Science, Policy and Management*, 149. 3: 281–92. doi:10.1016/j.envpol.2007.05.025.
- Peterson, J.; Lahm, P.; Fitch, M.; George, M.; Haddow, D., and others. 2018. NWCG Smoke Management Guide for Prescribed Fire. National Wildfire Coordinating Group. Boise, ID. PMS 420-2/NFES 1279. 306 pp.
- Rice, K. C.; Scanlon, T. M.; Lynch, J. A.; and Cosby, B. J. 2014. Decreased Atmospheric Sulfur Deposition across the Southeastern U.S.: When Will Watersheds Release Stored Sulfate? *Environmental Science & Technology* 48, no. 17: 10071–78.
- Sullivan, T. J.; Cosby, B. J.; Jackson, W. A.; Snyder, K. U.; and Herlihy, A. T. 2010. Acidification and Prognosis for Future Recovery of Acid-Sensitive Streams in the Southern Blue Ridge Province. *Water, Air, & Soil Pollution* 219, no. 1–4: 11–26.
- Urbanski, S. P. 2014. Wildland fire emissions, carbon, and climate: emission factors. *Forest Ecology and Management*. 317: 51–60.

### Climate and Carbon

- Agee, J. K. and C.N. Skinner. 2005. Basic principles of forest fuel reduction treatments. *Forest Ecology and Management*, 211: 83–96.

- Ahn, S., de Steiguer, J., Palmquist, R., & Holmes, T. (2000). Economic analysis of the potential impact of climate change on recreational trout fishing in the southern Appalachian Mountains: An application of a nested multinomial logit model. *Climatic Change*, 45(3-4), 493-509.  
doi:10.1023/A:1005511627247
- Aitken, S. N., Yeaman, S., Holliday, J. A., Wang, T., & Curtis-McLane, S. (2008). Adaptation, migration or extirpation: climate change outcomes for tree populations. *Evolutionary Applications*, 1, 95-111.
- Allen, C. D., Macalady, A. K., Chenchouni, H., Bachelet, D., McDowell, N., Vennetier, M., & Cobb, N. (2010). A global overview of drought and heat-induced tree mortality reveals emerging climate change risks for forests. *Forest Ecology and Management*, 259(4), 660-684.  
doi:10.1016/j.foreco.2009.09.001
- Anderson, M.G., A. Barnett, M. Clark, C. Ferree, A. Olivero Sheldon, J. Prince. 2016. Resilient Sites for Terrestrial Conservation in Eastern North America. The Nature Conservancy, Eastern Conservation Science.
- Anderson-Teixeira, K.J., A.D. Miller, J.E. Mohan, T.W. Hudiburg, B.D. Duval and E.H. DeLucia. 2013. Altered dynamics of forest recovery under a changing climate. *Global Change Biology*, 19: 2001–2021.
- Ayres, M. P. & Lombardero, M. J. (2000). Assessing the consequences of global change for forest disturbance from herbivores and pathogens. *The Science of the Total Environment*, 262, 263-286.
- Bendixsen, D. P., Hallgren, S. W., & Burton, J. A. (2015). Ecological succession following forest decline in a xeric oak forest of south-central United States. *Journal of Plant Ecology*, 9(4), 402-409.
- Bergman, R., M.E. Puettman, A. Taylor, and K.E. Skog. 2014. The carbon impacts of wood products. *Forest Products Journal*, 64: 220-231.
- Bernazzani, P., Bradley, B., and Opperman, J. (2012). Integrating climate change into habitat conservation plans under the U.S. Endangered Species Act. *Environmental Management*, 49(6), 1103-1114.  
doi:10.1007/s00267-012-9853-2
- Blaustein, A. R., Walls, S. C., Bancroft, B. A., Lawler, J. J., Searle, C. L., & Gervasi, S. S. (2010). Direct and indirect effects of climate change on amphibian populations. *Diversity*, 2(2), 281-313.  
doi:10.3390/d2020281
- Carpenter, S. R., Fisher, S. G., Grimm, N. B., & Kitchell, J. F. (1992). Global change and freshwater ecosystems. *Annual Review Ecological Systems*, 119-139.
- Carter, M.C. and C.D. Foster. 2004. Prescribed burning and productivity in southern pine forests: a review. *Forest Ecology and Management*, 191: 93–109.
- Clark, M. E., Rose, K. A., Levine, D. A., & Hargrove, W. W. (2001). Predicting climate change effects on Appalachian trout: combining GIS and individual-based modeling. *Ecological Applications*, 11(1), 161-178. doi:10.1890/1051-0761(2001)011[0161:PCCEOA]2.0.CO;2
- Corn, P. S. (2005). Climate change and amphibians. *Animal Biodiversity and Conservation*, 28, (1), 59 - 67.
- Currie, D. J. (2001). Projected Effects of Climate Change on Patterns of Vertebrate and Tree Species Richness in the Conterminous United States. *Ecosystems*, 4, 216-225. doi: 10.1007/s10021-001-0005-4
- D'Amato, A.W., J.B. Bradford, S. Fraver, and B.J. Palik. 2011. Forest management for mitigation and adaptation to climate change: Insights from long-term silviculture experiments. *Forest Ecology and Management*, 262: 803–816.

- Davis, S.C., A.E. Hessler, C.J. Scott, M.B. Adams, and R.B. Thomas. 2009. Forest carbon sequestration changes in response to timber harvest. *Forest Ecology and Management*, 258: 2101–2109.
- DeGaetano, A.T., W. Noon, and K.L. Eggleston (2014): Efficient Access to Climate Products in Support of Climate Services using the Applied Climate Information System (ACIS) Web Services, *Bulletin of the American Meteorological Society*, 96, 173–180
- Domke, G.M., C.H. Perry, B.F. Walters, L.E. Nave, C.W. Woodall, and C.W. Swanston. 2017. Toward inventory-based estimates of soil organic carbon in forests of the United States. *Ecological Applications*, 27: 1223-1235.
- Duehl, A. J., Koch, F. H., & Hain, F. P. (2011). Southern pine beetle regional outbreaks modeled on landscape, climate and infestation history. *Forest Ecology and Management*, 261(3), 473-479. doi:10.1016/j.foreco.2010.10.032
- Dugan, A. and D.C. McKinley. 2018. A forest carbon assessment for the Nantahala-Pisgah National Forests, on file at Region 8 regional office.
- Dugan, A.J., R. Birdsey, V.S. Mascorro, M. Magnan, C.E. Smyth, M. Olguin, W.A. Kurz. 2018. A systems approach to assess climate change mitigation options in landscapes of the United States forest sector. *Carbon Balance and Management*, 13: doi: 10/1186/s13021-018-0100-x.
- Dukes, J. S., Pontius, J., Orwig, D., Garnas, J. R., Rodgers, V. L., Brazee, N. ., Stange, E. E. (2008). Responses of insect pests, pathogens, and invasive plant species to climate change in the forests of Northeastern North America: What can we predict?. *Canadian Journal of Forest Research*, 39(2), 231-248.
- Elliott, K. J., Miniati, C. F., Pederson, N., & Laseter, S. H. (2015). Forest tree growth response to hydroclimate variability in the southern Appalachians. *Global change biology*, 21(12), 4627-4641.
- Emanuel, K. (2005). Increasing destructiveness of tropical cyclones over the past 30 years. *Nature*, 436, 686-688. doi: 10.1038/nature03906
- Erwin, K. L. (2009). Wetlands and global climate change: the role of wetland restoration in a changing world. *Wetlands Ecology and Management*, 17(1), 71-84. doi:10.1007/s11273-008-9119-1
- Flannigan, M. D., Stocks, B. J., & Wotton, B. M. (2000). Climate change and forest fires. *Science of the Total Environment*, 262, 221-229. [http://dx.doi.org/10.1016/S0048-9697\(00\)00524-6](http://dx.doi.org/10.1016/S0048-9697(00)00524-6)
- Flebbe, P. A., Roghair, L. D. & Bruggink, J. L. (2006). Spatial Modeling to Project Southern Appalachian Trout Distribution in a Warmer Climate. *Transactions of the American Fisheries Society*, 135(5), 1371-1382. doi: 10.1577/T05-217.1
- Fowler, C. and E. Konopik. 2007. The history of fire in the southern United States. *Human Ecology Review*, 14: 165-176.
- Gan, J. (2004). Risk and damage of southern pine beetle outbreaks under global climate change. *Forest Ecology and Management*, 191, 61–71. doi:10.1016/j.foreco.2003.11.001
- Gray, J.A., J.W. Bentley, J.A. Cooper, and D.J. Wall. 2017. North Carolina's timber industry-timber product output and use, 2015. e-Science Update SRS-126. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station. 5 p.
- Gustavsson L., R. Madlener, H.F. Hoen, G. Jungmeier, T. Karjalainen, S. Klöhn, et al. 2006. The role of wood material for greenhouse gas mitigation. *Mitigation and Adaptation Strategies for Global Change*, 11: 1097–1127.

- Hansen, A. J., Neilson, R. P., Dale, V. H., Flather, C. H., Iverson, L. R., Currie, D. J., Bartlein, P. J. (2001). Global change in forests: Responses of species, communities, and biomes. *BioScience*, 51, 765-779.
- Harmon, M., W.K. Ferrell, and J.F. Franklin. 1990. Effects on carbon storage of conversion of old-growth forests to young forests. *Science*, 247: 699-702.
- Healey, S. P., W.B. Cohen, Z. Yang, B.C. Brewer, E.B. Brooks, N. Gorelick, et al. 2018. Mapping forest change using stacked generalization: An ensemble approach. *Remote Sensing of Environment*, 204: 717–728.
- Heller, N., & Zavaleta, E. (2009). Biodiversity management in the face of climate change: A review of 22 years of recommendations. *Biological Conservation*, 142(1), 14-32.
- Heilman, W. E., Potter, B. E., & Zerbe, J. I. (1998). Regional climate change in the southern United States: The implications for wildfire occurrence. *Productivity & Sustainability of Southern Forest Ecosystems in a Changing Environment*, 1, 683-699.
- Hellmann, J. J., Byers, J. E., Bierwagen, B. G., & Dukes, J. S. (2008). Five potential consequences of climate change for invasive species. *Conservation Biology*, 22(3), 534-543.
- Hitch, A. T., & Leberg, P. L. (2007). Breeding Distributions of North American Bird Species Moving North as a Result of Climate Change. *Conservation Biology*, 21(2), 534-539. doi: 10.1111/j.1523-1739.2006.00609.x
- <https://apps.fs.usda.gov/Evalidator/evalidator.jsp>
- <https://www.esrl.noaa.gov/psd/data/gridded/data.livneh.metvars.html>
- [http://loca.ucsd.edu/~pierce/IEPR\\_Clim\\_proj\\_using\\_LOCA\\_and\\_VIC\\_2016-06-13b.pdf](http://loca.ucsd.edu/~pierce/IEPR_Clim_proj_using_LOCA_and_VIC_2016-06-13b.pdf)
- Hurteau, M. and M. North. 2009. Fuel treatment effects on tree-based forest carbon storage and emissions under modeled wildfire scenarios, *Frontiers in Ecology and the Environment*, 7: 409-414.
- Hutchinson, M. F. (2007). Potential impacts of climate change on the distribution of North American trees. *BioScience*, 57(11), 939-948.
- Ibáñez, I., Clark, J. S., & Dietze, M. C. (2008). Evaluating the sources of potential migrant species: implications under climate change. *Ecological Applications*, 18(7), 1664-1678. doi:10.1890/07-1594.1
- IPCC. 2014. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.). IPCC, Geneva, Switzerland, 151 p. <http://www.ipcc.ch/report/ar5/syr/>
- IPCC. 2007. Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri, R.K and Reisinger, A.(eds.)]. IPCC, Geneva, Switzerland, 104 p.
- IPCC. 2000. Intergovernmental Panel on Climate Change (IPCC), Special Report on Land Use, Land Use Change and Forestry, Summary for Policy Makers, 2000. IPCC, Geneva, Switzerland. 20 pp. [http://www.ipcc.ch/ipccreports/sres/land\\_use/index.php?idp=0](http://www.ipcc.ch/ipccreports/sres/land_use/index.php?idp=0)
- Irland, L. C., Adams, D., Alig, R., Betz, C. J., Chen, C., Hutchins, M., ... & Sohngen, B.L. (2001). Assessing Socioeconomic Impacts of Climate Change on US Forests, Wood-Product Markets, and Forest Recreation. *BioScience*, 51(9), 753-764. doi: 10.1641/0006-3568(2001)051[0753:ASIOCC]2.0.CO;2
- Iverson, L. R., Prasad, A. M., Matthews, S. N., & Peters, M. (2008). Estimating potential habitat for 134 eastern US tree species under six climate scenarios. *Forest Ecology and Management*, 254, 390–406. doi:10.1016/j.foreco.2007.07.023

- Jeltsch, F., Moloney, K. A., Schwager, M., Korner, K. & Blaum, N. (2011). Consequences of correlations between habitat modifications and negative impact of climate change for regional species survival. *Agriculture, Ecosystems and Environment*, 145, 49 – 58.
- Joyce, L. A., Blate, G. M., Littell, J. S., McNulty, S. G., Millar, C. I., Moser, S. C., Peterson, D. L. (2008). National forests. in: Preliminary review of adaptation options for climate-sensitive ecosystems and resources. a report by the U.S. climate change science program and the subcommittee on global change research. U.S. Environmental Protection Agency, 1-127.
- Karl, T. R., Melillo, J. M., & Peterson, T. C. (2009). Global climate change impacts in the United States. New York, NY, USA: Cambridge University Press
- Keys, J.E.; Cleland, D.T.; McNab, W.H. 2007. Delineation, peer review, and refinement of subregions of the conterminous United States. Gen. Tech. Report WO-76A. Washington, DC: U.S. Department of Agriculture, Forest Service. 11 p.
- Keyser, T.L. and S.J. Zarnoch. 2012. Thinning, age, and site quality influence live tree carbon stocks in upland hardwood forests of the Southern Appalachians. *Forest Science*, 58: 407-418.
- Knutson, T. R., McBride, J. L., Chan, J., Emanuel, K., Holland, G., Landsea, C., Held, I., Kossin, J. P., Srivastava, A. K., & Sugi, M. (2010). Tropical cyclones and climate change. *Nature Geoscience*, 3(3), 157-163. doi:10.1038/ngeo779
- Laseter, S. H., Ford, C. R., Vose, J. M., & Swift Jr., L. W. (2012). Long-term temperature and precipitation trends at the Coweeta Hydrologic Laboratory, Otto, North Carolina, USA. *Hydrology Research*, 43(6), 890-900. doi:10.2166/nh.2012.067
- Lippke, B., E. Oneil, R. Harrison, K. Skog, L. Gustavsson, and R. Sathre. 2011. Life cycle impacts of forest management and wood utilization on carbon mitigation: knowns and unknowns. *Carbon Management*, 2-3: 303-333.1.
- Manee, C., Rankin, W. D., Kauffman, G., & Adkison, G. (2015). Association between roads and the distribution of *Microstegium vimineum* in Appalachian forests of North Carolina. *Southeastern naturalist*, 14(4), 602-611.
- Matthews, S. N., O'Connor, R. J., Iverson, L. R., & Prasad, A. M. (2004). Atlas of climate change effects in 150 bird species of the Eastern United States (General Technical Report NE-318). Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station: 1-46.
- McDougall, K. L., Khuroo, A. A., Loope, L. L., Parks, C. G., Pauchard, A., Reshi, Z.A., & Kueffer, C. (2011). Plant invasions in mountains: Global lessons for better management. *Mountain Research and Development*, 31 (4), 380-387.
- McKinley, D.C., M.G. Ryan, R.A. Birdsey, C.P. Giardina, M.E. Harmon, L.S. Heath, et al. 2011. A synthesis of current knowledge on forests and carbon storage in the United States. *Ecological Applications*, 21: 1902-1924.
- McNulty, S., E. Treasure, L. Jennings, D. Meriwether, D. Harris, and P. Arndt. 2017. Translating national level Forest Service goals to local level land management: carbon sequestration. *Climatic Change DOI* 10.1007/s10584-017-2046-5.
- McNulty, S., S. Weiner, J. Moore Myers, H. Farahani, L. Fouladbash, D. Marshall, and R.F. Steele. 2015. Southeast Regional Climate Hub Assessment of Climate Change Vulnerability and Adaptation and Mitigation Strategies. United States Department of Agriculture, 61 p.
- Millar, C.I.; Stephenson, N.L., Stephens, S.L. 2007. Climate change and forests of the future: Managing in the face of uncertainty. *Ecological Applications*, 17: 2145-2151.

- Mohseni, O., Stefan, H. G., & Eaton, J. G. (2003). Global warming and potential changes in fish habitat in U.S. streams. *Climatic Change*, 59, 389-409
- Morrison, L. W., Korzukhin, M. D., & Porter, S. D. (2005). Predicted range expansion of the invasive fire ant, *Solenopsis invicta*, in the eastern United States based on the VEMAP global warming scenario. *Diversity and Distributions*, 11(3), 199-204. doi:10.1111/j.1366-9516.2005.00142.x
- Mulholland, P. J., Best, G. R., Coutant, C. C., Hornberger, G. M., Meyer, J. L., Robinson, P. J., Stenberg, J. R., & Wetzel, R. G. (1997). Effects of climate change on freshwater ecosystems of the south-eastern United States and the Gulf Coast of Mexico. *Hydrological Processes*, 11, 949-970. doi: 10.1002/(SICI)1099-1085(19970630)11:8<949::AID-HYP513>3.0.CO;2-G
- Pavelsky, T. M., Sobolowski, S., Kapnick, S. B. & Barnes, J. B. (2012). Changes in orographic precipitation patterns caused by a shift from snow to rain. *Geophysical Research Letters*, 39(L18706), 1 – 6. doi:10.1029/2012GL052741
- Pickles, B. J., Egger, K. N., Massicotte, H. B., and Green, D. S. (2012). Ectomycorrhizas and climate change. *Fungal Ecology*, 5(1), 73-84. doi:10.1016/j.funeco.2011.08.009
- Pierce, D. W., D. R. Cayan, and B. L. Thrasher, 2014: Statistical downscaling using Localized Constructed Analogs (LOCA). *Journal of Hydrometeorology*, volume 15, page 2558-2585.
- Potter, K. M., Hargrove, W. W., and Koch, F. H. (2010). Predicting climate change extirpation risk for central and Southern Appalachian forest tree species (General Technical Report NRS-P-64). In: Rentch, J. S., Schuler, T. M., eds. 2010. Proceedings from the conference on the ecology and management of high-elevation forests in the central and southern Appalachian Mountains. 2009 May 14-15; Slatyfork, WV. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station: 179-189.
- Pregitzer K.S. and E.S. Euskirchen. 2004. Carbon cycling and storage in world forests: biome patterns related to forest age. *Global Change Biology*, 10: 2052-2077.
- Prideaux, B., Coghlan, A., & McNamara, K. (2010). Assessing tourists' perceptions of climate change on mountain landscapes. *Tourism Recreation Research*, 35(2), 187-199.
- Rahel, F. J., & Olden, J. D. (2008). Assessing the Effects of Climate Change on Aquatic Invasive Species. *Conservation Biology*, 22(3), 521–533. doi: 10.1111/j.1523-1739.2008.00950.
- Richardson, R. B., Loomis, J. B. (2004). Adaptive recreation planning and climate change: a contingent visitation approach. *Ecological Economics*, 50, 83-99. doi:10.1016/j.ecolecon.2004.02.010
- Roccaforte J.P., P.Z. Fule, W.W. Chancellor, D.C. Laughlin. 2012 Woody debris and tree regeneration dynamics following severe wildfires in Arizona ponderosa pine forests. *Canadian Journal of Forest Research*, 42: 593–604.
- Rodenhouse, N. L., Christenson, L. M., Parry, D. Green, L. E. (2009). Climate change effects on native fauna of northeastern forests. *Canadian Journal of Forest Research*, 39, 249-263. doi:10.1139/X08-160
- Ryan M.G., M.E. Harmon, R.A. Birdsey, C.P. Giardina, L.S. Heath, R.A. Houghton, R.B. Jackson, D.C. McKinley, J.F. Morrison, B.C. Murray, D.E. Pataki, K.E. Skog. 2010. A synthesis of the science on forests and carbon for U.S. Forests in Ecological Society of America: Issues in Ecology, 13:1-16.
- Sanderson, B.M. and M.F. Wehner (2017): Weighting strategy for the Fourth National Climate Assessment. In: Climate Science Special Report: A Sustained Assessment Activity of the U.S. Global Change Research Program [Wuebbles, D.J., D.W. Fahey, K.A. Hibbard, D.J. Dokken, B.C. Stewart, and T.K. Maycock (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 644-653.



