United States
Department of
Agriculture

1989
Francis Marion National Forest
After Hurricane Hugo

2016
Francis Marion
National Forest

Final
Environmental Impact Statement
for the Final Revised Land Management Plan

Forest Service | Region 8 | Francis Marion National Forest | R8-MB 151 B | January 2017

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Francis Marion National Forest
Final Environmental Impact Statement
For the
Revised Land Management Plan

January 2017

Berkeley and Charleston Counties, South Carolina

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Abstract: Three alternatives for revision of the 1996 Francis Marion National Forest Revised Land and Resource Management Plan (forest plan) are described, compared and analyzed in detail in this final environmental impact statement. Alternative 1 represents no change from the current forest plan. Alternative 2 is the alternative preferred by the Forest Service and is the foundation for the revised forest plan. Alternative 3 is a variation of alternative 2 and considers less prescribed burning near communities and major roads.

The notice of intent to prepare an EIS was published in the Federal Register on April 30, 2014 (Vol. 79, No. 83, FR, pp. 24372 to 24375). The notice of intent asked for public comment on the proposal from May 1, 2014 to June 16, 2014. A 90-day comment period was initiated on August 14, 2015 with the publication of the Notice of Availability in the Federal Register (Vol. 80, No. 157, FR, p. 48854). Approximately 37 letters and emails were received during the comment period. The letters were reviewed and concern statements were developed. Specialists addressed these concern statements and their responses are provided in the response to comments. Public input was also used to update the revised forest plan and its associated final environmental impact statement. All changes were considered minor and were within the scope of the analysis in the draft environmental impact statement.

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Summary

This final environmental impact statement, prepared by the U.S. Forest Service, describes and analyzes in detail three alternatives for managing the land and resources of the Francis Marion National Forest (Francis Marion). It describes the affected environment and discloses environmental effects of the alternatives. The planning record is available on our public website at: http://www.fs.usda.gov/detail/scnfs/landmanagement/planning/?cid=stelprdb5393142. Maps can be viewed online through the Collaborative Talking Points Mapping Tool.

S.1 Proposed Action

The purpose of this proposed action is to revise the 1996 Francis Marion National Forest Revised Land and Resource Management Plan (forest plan). The area affected by the proposal includes nearly 260,000 acres of the Francis Marion National Forest, which is located about an hour's drive north of Charleston, South Carolina. The forest plan guides all natural resource management activities on the Francis Marion to meet the objectives of Federal law, regulations, and policy. The proposed action would also affect a wide range of socioeconomic factors as they relate to natural resources.

S.2 Issues Addressed

Significant issues came from a number of sources including public involvement, internal concerns, new information, and changes in law or policy. The planning team developed the following significant issues:

1. To what extent and where should native ecological systems be restored?
2. What is the best approach to dealing with the rapid change of land use from a forested, rural landscape to an urban environment with developments in near proximity to the national forest?

S.3 Alternatives

Three alternatives are described, compared, and analyzed in detail in this document:

- Alternative 1 represents the current forest plan and is also referred to as the 1996 forest plan.
- Alternative 2 is the alternative preferred by the Forest Service and describes the revised forest plan.
- Alternative 3 is a variation of alternative 2, developed to address concerns about the impacts to human health and safety from prescribed burning on the national forest.

S.4 Summary of Effects Analysis

These emphases would be expected to improve not only native species diversity, but also resilience of native communities to non-native invasive species, disease and insect outbreaks, extreme weather disturbances associated with climate change, and other stressors.

Soil, water and air quality would be maintained in all alternatives:

- Implementation of best management practices and proper mitigation measures would result in minimal soil and water effects. Analysis indicates that, at the forest level, the

expected intensity of management activities planned would result in improved watershed conditions for the priority watersheds, and no measurable changes, either beneficial or detrimental, to watershed condition for other watersheds.

- The air quality program for the Francis Marion provides guidance for conducting forest management activities in a manner that complies with state and Federal standards, protects human health, promotes safety, and does not degrade air quality. Prescribed burning is the activity that would most likely contribute air emissions.

While alternatives 2 and 3 emphasize the restoration of longleaf pine and habitat for at-risk species, alternative 2 introduces prescribed burning into portions of the Francis Marion that have not been prescribed burning recently. The additional prescribed burning in alternative 2 improves habitat for at-risk plants and animals while restoring longleaf pine ecosystems. Alternative 3 emphasizes the use of non-fire methods (thinning, herbicide applications) in portions of the Francis Marion that are closest to roads and towns. While non-fire treatments can reduce fuel loadings and maintain wildlife habitats, many at-risk species are adapted to fire and benefit from fire on the landscape.

Social and Economic Sustainability. Outdoor recreation opportunities enhance the quality of life not only for people who live within the administrative boundary, but for people across the entire U.S. No alternative proposes any new developed recreation opportunity. Alternatives 2 and 3 place an increased emphasis on disperse recreation opportunities using partnerships to create interconnected trail systems and to provide hunting and fishing opportunities. Alternative 2 includes creating two semi-primitive areas to enhance the wilderness character in the four wildernesses. Alternative 3 proposes expanding the Francis Marion’s four existing wildernesses.

Predicted urban development adjacent to national forest land would affect Francis Marion’s personnel’s ability to complete prescribed burning on a landscape level. The alternatives propose different strategies to reduce hazardous fuel levels in areas of the Francis Marion that border highways and human communities. Alternative 2 introduces fire to portions of the Francis Marion that in some instances have not been prescribed-burned since Hurricane Hugo. Alternative 3 emphasizes non-fire methods, although prescribed burning may be used in combination with non-fire methods.

Climate change is expected to create impacts, such as sea-level rise, increases in temperature, and greater variation in precipitation. Management actions across all alternatives focus on creating diverse, functioning ecosystems that are resilient to these changes. A focus on providing corridors across the landscape would allow for migration of species as changes occur.

The Francis Marion would provide similar benefits to the public across all alternatives. Vegetation management activities would encourage carbon sequestration and create jobs. Restoration of hydrologic flows would slow water flows and mitigate downstream flooding effects.

S.5 Scope of the Decision

The responsible official for this decision is the supervisor for the Francis Marion and Sumter National Forests. Based upon the effects of the alternatives, the responsible official decides the:

- Establishment of desired conditions and objectives;
- Establishment of forestwide design criteria (standards and guidelines);

- Establishment of management areas and geographic areas;
- Determination of suitability of land;
- Determination of the maximum amount of timber that might be removed;
- Areas recommendd for inclusion in the National Wilderness Preservation System (36 CFR 219.7(c)(2)(v)); and
- Identification of eligible wild and scenic rivers (36 CFR 219.7(c)(2)(vi)).