- Schultheis, E. H., Hopfensperger, K. N., & Brenner, J. C. (2010). Potential impacts of climate change on sphagnum bogs of the southern Appalachian Mountains. *Natural Areas Journal*, 30(4), 417-424. doi:10.3375/043.030.0407
- Scott, D., McBoyle, G., & Schwartzentruber, M. (2004). Climate change and the distribution of climatic resources for tourism in North America. *Climate Research*, 105-117.
- Shoo, L. P., Olson, D. H., McMenamin, S. K. Murray, K. A. Van Sluys, M., Herbert, S. M., Bishopm, P. J., & Hero, J. –M. (2011). Engineering a future for amphibians under climate change. *Journal of Applied Ecology*, 48, 487-492. doi: 10.1111/j.1365-2664.2010.01942.
- Skog, K.E., D.C. McKinley, R.A. Birdsey, S.J. Hines, C.W. Woodall, E.D. Reinhardt, and J.M. Vose. 2014. Chapter 7: Managing Carbon. In: *Climate Change and United States Forests, Advances in Global Change Research* 57, 151-182.
- Soulé, P. T. (2011). Changing Climate, Atmospheric Composition, and Radial Tree Growth in a Spruce-Fir Ecosystem on Grandfather Mountain, North Carolina. *Natural Areas Journal*, 31(1) 65-74. doi: 10.3375/043.031.0108
- Taylor K. E., Stouffer R. J., Meehl G. A. (2012): An overview of CMIP5 and the experiment design. *Bulletin of the American Meteorological Society*, 93, 485-498, doi:10.1175/bams-d-11-00094.1.
- Torti, V. M. & Dunn, P. O. (2005). Variable effects of climate change on six species of North American birds. *Oecologia*, 145, 486 – 495.
- Treasure, Emrys; McNulty, Steven; Moore Myers, Jennifer; Jennings, Lisa Nicole 2014. Template for assessing climate change impacts and management options: TACCIMO user guide version 2.2. Gen. Tech. Rep. SRS-GTR-186. Asheville, NC: USDA-Forest Service, Southern Research Station. 33 p.
- USDA Forest Service. 2009. Climate Change Consideration in Project Level NEPA Analysis. White Paper. Washington, D.C. 11p.
- USDA Forest Service. 2016. Future of America's Forests and Rangelands: Update to the 2010 Resources Planning Act Assessment. General Technical Report WO-GTR-94. Washington, D.C. 250 p.
- US EPA. 2015. US Inventory of Greenhouse Gas Emissions and Sinks: 1990 – 2013. Executive Summary. EPA 430-R15-004 United States Environmental Protection Agency. Washington, D.C. 27 p.
- U.S. Federal Government. 2021. U.S. Climate Resilience Toolkit Climate Explorer. [Online] <https://crt-climate-explorer.nemac.org/> Accessed September 30, 2021.
- U.S. Forest Service. 2018. U.S. Climate By Forest (adaptation of Climate Resilience Toolkit Climate Explorer). [Online] <http://climate-by-forest.nemac.org> Accessed August 8, 2018.
- Walther, G. –R. (2003). Plants in a warmer world. *Perspectives in Plant Ecology, Evolution and Systematics*, 6/3, 169 – 185.
- Warren, D. R., Robinson, J. M., Josephson, D. C., Sheldon, D. R., & Kraft, C. E. (2012). Elevated summer temperatures delay spawning and reduce redd construction for resident brook trout (*Salvelinus fontinalis*). *Global Change Biology*, 18(6), 1804-1811. doi:10.1111/j.1365-2486.2012.02670.x
- Wiedinbyer, C. and M.D. Hurteau. 2010. Prescribed fire as a means of reducing forest carbon emissions in the western United States. *Environmental Science and Technology*, 44: 1926-1932.
- Wu, W., Clark, J. S., and Vose, J. M. (2012). Response of hydrology to climate change in the southern Appalachian mountains using bayesian inferences. *Hydrological Processes*, Accepted 1 December, 2012. doi:10.1002/hyp.9677

## Geological Resources

- Anderson MG, and Ferree CE, 2010, Conserving the Stage: Climate Change and the Geophysical Underpinnings of Species Diversity. PLoS ONE 5(7): e11554. doi:10.1371/journal.pone.0011554 <http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0011554>
- Anderson, M., Prince, J., Ray, D., Sutton, M., and Watland, A. 2013. Southern Blue Ridge: an Analysis of Matrix Forests. The Nature Conservancy. pp. 51. <http://www.conservationgateway.org/Files/Pages/SouthernBlueRidgeAnAnalysisofMatrixForests.aspx>.
- Appalachian Landslide Consultants, PLLC, 2018, Jackson County Landslide Mapping Project map layers and Haywood County Geologic Stability Mapping map layers, Prepared for the Jackson County Planning Board; Haywood Waterways Association; and Southwestern NC Resource Conservation and Development Council. <https://appalachianlandslide.com/>
- Collins, T. K., 2005. Geologic Hazards on National Forests. Geo Institute of American Society of Civil Engineers: Geo-Strata, July/August 2005, Vol. 5, Issue 4, pp. 31-34. <https://cedb.asce.org/CEDBsearch/record.jsp?dockkey=0149967>
- Collins, T. K., 2008, Debris flows caused by failure of fill slopes: early detection, warning, and loss prevention. Springer-Verlag. Landslides. 5:107–120. <https://link.springer.com/article/10.1007/s10346-007-0107-y>
- Collins, T. K., 2017, Managing landslide hazards and risks on the George Washington and Jefferson National Forests in Virginia and West Virginia, 3rd North American Symposium on Landslides, Roanoke, VA, June 4-8, 2017, Association of Environmental & Engineering Geologists.
- Gori, P.L. and Burton, W.C., 1996, Debris-Flow Hazards in the Blue Ridge of Virginia: U.S. Geological Survey Fact Sheet 159-96. <https://pubs.er.usgs.gov/publication/fs15996>
- Newell, C.L., and Peet, R.K., 1998, Vegetation of Linville Gorge Wilderness, North Carolina. Castanea 63(3): 275-322. September 1998. <http://labs.bio.unc.edu/Peet/pubs/castanea63;276.pdf>.
- North Carolina Mountain Resources Commission, 2012a, Western North Carolina Vitality Index, Geology Overview. <http://www.wncvitalityindex.org/geology/geology-overview>
- North Carolina Mountain Resources Commission, 2012b, Western North Carolina Vitality Index: Mountain Topography and Geomorphology. <http://www.wncvitalityindex.org/topography/mountain-topography-and-geomorphology>
- North Carolina Mountain Resources Commission, 2012c, Western North Carolina Vitality Index: Geology – Rock Types. Data and mapping by North Carolina Geological Survey, <http://www.wncvitalityindex.org/geology/rock-types>
- Peper, J.D, Grosz, A.E., Kress T.H., Collins T.K., Kappesser G.B., Huber, C.M., and Webb, J.R, 1995, Acid deposition sensitivity map of the Southern Appalachian Assessment area; Virginia, North Carolina, South Carolina, Tennessee, Georgia, and Alabama, U.S. Geological Survey On-Line Digital Data Series Open-File Report 95-810, scale 1:1,000,000. <https://pubs.er.usgs.gov/publication/ofr95810>
- Pittillo, J.D., Hatcher, R.D., and Buol, S.W., 1998, Introduction to the Environment and Vegetation of the Southern Blue Ridge Province. Castanea, Vol. 63, No. 3 (Sep., 1998), Southern Appalachian Botanical Society. pp. 202-216 <http://www.jstor.org/stable/4033976>.
- Simon, S. A., Collins, T.K., Kauffman, G.L., McNab, W.H., and Ulrey, C.J., 2005, Ecological zones in the Southern Appalachians: first approximation. Research Paper SRS - 41. Asheville, NC: U.S. Dept. of Agriculture, Forest Service, Southern Research Station. <https://www.srs.fs.usda.gov/pubs/22125>

- Wieczorek, G.F., and Morgan, B., 2008, Debris-Flow Hazards within the Appalachian Mountains of the Eastern United States: U.S. Geological Survey Fact Sheet 2008-3070.  
<https://pubs.usgs.gov/fs/2008/3070/>
- Wooten R.M., Latham R.S., Witt A.C., Fuemmeler S.J., Gillon K.A., Douglas T.J., and Bauer J.B., 2006, Slope movement hazard maps of Macon County, North Carolina: North Carolina Geological Survey Geologic Hazards Map Series 1, 3 sheets, scale 1:48,000, and Digital Data Series GHMS-1 (DDS-GHMS-1). <https://deq.nc.gov/about/divisions/energy-mineral-land-resources/north-carolina-geological-survey/geologic-hazards/landslides>
- Wooten, R.M., Gillon, K. A., Witt, A. C., Latham, R. S., Douglas, T. J., Bauer, J. B., Fuemmeler, S. J., Lee, L. G., 2008, Geologic, geomorphic, and meteorological aspects of debris flows triggered by Hurricanes Frances and Ivan during September 2004 in the Southern Appalachian Mountains of Macon County, North Carolina (southeastern USA). *Landslides* (2008) 5:31–44; Springer-Verlag. DOI 10.1007/s10346-007-0109-9 <http://link.springer.com/content/pdf/10.1007%2Fs10346-007-0109-9.pdf>.
- Wooten R.M., Witt A.C., Gillon K.A., Douglas T.J., Latham R.S., Fuemmeler S.J., and Bauer J.B., 2008, Slope movement hazard maps of Watauga County, North Carolina: North Carolina Geological Survey Geologic Hazards Map Series 3, 4 sheets, scale 1:36,000, and Digital Data Series GHMS-3 (DDS-GHMS-3). <https://deq.nc.gov/about/divisions/energy-mineral-land-resources/north-carolina-geological-survey/geologic-hazards/landslides>
- Wooten R.M., Witt A.C., Gillon K.A., Douglas T.J., Fuemmeler S.J., Bauer J.B., and Latham R.S., 2009, Slope movement hazard maps of Buncombe County, North Carolina: North Carolina Geological Survey Geologic Hazards Map Series 4, 3 sheets, scale 1:52,000, and Digital Data Series GHMS-4 (DDS-GHMS-4). <https://deq.nc.gov/about/divisions/energy-mineral-land-resources/north-carolina-geological-survey/geologic-hazards/landslides>
- Wooten, R.M., Witt, A.C., Douglas, T.J., Fuemmeler S.J., Bauer, J.B., Gillon, K.A., and Latham, R.S., 2011, Digital data and maps of the slope movement hazards for Henderson County, North Carolina: North Carolina Geological Survey Digital Data Series GHMS-5 (DDS-GHMS-5). <https://deq.nc.gov/about/divisions/energy-mineral-land-resources/north-carolina-geological-survey/geologic-hazards/landslides>
- Wooten, R.M., Witt, A.C., Miniati, C.F., Hales, T.C., Aldred, J.A., 2015, Frequency and Magnitude of Selected Historical Landslide Events in the Southern Appalachian Highlands of North Carolina and Virginia: Relationships to Rainfall, Geological and Ecohydrological Controls, and Effects, In: *Natural Disturbances and Historic Range of Variation: Type, Frequency, Severity, and Post-disturbance Structure in Central Hardwood Forests USA* (Greenberg, C.H. and Collins, B.S. eds), pp 203-262.

## **Soils & Water**

- Brantley, S., Ford, C.R.; Elliott, K.J.; Lasseter, S.; Vose, J.M. 2011. Hemlock woolly adelgid mediated mortality of eastern hemlock influences timing and magnitude of streamflow from headwater catchments in the southern Appalachians. State of the science summary paper, Coweeta Hydrologic Laboratory, Otto, NC.
- Clinton, B.D., J.M. Vose, W.T. Swank, E.C. Berg, D.L. Loftis. 1998. Fuel consumption and fire characteristics during understory burning in a mixed white pine-hardwood stand in the Southern Appalachians. Res. Pap. SRS-12. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 8p.

- Clinton, Barton D. 2003. Light, temperature, and soil moisture responses to elevation, evergreen understory, and small canopy gaps in the southern Appalachians. *Forest Ecology Management* 186 (2003) 243-255.
- Clinton, B.D., J.M. Vose, J.D. Knoepp, K.J. Elliot. 2003. Stream nitrate response to different burning treatments in southern Appalachian forests. Pages 174-181 in K.E.M. Galley, R.C.
- Clinton, B.D., J.M. Vose, J.D. Knoepp, K.J. Elliot, B. Reynolds, S. Zarnock. 2010. Can structural and functional characteristics be used to identify riparian zone width in southern Appalachian headwater catchments? *Canadian Journal Forest Research* 40(2):235-253.
- Clinton, B.D. 2011. Stream water responses to timber harvest: Riparian buffer width effectiveness. *Forest Ecology and Management* 261:979–988.
- Dunne, Thomas and Luna B. Leopold. 1978. *Water in Environmental Planning*. W.H. Freeman and Company. Page 495.
- Elliot, K.J., J.M. Vose, B.D. Clinton, J.D. Knoepp. 2004. Effects of understory burning in a mesic mixed-oak forest of the southern Appalachians. Pages 272-283 in R.T. Engstrom, K.E.M. Galley, and W.J. de Groot (eds.). *Proceedings of the 22nd Tall Timbers Fire Ecology Conference: Fire in Temperate, Boreal, and Montane Ecosystems*. Tall Timbers Research Station Tallahassee, FL.
- Elliott, K.J., and J.M. Vose. 2006. Fire effects on water quality: a synthesis of response regulating factors among contrasting ecosystems, pp.77-87. In Fowler, D.L. (ed.), *Second interagency conference on research in the wetlands*. USDA Forest Service, Southern Research Station, Coweeta Hydrologic Laboratory, Otto, NC
- Ford, C.R.; Elliott, K.J.; Clinton, B.D.; Kloeppel, B.D.; Vose, J.M. 2011. Forest dynamics following eastern hemlock mortality in the southern Appalachians. *Oikos* 000: 000–000, 2011. doi: 10.1111/j.1600-0706.2011.19622.x. 14 pp.
- Jones, Dick. 2010. Upper Tellico OHV Trail Obliteration – Erosion Effectiveness Monitoring. USDA Forest Service. National Forests in North Carolina.
- Keeley, Jon E. 2009. Fire intensity, fire severity and burn severity: a brief review and suggested usage. *International Journal of Wildland Fire*, Volume 18, Number 1, (2009) 116-126.
- Knoepp, Jennifer D., J.M. Vose, and W.T. Swank. 2004. Long-term soil responses to site preparation burning in the Southern Appalachians. *Forest Science* 50(4): 540-550.
- Knoepp, Jennifer D., K.J. Elliott, B.D. Clinton, and J.M. Vose. 2009. Effects of prescribed fire in mixed oak forests of the southern Appalachians: forest floor, soil, and soil solution nitrogen responses. *Journal of the Torrey Botanical Society* 136(3): 380-391.
- Knoepp, Jennifer D. and B.D. Clinton. 2009. Riparian zones in southern Appalachian headwater catchments: Carbon and nitrogen responses to forest cutting. *Forest Ecology and Management* 258 (2009): 2282-2293.
- North Carolina Forest Service. *Forest Practices Guidelines Related to Water Quality. 02 NCAC 60C .0100 - .0209*
- North Carolina Forest Service. *North Carolina Forestry Best Management Practices Manual to Protect Water Quality*. 2021 Available at [www.ncforests-service.gov](http://www.ncforests-service.gov)
- NCDWQ. 2007. Assessing and controlling acid rock drainage on projects requiring section 401 water quality certification. Memorandum Letter, Dec 14, 2007.

- Page-Dumroese, Deborah S., Ann M. Abbott, and Thomas M. Rice. 2009. Forest Soil Disturbance Monitoring Protocol. USDA FS Gen. Tech. Report WO-82b.
- Sherrill, Michael. Unknown date. 1979-1999: Two Decades of Progress in Western North Carolina Soil Surveys. Natural Resources Conservation Service.  
<http://www.soil.ncsu.edu/about/century/1979.html>
- Swank, Wayne, DeBano, Leonard, and Nelson, Devon. 1989. Effects of Timber Management Practices on Soil and Water. Pages 79-106. From the Scientific Basis for Silvicultural and Management Decisions in National Forest System. General Technical Report WO-55.
- Swank, W.T., J.M. Vose, and K.J. Elliott 2001. Long-term hydrologic and water quality responses following commercial clearcutting of mixed hardwoods on a southern Appalachian catchment. *Forest Ecology and Management*, 143 (2001). 163-178.
- Swift, L.W., Jr., K.J. Elliot, R.D. Ottmar, and R.E. Vihnanek. 1993. Site preparation burning to improve southern Appalachian pine-hardwood stands: fire characteristics and soil erosion, moisture, and temperature. *Can. J. For. Res.* 23:2242-2253.
- TACCIMO. 2013. Climate change and your national forest. Lisa N. Jennings. USDA Forest Service Eastern Forest Environmental Threat Assessment Center, white paper.
- Trapp, H., Jr. and M. A. Horn. 1997. Ground water atlas of the United States. Delaware, Maryland, New Jersey, North Carolina, Pennsylvania, Virginia, West Virginia. HA 730-L. USGS.  
[http://pubs.usgs.gov/ha/ha730/ch\\_l/index.html](http://pubs.usgs.gov/ha/ha730/ch_l/index.html)
- USFS. 1994. Land and resource management plan, Nantahala and Pisgah National Forests, Amendment 5. March, 1994. Page III-24.
- USFS. 2005. Bent Creek Upstream of Powhattan Lake Findings and Recommendations for Emergency Watershed Improvements. October, 2005. 36p.
- USFS. 2007a. Pinnacle Fire - Burned Area Emergency Rehabilitation, Burned Area Report (FS-2500-8). Unpublished Report. May 10, 2007. 7p.
- USFS. 2007b. Technical Guide to Managing Ground Water Resources. FS-881. U.S. Dept. of Agriculture, forest Service, May 2007.
- USFS. 2010a. Forest Service watershed condition classification technical guide. October 25, 2010.
- USFS. 2010b. Stoney Fork Fire - Burned Area Emergency Rehabilitation, Burned Area Report (FS-2500-8). Unpublished Report. April 30, 2010. 8p.
- USFS. 2010c. Pinnacle Fire - Burned Area Emergency Rehabilitation, Burned Area Report (FS-2500-8) - Monitoring Results. Unpublished Report. November 9, 2010. 11p.
- USFS. 2011a. 2004 Storm Recovery Stream Rehabilitation Summary. Region 8, National Forests in North Carolina (NFsNC). White Paper prepared by B. Dodd.
- USFS. 2011b. Upper Tellico OHV Trail Obliteration- Erosion & Sedimentation Control Effectiveness Monitoring, 2011. Prepared by The Catena Group for the USDA Forest Service.
- USFS. NFsNC 2018. 2018 Forestry Best Management Practice Monitoring Report for the National Forests in North Carolina.
- USDA Forest Service National Best Management Practices. USDA Forest Service. 2012. National Best Management Practices for Water Quality Management on Forest -System Lands. Volume 1: National Core BMP Technical Guide. FS-990a. 162 pp. + Appendices.