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Chapter 1. Purpose and Need

1.1 Document Structure

This final environmental impact statement was prepared in compliance with the National Environmental Policy Act (NEPA) and other relevant Federal and state laws and regulations. It discloses the direct, indirect, and cumulative environmental impacts that would result from the proposed action and alternatives. This document is organized into the following sections:

- **Chapter 1. Purpose and Need:** This chapter includes information on the history of the project proposal, the purpose and need for the project, and the Forest Service's proposal for achieving the purpose and need. This section also details how the Forest Service informed the public of the proposal and how the public responded.
- **Chapter 2. Alternatives, Including the Proposed Action:** This chapter provides a more detailed description of the Forest Service's proposed action as well as alternative methods for achieving the stated purpose. These alternatives are based on significant issues raised by the public and other agencies. This discussion also includes any mitigation measures associated with the proposed action or alternatives. Finally, this section provides a summary table of the environmental consequences associated with each alternative.
- **Chapter 3. Affected Environmental and Environmental Consequences:** This chapter describes the environmental effects of implementing the proposed action and other alternatives. The analysis is organized by themes developed from public involvement. Major themes include ecological sustainability, social and economic sustainability, and resource integration.
- **Chapter 4. List of Preparers and Distribution:** This chapter provides a list of preparers and agencies consulted during the development of the final environmental impact statement.
- **References:** This section includes references for sources used in the development of this plan.
- **Appendices:** The appendices provide more detailed information to support the analyses presented in the document. This section also includes a glossary of common terms.
- **Index:** This section includes key words and the relevant page numbers in the document.

Additional documentation, including more detailed analyses of project area resources, may be found in the planning record at: http://www.fs.usda.gov/goto/scnfs/fmplan.

1.2 Background

The Francis Marion National Forest is located within Berkeley and Charleston Counties in southeastern South Carolina and contains 258,942 acres. The Forest occupies a triangle formed by the Santee River to the north, the Intracoastal Waterway to the east, and Lake Moultrie and the Cooper River to the west. The Forest comprises about 1.2 percent of the public lands in the State. Major highways into the Francis Marion include U.S. Highways 17, 17A, and 52, as well as State Highways 41 and 45. The Francis Marion is within a 60-minute drive north of the Charleston metropolitan area (see Figure 1-1).

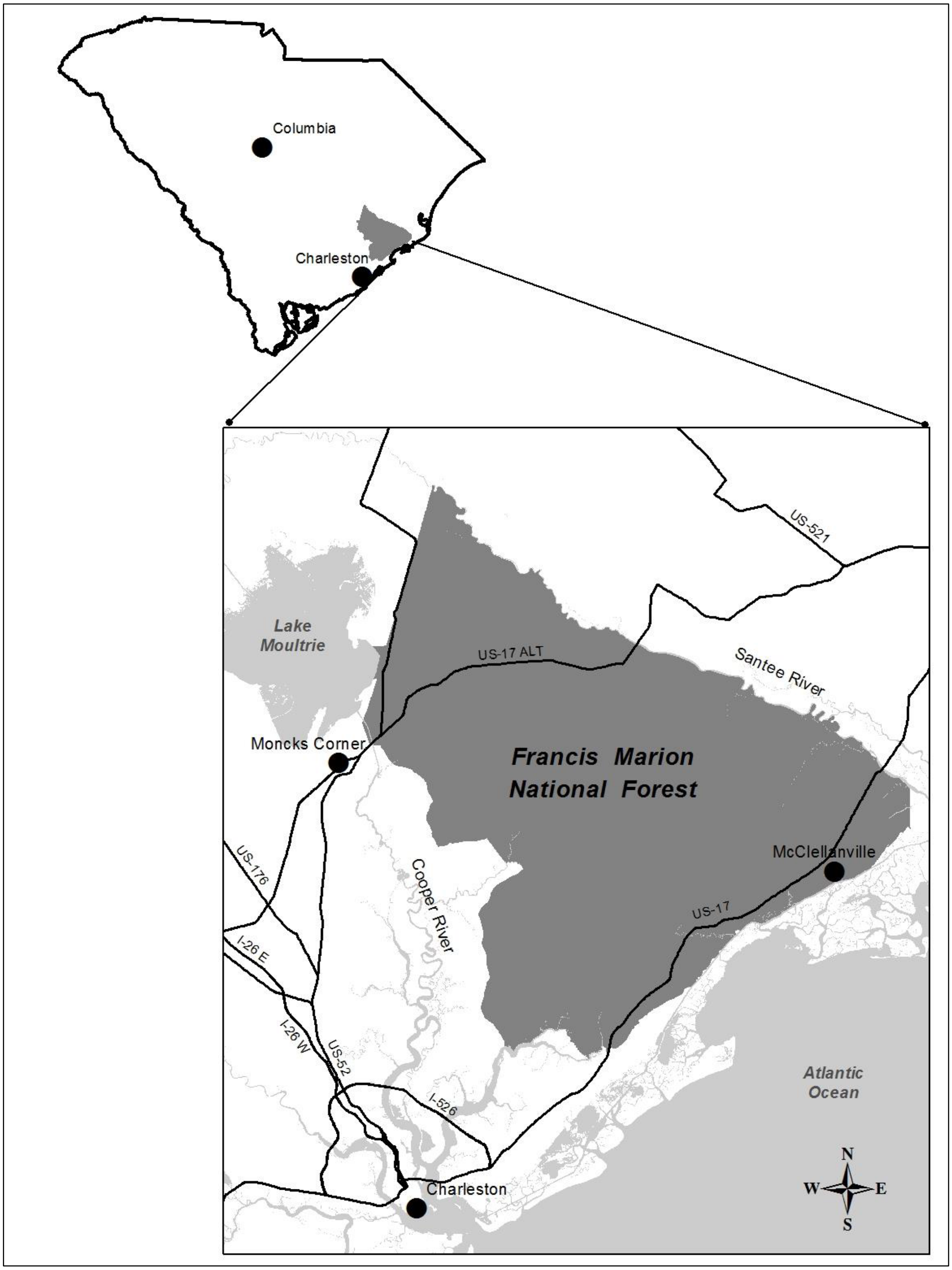

Figure 1-1. Vicinity map of the Francis Marion National Forest

The area surrounding the Francis Marion is predominantly urban (see Figure 1-3). While few people live within its boundaries, the Francis Marion includes the communities of Awendaw, Huger, Jamestown, and McClellanville. Persons per square mile in Berkeley and Charleston Counties are 161.8 and 382.3, respectively. In comparison, the State has 153.9 persons per square mile.

The 6,067-acre Santee Experimental Forest is located within the Francis Marion's boundaries. The Santee Experimental Forest research operations are guided by the Southern Research Station, not by the Francis Marion. Research is centered on the ecology and management of forested wetland ecosystems in the South Atlantic Coastal Plain.

This forest plan revision follows two previous forest planning efforts in 1985 and 1996. The 1985 plan was directed at the increased emphasis to do forest-level planning as outlined in the National Forest Management Act. However, the agency's available resource information and ability to process it effectively at landscape scales was limited in comparison to today.

Hurricane Hugo came ashore near Bull Island, South Carolina, on September 21, 1989 (see Figure 1-2). Estimated maximum sustained wind at landfall was 138 miles per hour. The center of the eye passed within 5 miles of the Francis Marion. Vast areas were blown down or damaged with a storm surge of up to 20 feet. Immediate concerns after Hurricane Hugo were life and safety, which included opening roads that were hidden under the fallen trees. It became obvious that the 1985 plan was no longer effective guidance.

Figure 1-2. Damage from Hurricane Hugo in 1989

The 1996 plan focused on recovery efforts from Hurricane Hugo. On the Francis Marion, 60 percent (about 92,500 acres) of pine received heavy or moderate damage; pine age-class distribution changed primarily to the 0- to 10-year age class. About 43 percent of the bottomland hardwood species was broken and another 43 percent was uprooted.

After they addressed immediate safety threats, Francis Marion personnel focused on recovery of the red-cockaded woodpecker, a federally endangered species. Many nesting trees with cavities were damaged, so recovery efforts focused on inserting artificial cavities. Other management efforts focused on creating foraging habitat. Today, the Francis Marion National Forest supports one of the largest populations of red-cockaded woodpecker in the world.

In 1996, Francis Marion staff also saw an opportunity to increase the amount of longleaf pine forest. Longleaf pine once dominated the Francis Marion, but past management efforts had established loblolly pine. They have continued to implement the revised forest plan since its completion in 1996.

In 2012, the Forest Service established a Francis Marion planning team to lead the plan revision process. In the fall of that same year, the team assessed what had been accomplished, new information, changes in technology and land uses, as well as what worked and did not work well in the 1996 forest plan. The team also developed three documents as follows:

- Francis Marion National Forest–Forest Plan Assessment. This document consists of specialists' reports and supporting supplemental reports. Several topics are covered including wildlife habitats, at-risk species, natural disturbances, and recreation opportunities. At the beginning of each subsection are findings that highlight accomplishments, changed conditions, challenges, opportunities, data gaps, and research needs. The assessment feeds into the affected environment in chapter 3 of this document.
- Francis Marion National Forest Need to Change. This document focuses on management direction that "needs to change" in the 1996 forest plan. Using the findings in the assessment, the team developed need to change statements. These statements formed the scope of the proposed action.
- Francis Marion Plan Revision: Proposed Management Strategies. This document addresses the need to change statements in the Francis Marion National Forest need to change document developed to address changes needed in the 1996 forest plan. Management strategies describe, in broad terms, how the agency would achieve desired conditions over time while considering priorities, such as program direction, budget trends, past program accomplishments, and partnership opportunities. In some instances, these tentative management approaches are applied to areas that are similar in some respect across the Francis Marion National Forest and were used to draft social zones or management areas.

These documents are located on the Francis Marion's website: http://www.fs.usda.gov/goto/scnfs/fmplan.