- Vose J.M., and W.T. Swank. 1993. Site preparation burning to improve southern Appalachian pine-hardwood stands: aboveground biomass, forest floor mass, and nitrogen and carbon pools. *Can. J. For. Res.* 23: 2255-2262.
- Vose J.M., W.T. Swank, B.D. Clinton, R.L. Hendrick, and A.E. Major. 1997. Using fire to restore pine/hardwood ecosystems in the southern Appalachians of North Carolina. In: Greenlee, Jason M. eds. *Proceedings: First conference on fire effects on rare and endangered species and habitats*. 1995 November. Coeur d'Alene, Idaho. Fairfield, WA. International Association of Wildland Fire. 149-154.
- Wemple, B. C., J. A. Jones, and G. E. Grant. 1996. Channel network extension by logging roads in two basins, western Cascades, Oregon. *Water Resources Bulletin* 32(6): 1195-1207.
- Wooten, Rick. 2008. Reference to email. NS Geological Survey, Raleigh, NC.
- Yeakley, J. Alan; Coleman, David C.; Haines, Bruce L.; Kloeppel, Brian D.; Meyer, Judy L.; Swank, Wayne T.; Argo, Barry W.; Deal, James M.; Taylor, Sharon F. 2003. Hillslope nutrient dynamics following upland riparian vegetation disturbance. *Ecosystem* 6: 154-167.

### **Aquatic Systems**

- Borawa, J.C., J.H. Mickey, C.J. Goudreau, and M.M. Clemmons. 2001. Wild trout stream fish population monitoring, 1989-1996. NCWRC Federal Aid in Fish Restoration Report F-24. Raleigh, NC. 45 pages plus appendices.
- Burr, B.M. and R.L. Mayden. 1992. Phylogenetics and North American freshwater fishes. Pages 18-75 in R.L. Mayden, editor. *Systematics, historical ecology, and North American freshwater fishes*. Stanford University Press, Stanford, California.
- Butler, R.S. 2002. Crayfishes of the southern Appalachian ecosystem, with emphasis on the imperiled fauna. U.S. Fish and Wildlife Service, Asheville, NC.
- Eastern Brook Trout Joint Venture (EBTJV). 2006. Eastern brook trout: status and threats. [www.easternbrooktrout.org](http://www.easternbrooktrout.org).
- EBTJV 2018. Eastern Brook Trout Status and Threats, available at <https://easternbrooktrout.org/reports/eastern-brook-trout-status-and-threats/view>.
- Karr, J. R. 1981. Assessment of biotic integrity using fish communities. *Fisheries*. 6:21 - 27.
- Karr, J.R., Fausch, K. D., Angermeier, P. L., Yant, P. R, and I. J. Schlosser. 1986. Assessing biological integrity in running water: a method and its rationale. Illinois Natural History Survey Special Publication 5.
- Master, L.L, S.R. Flack, and B.A. Stein, editors. 1998. *Rivers of life: critical watersheds for protecting freshwater biodiversity*. The Nature Conservancy, Arlington, Virginia.
- Minckley, W.L. and J.E. Deacon. 1991. *Battle against extinction: native fish management of the American west*. University of Arizona Press, Tucson, Arizona.
- Neves, R.J., A.E. Bogan, J.D. Williams, S.A. Ahlstedt, and P.W. Hartfield. 1997. Status of aquatic mollusks in the southeastern United States: a downward spiral of diversity. Pages 43-86 in G.W. Benz and D.E. Collins, editors. *Aquatic fauna in peril: the southeastern perspective*. Southeast Aquatic Research Institute, Decatur, Georgia.
- North Carolina Division of Water Quality (NCDWQ). 2006. Standard operating procedure: biological monitoring stream fish community. [http://portal.ncdenr.org/c/document\\_library/get\\_file?uuid=36784c06-f53d-430e-90f9-2f643c9b645b&groupId=38364](http://portal.ncdenr.org/c/document_library/get_file?uuid=36784c06-f53d-430e-90f9-2f643c9b645b&groupId=38364).

North Carolina Division of Water Quality (NCDWQ). 2017. NCDWQ stream fish community assessment program: NCIBI scores and ratings.

<http://portal.ncdenr.org/web/wq/ess/bau/ncibi-scores>.

NCWCF 2012. National Forests in North Carolina Watershed Condition Framework.

NFsNC 2018. 2018 Forestry Best Management Practice Monitoring Report for the National Forests in North Carolina. Report submitted to the Forest Supervisor, and part of the project record.

NPESE 2018. Nantahala/Pisgah Ecological Sustainability Evaluation conducted by the National Forests in North Carolina for the Nantahala/Pisgah Forest Plan Revision, including all data sources referenced wherein.

Raleigh, R.F. 1982. Habitat suitability index models: brook trout. U.S. Fish and Wildlife Service FWS/OBS-82/10.24. 42 pages.

Raleigh, R.F., L.D. Zuckerman, and P.C. Nelson. 1986. Habitat suitability index models and instream flow suitability curves: brown trout, revised. U. S. Fish and Wildlife Service Biological Report 82(10.124). 65 pages.

Raleigh, R.F., T. Hickman, and P.C. Nelson. 1984. Habitat suitability information: rainbow trout. U. S. Fish and wildlife Service FWS/OBS-82/10.60. 64 pages.

Schmitt, C.J, A.D. Lemly, and P.V. Winger. 1993. Habitat suitability index model for brook trout in streams of the Southern Blue Ridge Province: surrogate variables, model evaluation, and suggested improvements. USDI Fish and Wildlife Service Biological Report 18, Washington, D.C. 43 pages.

Taylor, C.A., M.L. Warren, J.F. Fitzpatrick, H.H. Hobbs, R.F. Jezerinac, W.L. Pflieger, and H.W. Robison. 1996. Conservation status of crayfishes of the United States and Canada. *Fisheries* 21:25-38.

USGS 2018. United States Geological Service Nonindigenous Aquatic Species (NAS) database. Available at: <https://nas.er.usgs.gov/default.aspx>.

Vannote, Robin L., G.W. Minshall, K.W. Cummins, J.R. Sedell, and C.E. Cushing. 1980. The River Continuum Concept. *Canadian Journal of Fisheries and Aquatic Sciences*. 37(1): 130-137.

Warren, M.L. and B.M. Burr. 1994. Status of freshwater fishes of the United States: overview of imperiled fauna. *Fisheries* 19:6-18.

Warren, M.L., B.M. Burr, S.J. Walsh, H.L. Bart, R.C. Cashner, D.A. Etnier, B.J. Freeman, B.R. Kuhajda, R.L. Mayden, H.W. Robison, S.T. Ross, and W.C. Starnes. 2000. Diversity, distribution, and conservation status of the native freshwater fishes on the southern United States. *Fisheries* 25(10):7-31.

Warren, M.L., P.L. Angermeier, B.M. Burr, and W.R. Haag. 1997. Decline of a diverse fish fauna: patterns of imperilment and protection in the southeastern United States. Pages 104-164 in G.W. Benz and D.E. Collins, editors. *Aquatic fauna in peril: the southeastern perspective*. Southeast Aquatic Research Institute, Decatur, Georgia.

Williams, J.D., M.L. Warren, K.S. Cummings, J.L. Harris, and R.J. Neves. 1993. Conservation status of the freshwater mussels of the United States and Canada. *Fisheries* 18:6-22.

### **Terrestrial Ecosystems**

Abella, Scott R., and Victor B. Shelburne. 2003. Eastern white pine establishment in the oak landscape of the Ellicott Rock Wilderness, southern Appalachian mountains. *Castanea* 2003: 201-210.

Abrams, M.D. 2003. Where has all the white oak gone? *BioScience* 53(10): 927-939.

- Allen, J.L., and Lendemer, J.C., 2016, Climate change impacts on endemic, high-elevation lichens in a biodiversity hotspot: *Biodiversity and Conservation*, v. 25, no. 3, p. 555–568.
- Allen, J.L. Testing lichen transplant methods for conservation applications in the southern Appalachian Mountains, North Carolina, U.S.A. *The Bryologist* 120 (3), 311-319, (25 July 2017) <https://doi.org/10.1639/0007-2745-120.3.311>
- Anderson, D.P., M.G. Turner. S.M. Pearson, T.P. Albright, R.K. Peet, & A. Wiebenl. 2013. Predicting *Microstegium vimineum* invasion in natural plant communities of the southern Blue Ridge Mountains, U.S.A. *Biological Invasions* 15:1217-1230.
- Appalachian Mountains Joint Venture (AMJV). 2019. Conservation: Bird Conservation: Priority Species. <http://amjv.org/priority-species/>.
- Arthur, M. A., H.D. Alexander, D.C. Dey, C. J. Schweitzer, and D.L. Loftis. 2012. Refining the oak-fire hypothesis for management of oak-dominated forests of the eastern United States. *Journal of Forestry*. 110(5): 257-266.
- Baker, T. T. and D. H. van Lear. 1998. Relations between density of rhododendron thickets and diversity of riparian forests. *Forest Ecology and Management* 109:21-32.
- Barber, H.L. 1984. Eastern mixed forest. Pages 345–354 in L. K. Halls, editor. *White-tailed Deer: Ecology and Management*. Stackpole Books. Harrisburg, Pa.
- Bartlett, J.G., 1995. Relative abundance of breeding birds and habitat associations of select neotropical migrant songbirds on the Cherokee National Forest, Tennessee. Doctoral dissertation, University of Tennessee, Knoxville.
- Baydack, R.K., H.I. Campa, and J.B. Haufler (Eds.). 1999. Practical approaches to the conservation of biological diversity. Island Press, Washington, DC, Island Press. 313p.
- Beringer, J. J. 1986. Habitat use and response to roads by black bears in Harmon Den, Pisgah National Forest, North Carolina. PhD Dissertation, University of Tennessee, Knoxville.
- Billings, W. D., and L. E. Anderson. 1966. Some Microclimatic Characteristics of Habitats of Endemic and Disjunct Bryophytes in the Southern Blue Ridge. *The Bryologist*, vol. 69, no. 1, pp. 76–95.
- Boufford, D.E, J.T. Kartesz, S. Shi, and R. Zhou. 2014. *Packera serpenticola* (Asteraceae; Senecioneae), a New Species from North Carolina, U. S. A. *Systematic Botany* 39(3): 1027-1030
- Boyce, J.S. 1957. Oak wilt spread and damage in the southern Appalachians. *Journal of Forestry*. 55: 499-505.
- Brody, A.J. 1984. Habitat Use by Black Bears in Relation to Forest Management in Pisgah National Forest, North Carolina. Master's Thesis. University of Tennessee, Knoxville.
- Brody, A. J., and M. R. Pelton. 1989. Effects of Roads on Black Bear Movements in Western North Carolina. *Wildlife Society Bulletin* (1973-2006), vol. 17, no. 1, pp. 5–10.
- Brody, A. J. (1984). Habitat use by black bears in relation to forest management in Pisgah National Forest, North Carolina.
- Brose, P. H., D. C. Dey, R. J. Phillips, and T. A. Waldrop. 2012. A meta-analysis of the fire-oak hypothesis: does prescribed burning promote oak reproduction in eastern North America? *Forest Science*, 13 pages.
- Bryan, S.; Smallings, C. 2020. Bird habitat use by canopy opening size. Project record. NP FEIS.
- Buckner, E, and W. McCracken. 1978. Yellow poplar: a component of climax forests? *Journal of Forestry* 76:421-423.



- Buehler, D.M., J.J. Giocomo, J. Jones, P.B. Hamel, C.M. Rogers, T.A. Beachy, D.W. Varble, C.P. Nicholson, K.L. Roth, and J. Barg. 2008. Cerulean Warbler reproduction, survival, and models of population decline. *Journal of Wildlife Management*. 72:646–653.
- Busing, R. T., and E.F. Pauley. 1994. Mortality trends in a southern Appalachian red spruce population. *For. Ecol. Manage.* 64: 41-45.
- Cameron, S., S. Jepsen, E. Spevak, J. Strange, M. Vaughan, J. Engler and O. Byers O. (eds.). 2011. North American Bumble Bee Species Conservation Planning Workshop Final Report. IUCN/SSC Conservation Breeding Specialist Group, Apple Valley, MN.
- Carlock, D.M. and working group. 1983. The tri-state black bear study. Unpublished working group report.
- Carolina Vegetation Survey. 2019. Natural Community plot data accessed at <http://cvs.bio.unc.edu/>.
- Carter, E.A., T.P. McDonald, and J.L. Torbert. 2000. Harvest traffic monitoring and soil physical response in a pine plantation. *Proceedings of the 5th International Conference on Precision Agriculture*.
- Carter, E.A. J.P. Field, and K.W. Farrish. 2000. Soil and nutrient loss following site preparation burning. In: 2000 ASAE Annual International Meeting, Nacogdoches, TX.
- Chafin, L. G. and S. B. Jones. 1989. Community Structure of Two Southern Appalachian Boulderfields. *Castanea*, vol. 54, no. 4, pp. 230–237.
- Church, S.A., and D.R. Taylor. 2005. Speciation and hybridization among *Houstonia* (Rubiaceae): species: the influence of polyploidy on reticulate evolution. *Botanical Society of America*. 92(8): 1372–1380.
- Clark, L.C. (2019). Development of microsatellite markers to evaluate current species boundaries between *Liatris helleri* Porter and *Liatris turgida* Gaiser (Asteraceae). (Unpublished master's thesis). Appalachian State University, Boone, North Carolina. 69 pp.
- Clark III, A. and J.G. Schroeder. 1985. Weight, volume, and physical properties of major hardwood species in the southern Appalachian mountains. USDA Forest Service Resource Paper SE-253. Asheville, NC.
- Clatterbuck, W.K. 1991. Forest development following disturbances by fire and timber harvesting for charcoal production. In: Nodvin, S.C. and T.A. Waldrop, eds. *Fire and the environment: Ecological and cultural perspectives*. *Proceedings of an international symposium*. Gen. Tech. Rep. SE-69. Asheville, NC.
- Clebsch, E.E.C. and R.T. Busing. 1989. Secondary Succession, Gap Dynamics, and Community Structure in a Southern Appalachian Cove Forest. *Ecology*. 70:728-735.
- Clinton, B. D.; Baker, C.R. 2000. Castastropic windthrow in the southern Appalachians: characteristics of pits and mounds and initial vegetation responses.
- CMP. 2018. The Open Standards for the Practice of Conservation. <http://cmp-openstandards.org/>.
- Costanza, J. 2021. Working paper in progress: Summary of drought projections for the Nantahala Pisgah landscape.
- Coyle, F. A. 1981. The mygalomorph spider genus *Microhexura* (Araneae, Dipluridae). *Bulletin of the American Museum of Natural History*. 170:64-75.
- Coyle, F. A. 2009. Status survey of the spruce-fir moss spider, *Microhexura montivaga*. Unpublished report to the US Fish and Wildlife Service, 13 pp. (plus 4 tables, map and appendix).
- Curtis, J.T. 1959. The vegetation of Wisconsin: an ordination of plant communities. University of Wisconsin Press.

- Danley, D.D. 2012. US Forest Service, Pisgah National Forest. Personal communication to Gary Kauffman.
- Davis, L.S., K.N. Johnson, P.S. Bettinger, and T.E. Howard. 2001. Forest Management to Sustain Ecological, Economic, and Social Values. McGraw Hill, Boston.
- DeLapp, J.A. 1978. Gradient analysis and classification of the high elevation red oak community of the Southern Appalachians. North Carolina State University, Raleigh, NC. 140 p.
- DeSelm, H. R., and Nora Murdock. 1993. Grass-dominated communities. Biodiversity of the southeastern United States: Upland terrestrial communities. John Wiley and Sons, New York.
- Dey, D.C., A.A. Royo, P.H. Brose, T.F. Hutchinson, M.A. Spetich, and S.H. Stoleson. 2010. An ecologically based approach to oak silviculture: a synthesis of 50 years of oak ecosystem research in North America. *Revista Columbia Forestal*. 13(2): 201-222.
- Donaldson, J. 1999a. 1997-1998 Final Report: Inventory and monitoring the federally rare spreading avens (*Geum radiatum*), Roan Mountain bluet (*Houstonia montana*), and Blue Ridge goldenrod (*Solidago spithamea*). Unpublished report. December 15, 1999. 11 p.
- Donaldson, J. 1999b. 1999 Final Report: Inventory and monitoring the federally rare spreading avens (*Geum radiatum*), Roan Mountain bluet (*Houstonia montana*), and Blue Ridge goldenrod (*Solidago spithamea*). Unpublished report. December 27, 1999. 13 p.
- Donaldson, J. 2002. 2001 Inventory and monitoring the federally rare spreading avens (*Geum radiatum*), Roan Mountain bluet (*Houstonia montana*), and Blue Ridge goldenrod (*Solidago spithamea*). Unpublished report. March 2002. 4 p.
- Donaldson, J.T. 2004. 2003 Mountain golden heather (*Hudsonia montana*) photo monitoring and third global inventory. 26 pp.
- D Dull, C.W., J.D. Ward, H.D. Brown, O.W. Ryan, W.H. Clerke, R.J. Uhler. 1988. Evaluation of spruce and fir mortality in the Southern Appalachian Mountains. USDA Forest Service, Southern Region, Protection Report R8-PR 13, Atlanta, GA.
- Deyer, J.M. and T.F. Hutchinson. 2019. Topography and soils-based mapping reveals fine-scale compositional shifts over two centuries within a central Appalachian landscape. *Forest Ecology and Management*. 433: 33-42.
- Eiler, J. H. 1981. Reproductive biology of black bears in the Smoky Mountains of Tennessee. Master's Thesis, University of Tennessee, Knoxville. 127 pages.
- Eiler, J. H., W. G. Wathen, and M. R. Pelton. 1989. Reproduction in black bears in the southern Appalachian mountains. *The Journal of Wildlife Management*, vol. 53, no. 2, pp. 353–360.
- Elliott, K.J., L.R. Boring, W.T. Swank, T. Wayne, and B.L. Haines. 1997. Successional changes in plant species diversity and composition after clearcutting a Southern Appalachian watershed. *Forest Ecology and Management* 92 (1997) 67-85.
- Elliot, K.J., W.T. Swank. 2008. Long-term changes in forest composition and diversity following early logging (1919-1923) and the decline of American chestnut (*Castanea dentata*). *Plant Ecology*, 197: 155-172.
- Estep, M.C. 2019. Appalachian State University Botany Professor. Personal communication December 9, 2019 with Rebekah Reid, USFWS biologist, and Gary Kauffman.
- Evans, A.W. 1947. A study of certain North American Cladoniae. *The Bryologist* 50:14-51.
- Federal Cave Resources Protection Act. 1988. 16 USC 63: 4301-4310.

- Feldhammer, G. A., T.R Kilbane, and D.W. Sharp. 1989. Cumulative effect of winter on acorn yield and deer body weight.
- Fralish, James S. 2004. The Keystone Role of Oak and Hickory in the Central Hardwood Forest. Gen. Tech. Rep. SRS-73. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. pp. 78-87.
- Ford, W. M., A. S. Johnson, P. E. Hale, and J. M. Wentworth. 1993. Availability and use of spring and summer woody browse by deer in clearcut and uncut forests of the Southern Appalachians. *South. J. Appl. For.* 17:116-119.
- Forrest, J., D.W. Inouye and J.D. Thomson. 2010. Flowering phenology in subalpine meadows: Does climate variation influence community co-flowering patterns? *Ecology* 91(2): 431-440.
- Frost, C. C. 1990. *Hudsonia montana* final report: Effects of fire, trampling, and interspecies competition, 1985-1989. Final report submitted to the USFWS and USFS, Asheville, NC. 93 pp.
- Gilliam, F.S. 2007. The ecological significance of the herbaceous layer in temperate forest ecosystems. *BioScience*. 57(10): 845-858. <https://doi.org/10.1641/B571007>.
- Glennon, K.L., J.T. Donaldson, and S.A. Church. 2011. Evidence for hybridization between the endangered Roan Mountain bluet, *Houstonia purpurea* var. *montana* (Rubiaceae) and its common congener. *The Journal of the Torrey Botanical Society* 138(3):272–286.
- Greenberg, C., B. Collins, and F. Thompson III (editors). 2011. *Sustaining Young Forest Communities: Ecology and Management of Early Successional Habitats in the Central Hardwood Region, USA*. 309 pages.
- Greenberg, C., B. Collins, and F. Thompson III (editors). 2011. *Sustaining Young Forest Communities: Ecology and Management of Early Successional Habitats in the Central Hardwood Region, USA*. 309 pages.
- Greenberg, C.H; Collins,B.; ThompsonIII,F.R.; McNab,W.H. 2011. What are early successional habitats, why are they important, and how can they be sustained? In C.H. Greenberg et al. (eds.), *Sustaining Young Forest Communities*, 1 Managing Forest Ecosystems 21, DOI 10.1007/978-94-007-1620-9\_1,
- Gross, K., J. Lockwood, C.C. Frost, and W. Morris 1998. Modeling controlled burning and trampling reduction for conservation of *Hudsonia montana*. *Conservation Biology* 2:1291-1301.
- Groth, J. G. 1988. Resolution of cryptic species in Appalachian red crossbills. *Condor* 90:745-760.
- Guyon, Lyle J., Rolfe, Gary L., Edgington, John M., A, Guillermo. 2003. Mendoza. A Comparative Analysis of the Diversity of Woody Vegetation in Old-Growth and Secondary Southern Appalachian Cove Forests.
- Hadley, Jarvis B. Preliminary report on corundum deposits in the Buck Creek peridotite, Clay County, North Carolina. US Government Printing Office, 1949.
- Hamel, P. 1992. The Land Manager's Guide to Birds of the South. The Nature Conservancy and the Southern Region, US Forest Service. U.S. Forest Service General Technical Report SE-22. 437pp.
- Hanberry, B.B., Abrams, M.D. 2018. Recognizing loss of open forest ecosystems by tree densification and land use intensification in the Midwestern USA. *Reg Environ Change* 18:1731–1740.
- Harlow, R.F., J.B. Whelan, H.s. Crawford, and J.E. Skeen. 1975. Deer foods during years of oak mast abundance and scarcity. *The Journal of Wildlife Management*, vol. 39, no. 2, pp. 330–336.
- Harrod, J., P.S. White, and M.E. Harmon. 1998. Changes in xeric forests in western Great Smoky Mountains National Park, 1936-1995. *Castanea* 63(3):346-360.

- Hart, J.L. 2015. Gap scale disturbances in central Appalachian hardwoods with implications for management. In C.H. Greenberg, et al (Eds). Natural disturbances and historic range of variation: type, frequency, severity, and post-disturbance structure in central hardwood forests, USA.
- Healy, William M., and Edward S. Nenko. Minimum maintenance versus intensive management of clearings for wild turkeys. *Wildlife Society Bulletin* (1973-2006) 11.2 (1983): 113-120.
- Hunter, W.C., R. Katz, D. Pashley, and B. Ford. 1999. Partners In Flight Bird Conservation Plan for the Southern Blue Ridge (Physiographic Area 23). Atlanta (GA): American Bird Conservancy. [http://www.partnersinflight.org/bcps/plan/pl\\_23\\_10.pdf](http://www.partnersinflight.org/bcps/plan/pl_23_10.pdf).
- Hurst, G.S. 1978. Effects of controlled burning on wild turkey poult food habits. *Proceedings of the Annual Conference of the Southeast Association of Fish and Wildlife Agencies*. 32: 30-37.
- Inouye, D.W. 2008. Effects of climate change on phenology, frost damage, and floral abundance of montane wildflowers. *Ecology* 89(2): 353-362.
- James, N.A.; Abt, K.L.; Frey, G.E.; Han, X.; Prestemon, J.P. 2020. Fire in the southern Appalachians: understanding impacts, interventions, and future fire events. E-General Technical Report SRS-249. Forest Service.
- Jeffrey D. Parrish, J.D., D.P. Braun, R.S. Unnasch. 2003. Are We Conserving What We Say We Are? Measuring Ecological Integrity within Protected Areas. *BioScience*, 53(9): 851–860.
- Johns, M. 2005. A bird conservation plan for North Carolina; a bird conservation strategy by NC Partners in Flight. Raleigh, NC. [https://partnersinflight.org/working\\_groups/eastern/](https://partnersinflight.org/working_groups/eastern/).
- Johnson, A.S., P.E. Hale, and W.M. Ford. 1995. White-Tailed Deer Foraging in Relation to Successional Stage, Overstory Type and Management of Southern Appalachian Forests. *American Midland Naturalist*, vol. 133, no. 1, pp. 18–35.
- Johnson, M., D.L. Peterson, and C. Raymond. 2009. Fuel treatment guidebook: illustrating treatment effects on fire hazard. *Fire Management Today*. 69(2): 29-33.
- Johnson, P. S., S. R. Shifley and R. Rogers. *The Ecology and Silviculture of Oaks*, 2<sup>nd</sup> ed. 2009. CABI, Cambridge, MA. 580 pages.
- Kaufmann, M. R., Graham, R. T., Boyce, D. A., Jr., Moir, W. H., Perry, L., Reynolds, R. T., Bassett, R. L., Mehlhop, P., Edminster, C. B., Block, W. M., and Corn, P. S. 1994. An ecological basis for ecosystem management. General Tech. Rep. RM 246. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 22 p.
- Kauffman, G.L., G.L. Nesom, A.S. Weakley, T.E. Govus, and L.M. Cotterman. 2004. A new species of *Symphyotrichum* (Asteraceae: Astereae) from a Serpentine Barren in Western North Carolina. *Sida* 2:827-39.
- Keyser, C. and J.A. Rodrigue. 2014. Forest vegetation simulation modeling for the Nantahala and Pisgah National Forests. Asheville, NC.
- Kirkman, W.B., T.R. Wentworth, and J.R. Ballington. 1989. The Ecology and Phytosociology of the Creeping Blueberries, *Vaccinium* Section *Herpothamnus*. *Bulletin of the Torrey Botanical Club*. Vol. 116, No. 2.
- Knoepp, J. D., L. L. Tieszen, and G. G. Fredlund. 1998. Assessing the vegetation history of three southern Appalachian balds through organic matter analysis. Research Paper SRS-13. US Department of Agriculture, Forest Service, Southern Research Station, Asheville, NC.

- Kudo, G., Y. Nishikawa, T. Kasagi and S. Kosuge. 2004. Does seed production of spring ephemerals decrease when spring comes early? *Ecological Research* 19(2): 255-259.
- Kuppinger, D. M., M. A. Jenkins, and P. S. White. 2010. Predicting the post-fire establishment and persistence of an invasive tree species across a complex landscape. *Biol. Invasions*. 12: 3473-3484.
- Lafron, C.W., A.T. Naito, Adam T., H.D. Grissino-Mayer, S.P. Horn, and T.A. Waldrop. 2017. Fire history of the Appalachian region: a review and synthesis. Gen. Tech. Rep. SRS-219. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 97 p
- Lewis, C., S. Bryan, G. Kauffman, and J. Rodrigue. 2017. Identification of canopy gap and early successional habitat patches on the Nantahala and Pisgah National Forests.
- Lindenmayer, D.B., and J.F. Franklin. 2002. *Conserving Forest Biodiversity: A Comprehensive Multiscaled Approach*. Washington, DC, Island Press. 353 p.
- Lindsay, M. M., and S.P. Bratton. 1979. Grassy balds of the Great Smoky Mountains: their history and flora in relation to potential management. *Environmental Management*, 3(5), 417-430.
- Lodge, D.J. and T. R. Wentworth. 1990. Negative Associations among VA-Mycorrhizal Fungi and Some Ectomycorrhizal Fungi Inhabiting the Same Root System. *Oikos* 57:3, 347-356.
- Lorber, J., M. Thomas-VanGundy, and S. Croy. 2018. Characterizing effects of prescribed fire on forest canopy cover in the George Washington and Jefferson National Forests. Research Paper NRS-31. Newtown Square, PA.
- Lorimer, C.G. 1980. Age Structure and Disturbance History of a Southern Appalachian Virgin Forest. *Ecology*, 61: 1169-1184.
- Lorimer, C.G. 2001. Historical and ecological roles of disturbance in eastern North American forests: 9,000 years of change. *Wildlife Society Bulletin* 29: 425-439.
- Lorimer, C.G., and A.S. White. 2003. Scale and frequency of natural disturbances in the northeastern US: implications for early successional forest habitats and regional age distributions. *Forest Ecology and Management* 185(1): 41-64.
- Mansberg, L. and T.R. Wentworth 1984. Vegetation and soils of a serpentine barren in western North Carolina. *Bull. Torrey Bot. Club* 111:273-286.
- Martin, J., and R.D. Noble. 1996. A quantitative study on ecological status and trends in an endangered lichen, *Gymnoderma lineare* (Evans) Yoshimura and Sharp. Unpublished report prepared for USDA Forest Service, National Forests in North Carolina, Asheville, NC, and USDI Fish and Wildlife Service, Asheville, NC. 30 pp.
- Mays, Jason. 2019. Recovery Biologist. U.S. Fish and Wildlife Service, Asheville Field Office. Asheville, NC.
- McCormick, M.K., and H. Jacquemyn, 2014 What constrains the distribution of orchid populations? *New Phytologist*, 202, 392– 400.
- McLeod, D.E. 1988. Vegetation patterns, floristics, and environmental relationships in the Black and Craggy Mountains of North Carolina. Ph.D. Thesis, University of North Carolina, Chapel Hill, NC.
- McManamay, R.H., L.M. Resler, J.B. Campbell, and R.A. McManamay. 2011. Assessing the Impacts for Balsam Woolly Adelgid (*Adelges piceae* Ratz.) and Anthropogenic Disturbance on the Stand Structure and Mortality of Fraser Fir [*Abies fraseri* (Pursh) Poir.] in the Black Mountains, North Carolina. *Castanea*: 76(1): 1-19.

- McNab, W.H.; Greenberg C.H.; Berg, E.C. 2003. Landscape distribution and characteristics of large hurricane-related gaps in a southern Appalachian watershed. *Forest Ecology and Management* 195, 435-447.
- Memmott, J., P.G. Craze, N.M. Waser and M.V. Price. 2007. Global warming and the disruption of plant-pollinator interactions. *Ecology Letters* 10(8): 710-717.
- Montgomery, A.D. 2014. Predicting threatened orchid (*Isotria medeoloides* [Pursh] RAF.) habitat in the Southern Appalachian region using maxent model. Masters thesis, Western Carolina University, Cullowhee, NC. 93 pp.
- Morin, R.S. and R.H. Widmann. 2010. A comparison of the status of spruce in high-elevation forests on public and private land in the southern and central Appalachian Mountains. In: Rentch, James S.; Schuler, Thomas M., eds. 2010. Proceedings from the conference on the ecology and management of high-elevation forests in the central and southern Appalachian Mountains. 2009 May 14-15; Slatyfork, WV. Gen. Tech. Rep. NRS-P-64. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station: 134-139.
- Murdock, N.A. 2000. USFWS biologist, Asheville field office. Personal communication with Gary Kauffman.
- Muzika, R.M.; Stephenson, S.L.; Adams, H.S.; Lawrence, D.M.; Miller, G.W. 1999. Patterns of woody species composition on the Fernow Experimental Forest and adjacent portions of the Otter Creek Wilderness Area. In: Eckerlin, Ralph P., ed. Proceedings of the Appalachian biogeography symposium; 1995 June 25 29; Blacksburg, VA. Special Publ. No. 7. Martinsville, VA: Virginia Museum of Natural History: 35-44.
- NatureServe. 2021. NatureServe Explorer: An online encyclopedia of life [web application]. Version 1.8. NatureServe, Arlington, Virginia. Available <http://www.natureserve.org/explorer>.
- NC Biotics, 2021. NatureServe database as maintained for NC by the North Carolina Natural Heritage Program, accessed 2019, 2021.
- Nenno, E. S. and J. S. Lindzey. 1979. Wild turkey poultry feeding activity in old field agriculture clearing, and forest communities. *Transactions of the Northeastern Section of the Wildlife Society*. 36:97.
- Nesbitt, W.A. 1941. History of early settlement and land use on the Bent Creek Experimental Forest, Buncombe County, N.C. Unpublished report. On file with: Southern Research Station, Upland Hardwood Ecology and Management Research Work Unit, 1577 Brevard Road, Asheville, NC 28806. 78 p.
- Nesom, G. 2005. Broadened Concept of *Liatrix helleri* (Asteraceae: Eupatorieae). *Sida* 21(3):1323-1333.
- Newberry, G. 1991. Factors affection the survival of the rare plant, *Sagittaria fasciculata* E.O. Beal (Alismataceae). *Castanea* 56(1): 59-64.
- Newell, C.L. and R.K. Peet. 1998. Vegetation of Linville Gorge Wilderness, North Carolina. *Castanea*. 63(3): 275–322.
- Newell, C.L., R.K. Peet, and J. C. Harrod. 1997. Vegetation of Joyce Kilmer-Slickrock Wilderness. Unpublished report to the United States Forest Service, Asheville, North Carolina.
- North Carolina Natural Heritage Program (NCNHP). 2021. <https://www.ncnhp.org/>.
- North Carolina Wildlife Resources Commission (NCWRC). 2005. North Carolina Wildlife Action Plan. Raleigh, NC.

- North Carolina Wildlife Resources Commission (NCWRC). 2015. Revised North Carolina Wildlife Action Plan. Raleigh, NC.
- North Carolina Wildlife Resources Commission (NCWRC). 2016. Wildlife Habitat Active Management Areas. Information and data provided directly to the Forest Service.
- North Carolina Wildlife Resources Commission (NCWRC). 2017. Wildlife Diversity Quarterly Reports. <https://www.ncwildlife.org/Conserving/Programs/Wildlife-Diversity-Program/WDP-Quarterly-Reports#71481435-2017-quarterly-reports>.
- North Carolina Wildlife Resources Commission (NCWRC). 2019. 2018-19 North Carolina Avid Grouse Hunter Survey.
- Nowacki, Gregory J.; Abrams, Marc D. 2008. The demise of fire and "mesophication" of forests in the eastern United States. *BioScience*. 58(2): 123-138.
- Nantahala/Pisgah Ecological Sustainability Evaluation (NPESE). 2019. The Ecological Sustainability Evaluation Tool for the Nantahala and Pisgah National Forests. Asheville, NC. May also be cited as NPESE 2018.
- Norman, S.P. 2021. Landscape patterns of wildfires and prescribed fires on the Pisgah and Nantahala national forests. USDA Forest Service, Southern Research Station. (under review)
- Oak, Steven W. 2002. From the Bronx to Birmingham: Impact of Chestnut Blight and Management Practices on Forest Health Risks in the Southern Appalachian Mountains. *The Journal of the American Chestnut Foundation*, Vol. 16, No. 1, Fall 2002
- Oliver, Chadwick D. 1997. Integrating silviculture, forest management, and forest policy. In: Pallardy, Stephen G.; Cecich, Robert A.; Garrett, H. Gene; Johnson, Paul S., eds. *Proceedings of the 11th Central*
- Oliver, C. D., Osawa, A., and Camp, A. 1997. Forest dynamics and resulting animal and plant population changes at the stand and landscape levels. *Journal of Sustainable Forestry*, 6(3-4), 281-312.
- Oswalt, S.N.; Smith, W.B.; Miles, P.D.; Pugh, S. A. 2019. *Forest Resources of the United States, 2017*. General Technical Report Wo-97. Forest Service.
- Pack, J. C., W. K. Igo, and C. I. Taylor. 1988. Use of prescribed fire in conjunction with thinning to increase wild turkey brood range habitat in oak–hickory forests. *Transactions of the Northeast Section of the Wildlife Society* 45:37–48.
- Pashley, D.N., C.J. Beardmore, J.A. Fitzgerald, R.P. Ford, W.C. Hunter, M.S. Morrison, and K.V. Rosenberg. 2000. *Partners in Flight: Conservation of the Land Birds of the United States*.
- Peet, R.K., 2019. Natural Community plot data accessed at <http://cvs.bio.unc.edu/>.
- Peterson, C.J.; Cannon, J.B.; Godfrey, C.M. 2015. First steps toward defining the wind disturbance regime in central hardwood forests. In C.H. Greenberg, et al (Eds). *Natural disturbances and historic range of variation: type, frequency, severity, and post-disturbance structure in central hardwood forests, USA*.
- Petranka, J. W. (1998). *Salamanders of the United States and Canada*. Smithsonian Institution Press.
- Pittillo, J.D.; Hatcher, R.D., Jr.; Buol, S.W. 1998. Introduction to the environment and vegetation of the southern Blue Ridge Province. *Castanea*. 63(3): 202–216.
- Prestemon, J.P.; Shankar, U.; Xiu, A.; Talgo, K. Yang, D.; Dixon IV, E.; McKensie, D.; Abt, K. 2016. Projecting wildfire area burned in the south-eastern United States, 2011-2060. *International journal of wildland fire* 25, 715-729. <http://dx.doi.org/10.1071/WF15124>.

- Prince, J. and L. Morse. 1985. The Nature Conservancy Global Ranking form: *Geum radiatum*. The Nature Conservancy National Office. Arlington, Va. 2 pp.
- Pyle, C., and M.P. Schafale. 1988. Land use history of three spruce-fir forest sites in southern Appalachia. *Journal of Forest History* 32(1):4-21.
- Ramseur, G.S. 1960. The vascular flora of high mountain communities of the southern Appalachians. *Journal of Elisha Mitchell Scientific Society* 76(1):82-112.
- Reagan, S. 1990. Habitat use by female black bears in a southern Appalachian bear sanctuary. Master's Thesis. University of Tennessee, Knoxville. 110 pages.
- Rich, T.D, C.J. Beardmore, H. Berlanga, P.J. Blancher, M.S.W. Bradstreet, G.S. Butcher, D.W. Demarest, E.H. Dunn, W.C. Hunter, and E.E. Inigo-Elias. 2004. Partners in Flight North American Landbird Conservation Plan. Ithaca (NY): Cornell Lab of Ornithology.
- Roberts, M. R., & Gilliam, F. S. (1995). Patterns and mechanisms of plant diversity in forested ecosystems: implications for forest management. *Ecological Applications*, 5(4), 969-977.
- Robinson, L. G. 2018. Natural Heritage Program List of Rare Plant Species of North Carolina 2018. Published by the NC Natural Heritage Program, Raleigh, NC. 175 pp.
- Runkle, J.R. and T.C. Yetter. 1987. Treefalls Revisited: Gap Dynamics in the Southern Appalachians. *Ecology*. 68(2):417-424.
- Runkle, J.R. 1998. Changes in Southern Appalachian Canopy Tree Gaps Sampled Thrice. *Ecology*, 79: 1768-1780.
- Sauer J.R., W.A. Link, J.E. Fallon, K.L. Pardieck, and D.J. Ziolkowski, Jr. 2013. The North American Breeding Bird Survey 1966–2011: summary analysis and species accounts. North American Fauna (as cited in NCWRC 2015).
- Schafale, M. P. 2012. Guide to the Classification of the Natural Communities of North Carolina (Fourth Approximation), North Carolina Natural Heritage Program, Raleigh, North Carolina. 217 p.
- Schafale, M. P. 2021. Classification of Natural Communities (Fourth Approximation, in prep), North Carolina Natural Heritage Program, Raleigh, North Carolina. Accessed at <https://www.ncnhp.org/references/nhp-publications/fourth-approximation-descriptions>.
- Schafale, M. P., and A. S. Weakley. 1990. Classification of the Natural Communities of North Carolina: Third Approximation. North Carolina Natural Heritage Program, Raleigh, North Carolina.
- Seymour, R., and M. Hunter. 1999. Maintaining biodiversity in forest ecosystems. In: M. Hunter (ed., Managing Biodiversity in forested ecosystems. Cambridge, UK, Cambridge University Press.
- Shifley, S.R., and F.R. Thompson III. 2011. Spatial and Temporal Patterns in the Amount of Young Forests and Implications for Biodiversity. In: Greenberg C., Collins B., Thompson III F. (eds) Sustaining Young Forest Communities. Managing Forest Ecosystems, vol 21. New York.
- Simon, Steve S. 2011. Ecological Zones in the Southern Blue Ridge, 3<sup>rd</sup> Approximation. Unpublished report submitted to The Nature Conservancy and USFS, National Forests in North Carolina. 25 p.
- Small, Christine J., Wentworth, Thomas R. (1998) Characterization of Montane Cedar-Hardwood Woodlands in the Piedmont and Blue Ridge Provinces of North Carolina, *Castanea*, Vol. 63, No. 3 (Sep., 1998), pp. 241-261
- Smith, G.F., and N.S. Nicholas. 1999. Post-disturbance spruce-fir forest stand dynamics at seven disjunct sites. *Castanea* 64(2):175-186.