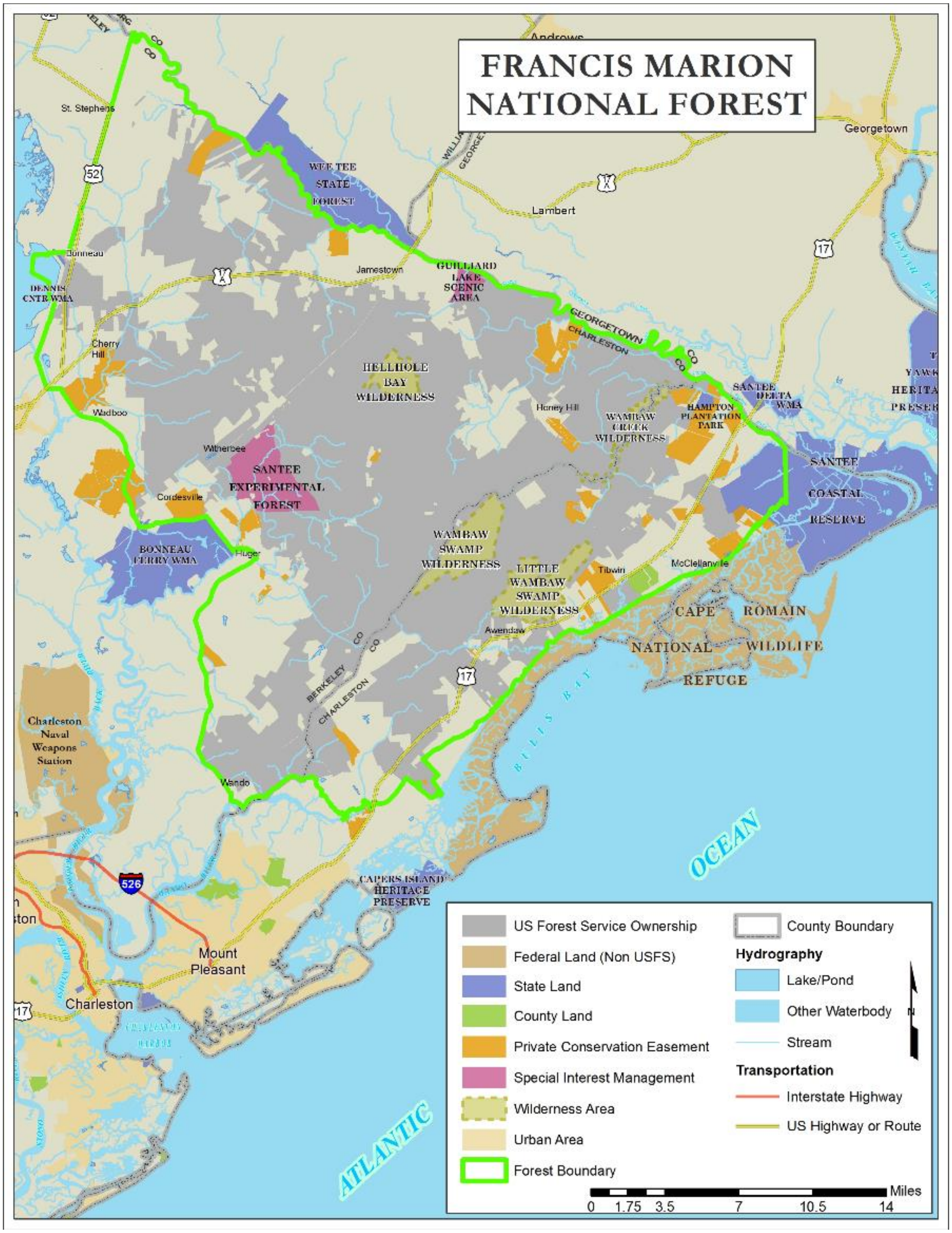

Figure 1-3. Map of the Francis Marion National Forest and surrounding area

1.3 Purpose and Need for Action

The need to revise the current forest plan includes: (1) the existing forest plan is more than 15 years old; (2) since the forest plan was approved, there have been changes in economic, social, and ecological conditions, new policies and priorities, and new information based on monitoring and scientific research; and (3) extensive public and employee involvement, along with science-based evaluations, have helped to further identify the areas of the 1996 forest plan that need to be changed.

In general, the need to change includes addressing questions about how the Francis Marion will manage terrestrial plants, terrestrial animals, rare species (including threatened, endangered and candidate species and species of conservation concern), old-growth characteristics, riparian areas, water quality, aquatic species and habitat, wood products, scenery, recreation opportunities (hiking, mountain biking, off-highway vehicle use, horseback riding), areas to be evaluated for possible wilderness recommendations, wilderness, forest health, roads, minerals, fire, lands, air quality, special uses, and the contributions of the Francis Marion to local economies. A number of concerns also involve impacts to the Francis Marion from outside its boundary. These concerns include climate change, sea-level rise, non-native invasive species, increasing development adjacent to the Francis Marion, increasing demands for use of the Francis Marion (such as for salable minerals and private access), increasing demands for access to the Forest, and increasing law enforcement problems due to trespass or unauthorized roads.

The following is a summary of the main "themes" of areas that have been identified as needing to be changed. A more fully developed description of the need to change is available in the planning records. These themes represent broad concepts relating to the public preferences and resource management that need to be addressed in revising the forest plan for the Francis Marion National Forest.

Theme 1: Maintain, improve, or restore the unique landscapes and features on the Francis Marion National Forest. The Francis Marion has nearly 260,000 acres of natural landscapes that are adjacent to the Atlantic Ocean and the major metropolitan area of Charleston, South Carolina. Many of the natural features on the Francis Marion are unique in local and regional settings. These landscapes form important ecological and historical centerpieces for the surrounding area adjacent to the national forest. For example, the restored longleaf pine ecosystems on the national forest not only provide habitat for animals, such as the endangered red-cockaded woodpecker, but also provide outstanding scenery of open pine stands of trees with grasses and rare plants. Wetland drainage, stream, and other hydrologic modifications have altered habitats and function, and the restoration of aquatic ecosystems, watersheds, and riparian areas needs to be addressed.

Theme 2: Improve the quality of life and health for stakeholders. Stakeholders have said that interacting with the Francis Marion improves their quality of life, health, and well-being. Stakeholders also cited important aspects of improving their livelihoods to include getting away from congestion and reducing stress, enjoying the benefits of silence, becoming healthier through exercising, learning about the natural environment, and sustaining income and other basic needs for living.

Theme 3: Respond to challenges. Among the major challenges that need to be addressed are how to maintain fire-adapted natural systems in the face of severe restrictions on the use of prescribed fire in areas adjacent to development; the invasion of non-native species, such as the degradation of ecosystems caused by feral hogs; and management challenges, such as reducing

conflicts among recreation users, especially during a time of budget reductions. Additionally, responding to major disturbances such as sea level rise, hurricanes, and storm evacuations, floods, and severe wildfire is important for the stability of local communities.

Theme 4: Share operational and planning resources among partners; keep ongoing collaborative efforts vibrant and develop new ones. Sharing resources with partners and integrating them into other planning efforts are important strategies. Stakeholders are also interested in having a forest plan that considers the contributions they can make to national forest management and to help facilitate the idea of "doing more with less."

In 2007, a multi-agency/organization group developed a Range-Wide Conservation Plan for Longleaf Pine. This effort, spearheaded by the Longleaf Pine Partnership Council, is called America's Longleaf Restoration Initiative (see www.americaslongleaf.org). The rangewide plan has a goal of increasing longleaf pine forests to 8 million acres by 2024 and improving the condition of existing longleaf pine forests. The group is already seeing success, as the recent increase in acreage rangewide is attributed to restoration efforts throughout the range, including the three project areas in South Carolina. As part of this effort, we completed an assessment of potential longleaf restoration on the Francis Marion.

One of the project areas identified in the Range-Wide Conservation Plan for Longleaf Pine is called the Sewee Longleaf Conservation Cooperative. The cooperative was formed in 2012 on the coast of South Carolina in parts of Charleston, Berkeley, Williamsburg, and Georgetown Counties (see Figure 1-4). The cooperative (see seweelongleafcoop.org/), founded in 2012, is a partnership of public and private organizations uniting with private landowners to share resources and work across boundaries. The goals of the cooperative are to support America's Longleaf Restoration Initiative by promoting restoration of longleaf pine forests through education and implementation on the ground. The anchor of the Sewee Longleaf Conservation Cooperative is the Francis Marion National Forest.

Theme 5: Develop a monitoring strategy that provides information for rapid responses to changing conditions. A broad-scale and local-level monitoring strategy is needed to respond to changing conditions. Stakeholders would also like to know how other government agencies' and non-governmental entities' information can be used to support a robust adaptive management system.

Theme 6: Integrate and coordinate resource management. An integrated approach is needed to manage the various natural resources and multiple uses of the national forest. The desired conditions for landscapes and compatible multiple uses need to be packaged in discrete management areas/geographic areas that would provide the most benefit for the American public while protecting sensitive areas.