- Southern Appalachian Man and the Biosphere (SAMAB). "Atmospheric Technical Report," 1996. The Southern Appalachian Assessment. Prepared by Federal and State Agencies, coordinated through SAMAB Cooperative. <http://www.samab.org/wp-content/uploads/2011/06/SAA-Atmos-report.pdf>
- Stauffer, Dean F., ed. Ecology and management of Appalachian ruffed grouse. Hancock House Publishers Limited, 2011.
- Thomson, J.D. 2010. Flowering phenology, fruiting success and progressive deterioration of pollination in an early-flowering geophyte. *Philosophical Transactions of the Royal Society B: Biological Sciences* 365(1555): 3187-3199.
- Thompson, A. 2018. *Solidago spithamea* monitoring data from 2016 and 2017. North Carolina State University, Raleigh, NC. Unpublished spreadsheet.
- Thomas-Van Gundy, M. and M. Strager. 2011. Site characteristics of American chestnut, oak, and hickory witness trees on the Monongahela National Forest, West Virginia. *In*: Fei, Songlin; Lhotka, John M.; Stringer, Jeffrey W.; Gottschalk, Kurt W.; Miller, Gary W., eds. Proceedings, 17th central hardwood forest conference; 2010 April 5-7; Lexington, KY; Gen. Tech. Rep. NRS-P-78. Newtown Square, PA.
- Tompkins, Bryan. 2019. Recovery Biologist. U.S. Fish and Wildlife Service, Asheville Field Office. Asheville, NC.
- Turner, G.G., D.M. Reeder, and J.T.H. Colman. 2011. A five-year assessment of mortality and geographic spread of white-nose syndrome in North American bats and a look into the future. *Bat Research News*. 52(2): 13-27.
- Ulrey C.J. 1999. Classification of the Vegetation of the Southern Appalachians. Asheville, NC: U.S. Forest Service, Southern Research Station, Bent Creek Experimental Forest. 91 p.
- Ulrey, C.J. 2002. The Relationship between Soil Fertility and the Forests of the Southern Appalachian Region. PhD Dissertation, NC State University. 234 p.
- Ulrey, C. 2016. National Park Service plant ecologist, Blue Ridge Parkway. Personal communication to Gary Kauffman.
- Ulrey, C., P.F. Quintana-Ascencio, G. Kauffman, A.B. Smith, and E.S. Menges. 2016. Life at the top: Long-term demography, microclimatic refugia, and responses to climate change for a high-elevation southern Appalachian endemic plant. *Biological Conservation* 200: 80–92.
- U.S. Fish and Wildlife Service (USFWS). 1967. Native fish and wildlife; endangered Species. Federal Register. 32 FR 4001.
- U.S. Fish and Wildlife Service (USFWS). 1976. Endangered and threatened wildlife and plants; Determination that two species of butterflies are threatened species and two species of mammals are endangered species. Federal Register. 41 FR 17736-17740.
- U.S. Fish and Wildlife Service (USFWS). 1976. Endangered and threatened wildlife and plants; determination of critical habitat for American crocodile, California condor, Indiana bat, and Florida manatee. Federal Register. 41 FR 41914-41916
- U.S. Fish and Wildlife Service (USFWS). 1977. Endangered and threatened wildlife and plants; final threatened status and critical habitat for five species of southeastern fishes. Federal Register. 42 FR 45526-45530.
- U.S. Fish and Wildlife Service (USFWS). 1977. Endangered and threatened wildlife and plants; Final rule; correction and augmentation of published rulemaking on critical habitats. Federal Register. 41 FR 41914-41916

- U.S. Fish and Wildlife Service (USFWS). 1978. Final determination that seven eastern U.S. land snails are endangered or threatened species. Federal Register. 43 FR 28932-28935.
- U.S. Fish and Wildlife Service (USFWS). 1979. Endangered and threatened wildlife and plants; re-proposal of critical habitat for the Virginia big-eared bat. Federal Register. 44 FR 51144-51145.
- U.S. Fish and Wildlife Service. 1979. Determination that *Sagittaria fasciculata* is an Endangered Species. 44 Federal Register 43700-43701.
- U.S. Fish and Wildlife Service. 1980. Endangered and Threatened Wildlife and Plants: determination of *Hudsonia montana* to be threatened species, with critical habitat. Federal Register 204:69360-69363.
- U.S. Fish and Wildlife Service. 1983. Mountain Golden heather Recovery Plan. Atlanta, Georgia. 26 pp.
- U.S. Fish and Wildlife Service. 1983. Recovery Plan for the Bunched Arrowhead (*Sagittaria fasciculata*). Atlanta, Georgia. 37 pp.
- U.S. Fish and Wildlife Service (USFWS). 1985. Endangered and threatened wildlife and plants; determination of endangered status for two kinds of northern flying squirrel. Federal Register. 50 FR 26999-27002.
- US Fish and Wildlife Service. 1985. Endangered and Threatened Wildlife and Plants; Determination of Threatened Status for *Solidago spithamea* (Blue Ridge Goldenrod). Federal Register 50(60):12306-12309.
- U.S. Fish and Wildlife Service. 1987. Determination of threatened status for *Liatris helleri*. Federal Register 52(223): 44397-44401.
- U.S. Fish and Wildlife Service. 1988. Determination of *Helonias bullata* (Swamp Pink) to be a Threatened Species. Federal Register 53:35076–35080.
- U.S. Fish and Wildlife Service. 1988. Endangered and Threatened Wildlife and Plants; Determination of Endangered Status for *Sarracenia rubra ssp. jonesii* (Mountain Sweet Pitcher Plant). Federal Register 53(190):38470-38473.
- U.S. Fish and Wildlife Service (USFWS). 1988. Endangered and threatened wildlife and plants; determination of endangered species status for the little-wing pearly mussel. Federal Register. 53 FR 45861-45865.
- U.S. Fish and Wildlife Service. 1990. Endangered and Threatened Wildlife and Plants; Determination of Endangered Status for *Geum radiatum* and *Hedyotis purpurea var. montana*. Federal Register 55(66):12793-12797.
- U.S. Fish and Wildlife Service. 1990. Mountain sweet pitcher plant recovery plan. Atlanta, GA. 39 pp.
- U.S. Fish and Wildlife Service. 1990. Threatened status determined for *Spiraea virginiana* (Virginia Spiraea). Federal Register 55(116): 24241-24246.
- U.S. Fish and Wildlife Service. 1991. Swamp Pink (*Helonias bullata*) Recovery Plan. Newton Corner, Massachusetts. 56 pp.
- U.S. Fish and Wildlife Service. 1993. Spreading Avens Recovery Plan. Atlanta, Georgia. 32 pp.
- U.S. Fish and Wildlife Service (USFWS). 1993. Endangered and threatened wildlife and plants; proposal to list the Appalachian elktoe as an endangered species. Federal Register. 58 FR 46940-46945.
- U.S. Fish and Wildlife Service (USFWS). 1995. Endangered and threatened wildlife and plants; spruce-fir moss spider determined to be endangered. Federal Register. 60 FR 6968-6974.

- U.S. Fish and Wildlife Service. 1995. *Gymnoderma lineare* (Rock Gnome Lichen) Determined to be Endangered. Federal Register 60(11): 3557 – 3562.
- U.S. Fish and Wildlife Service. 1996. Roan Mountain Bluet (*Hedyotis purpurea* (L.) Torrey & Gray var. *montana* (Small) Fosberg) Recovery Plan. Atlanta, Georgia. 46 pp.
- U.S. Fish and Wildlife Service. 1997. Recovery Plan for Rock Gnome Lichen (*Gymnoderma lineare*) (Evans) Yoshimura and Sharp. Atlanta, GA. 30pp.
- U.S. Fish and Wildlife Service (USFWS). 1998. Recovery plan for the spruce-fir moss spider. Atlanta, Georgia.
- U.S. Fish and Wildlife Service. 1999. Recovery Plan for *Liatris helleri* Porter (Heller's Blazing Star). Atlanta, GA. 25 pp.
- US Fish and Wildlife Service. 2001. Determination that designation of critical habitat is not prudent for rock gnome lichen. Federal Register 66(195) :51445-51452.
- U.S. Fish and Wildlife Service (USFWS). 2001. Endangered and threatened wildlife and plants; designation of critical habitat for the spruce-fir moss spider. Federal Register. 66 FR 35547-35566.
- U.S. Fish and Wildlife Service (USFWS). 2002. Endangered and threatened wildlife and plants; designation of critical habitat for the Appalachian elktoe. Federal Register. 67 FR 61016-61040.
- U.S. Fish and Wildlife Service (USFWS). 2009. Gray Bat (*Myotis grisescens*) 5-year review: summary and evaluation. [https://ecos.fws.gov/docs/five\\_year\\_review/doc2625.pdf](https://ecos.fws.gov/docs/five_year_review/doc2625.pdf).
- US Fish and Wildlife Service. 2009. Virginia Spiraea (*Spiraea virginiana* Britton) 5-Year Review: Summary and Evaluation. Gloucester, Va. 26 pp.
- US Fish and Wildlife Service. 2012. Blue Ridge Goldenrod (*Solidago spithamea*) 5-Year Review: Summary and Evaluation. Asheville, NC. 17 pp.
- U.S. Fish and Wildlife Service (USFWS). 2013. Endangered and Threatened Wildlife and Plants; 12-Month Finding on a Petition To List the Eastern Small-Footed Bat and the Northern Long-Eared Bat as Endangered or Threatened Species. Federal Register: 78 FR 61045 6108078.
- US Fish and Wildlife Service. 2013. Rock Gnome Lichen (*Gymnoderma lineare*) 5-Year Review: Summary and Evaluation. Asheville, NC. 16 pp.
- US Fish and Wildlife Service. 2013. Spreading Avens (*Geum radiatum*) 5-Year Review: Summary and Evaluation. Asheville, NC. 16 pp.
- US Fish and Wildlife Service. 2012. Mountain golden heather (*Hudsonia montana*) 5-Year Review: Summary and Evaluation. Asheville, NC. 18 pp.
- U.S. Fish and Wildlife Service (USFWS). 2015. Endangered and threatened wildlife and plants; listing the northern long-eared bat with a rule under section 4(d) of the act. Federal Register. 80 FR 2371-2378.
- U.S. Fish and Wildlife Service (USFWS). 2015. Endangered and threatened wildlife and plants; listing the northern long-eared bat with a rule under section 4(d) of the act; correction. Federal Register. 80 FR 5079.
- US Fish and Wildlife Service. 2016. Endangered and Threatened Wildlife and Plants; Threatened Species Status for *Platanthera integrilabia* (White Fringeless Orchid). Federal Register 81(177):62826-68833.
- U.S. Fish and Wildlife Service (USFWS). 2017. Endangered and threatened wildlife and plants; endangered species status for rusty patched bumble bee. Federal Register. 82 FR 3186-3209.

- US Fish and Wildlife Service. 2019. Blue Ridge Goldenrod (*Solidago spithamea*) 5-Year Review: Summary and Evaluation. Asheville, NC. 11 pp.
- U.S. Fish and Wildlife Service (USFWS). 2019. <https://www.fws.gov/endangered/>. Cited for several federally listed species.
- US Fish and Wildlife Service. 2019. Mountain golden heather (*Hudsonia montana*) 5-Year Review: Summary and Evaluation. Addendum 1. Summary of new information obtained since the 2013 5-year review. Asheville, NC. 19 pp.
- US Fish and Wildlife Service. 2020. Rock Gnome Lichen (*Gymnoderma lineare*) 5-Year Review: Summary and Evaluation Addendum. Asheville, NC. 17 pp.
- US Fish and Wildlife Service. 2020. Bunched Arrowhead (*Sagittaria fasciculata*) 5-Year Review: Summary and Evaluation Addendum. Asheville, NC. 18 pp.
- US Fish and Wildlife Service. 2021. Mountain Sweet Pitcher Plant (*Sarracenia rubra ssp. jonesii*) 5-Year Review: Summary and Evaluation Addendum. Asheville, NC. 18 pp.
- U.S. Geological Survey (USGS). 2018. U.S. Land Cover analysis. <https://www.usgs.gov/core-science-systems/national-geospatial-program/land-cover>.
- Vandermaast, D. B. and D. H. Van Lear. Riparian vegetation in the southern Appalachian mountains (UAS) following chestnut blight. 2002. Forest Ecology and Management 155: 97 – 106.
- vanLear, David H.; Vandermaast, D.B.; Rivers, C.T.; Baker, T.T.; Hedman, C.W.; Clinton, B.D.; Waldrop, T.A. 2002. American chestnut, rhododendron, and the future of appalachian cove forests. Gen. Tech. Rep. SRS-48. Asheville, NC.
- Von Oettingen, S.L. 1992. Small Whorled Pogonia (*Isotria medeoloides*) recovery plan. U.S. Fish and Wildlife Service, Newton Comer, Massachusetts.
- Virginia Department of Game and Inland Fisheries (VDGIF). 2007. 2007-2008 Hunter Survey Report. <https://www.dgif.virginia.gov/wp-content/uploads/2007-08-Hunter-Survey-Report.pdf>.
- Vose, J.M., W.T. Swank, B. D. Clinton, R.L. Hendrick, and A.E. Major, Amy E. 1997. Using fire to restore pine/hardwood ecosystems in the Southern Appalachians of North Carolina. Proceedings: First conference on fire effects on rare and endangered species and habitats conference; 1995 November 13-16; Coeur d'Alene, ID; Fairfield, WA: International Association of Wildland Fire: 149-154.
- Waldrop, M. P., J. G. McColl, and R. F. Powers. 2003. Effects of Forest Postharvest Management Practices on Enzyme Activities in Decomposing Litter. Soil Sci. Soc. Am. J. 67:1250-1256. doi:10.2136/sssaj2003.1250
- Wang, G. Geoff; Knapp, Benjamin O.; Clark, Stacy L.; and Mudder, Bryan T. 2013. The Silvics of Castanea dentata (Marsh.) Borkh., American chestnut, Fagaceae (Beech Family). Gen. Tech. Rep. SRS-GTR-173. Asheville, NC. 18 pages.
- Watson-Cook, E.L. 2017. Characteristics and Classification of southern Appalachian spruce-fir forests. B.S. Thesis, UNC-Chapel Hill.
- Wathen, W.G. 1983. Reproduction and denning of black bears in the Great Smoky Mountains. M.S. Thesis. Univ. of Tenn., Knoxville. 135pp.
- Weakley, A.S, J.C Ludwig, and J.F. Townsend. 2012. Flora of Virginia. 2015. Bland Crowder, ed. Foundation of the Flora of Virginia Project, Inc., Richmond. Forth Worth, Botanical Research Institute of Texas Press. 1554 p.

- Weakley, A.S. 2020. Flora of the Southeastern United States, working draft of 20, October 2020. Chapel Hill. UNC Herbarium, North Carolina Botanical Garden, UNC at Chapel Hill. 1848 p.
- Weakley, A.S. 2018. "Hexastylis species #1 status". Message to Gary Kauffman, July 27, 2018. E-mail communication
- Wear, David N.; Greis, John G. 2012. The Southern Forest Futures Project: summary report. Gen. Tech. Rep. SRS-GTR-168. Asheville, NC: USDA-Forest Service, Southern Research Station. 54 p.
- Webster, Christopher R.; Dickinson, Yvette L.; Burton, Julia I.; Frelich, Lee E.; Jenkins, Michael A.; Kern, Christel C.; Raymond, Patricia; Saunders, Michael R.; Walters, Michael B.; Willis, John L. 2018. Promoting and maintaining diversity in contemporary hardwood forests: Confronting contemporary drivers of change and the loss of ecological memory. *Forest Ecology and Management*. 421: 98-108.
- Weigl, P. D. and T. W. Knowles. 1999. Antiquity of southern Appalachian grass balds: The role of keystone megaherbivores. *Proceedings of the Appalachian Biogeography Symposium*. Virginia Museum of Natural History Special Publication. No. 7. 1999.
- Weigl, P.D., and T.W. Knowles. 2014. Temperate mountain grasslands: a climate-herbivore hypothesis for origins and persistence. *Biological Reviews* 89:466-476
- Weigl, P. D., T.W. Knowles, and A.C. Boynton. 1999. The distribution and ecology of the northern flying squirrel, *Glaucomys sabrinus coloratus*, in the southern Appalachians. North Carolina Wildlife Resources Commission, Nongame and Endangered Wildlife Program, Division of Wildlife Management.
- Wells, B.W. 1937. Southern Appalachian grass balds. *Journal of the Elisha Mitchell Scientific Society* 53: 1-26.
- Wentworth, J. M. 1989. Deer-habitat relationships in the southern Appalachian mountains. Ph.D. Dissertation, University of Georgia, Athens, GA.
- Wentworth, J. M., A. S. Johnson, and P. E. Hale. 1990a. Influence of acorn use on nutritional status and reproduction of deer in the Southern Appalachians. *Proc. Annu. Conf: Southeast. Assoc. Fish and Wildl. Agencies*, 44:142-154.
- Wentworth, J. M., A. S. Johnson, P. E. Hale, and K. E. Kammermeyer. 1990b. Seasonal use of clearcuts and food plots by white-tailed deer in the Southern Appalachians. *Proc. Annu. Conf: Southeast. Assoc. Fish and Wildl. Agencies*, 44:215-223.
- Wentworth, J. M., A. S. Johnson, P. E. Hale, and K. E. Kammermeyer. 1992. Relationships of acorn abundance and deer herd characteristics in the Southern Appalachians. *South J Appl. Forestry*. 16: 5-8.
- Whigham, D.; McCormick, M.; Brooks, H.; Josey, B.; Floyd, R.; Applegate, J. *Isotria medeoloides*, a North American Threatened Orchid: Fungal Abundance May Be as Important as Light in Species Management. *Plants* 2021, 10, 1924. <https://doi.org/10.3390/plants10091924>
- White, P.B., S.L. van de Gevel, P.T. Soule. 2012. Succession and disturbance in an endangered red spruce-Fraser fir forest in the southern Appalachian Mountains, North Carolina, USA. *Endangered Species Research*. 18:17-25.
- White, P.S. and C.V. Cogbill. 1992. Spruce-fir forests of eastern North America. In: *Ecology and decline of red spruce in the eastern United States*. C. Eagar and M.B. Adams (Eds.). New York, Springer Verlag. 416 p.

- White, P.S.; Collins, B.; and Weins, G.R. 2011. In C.H. Greenberg, et al (Eds), Sustaining young forest communities, Managing forest ecosystems 21, DOI 10.1007/978-94-007-1620-9\_3, Springer Science + Business Media B.V.
- Wichmann, B.L. 2021. Natural Heritage Program List of Rare Plant Species of North Carolina. North Carolina Natural Heritage Program, Raleigh, North Carolina. 188 p.
- Wiser, S. K, R.K. Peet, and P.S. White. 1996. High-elevation rock outcrop vegetation of the Southern Appalachian Mountains. *Journal of Vegetation Science* 7: 703-722, 1996
- Williams, P.H., R.W. Thorp, L.L. Richardson, and S.R. Colla. 2014. Bumble bees of North America: an Identification Guide. Princeton University Press. 208 pp.
- Williams, S. 2020. Broad Scale Climate Change Monitoring Evaluation Report for the Southern Region. USDA Forest Service, Southern Region.
- Wiser, S.K., R. K. Peet, and P.S. White. 1996. High-elevation rock outcrop vegetation of the Southern Appalachian Mountains. *Journal of Vegetation Science*. 7(5): 703–722.
- Woodward, A., 2021, Rock gnome lichen (*Gymnoderma lineare*) monitoring assessment, southern Appalachian Mountains, 1983–2008: U.S. Geological Survey Open-File Report 2021–1011, 12 p., <https://doi.org/10.3133/ofr20211011>.
- Wooten, R.M.; Witt, A.C.; Hales, T.C.; Aldred, J.L. 2015. Frequency and magnitude of selected historical landslide events in the southern Appalachian highlands of North Carolina and Virginia: relationships to rainfall, geological and ecohydrological controls and effects. . In C.H. Greenberg, et al (Eds). Natural disturbances and historic range of variation: type, frequency, severity, and post-disturbance structure in central hardwood forests, USA.
- Wunz, G.A., and J.C. Pack. 1992. Eastern turkey in eastern oak– hickory and northern hardwood forests. Pages 232–264 in *The Wild Turkey: Biology and Management* (J. G. Dickson, Ed.). Stackpole Books, Harrisburg, Pennsylvania.
- Yelton, J.D. 2015. East Tennessee University graduate student in 1970's. Personal communication and field trip with Gary Kauffman.
- Zartman, C.E. and J.D. Pittillo. 1998. Spray Cliff Communities of the Chattooga Basin. *Castanea*, vol. 63, no. 3, pp. 217–240.

## Old Growth

- Ackerly, D. D., S. R. Loarie, W. K. Cornwall, S. B. Weiss, H. Hamilton, R. Branciforte, and N. J. B. Kraft. 2010. The geography of climate change: implications for conservation biogeography. *Diversity and Distributions* 16:476–487.
- Anderson, M.G., M. Clarke, and A.O. Sheldon. 2014. Estimating Climate Resilience for Conservation across Geophysical Settings. *Conservation Biology* 28(4) 959-970.
- Ardron, J. A., Possingham, H. P., & Klein, C. (2010). *Marxan Good Practices Handbook* (2 ed.). Victoria, BC: PacMARA. Retrieved from <http://pacmara.org/wp-content/uploads/2010/07/Marxan-Good-PracticesHandbook-v2-2010.pdf>
- Barton, A.M. 2018. Introduction: Ecological and Historical Context. In A. M. Barton and W.S. Keeton (Eds.), *Ecology and Recovery of Eastern Old-growth Forests*. Washington, D.C., Island Press. 340 p.
- Busing, R. T. and P.S. White. 1997. Species diversity and small-scale disturbance in an old-growth temperate forest: a consideration of gap partitioning concepts. *Oikos* 78: 562-568.

- Busing, R.T., and P.S. White. 1993. Effects of area on old-growth forest attributes: implications for the equilibrium landscape concept. *Landscape Ecology* 8:119-126.
- Butler S.A., A. S. White, K.J. Elliott, and R.S. Seymour. 2014. Disturbance history and stand dynamics in secondary and old-growth forests of the Southern Appalachian Mountains, USA. *Journal of Torrey Botanical Society* 141(3):189-204.
- C.W. Lafon. 2006. Forest disturbance by ice storms in *Quercus* forests of the southern Appalachian Mountains, USA. *Ecoscience* 13(1): 30-43.
- Chapman, J.I., and R.W. McEwan. 2018. Topography and vegetation patterns in and old-growth Appalachian forest: Lucy Braun, you were right. In A. M. Barton and W.S. Keeton (Eds.), *Ecology and Recovery of Eastern Old-growth Forests*. Washington, D.C., Island Press. 340 p.
- Chester, E.W., S.M. Noel, J.M. Baskin, C.C. Baskin, and M.L. McReynolds. 1995. A phytosociological analysis of an old-growth upland wet woods on the Pennyroyal Plain, southcentral Kentucky, USA. *Natural Areas Journal* 15:297-307.
- Ciegler, A., U.H. Eliasson, and H.W. Keller. 2003. Tree canopy lichens of the Great Smoky Mountains National Park. *Evansia* 20:114-131.
- Cogbill, C.V., and P.S. White. The Latitude-Altitude Relationship for Spruce-Fir Forest and Treeline along the Appalachian Mountain Chain. *Vegetatio* 94:153-175.
- Davis, M.B. Ed., 1996. *Eastern Old-growth Forests: Prospects for Rediscovery and Recovery*. Washington, D.C., Island Press. 383 p.
- Duffy, C.D. and A.J. Meir. 1992. Do Appalachian herbaceous understories ever recover from clearcutting? *Conservation Biology* 6(2): 196- 201.
- Elliott, K.J., and D.L. Loftis. 1993. Vegetation diversity after logging in the Southern Appalachians. *Conservation Biology* 7:220-221.
- Elliott, K.J., and W.T. Swank. 1994. Changes in tree species diversity after successive clearcuts in the Southern Appalachians. *Vegetatio* 115: 11-18.
- Esseen, P.A, K.E. Renhorn, and R.B. Pettersson. 1996. Epiphytic Lichen Biomass in Managed and Old-Growth Boreal Forests: Effect of Branch Quality. *Ecological Applications* 6(1): 228-238.
- Flatley, W.T., C.W. Lafon, H.D. Grissino-Mayer, and L.B. LaForest. 2013. Fire history, related to climate and land use in three southern Appalachian landscapes in the eastern United States. *Ecological Applications* 23(6):1250-1266.
- Franklin, J.F., and R. Van Pelt. 2004. Spatial Aspects of Structural Complexity in Old-growth Forests. *Journal of Forestry* 102(3):22-28.
- Franklin, J.F., T.A. Spies, R. Van Pelt, A.B. Carey, D.A. Thornburgh, D. Rae Berg, D.B. Lindenmayer, M.E. Harmon, W.S. Keeton, D.C. Shaw, K. Bible, and J. Chen. 2002. Disturbances and structural development of natural forest ecosystems with silvicultural implications, using Douglas-fir forests as an example. *Forest Ecology and Management* 155:399-423.
- Freemark, K.E., and H.G. Merriam. 1986. Importance of area and habitat heterogeneity to bird assemblages in temperate forest fragments. *Biological Conservation* 36(2): 115-141.
- Greenberg, C., B. Collins, and F. Thompson III (Eds.) 2011. *Sustaining Young Forest Communities*. Springer, New York.

- Gregory G McGee, G.G., and R.W. Kimmerer. 2002. Forest age and management effects on epiphytic bryophyte communities in Adirondack northern hardwood forests, New York, U.S.A. *Canadian Journal of Forest Research* 32(9): 1562-1576.
- Harmon, M.E., S.P. Bratton, and P.S. White. 1983. Disturbance and vegetation response in relation to environmental gradients in the Great Smoky Mountains. *Vegetatio*. 55:129-139.
- Harrod, J.C., M.E. Harmon, and P.S. White. 2000. Post-fire succession and twentieth century reduction in fire frequency on xeric southern Appalachian sites. *Journal of Vegetation Science*. 11:465-472.
- Hunter, M.L., and A.S. White. 1997. Ecological thresholds and the definition of old-growth forest stands. *Natural Areas Journal* 17:292-296.
- Hunter, M.L., G.L. Jacobson, and T Webb III. 1988. Paleoecology and the Coarse-Filter Approach to Maintaining Biological Diversity. *Conservation Biology* 2(4): 375-385.
- Jackson B.C., J.D. Pitillo, H.L. Allen, T.R. Wentworth, B. P. Bullock, and D.L. Loftis. 2009. Species diversity and composition in old growth and second growth rich coves of the Southern Appalachian Mountains. *Castanea* 74: 27-38.
- Juday, G.P. 1990. An Interview with Jerry F. Franklin, Bloedel Professor of Forestry, University of Washington. *Natural Areas Journal* 10(4):163-172.
- Lendemer, J.C., R.C. Harris., and E.A. Tripp. 2013. *The Lichens and Allied Fungi of Great Smoky Mountains National Park: An Annotated Checklist with Comprehensive Keys*. New York, The New York Botanical Garden Press. 152 p.
- Martin, W.H. 1992. Characteristics of old-growth mixed mesophytic forests. *Natural Areas Journal*. 12(3): 127-135.
- McDonald, L./ Van Woudenberg, M./ Dorin, B./ Adcock, A.M./ McMullin, R.T./ Cottenie, K. 2017: The effects of bark quality on corticolous lichen community composition in urban parks of southern Ontario. - *Botany* 95(12): 1141-1149.
- Miller, K.M., R.G. Wagner, and S.A. Woods. 2008. Arboreal arthropod associations with epiphytes following gap harvesting in the Acadian forest of Maine. *The Bryologist* 111:424-434.
- Pickett, S.T.A., and J.N. Thompson. 1978. Patch dynamics and the size of nature reserves. *Biological Conservation* 13: 27–37.
- R.T. McMullina, R.T., P. N. Duinker, D.H.S. Richardson, R. P. Cameron, D.C. Hamilton, and S.G. Newmaster. 2018. Relationships between the structural complexity and lichen community in coniferous forests of southwestern Nova Scotia. *Forest Ecology and Management* 260(5): 744-749.
- Root, H.T., G.G. McGee, and R.A. Norton. 2007. Arboreal Mite Communities on Epiphytic Lichens of the Adirondack Mountains of New York. *Northeastern Naturalist* 14(3):425-438.
- Rubino, D.L. and B.C. McCarthy. 2003. Composition and ecology of macrofungal and myxomycete communities on oak woody debris in a mixed-oak forest of Ohio. *Canadian Journal of Forest Research* 33(11): 2151-2163
- Runkle, J.C., and T. C. Yetter. 1987. Treefalls Revisited: Gap Dynamics in the Southern Appalachians. *Ecology* 68(2): 417-424.
- Runkle, J.R. 1982. Patterns of disturbance in some old-growth mesic forests of the Eastern United States. *Ecology*. 63: 1533-1546.
- Shugrart, H.H. 1984. *A theory of forest dynamics: the ecological implications of forest succession models*. New York, Springer-Verlag.



- Simon, Steve S. 2011. Ecological Zones in the Southern Blue Ridge, 3<sup>rd</sup> Approximation. Unpublished report submitted to The Nature Conservancy and USFS, National Forests in North Carolina. 25 p.
- Stevens. T. 2002. Rigor and Representativeness in Marine Protected Area Design. *Coastal Management*. 30:237-248.
- Tripp. E.A., and J.C. Lendemer. 2020. *Field Guide to the Great Smoky Mountains National Park*. University of Tennessee Press, Knoxville. 572 p.
- Turner, M.G. 1989. Landscape Ecology: The Effect of Pattern on Process. *Annual Review of Ecology and Systematics* 20:171-197.
- USDA, USFS Region 8. 1997. Guidance for Conserving and Restoring Old-Growth Forest Communities on National Forests in the Southern Region. Unpublished report on file with USDA, USFS Region 8. Atlanta, Georgia. 121 p.
- Watson, Polak, T., Bennett, J.R., Possingham, H., Fuller, R., Carwardine, J. (2016). Balancing ecosystem and threatened species representation in protected areas and implications for nations achieving global conservation goals. *Conservation Letters*, November/December 2016, 9(6), 438-445.
- Watson, J., Darling, E., Venter, O., Maron, M., Walston, J., & Possingham, H. (2015). Bolder science needed now for protected areas. *Conservation biology*.
- White, P.S. 1987. Natural Disturbance, Patch Dynamics, and Landscape Pattern in Natural Areas. *Natural Area Journal* 7(1):14-22.
- White, P.S., J.P. Tuttle, and B. S. Collins. 2018. Old-growth Forests in the Southern Appalachians: Dynamics and Conservation Frameworks. In A. M. Barton and W.S. Keeton (Eds.), *Ecology and Recovery of Eastern Old-growth Forests*. Washington, D.C., Island Press. 340 p.
- Willis, K. J., and S. A. Bhagwat. 2009. Biodiversity and climate change. *Science* 326:806–807.
- Wyatt, J.L., and M.R. Silman. 2010. Centuries-old logging legacy on spatial and temporal patterns in understory herb communities. *Forest Ecology and Management* 260(1):116-124.

## Fire

- Aldrich, S., Lafon, C., Grissino-Mayer, H., DeWeese, G., Hoss, J. 2010. Three centuries of fire in montane pine-oak stands on a temperate forest landscape. *Applied Vegetation Science* 13: 26-46.
- Andreu, A, Hermansen-Baez, L. 2008. Fire in the South 2 The Southern Wildfire Risk Assessment 32 pages (see [www.southernwildfirerisk.com/reports/FireInTheSouth2.pdf](http://www.southernwildfirerisk.com/reports/FireInTheSouth2.pdf)).
- Bowles, M.L.; Jacobs, K.A.; Mengler, J.L. 2007. Long-term changes in an oak forest's woody understory and herb layer with repeated burning. *Journal of the Torrey Botanical Society*. 134(2): 223-237.
- Brose. P., Waldrop, T. 2006. Fire and the origin of Table Mountain pine-pitch pine communities in the southern Appalachian Mountains, USA *Canadian Journal of Forestry* 36 710-718.
- Buchanan, B. 2019. Cherokee NF response of trees following prescribed fire, Unpublished, 2019.
- Bucher, M., Buchanan, B., Mohr, H. 2019. Shortleaf pine and pine oak woodland restoration. Southern Blue Ridge Fire Learning Network Workshop 14. Unpublished presentation.
- Cohen D., B. Dellinger, R. Klein, B. Buchanan. 2007 Patterns in Lightning-caused Fires at Great Smoky Mountains National Park, *Fire Ecology Special Issue*, Vol 3 No 2 68-82.

- Connor, K., ed. 2006. Proceedings of the 13th biennial southern silvicultural research conference. Gen. Tech. Rep. SRS-92. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 640 p.
- Delcourt, H.R., P.A. Delcourt. 1997. Pre-Columbian Native American Use of Fire on Southern Appalachian Landscapes, *Conservation Biology* 11 (4) 1010-1014.
- Deneven, W.M. 1992. The Pristine Myth: The Landscape of the Americas in 1492. *Annals of the Association of American Geographers* 82(3) 369-385.
- DeVivo, M.S. 1991. Indian use of fire and land clearance in the southern Appalachians. In: S.C. Nodvin and T.A. Waldrop (eds.). *Fire and the Environment: ecological and cultural perspectives*. Proceedings of an International symposium. USDA For. Serv. Gen. Tech. Rep. SE-69. Asheville, NC. pp. 306-310.
- Elliott, K.J.; Vose, J.M.; Hendrick, R.L. 2009. Long-term effects of high intensity prescribed fire on vegetation dynamics in the Wine Spring Creek watershed, Western North Carolina, USA. *Fire Ecology*. 5(2): 66-85. <https://doi.org/10.4996/fireecology.0502066>.
- Flatley, W.T., C.W. Lafon, H.D. Grissino-Mayer, L.M. LaForest. 2013. Fire history, related to climate and land use in three southern Appalachian landscapes in the eastern United States. *Ecological Applications*. 23(6) 1250-1266.
- Flatley, W.T.; Lafon, C.W.; Grissino-Mayer, H.D. [and others]. 2015. Changing fire regimes and old-growth forest succession along a topographic gradient in the Great Smoky Mountains. *Forest Ecology and Management*. 350: 96-106.
- Fox, S., Jackson, B., Jackson, S., Kauffmann, G., Koester, M., Mera, R., Seyden, T., Van Sickle, C., Chipley, S., Fox, J., Hicks, J., Hutchins, M., Lichtenstein, K., Nolan, K., Pierce, T., Porter, B. 2011. Western North Carolina report card on forest sustainability. Gen. Tech. Rep. SRS-142. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station, 198 p.
- Gilliam, F.S. 2007. The ecological significance of the herbaceous layer in temperate forest ecosystems. *BioScience*. 57(10): 845-858. <https://doi.org/10.1641/B571007>.
- Glasgow, L.S.; Matlack, G.R. 2007. Prescribed burning and understory composition in a temperate deciduous forest, Ohio, USA. *Forest Ecology and Management*. 238: 54-64. <https://doi.org/10.1016/j.foreco.2006.08.344>.
- Jackson, W. 2018. Nantahala and Pisgah NFs Available Burn Days Per Year. Unpublished data.
- Johnson, A. S., Hale, P. E. 2002. The historical foundations of prescribed burning for wildlife: a southeastern perspective. In: Ford, W. Mark; Russell, Kevin R.; Moorman, Christopher E., eds. *Proceedings: the role of fire for nongame wildlife management and community restoration: traditional uses and new directions*. Gen. Tech. Rep. NE-288. Newtown Square, PA: U.S. Dept. of Agriculture, Forest Service, Northeastern Research Station. 11-23.
- Keyser, C., Rodrigue, J. 2014. Forest vegetation simulation modeling for the Nantahala and Pisgah National Forests. Asheville, NC.
- Lafon, C. W., Naito, A., Grissino-Mayer, H., Horn, S., Waldrop, T. 2017. Fire history of the Appalachian region: a review and synthesis. Gen. Tech. Rep. SRS-219. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 97 p.
- Lorber, J., Thomas-Van Gundy, M., Croy, S. 2018. Characterizing effects of prescribed fire on forest canopy cover in the George Washington and Jefferson National Forests. Research Paper NRS-31. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 30 p.

- Norman, S., G. Kauffman, and L. Hayden. 2021. Landscape insights into wild and prescribed fire effects across Western NC 1999-2019. Presentation to Southern Blue Ridge Fire Learning Network, May 2021.
- Nowacki, G. J., & Abrams, M. D. (2008). The demise of fire and "mesophication" of forests in the eastern United States. *BioScience*, 58(2), 123-138. <https://doi.org/10.1641/B580207>
- Radeloff, V., Hammer, R., Stewart, S., Fried, J., Holcomb, S., McKeefry, J. 2005. The wildland-urban interface in the United States. *Ecological Applications* 15(3):799-805.
- Schmidt, K., Menakis, J., Hardy, C., Hann, W., Bunnell, D. 2002. Development of coarse-scale spatial data for wildland fire and fuel management. Gen. Tech. Rep. RMRS-GTR-87. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 41 p. + CD.
- Simon, S. 2011. Ecological Zones in the Southern Blue Ridge, 3rd Approximation. Unpublished report submitted to The Nature Conservancy and USFS, National Forests in North Carolina. 25 p.
- SWRA's SouthWRAP program (Southern Wildfire Risk Assessment Portal Southern Group of State Foresters Wildfire Risk Assessment Portal. <https://www.southernwildfirerisk.com/>.
- USDA, USDI, et.al. 2009. Guidance for Implementation of Federal Wildland Fire Management Policy. National Interagency Fire Center. [Online] February 13, 2009. [Cited: June 28, 2013.] [http://www.nifc.gov/policies/policies\\_documents/GIFWFMP.pdf](http://www.nifc.gov/policies/policies_documents/GIFWFMP.pdf).
- USDA, USDI, Office of Wildland Fire Coordination. 2011. A national cohesive wildland fire management strategy. Washington, DC: Wildland Fire Leadership Council. 43 p.
- Waldrop, T., Mohr, H., Brose, P. 2006. Early dynamics of table mountain pine stands following stand-replacement prescribed fires of varying intensity. Gen. Tech. Rep. SRS-92. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. pp. 471-474.
- Waldrop, T., Brose, P. 1999. A Comparison of Fire Intensity levels for stand replacement of table mountain pine (*Pinus pungens* Lamb.). *Forest Ecology and Management*. 113: 155-166.
- Waldrop, T.A.; White, D.L.; Jones, S.M. 1992. Fire regimes for pine-grassland communities in the Southeastern United States. *Forest Ecology and Management*. 47: 195–210.
- Yarnell, S L. 1998. The Southern Appalachians: A History of the Landscape. Gen. Tech. Rep. SRS-18. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 52 p.