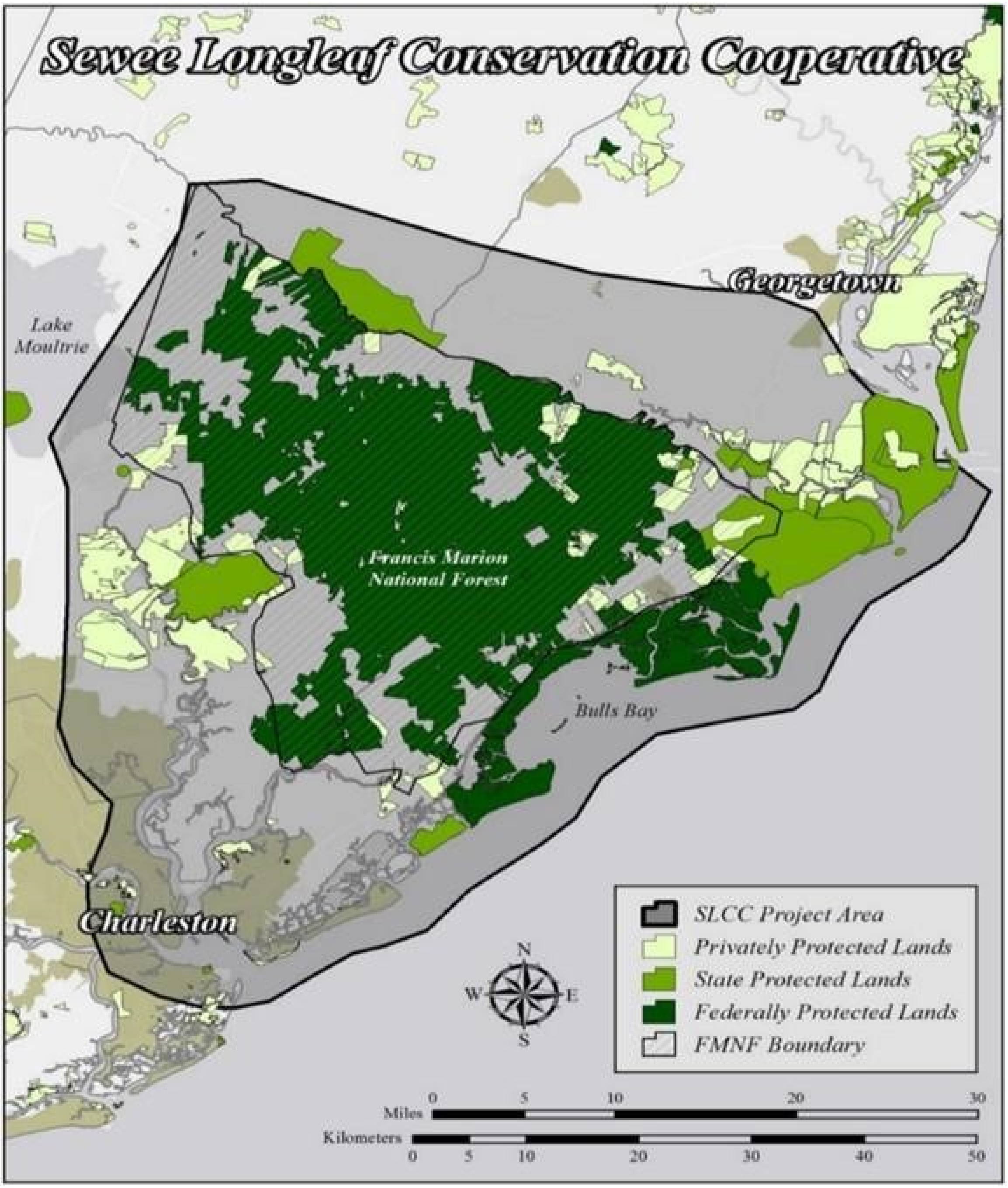

Figure 1-4. Sewee Longleaf Conservation Cooperative Project Area

1.4 Proposed Action

The proposed action is to revise the forest plan to address the statements identified above in the "Purpose and Need for Action". Responding to these challenges and opportunities, along with monitoring the implementation of the forest plan, requires not only coordination across boundaries, but also a collaborative approach in the development of forest plan direction. The proposed action is to provide management direction for the following resource topics.

Ecosystem Diversity (terrestrial and aquatic ecosystems). Restore and maintain a variety of native ecosystems on suitable sites. This would be accomplished primarily through vegetation management programs that result in improved habitats for a variety of plants and animals (including threatened and endangered species and species of conservation concern) and increased resilience to potential effects from climate change. Management would focus on restoring and maintaining composition, structure, function, and connectivity for terrestrial and aquatic ecosystems.

Species Diversity (threatened and endangered species, candidate species, and species of conservation concern). Direct management for sustaining species diversity by emphasizing ecological conditions that protect and promote improved habitat conditions for federally-listed species, and support a diversity of native plant and animal species in the long term. The overall approach for managing species diversity would be achieved through cooperation with State, Federal, and private partners, and would focus on maintaining and restoring composition, structure, fire regimes and connectivity; reducing non-native invasive species; returning native ecological systems to appropriate sites; and restoring historic fire regimes to the landscape.

Physical Environment (watersheds and soil, water and air quality). Provide desired conditions and objectives for maintaining, restoring, and monitoring the soil, water, and air resources on the Francis Marion. National forest lands on the Francis Marion encompass only a small percentage of the streams and associated drainage areas within the coastal plain of the State. In addition, much of the impacts to air and water resources are due to activities outside of the area managed by the Forest Service. Therefore, the focus will be on sustaining and improving watershed areas within national forest control while working cooperatively with other agencies and landowners to improve statewide watershed health and water, soil, and air quality.

Healthy Forests (vegetation management, climate change, non-native invasive species, prescribed burning, lands, and special uses). Management direction for achieving healthy forests is to use a combination of vegetation management practices, including prescribed burning, to restore and maintain resilient native ecosystems. The areas being emphasized include maintaining and restoring fire-adapted ecosystems and longleaf pine; maintaining moderate stand densities in pine and pine-hardwood stands; regenerating stands to either restore more desired species, such as longleaf pine, and/or to create young-aged forest stands for ecological sustainability; and controlling non-native invasive plant species and insect and disease outbreaks.

Infrastructure (roads, facilities, trails). Management direction will focus primarily on the safety and maintenance of the existing infrastructure (such as roads, trails, and facilities). This includes addressing backlogged repairs and upgrades, improvements for environmental protection, disposal of facilities that are no longer needed, and rehabilitation of user-created trails and roads. We anticipate limited infrastructure additions, depending on funding availability.