### **Forest Health and Nonnative Invasive Species**

- Aukema, J. E., D. G. McCullough, B. Von Holle, A. M. Liebhold, k. Britton, and S. J. Frankel. 2010. Historical accumulation of nonindigenous forest pests in the continental United States. *BioScience* 60(11): 886 – 987.
- Brantley, S. T., A. E. mayfiellIII, R. M. Jetton, C. F. Miniati, D. R. Zietlow, C. L. Brown, J. R. Rhea. 2017. Elevated light levels reduce hemlock woolly adelgid infestations and improve carbon balance of infested eastern hemlock seedlings. *Forest Ecology and Management* 385: 150 – 160.
- Crow, T. E. 2014. Functional restoration: from concept to practice. *J. Sustainable Forestry*, 33:S3 –S14.
- Fahey, Robert T.; Alvesshere, Brandon C.; Burton, Julia I.; D'Amato, Anthony W.; Dickinson, Yvette L.; Keeton, William S.; Kern, Christel C.; Larson, Andrew J.; Palik, Brian J.; Puettmann, Klaus J.; Saunders, Michael R.; Webster, Christopher R.; Atkins, Jeff W.; Gough, Christopher M.; Hardiman, Brady S. 2018. Shifting conceptions of complexity in forest management and silviculture. *Forest Ecology and Management*. 421: 59-71. <https://doi.org/10.1016/j.foreco.2018.01.011>.

- Fajvan, M. A. 2008. The role of silvicultural thinning in eastern forests threatened by hemlock woolly adelgid (*Adelges tsugae*). in. Deal, R.L., tech. ed. 2008. Integrated restoration of forested ecosystems to achieve multiple-source benefits: proceedings of the 2007 national silviculture workshop. Gen. Tech. Rep. PNW-GTR-733. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 306 p
- Fei, S., R. S. Morin, C. M. Oswalt, and A. M. Liebhold. 2019. Biomass losses resulting from insect and disease invasions in US forests. Proceedings of the National Academy of Sciences: 201820601. 6 p. <https://doi.org/10.1073/pnas.1820601116>.
- Guldin, J. M. 2018. Silvicultural options in forests of the southern United States under changing climatic conditions. New Forests <https://doi.org/10.1007/s11056-018-9656-2>
- Halofsky, J. E., S. A. Andrews-key, J. E. Edwards, M. H. Johnston, H. W. Nelson, D. L. Peterson, K. M. Schmitt, C. W. Swanston, T. B. Williamson. 2018. Adapting forest management to climate change: The state of science and applications in Canada and the United States. Forest Ecology and Management 421: 84-97.
- Holzmueller, E. J., S. Jose and M. I. A. Jenkins. 2006. The effect of Fire on Flowering dogwood stand dynamics in Great Smokey Mountains National Park. In. K. F. Connor, ed. Proceedings of the 13th biennial southern silvicultural research conference. GTR SRS-92. Asheville, NC: USDA-FS, SRS. 640 p.
- Juzwik, J., D. N. Appel, W. L. MacDonald, S. Burks. 2011. Challenges and successes in managing oak wilt in the United States. Plant Disease. 95(8): 888-900.
- Knight, K. S., J. P. Brown, R. P. Long. 2013. Factors affecting the survival of ash (*Fraxinus spp.*) trees infested by emerald ash borer (*Agrilus planipennis*). Biol Invasions 15:371-383.
- Kolb, T. E., M. R. Wagner, and W. W. Covington. 1994. Forest health from different perspectives. Journal of Forestry 92(7) 10 – 15.
- Kolb, Thomas E.; Fettig, Christopher J.; Ayres, Matthew P.; Bentz, Barbara J.; Hicke, Jeffrey A.; Mathiasen, Robert; Stewart, Jane E.; Weed, Aaron S. 2016. Observed and anticipated impacts of drought on forest insects and diseases in the United States. Forest Ecology and Management. 380: 321-334
- Liebhold, A., Bentz, B. 2011. Insect Disturbance and Climate Change. U.S. Department of Agriculture, Forest Service, Climate Change Resource Center. [www.fs.usda.gov/ccrc/topics/insect-disturbance/insect-disturbance](http://www.fs.usda.gov/ccrc/topics/insect-disturbance/insect-disturbance)
- Liebhold, A., and M. Wingfield. 2014. Globalization and its implications to forest health (Ch 4). In. W. Nikolakis and J. Innes, eds. Forests and Globalization: Challenges and opportunities for sustainable development. Routledge, New York. Pp. 36 – 47.
- Liebhold, A. m. and J. M. Kean. 2018. Eradication and containment of non-native forest insects: successes and failures. Journal of Pest Science. <https://doi.org/10.1007/s10340-018-1056-z>
- Mayfield III, A. E., C. Villari, J. I. Hamilton, J. Slye, W. Langston, K. Oten, W. Fraedrich. 2019. First report of laurel wilt disease caused by *Raffaelea lauricola* on sassafras in North Carolina. Plant disease. The American Phytopathological Society, Disease Notes v 103: (1) page 155.
- McAvoy, T. J., R. Mays, N. G. Johnson and S. M. Salom. 2017. The effects of shade, fertilizer, and pruning on eastern hemlock trees and hemlock woolly adelgid. Forests. 8, 18 pages.
- Millar, C. I. 2014. Historic variability: informing restoration strategies, not prescribing targets. J. Sustainable Forestry, 33:S28 –S42.

- Newton, L. and G. Fowler. 2009. Pathway Assessment: *Geosmithia* sp. and *Pityophthorus juglandis* Blackman movement from the western into the eastern United States. USDA-APHIS, 50 pages.
- Nowak, J. T., J. R. Meeker, D. R. Coyle, C. A. Steiner, and C. Brownie. 2015. Southern pine beetle infestations in relation to forest stand conditions, previous thinning, and prescribed burning: evaluation of the southern pine beetle prevention program. *Journal of Forestry* 113(5):454 – 462.
- Poland, T. M., Y. Chen, J. Koch, D. Pureswaran. 2015. Review of the emerald ash borer (Coleoptera: Buprestidae), life history, mating behaviors, host plant selection, and host resistance. *Can. Entomol.* 147: 252-262.
- Potter, K. M., M. E. Escanferla, R. M. Jetton, G. Man. 2019. Important insect and disease threats to United States tree species and geographic patterns of their potential impacts. *Forests* 10. 16 pages.
- Potter, K. M., M. E. Escanferla, R. M. Jetton, G. Man, B. S. Crane. 2019. Prioritizing the conservation needs of United States tree species: Evaluating vulnerability to forest insects and disease threats. *Global Ecology and Conservation* 18 e00622
- Reed, S. E., J. T. English, R. M. Muzika. 2019. *Phytophthora* species detected in two Ozark forests with unusual patterns of white oak mortality. *Plant Disease* 103: 102-109.
- Schoettle, A. W., J. G. Klutsch, R. A. Snieszko. 2012. Integrating regeneration, genetic resistance, and timing of intervention for the long-term sustainability of ecosystems challenged by non-native pests – a novel proactive approach. in. Snieszko, R. A.; Yanchuk, A. D.; Kliejunas, J. T.; Palmieri, K. M.; Alexander, J. M.; Frankel, S. J., tech. coords. *Proceedings of the fourth international workshop on the genetics of host-parasite interactions in forestry: Disease and insect resistance in forest trees*. Gen. Tech. Rep. PSW-GTR-240. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture. 372 p.
- Schoettle, A. W., W. R. Jacobi, K. M. Waring, K. S. Burns. 2019. Regeneration for resilience framework to support regeneration decisions for species with populations at risk of extirpation by white pine blister rust. *New Forests* 50: 89 – 114.
- Schulz, Ashley N.; Mech, Angela M.; Asaro, Christopher; Coyle, David R.; Cram, Michelle M.; Lucardi, Rima D.; Gandhi, Kamal J.K. 2018. Assessment of abiotic and biotic factors associated with eastern white pine (*Pinus strobus* L.) dieback in the Southern Appalachian Mountains. *Forest Ecology and Management*. <https://doi.org/10.1016/j.foreco.2018.02.021>.
- Stanturf, John A. 2004. Disturbance dynamics of forested ecosystems. In: *Proceedings of the International Conference*, May 27-29, Tartu, Estonia, p. 7-12
- Stanturf, J. A., B. J. Palik, R. K. Dumroese. 2014. Contemporary forest restoration: A review emphasizing function. *Forest Ecology and Management* 331: 292 – 323.
- Sumpter, K. I., T. J. McAvoy, C. C. Brewster, A. E. Mayfield III. And S. M. Salom. 2018. Assessing an integrated biological and chemical control strategy for managing hemlock woolly adelgid in southern Appalachian forests. *Forest Ecology and Management* 411: 12 – 19.
- Van Arsdel, E. P. 1972. Environment in Relation to White Pine Blister Rust Infection. In. R. T. Bingham, R. J. Hoff and G. I. McDonald. *Biology of Rust Resistance in Forest Trees: Proceedings of a NATO-IFURO Advanced Study Institute*. August 17-24, 1969. Moscow, ID. USDA-FS Misc Pub 1221.
- Vose, James M.; Elliott, Katherine J. 2016. Oak, fire, and global change in the eastern USA: what might the future hold?. *Fire Ecology* 12(2): 160–179. 20 p. doi: 10.4996/fireecology.1202160

Wang, G. G., B. O. Knapp, S. L. Clark, and B. T. Mudder. 2013. The Silvics of *Castanea dentata* (Marsh.) Borkh., American chestnut, Fagaceae (Beech Family). Gen. Tech. Rep. SRS-173. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station. 18 p.

Williamson, M. and A. Fritter. 1996. The varying success of invaders. *Ecology* 77(6) pp. 1661-1666.

Wear, David N.; Greis, John G. 2012. The Southern Forest Futures Project: summary report. Gen. Tech. Rep. SRS-GTR-168. Asheville, NC: USDA-Forest Service, Southern Research Station. 54 p

### **Cultural Resources**

Blue Ridge National Heritage Area (2011). Official website of the Blue Ridge National Heritage Area. Retrieved on August 12, 2013 from [www.blueridgeheritage.com](http://www.blueridgeheritage.com).

Johnson, G. G. (2002). A Social History: Electronic Edition. Chapel Hill, The University of North Carolina Press. Retrieved on August 21, 2013 from <http://docsouth.unc.edu/nc/johnson/chapter12.html>.

United States Department of Agriculture Forest Service (2010). *A U.S. Forest Service Special Forest Products Appraisal System: Background, Methods, and Assessment*. (General Technical Report. PNW-GTR-822). Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Pacific Northwest Research Station.

United States Department of Agriculture Forest Service (2011). *Western North Carolina Report Card on Forest Sustainability* (General Technical Report. SRS-142). Asheville, NC: United States Department of Agriculture Forest Service, Southern Research Station.

### **Tribal Resources**

Eastern Band of Cherokee (2013). Cherokee North Carolina web site. Retrieved on August 12, 2013 from [http://www.cherokeesmokies.com/about\\_cherokee.html](http://www.cherokeesmokies.com/about_cherokee.html).

### **Inventoried Roadless Areas**

Roadless Area Conservation Rule 36 CFR Part 294

### **Recreation**

Forest Service Manual 2300 – Recreation, Wilderness, and Related Resources Management; Chapter 2350 – Trail, River, and Similar Recreation Opportunities

Comprehensive Plan for the Protection, Management, Development and Use of the Appalachian National Scenic Trail; Appalachian Trail Project Office, National Park Service, 1981

U.S. Department of Agriculture, U.S. Forest Service (USFS). 2010. A Framework for Sustainable Recreation.

U.S. Department of Agriculture, U.S. Forest Service (USFS). 2018. Visitor Use Report Nantahala-Pisgah NFs (national Forest in North Carolina) FY2013. National Visitor Use Monitoring Program. Available at <https://www.fs.fed.us/recreation/programs/nvum/>

Wear, David N., Greis, John G. The Southern Forest Futures Project. 2013. Gen. Tech. Rep. SRS-178. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station.

U.S. Department of Agriculture, U.S. Forest Service (USFS). 2014. Nantahala and Pisgah National Forests Forest Plan Assessment: Recreation.

U.S. Department of Agriculture, U.S. Forest Service (USFS). 2012. National Forest System Land Management Planning, Federal Register Vol. 77, No. 68.

## **Scenery**

Landscape Aesthetics, A Handbook for Scenery Management

USDA Forest Service, Agriculture Handbook Number 701, 1995

National Forest Landscape Management Volume 2; Chapter 1, The Visual Management System

USDA Forest Service, Agriculture Handbook Number 462, 1974

Forest Service Manual 2300 – Recreation, Wilderness, and Related Resources Management; Chapter 2380 - Landscape Management

## **Wilderness and Inventoried Roadless Areas**

Holmes, T.M., J.M. Bowker, J. Englin, E. Hjerpe, J.B. Loomis, S. Phillips, and R. Richardson. 2016. A Synthesis of the Economic Values of Wilderness. *Journal of Forestry* 114(3) 320-328.

Hjerpe, E.E., T. Holmes, and E. M. White. 2017. National Community Market Contributions of Wilderness, Society and Natural Resources, 30:3, 265-280, DOI: 10.1080/08941920.2016.1196280.

Public Law 88-577 (16 U.S.C. 1131-1136). The Wilderness Act of 1964.

Wear, David N.; Greis, John G. 2012. The Southern Forest Futures Project: summary report. Gen. Tech. Rep. SRS-GTR-168. Asheville, NC: USDA-Forest Service, Southern Research Station. 54 p.

## **Wild and Scenic Rivers**

USDA Forest Service. 2002. National Survey on Recreation and the Environment (NSRE) 2000-2002.

The Interagency National Survey Consortium, Coordinated by the United States Department of Agriculture Forest Service, Recreation, Wilderness, and Demographics Trends Research Group, Athens, GA and the Human Dimensions Research Laboratory, University of Tennessee, Knoxville, TN. Retrieved June 1, 2013 from: <http://www.srs.fs.usda.gov/trends/nsre-directory>.

Forest Service Manual 2300 – Recreation, Wilderness, and Related Resources Management; Chapter 2350 – Trail, River, and Similar Recreation Opportunities

Wilson Creek National Wild and Scenic River Comprehensive River Management Plan. Nantahala-Pisgah Land and Resource Management Plan Amendment #18 USDA, Southern Region, Forest Service, National Forests in North Carolina, 2005

Wild and Scenic River Study Report and Final Environmental Impact Statement on the Nolichucky River Managing Recreation Uses in the Upper Segment of the Chattooga Wild and Scenic River Corridor. Nantahala and Pisgah National Forests Land and Resource Management Plan Amendment #22, 2012

Decision Notice and Finding of No Significant Impact. Chattooga River Boating Access, US Forest Service – Region 8, 2016

Management Direction for the Horsepasture Wild and Scenic River. Nantahala and Pisgah National Forest Land and Resource Management Plan, 1991

USDA Forest Service. 2002. National Survey on Recreation and the Environment (NSRE) 2000-2002.

The Interagency National Survey Consortium, Coordinated by the United States Department of Agriculture Forest Service, Recreation, Wilderness, and Demographics Trends Research Group, Athens, GA and the Human Dimensions Research Laboratory, University of Tennessee, Knoxville, TN. Retrieved June 1, 2013 from: <http://www.srs.fs.usda.gov/trends/nsre-directory>.

## Timber Resources

- Barbour, M. G. and N. L. Christensen. 1993. Vegetation. In. Flora of North America Editorial Committee eds. Flora of North America North of Mexico. V1. Oxford University Press: New York. Pages 97 – 132.
- Brown, M. J. 2018. Forest of North Carolina, 2016 Resource Update FS-152/ Asheville NC: USDA FS SRS 4p.
- Fahey, R. T., C. C. Alveshire, J. I. Burton, A. W. D'Amato, Y. I. Dickinson, W. S. Keeton, C. C. Kern, A. J. Larson, B. P. Palik, K. J. Puettman, M. R. Saunders, C. R. Webster, J. W. Atkins, C. M. Gough, and B. S. Hardiman. 2018. Shifting conceptions of complexity in forest management and silviculture. *Forest Ecology and Management*. 421: 59-71.
- Fox, S., B.J., S. J. [and others]. 2011. Western North Carolina report card forest sustainability. Gen. Tech. Rep, SRS-142. Asheville, NC: U.S. Dept. of Agri. For. Serv. SRS, 198 p.
- Gray, J. A., J. W. Bentley, J. A. Cooper, D.J. Wall. 2017. North Carolina's Timber industry – timber product output and use, 2015. E-science Update SRS – 126. Asheville, NC: USDA FS SRS 5p.
- Kern, C. C, J. I. Burton, P. Raymond, A. W. D'Amato, W. S. Keeton, A. A. Royo, M. B. Walters, C. R. Webster, and J. L. Willis. 2017. Challenges facing gap-based silviculture and possible solutions for mesic northern forests in North America. *Forestry* 90: 4-17.
- Keyser, T., J. Malone, C. Cotton, and J. Lewis. 2014. Outlook for Appalachian-Cumberland Forests: A Subregional Report for the Southern Forest Futures Project. USDA – FS GTR SRS – 188. Asheville, NC. 83 pages.
- Keyser, T. L.; Zarnoch, S. J. 2014. Stump sprout dynamics in response to reductions in stand density for nine upland hardwood species in the southern Appalachian Mountains. *Forest Ecology and Management*. 319:29-35. 7 p.
- Lhotka, John M, Cunningham, Russell, Stringer, Jeffrey. 2018. Effect of silvicultural gap size on 51 year species recruitment, growth and volume yields in *Quercus* dominated stands of the Northern Cumberland Plateau, USA. *Forestry: An International Journal of Forest Research*. Volume 91: 451-458. <https://doi.org/10.1093/forestry/cpy003>
- Lussier, Jean-Martin, Meek, Philippe. 2014. Managing Heterogeneous Stands Using a Multiple-Treatment Irregular Shelterwood Method. *Journal of Forestry*. Volume 112: 287-295. <https://doi.org/10.5849/jof.13-041>
- McNab, W Henry, Oprean, Theodore M, III. 2021. Composition and Structure of Reproduction in Group Selection Openings after 20 Years in a Southern Appalachian Mixed-Hardwood Forest. *Forest Science*. Volume 67: 335-346. UL <https://doi.org/10.1093/forsci/xfab001>
- Mitchell, S. J. and W. J. Beese. 2002. The retention system: reconciling variable retention with the principles of silvicultural systems. *The For Chron*. Vol 2, No 3: 397-403
- Puettmann, K. J. 2014. Restoring the adaptive capacity of forest ecosystems. *J. Sustainable Forestry*, 33:S15 – S27.
- Raymond, P., S. Bedard, V. Roy, C. Larouche, and S. Tremblay. 2009. The irregular shelterwood system: review, classification, and potential application to forests affected by partial disturbance. *Journal of Forestry*: 405-413.
- Raymond, Patricia, Bédard, Steve. 2017. The irregular shelterwood system as an alternative to clearcutting to achieve compositional and structural objectives in temperate mixedwood stands.



Forest Ecology and Management, Volume 398: 91-100.

<https://doi.org/10.1016/j.foreco.2017.04.042>.

(<https://www.sciencedirect.com/science/article/pii/S0378112717303171>)

Yarnell, S. L. 1998. The Southern Appalachians: A History of the Landscape. USDA – FS GTR SRS – 18. Asheville, NC. 52 pages.

## Minerals and Energy

Collins T.K.; Craig J.R.; English D.B.K. 1997. Meeting Human Needs for Food, Water, Minerals and other Basic Resources: Maslow's Hierarchy of Human Needs and its Foundation. In: Cordell H.K., ed.; Caldwell L.; Mou S., comps. Integrating Social Science and Ecosystem Management: A National Challenge; December 12-14, 1995; Helen, GA. Gen. Tech. Rep. SRS-17. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station: 202-210. <http://www.srs.fs.usda.gov/pubs/334>

MacCleery, Douglas W., 1992, American forests: a history of resiliency and recovery. FS-540. In cooperation with the Forest History Society, Durham, NC. Washington, DC: U.S. Department of Agriculture, Forest Service. 58 p. [https://foresthistory.org/wp-content/uploads/2016/12/American\\_Forests.pdf](https://foresthistory.org/wp-content/uploads/2016/12/American_Forests.pdf)

Milici R.C., et al , 2012, Assessment of Undiscovered Oil and Gas Resources of the East Coast Mesozoic Basins of the Piedmont, Blue Ridge Thrust Belt, Atlantic Coastal Plain, and New England Provinces, U.S. Geological Survey, Fact Sheet 2012–3075. <https://pubs.usgs.gov/fs/2012/3075/>

National Academy of Sciences, 2007, Minerals, Critical Minerals, and the U.S. Economy\_Report in Brief. (online report): [http://dels.nas.edu/resources/static-assets/materials-based-on-reports/reports-in-brief/critical\\_minerals\\_final.pdf](http://dels.nas.edu/resources/static-assets/materials-based-on-reports/reports-in-brief/critical_minerals_final.pdf).

National Renewable Energy Laboratory, 2005, “Assessing the Potential for Renewable Energy on National Forest System Lands”, National Renewable Energy Laboratory Report NREL/BK-710-36759. <https://www.nrel.gov/docs/fy05osti/36759.pdf>

North Carolina Department of Environmental Quality, 2016, NC Oil and Gas Wells, North Carolina Oil and Gas Program. [https://files.nc.gov/ncdeq/Energy%20Mineral%20and%20Land%20Resources/Energy/documents/Energy/NC\\_Oil\\_%26\\_Gas\\_Wells\\_terrane\\_plot.jpg](https://files.nc.gov/ncdeq/Energy%20Mineral%20and%20Land%20Resources/Energy/documents/Energy/NC_Oil_%26_Gas_Wells_terrane_plot.jpg)

North Carolina Department of Environmental Quality, 2018, Oil and Gas Program Geologic Assessment, North Carolina Oil and Gas Program. <https://deq.nc.gov/about/divisions/energy-mineral-land-resources/energy-mineral-land-data/oil-gas-program-geologic-assessment>

North Carolina Division of Energy, Mineral and Land Resources, 2018, North Carolina Mine Inventory. Accessed 2018 September 4. <https://deq.nc.gov/about/divisions/energy-mineral-land-resources/energy-mineral-land-permits/mining-program>

North Carolina Mountain Resources Commission, 2012, Western North Carolina Vitality Index: Mineral Resources. Data from North Carolina Geological Survey and U.S. Geological Survey. <http://www.wncvitalityindex.org/geology/mineral-resources>.

Reid, J.C., 2009, Natural Gas and Oil in North Carolina, North Carolina Geological Survey, Information Circular 36. [https://files.nc.gov/ncdeq/Energy%20Mineral%20and%20Land%20Resources/Geological%20Survey/Oil%20and%20Gas%20Research/NCGS\\_IC\\_36\\_oil%20and%20gas\\_FINAL.pdf](https://files.nc.gov/ncdeq/Energy%20Mineral%20and%20Land%20Resources/Geological%20Survey/Oil%20and%20Gas%20Research/NCGS_IC_36_oil%20and%20gas_FINAL.pdf)

- Reid, J.C., 2012, North Carolina's Mineral Storehouse and Emerging Resources. North Carolina Geological Survey presentation at Interstate Mining Compact Commission workshop in December 2012 in Charlotte, N.C.  
<http://www.imcc.isa.us/North%20Carolina's%20Mineral%20Storehouse%20and%20Emerging%20Resources.pdf>.
- Reid, J.C., 2013, Summary, Geologic Maps, Oil and Gas, and Mineral comments. In Response to the U.S. Forest Service (USFS) draft assessment for the Pisgah and Nantahala National Forests, North Carolina. North Carolina Geological Survey, December 16, 2013. p. 22.
- Robinson, G.R. Jr. and others, 1992, Bedrock Geology and Mineral Resources of the Knoxville 1°x2° Quadrangle, Tennessee, North Carolina, and South Carolina, U.S. Geological Survey Bulletin 1979.  
[http://pubs.usgs.gov/of/2004/1075/user\\_files/Pub\\_text.pdf](http://pubs.usgs.gov/of/2004/1075/user_files/Pub_text.pdf).
- U.S. Department of Interior, Bureau of Land Management, 2019, Response to a federal strategy to ensure secure and reliable supplies of critical minerals. <https://www.blm.gov/press-release/trump-administration-announces-strategy-strengthen-america's-economy-defense-0>
- U.S. Department of Commerce, 2019, A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals. Interagency report (June 4, 2019) pursuant to Executive Order 13817, pp 50.  
<https://www.commerce.gov/news/reports/2019/06/federal-strategy-ensure-secure-and-reliable-supplies-critical-minerals>
- U.S. Department of Interior, 2018, Final List of Critical Minerals 2018, Federal Register, Vol. 83, No. 97, Friday, May 18, 2018, p. 23295-23296.  
<https://www.federalregister.gov/documents/2018/05/18/2018-10667/final-list-of-critical-minerals-2018>
- U.S. Department of Energy, 2010, 2010 Critical Materials Strategy Summary.  
[http://energy.gov/sites/prod/files/10\\_Critical\\_Materials\\_Strategy\\_Exec\\_Summary\\_final.pdf](http://energy.gov/sites/prod/files/10_Critical_Materials_Strategy_Exec_Summary_final.pdf).
- U.S. EPA, 1997, EPA's National Hardrock Mining Framework, U.S. Environmental Protection Agency, Washington D.C.
- U.S. EPA, 2011, EIA Technical Review Guideline: Non-Metal and Metal Mining Volume 1, U.S. Environmental Protection Agency, Washington D.C.
- U.S. EPA, 2016, Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States, U.S. Environmental Protection Agency, Washington D.C.
- USDA Forest Service, 2014, Supplemental Report Energy and Mineral Resources Assessment Plan Revision Nantahala and Pisgah National Forests.  
<https://www.fs.usda.gov/detail/nfsnc/home/?cid=stelprdb5436772>
- U.S. Department of Interior, Bureau of Land Management, 2008, North Carolina - Reasonable Foreseeable Development Scenario for Fluid Minerals, BLM Eastern States, Jackson Field Office, Jackson, MS, May 2008. U.S. Executive Office of the President, 2017, Executive Order 13817: A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals, Federal Register, Vol. 82, No. 246, December 26, 2017, p. 60835-60837.  
<https://www.federalregister.gov/documents/2017/12/26/2017-27899/a-federal-strategy-to-ensure-secure-and-reliable-supplies-of-critical-minerals>
- U.S. Geological Survey, 2013, Mineral Resources Data System (MRDS), On-Line Spatial Data.  
<https://mrdata.usgs.gov/mrds/>

U.S. Geological Survey, 2014, Critical Mineral Resources for the 21st Century. (online, accessed 1/20/2014) <http://minerals.usgs.gov/east/critical/index.html>.

U.S. Geological Survey, 2019, Response to a federal strategy to ensure secure and reliable supplies of critical minerals. <https://www.usgs.gov/news/trump-administration-announces-strategy-strengthen-america-economy-defense>

U.S. Government Accountability Office, 1984, Private Mineral Rights Complicate the Management of Eastern Wilderness Areas. RCED-84-101, Jul 26, 1984. <http://www.gao.gov/products/RCED-84-101>.

### **Social and Economic Resources**

American Horse Council, 2018, *North Carolina Economic Impact Study*. Available at: [www.horsecouncil.org/product/north-carolina-economic-impact-study/](http://www.horsecouncil.org/product/north-carolina-economic-impact-study/).

Andereck, K. A. and C. Knopf. (2007). The Relationship Between Experiences Sought, Preferred Settings, Resource Conditions, and Management Preferences in an Urban-Proximate Recreation Area. *Journal of Park and Recreation Administration*, 25(4), 39-61.

Brown, G. and Reed, P. 2000. Validation of a forest values typology for use in national forest planning. *For. Sci.* 46(2): 240-247.

Clark, D. and W. Hunter. 1992. "The Impact of Economic Opportunity, Amenities and Fiscal Factors on Age-Specific Migration Rates." *Journal of Regional Science* 32(3): 349-365.

Cordell, H. K. (2012). Outdoor Recreation Trends and Futures: A Technical Document Supporting the Forest Service 2010 RPA Assessment. Gen. Tech. Rep. SRS-150. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station, 167 p.

Council on Environmental Quality (CEQ). 1997. Environmental Justice: Guidance Under the National Environmental Policy Act. Washington, DC: Executive Office of the President.

Deller, S. C., T.H.S. Tsai, D.W. Marcouiller, and D.B. English. 2001. The role of amenities and quality of life in rural economic growth. *American Journal of Agricultural Economics* 83 (2): 352-65.

Grinspoon, E., J. Schaefer, R. Periman, J. Smalls, C. Manning, T. Lo Porto. 2014. Striving for Inclusion. Environmental Justice for Forest Service NEPA. U.S. Forest Service.

IMPLAN (MIG). 2015. Impacts for PLANning (IMPLAN). Minnesota Implan Group, Inc. Version 3.1.1001.13 Copyright 2013. Additional information available at [www.implan.com](http://www.implan.com).

IMPLAN (MIG). 2016. Impacts for PLANning (IMPLAN). Minnesota Implan Group, Inc. Version 3.1.1001.13 Copyright 2013. Additional information available at [www.implan.com](http://www.implan.com).

Jaret, C. & Baird, J. (2013). Patterns of Interstate Migration in the Mid-2000s: Are Racial Groups Moving in Different Directions? *The Journal of Public and Professional Sociology*: 5(1), Article 3. Available at <http://digitalcommons.kennesaw.edu/jpps/vol5/iss1/3>.

Knapp, T. and P. Graves. 1989. On the Role of Amenities in Models of Migration and Regional Development. *Journal of Regional Science*, 29(1):71-87.

Lewis, D., G.L. Hunt, and A.J. Plantinga. 2002. "Public Conservation Land and Employment Growth in the Northern Forest Region" *Land Economics*, 78(2): pp 245-259.

McGranahan, David A. 1999. Natural amenities drive rural population change. Agricultural Economic Report no. 781. Washington, DC: Food and Rural Economics Division, Economic Research Service, U.S. Department of Agriculture. Section 6.2.

- Hjerpe, E., T. Holmes and E. White. 2016. National and Community Market Contributions of Wilderness. *Society & Natural Resources*. 30(3):265-280.
- Holmes, Thomas P., J.M. Bowker, J. Englin, E. Hjerpe, J.B. Loomis, S. Phillips, and R. Richardson. 2015. A Synthesis of Economic Values of Wilderness. *Journal of Forestry*. Published online June 18, 2015.
- Maples, J. and M. Bradley. 2017a. Economic Impact of Mountain Biking in the Nantahala and Pisgah National Forests. Report submitted to Outdoor Alliance on August 5, 2017.
- Maples, J. and M. Bradley. 2017b. Economic Impact of Non-Commercial Paddling and Preliminary Estimates of Commercial Paddling in the Nantahala and Pisgah national Forests. Report submitted to Outdoor Alliance on August 5, 2017.
- Maples, J. and M. Bradley. 2017c. Economic Impact of Rock Climbing in the Nantahala and Pisgah national Forests. Report submitted to Outdoor Alliance on August 5, 2017.
- Mueser, P.R., and P.E. Graves. 1995. "Examining the Role of Economic Opportunity and Amenities in Explaining Population Redistribution." *Journal of Urban Economics* 37(2): 176-200.
- Parker, S.E. & Green, G.T. (2016). A Comparative Study of Recreation Constraints to National Use Bu Ethnic Groups in Northern Georgia. *Journal of Forestry*; 114(4): 449-457.
- Power, T.M. 1992. The economics of wildland preservation: The view from the local economy. GTR SE-78. Asheville, NC: Department of Agriculture, Forest Service, Southeastern research station.
- Responsive Management. 2015. Mountain Trout Fishing: Economic Impacts on and Contributions to North Carolina's Economy. *Conducted for the North Carolina Wildlife Resources Commission by Responsive Management and Southwick Associates*. Available at: <https://www.ncwildlife.org/Portals/0/Fishing/documents/Mountain%20Trout%20Fishing%20Economic%20Impacts%20on%20and%20Contributions%20to%20North%20Carolinas%20Economy.pdf>.
- Rolston, H. and J. Coufal. 1991. A Forest Ethic and Multivalue Forest management. *Journal of Forestry*, 89(4):35-40.
- Rudzitis, G. and Johnson, R. 2000. The impact of wilderness and other wildlands on local economies and regional development trends. In: McCool, Stephen F.; Cole, David N.; Borrie, William T.; O'Loughlin, Jennifer, comps. 2000. Wilderness science in a time of change conference—Volume 2: Wilderness within the context of larger systems; 1999 May 23–27; Missoula, MT. Proceedings RMRS-P-15-VOL-2. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. p. 14-26.
- Seesholtz, D.; Wickwar, D.; Russell, J. 2006. Social economic profile technical guide. USDA Forest Service, Inventory Monitoring Institute.
- Sorenson, C., C. Keegan III, T. Morgan, C. McIver, M. Niccolucci. 2016. Employment and Wage Impacts of Timber Harvesting and Processing in the United States. *Journal of Forestry*, 114(4) 474-482.
- Stedman, R. 2003. Is it Really Just a Social Construction?: The Contribution of the Physical Environment to Sense of Place. *Society & Natural Resources*, 16(8):671-685, DOI: 10.1080/08941920309189.
- U.S. Department of Agriculture, U.S. Forest Service (USFS). 2018. Secure Rural Schools Payments and Receipts. Accessed <https://www.fs.usda.gov/main/pts/securepayments/projectedpayments> on September 18, 2018.
- U.S. Department of Agriculture, U.S. Forest Service (USFS). 2020. Visitor Use Report Nantahala-Pisgah NFs (national Forest in North Carolina) FY2018. National Visitor Use Monitoring Program. Available at <https://www.fs.fed.us/recreation/programs/nvum/>

- Forest Service, U.S. Department of Agriculture (USFS). 2014. Nantahala and Pisgah National Forests Forest Plan Assessment: Economic Conditions and Trends.
- Forest Service, U.S. Department of Agriculture (USFS). 2018. *Forest Economic Analysis Spreadsheet Tool (FEAST)*. Inventory and Monitoring Institute, Fort Collins, Colorado
- U.S. Department of Agriculture. 2017. Forest Service Cut and Sold Reports for All Convertible Products by Region, State, and National Forest, 1980 to 2016. Accessed August 8, 2017 via Headwaters Economics <https://headwaterseconomics.org/dataviz/national-forests-timber-cut-sold/>
- US Department of Agriculture, Economic Research Service (ERS). 2017. County Typology Codes. Accessed <https://www.ers.usda.gov/data-products/county-typology-codes.aspx> on April 7, 2017.
- U.S. Department of Commerce. 2010. Census Bureau. Decennial Census, Washington, D.C. Accessed <https://factfinder.census.gov/> on September 18, 2018.
- U.S. Department of Commerce. 2016a. Bureau of Economic Analysis, Washington, D.C., reported by Headwaters Economics' Economic Profile System, [headwaterseconomics.org/eps](http://headwaterseconomics.org/eps). Accessed on August 9, 2017.
- U.S. Department of Commerce. 2016b. Census Bureau. American Community Survey 5-year estimates, Washington, D.C., reported by Headwaters Economics' Economic Profile System, [headwaterseconomics.org/eps](http://headwaterseconomics.org/eps). Accessed on August 9, 2017.
- U.S. Department of Commerce. 2017. Bureau of Economic Analysis, Regional Economic Accounts, Washington, D.C., reported by Headwaters Economics' Economic Profile System, [headwaterseconomics.org/eps](http://headwaterseconomics.org/eps). Accessed on December 4, 2018.
- U.S. Department of Commerce. 2018. Census Bureau American Community Survey 5-year estimates, Washington, D.C. Accessed <https://factfinder.census.gov/> on September 18, 2018.
- U.S. Department of the Interior. Payment in Lieu of Taxes, 2016. <https://www.doi.gov/pilt> Accessed August 7, 2017.
- U.S. Department of the Interior, U.S. Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau. 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation.
- U.S. Department of Labor. 2016. Bureau of Labor Statistics. Quarterly Census of Employment and Wages. Washington, D.C.
- U.S. Department of Labor. 2017. Bureau of Labor Statistics. Local Area Unemployment Statistics. Washington, D.C. Accessed [www.bls.gov](http://www.bls.gov) on February 10, 2017.
- White, Eric M. 2017. Spending Patterns of Outdoor Recreation Visitors to National Forests. General Technical Report PNW-GTR-961. Pacific Northwest Research Station, Forest Service.

## List of Appendices

### **Appendix A – Response to Comments**

This appendix responds to comments received during the 135-day comment period on the draft Environmental Impact Statement and proposed plan.

### **Appendix B – Description of the Analysis Process**

This appendix more fully documents the various analysis models that were used in the development of Chapter 3. Additional records on some analyses are available in the project record.

### **Appendix C – Ecological Sustainability Analysis**

This appendix is used to document the terrestrial and aquatic systems analysis and how species are being supported via plan components.

### **Appendix D – Vegetation Modeling Methods**

This appendix is used to document the vegetation modeling methods that were used in the terrestrial ecosystems sections.

### **Appendix E – Wilderness Evaluation Process**

This appendix documents the inventory, evaluation, and analysis stages of the wilderness evaluation.

### **Appendix F – Wild and Scenic River Evaluation Process**

This appendix documents the process used to evaluate wild and scenic rivers.

### **Appendix G – Coordination with Other Public Planning Efforts**

This appendix reviews planning and land use policies of other Federal agencies, and State and local governments in the planning area.

### **Appendix H – Public and Government Involvement**

This appendix documents involvement of various parties in the development of the revised forest plan and the draft Environmental Impact Statement.

### **Appendix I – Maps**

This appendix includes maps of each alternative.

## **Accompanying Document**

### **Nantahala and Pisgah National Forests Land Management Plan (Revised Plan)**

The Nantahala and Pisgah National Forests Final Land Management Plan contains the plan direction that is being analyzed by this Environmental Impact Statement.

## **Additional Resource**

### **Final Response to Objection Issues and Instructions**

This document was prepared following the plan's pre-decisional administrative review process.