Recreation, Cultural Resources, and Forest Setting (wilderness, wild and scenic rivers, hunting, fishing, roadless areas, and scenery). The Francis Marion provides a diverse range of

quality natural and recreation opportunities in partnership with its users and communities. Management direction will provide for this range of outdoor recreation opportunities. The Forest's recreation niche is showcasing the diverse ecosystems that abound on the coastal plain, especially through dispersed recreation opportunities. There is a significant public stewardship responsibility for the cultural resources within the Francis Marion National Forest and protecting heritage sites and maintaining a natural forest setting will be emphasized. The Forest Service will also strive to provide opportunities to enhance learning about the area's cultural resources.

Economic Benefits. A steady flow of benefits essential to sustaining life and fulfilling basic human needs and desires will be provided. These benefits will be derived from a number of provisioning, regulating, cultural, and supporting services (collectively known as ecosystem services) produced by biophysical and ecological processes within the Francis Marion. The Francis Marion's provision of ecosystem services will promote human health and well-being at local, regional, and global scales. The Forest will also actively engage and collaborate with neighboring communities, partners, other agencies, and representatives from Native American and Gullah/Geechee Nations in working toward meeting a collective desired vision for the Francis Marion National Forest.

1.5 Decision Framework

The Revised Land Management Plan for the Francis Marion National Forest (hereafter referred to as the plan or forest plan) will guide management of National Forest System 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)).

Desired conditions, objectives, suitability of lands, standards and guidelines, and management area and geographic areas will provide a management framework for the Francis Marion National Forest until amended or revised. Desired conditions are in the long term, and may not be immediately achieved. This plan serves as the principle mitigation tool to avoid, minimize, rectify, or compensate any adverse environmental impacts associated with multiple-use management on the Francis Marion National Forest.

The accompanying revised forest plan is the preferred alternative (alternative 2) as outlined in this final environmental impact statement. The final revised forest plan and final environmental impact statement have been prepared in accordance with Title 36 Code of Federal Regulations, Part 219 – National Forest System Land Management Planning (2012 planning regulations), the National Forest Management Act of 1976 (NFMA), and the National Environmental Policy Act (NEPA) of 1969.

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.

The 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).

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, sections 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 and 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).

1.6 Public Involvement

The notice of intent (NOI) to prepare an EIS was published in the *Federal Registe*r on April 30, 2014. The notice asked for public comment on the proposal from May 1, 2014, to June 16, 2014. In addition, as part of the public involvement process, the Forest Service hosted the following series of community conversations:

- Two public meetings to kick off the Francis Marion Forest Plan revision in fall 2012;
- Sustainable Recreation and Ecosystem Services (February 26, 2013);
- Ecological Sustainability Forum (August 6, 2013);
- Preliminary Need to Change (February 26, 2014);
- At-Risk Species (April 15–17, 2014);
- Recreation Zones, Potential Wilderness, and Eligible Wild and Scenic Rivers meeting (August 16, 2014);
- Recreation Zones, Potential Wilderness, and Eligible Wild and Scenic River field trip (September 13, 2014);
- Draft Plan/Rolling Alternative meeting (September 23, 2014); and
- Public comment period meeting (October 27, 2015).

A 90-day public comment period on the draft forest plan and associated draft environmental impact statement was initiated on August 14, 2015. To view all scoping comments received during the comment period, visit the Comment Analysis and Response Application (CARA) reading room at https://cara.ecosystem-management.org/Public/ReadingRoom?project=40695. Response to these public comments can be found in appendix H.

This FEIS was also subject to a pre-decisional objection process pursuant to 36 Code of Federal Regulation (CFR) § Part 219 Subpart B. A 60-day objection period on the draft Record of Decision (ROD), revised forest plan, and final environmental impact statement ran concurrently with an objection period for the Francis Marion's list of species of conservation concern (SCC). This objection period was initiated on August 26, 2016 with the publication of the Notice of Objection Filing Period in *The State* newspaper. One objection was received during the objection filing period. The objector brought up issues concerning forest plan components and related analysis in the FEIS, as well as concerns about the process and documentation related to the selection of the Francis Marion's SCC. These two topics are addressed by different reviewing officers and separate meetings were held with the objector to discuss their objection issues.

On December 1, 2016, the reviewing officer for Region 8 and his staff met with the objector and agreed to changes in forest plan components, the draft ROD and the FEIS that primarily addressed issues with plan component specificity, old growth, riparian management zones, management requirements for the Red-cockaded woodpecker, habitat conditions for other at-risk species and clarified the process used for ecological sustainability (including species grouping and key characteristics of their habitat conditions). These changes are detailed in a document titled –*Summary of Changes to the Revised Plan and FEIS* and is available on the Forest's website at http://www.fs.usda.gov/detail/scnfs/landmanagement/planning/?cid=stelprdb5393142.

On December 2, 2016, the reviewing officer for the Washington Office and his staff met with the objector and agreed to review 25 species for further consideration as species of conservation concern, which will take place early in calendar year 2017. This review may result in changes to the list of the Francis Marion's Species of Conservation Concern, and in turn, any applicable forest plan components and FEIS analysis related to any species added to the Francis Marion's Species of Conservation Concern list. If substantial changes are needed, then a forest plan amendment and updated analysis in the FEIS may be required.

1.7 Issues

Based on comments from Forest Service personnel, public, other agencies and non-governmental organizations, the planning interdisciplinary team developed a list of issues to address in this document. The planning interdisciplinary team separated the issues into two groups: non-significant and significant. The Council on Environmental Quality's (CEQ) NEPA regulations explain this delineation in section 1501.7, "identify and eliminate from detailed study the issues which are not significant or which have been covered by prior environmental review (Sec. 1506.3)." Additional information is available on our public website at: http://www.fs.usda.gov/goto/scnfs/fmplan.

1.7.1 Significant Issues

Significant issues are defined as those directly or indirectly caused by implementing the proposed action. These issues drive the range of alternatives and effects analysis. The Forest Service identified the following significant issues during scoping.

1.7.1.1 Significant Issue 1

1. To what extent and where should native ecological systems be restored? By restoring and maintaining the key characteristics, desired conditions, and function of native ecological systems, the Francis Marion should be able to improve ecological system diversity on a landscape scale, while simultaneously providing for the needs of diverse plant and animal species, as well as people (see Figure 1-5).

1a. Some people want all the fire-maintained ecological systems, such as longleaf pine, restored by using prescribed fire, while others are concerned that substantial increases in these systems would cause adverse effects from smoke.

Unit of Measure: Acres of native ecosystems maintained and restored.

1b. Some people want to increase the amount of prescribed burning during the growing season to enhance the restoration of fire-maintained ecosystems, while others are concerned about impacts to wildlife, particularly the resulting mortality of vulnerable young animals.

Unit of Measure: Acres of fire-adapted ecosystems in management area 1 within which growing season burning would be applied.

1c. Forested wetlands, streams, and floodplains have been changed by past land-use practices, such as ditching and draining. Some people want an aggressive program to restore the natural hydrology of the area while others are concerned that hydrologic restoration practices may cause more adverse effects than potential benefits.

Unit of Measure: Estimated acres of hydrologic function improvements.

Figure 1-5. A prescribed burn on the Francis Marion

1.7.1.2 Significant Issue 2

2. What is the best approach to dealing with the rapid change of land use from a forested, rural landscape to an urban environment with developments in close proximity to the national forest? Much of the area near the Francis Marion is rapidly being developed. Land development trends suggest that the area would likely become increasingly urban. Increases in human population and urban development may present direct conflicts to conducting effective management programs (see Figure 1-6).

2a. There could be impacts to human health and safety from increases in the potential for and the intensity of wildfires if national forest management options are constrained due to rapid changes in land uses.

Unit of Measure: Acres in management areas 1 and 2; acres in fire regime condition classes 2 and 3.

2b. Some people want to see increases in restoration efforts on national forest land, but the work needed to complete restoration of fire-maintained ecosystems may affect the health and safety of nearby residents and communities; it could also impact infrastructure, particularly buildings that are adjacent to national forest land.

Unit of Measure: Acres in management areas 1 and 2; acres in fire regime condition classes 2 and 3.

2c. Some people are concerned that threatened or endangered species habitat would be lost in areas adjacent to urban environments, while others are concerned that access to use the national forest might be constrained.

Unit of Measure: Acres in management area 1; acres managed for at-risk species.

2d. In response to increasing development and human use, some people want to preserve opportunities for solitude and remote recreation experiences by closing roads or increasing wilderness areas, while others are concerned that an increase in wilderness could affect the amount of restoration or search and rescue efforts.

Unit of Measure: Acres of recommended wilderness.

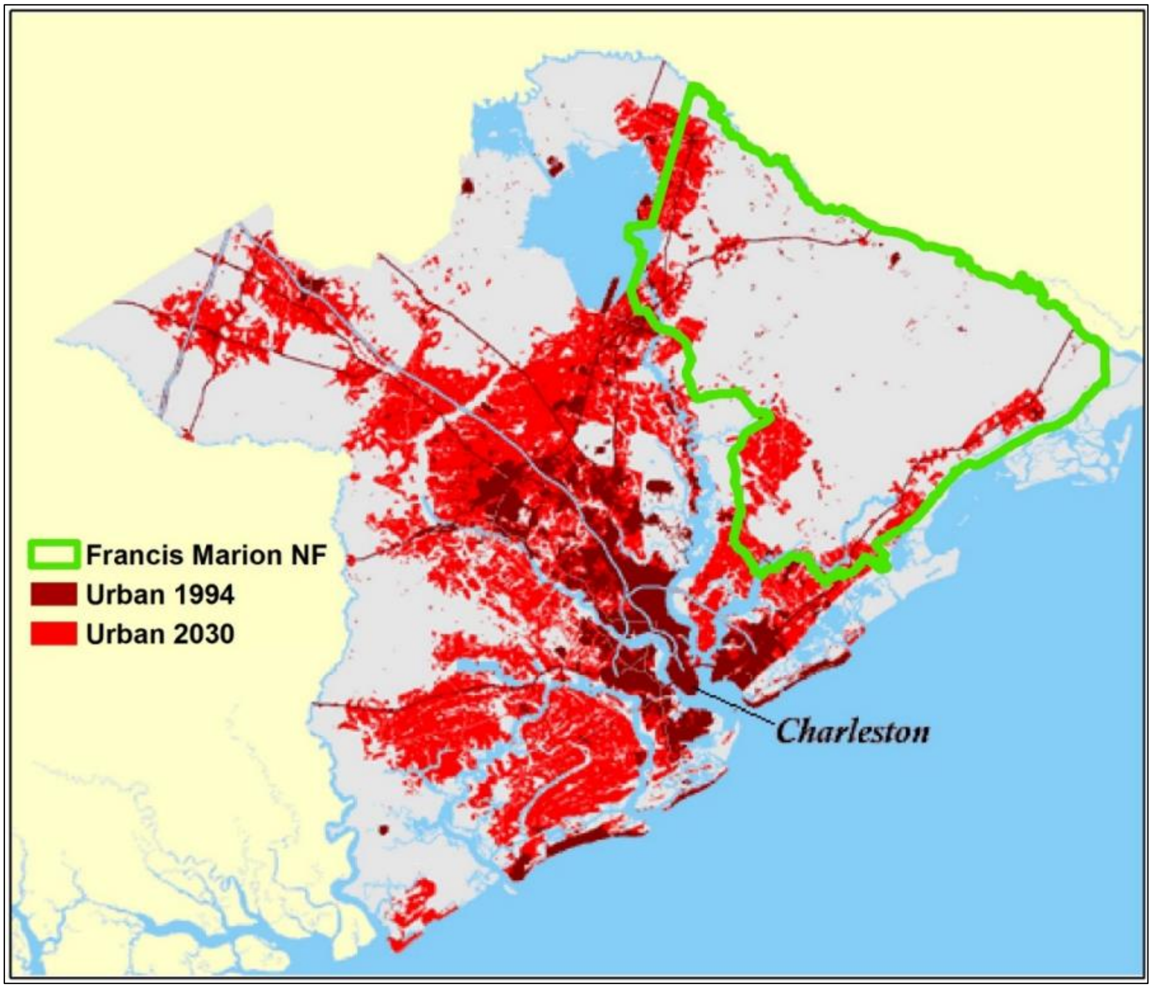

Figure 1-6. Projected urban development near the Francis Marion National Forest

1.8 Relationship to Other Documents

This document incorporates by reference (40 CFR 1502.21) the management direction and environmental analysis from the following regional programmatic decisions:

- The Final Environmental Impact Statement and Record of Decision for Suppression of Southern Pine Beetle, April 1987, as amended;
- The Final Environmental Impact Statement and Record of Decision for the Management of the Red-cockaded Woodpecker and Its Habitat on National Forests in the Southern Region, June 1995.

1.9 Other Related Efforts

Other ongoing efforts influencing the decision to be made include transportation analysis planning, the watershed condition framework, and the landownership adjustment strategy.

Chapter 2. Alternatives, Including the Proposed Action

This chapter describes and compares the alternatives considered for the Francis Marion Forest plan revision. Each alternative represents a different management emphasis for the Francis Marion that addresses the significant issues identified during the planning process. Each alternative provides a different mixture of goods and services for the public and a different combination of resource outputs, land uses, and environmental effects. The alternatives were developed according to NEPA procedures (40 CFR 1502).

In response to issues raised by the public, the Forest Service developed three alternatives considered in detail, including alternative 1 (no action) (1996 forest plan), alternative 2 (proposed action and the preferred alternative) and alternative 3. The tables at the end of this chapter summarize the responses to the significant issues described in chapter 1.

Some alternatives are "not considered in detail" because they do not meet law, policy, or best available scientific information; they are outside the scope of this Forest Plan; or they are outside of our fiscal and technical capability. The alternatives are discussed as follows.

2.1 Alternative Development

Federal guidelines require that a "reasonable" range of alternatives is developed including a no-action alternative. For this document, the no-action alternative in the 1996 forest plan was not developed in response to a significant issue, but is provided as a baseline for comparison of the other alternatives considered in detail. Some items do not vary between alternatives 2 and 3 due to requirements in law or policy, considerations of the best available scientific information, or lack of public concern.

Restoration of fire-maintained ecosystems and hydrologic function of wetlands are the foundations of alternatives 2 and 3. Alternatives 2 and 3 were developed to display tradeoffs of certain management actions needed to address the significant issues including:

- How much and where longleaf pine should be restored while considering our technical and fiscal capability to prescribed burn. In addition, restoration of longleaf pine on the Francis Marion is coordinated with the longleaf restoration efforts of the Sewee Longleaf Conservation Cooperative in order to connect longleaf ecosystems across the landscape.
- Closely connected to the first item is how much and where to increase the prescribed burn program near major roads and towns to improve habitat for fire-adapted at-risk species. Additional developments are projected in the southeastern corner of the Francis Marion where many at-risk species occur.
- How much and where historic water flows can be restored. Extensive hydrologic modifications occurred, such as ditching that diverted streams or drained wetlands, construction of dams that altered the amount of water flowing, construction of dikes that altered overland flow of water, and the installation of culverts that diverted water flows.
- How much and where additional areas should be recommended for inclusion in the Wilderness Preservation System with balancing the need to restore hydrologic function, control non-native invasive species (notably Japanese climbing fern), and maintain red-cockaded woodpecker clusters and foraging habitat.

2.1.1 How Alternatives 2 and 3 Were Developed

To address significant issues 1a, 1b, 2a, 2b, and 2c, some interconnected pieces were considered in developing alternatives 2 and 3, including:

- The results of the America's Longleaf Restoration Initiative's rangewide assessment, the 2010 assessment of historic longleaf pine forest on the Francis Marion, the potential ecological systems identified in the Francis Marion assessment, and the development of the Sewee Longleaf Conservation Cooperative;
- The needs of at risk species and recommendations in the South Carolina Wildlife Action Plan;
- Our technical and fiscal capability to maintain fire on the landscape along with the implementation of Awendaw Fire District's Community Wildfire Protection Plan and the development of the Community Wildfire Protection Plan for Berkeley County; and
- The extensive modifications that have occurred and how that affects our ability to work toward ecological integrity and diversity. Some of these modifications include the lack of fire, past efforts to drain wetlands and divert streams, and the planting of loblolly in areas that were historically longleaf pine forest.

This information was used to determine what managers could accomplish over the next 10 to 15 years, and the management direction needed among the different alternatives. The team went through several steps to figure out how much and where longleaf pine could be restored and how and where we could improve habitat for fire-adapted, at-risk species.

One of the first steps was to identify what ecological systems occurred here historically; these are detailed in the 2014 Francis Marion National Forest Assessment. These ecological systems were eventually grouped by similar composition, structure, function, and system drivers (primarily fire and flooding) to develop forest plan direction. This process is detailed in appendix E of this document, and for this discussion on alternative development, we will focus on just the longleaf pine ecological systems and ecosystems.

Based on the 2010 assessment of the historic longleaf pine forest and the potential ecological systems, approximately half of the Francis Marion was dominated by longleaf pine ecosystems prior to European settlement. See Table 2-1 for a summary of acreages on longleaf pine ecosystems.

Table 2-1. Extent of mapped longleaf pine ecological systems and ecosystems in the Francis Marion project area

Ecological System	Acreage (rounded)	% of Francis Marion
Wet Pine Savanna and Flatwoods Ecosystems Total	85,500	
Upland Longleaf Ecosystems and Loblolly Pine Woodlands Total	51,500	
Potential Longleaf Pine Ecosystems	138,280	53.4

Source: Simon and Hayden (2014)

Because of where longleaf pine occurred historically, the Francis Marion is considered a significant landscape for longleaf pine conservation by the America's Longleaf Restoration

Initiative, a collaborative effort of multiple public and private sector partners (America's Longleaf Restoration Initiative 2009). One of the landscape cooperatives developed as a result of the America's Longleaf Restoration Initiative was the Sewee Longleaf Conservation Cooperative. Started in 2012, the Sewee Longleaf Conservation Cooperative encourages government agencies, nongovernmental organizations, private landowners, practitioners, and other stakeholders to reestablish, maintain, and enhance the longleaf pine ecosystem in the Sewee landscape (centered in and around the Francis Marion National Forest) through resource sharing, collaboration, and applied learning. Partnership initiatives, such as the Sewee Longleaf Landscape Cooperative, provide incentives to private landowners to prescribe burn and plant longleaf.

Another step was to consider the needs of at-risk species (federally listed threatened and endangered species and species of conservation concern). For additional information on these species, see appendix E of this document. Frequent, low-intensity fire is needed to maintain the habitat of many at-risk species on the Francis Marion, and some of these habitats occur in portions of the Francis Marion that have not been burned recently—in cases not since Hurricane Hugo hit the area in 1989. Without introducing the needed fire, the Forest Service may be considered liable for a 'take' for federally listed species and be subject to fines and penalties. Notably the designated critical habitat for the federally endangered frosted flatwoods salamander occurs in an unburned portion of the Francis Marion. The designated critical habitat includes breeding wetlands embedded in longleaf pine ecosystems located off State Highway 41 near the town of Wando, some industrial sites, and proposed housing developments. In order to introduce fire into the designated critical habitat, the Forest Service would need to move forward carefully by addressing smoke management concerns of our neighbors.

Using all this information, the team had to evaluate how much and where longleaf pine could be maintained and restored over the next 10 to 15 years. Currently there are approximately 50,000 to 55,000 acres of longleaf pine forest-type; the majority of the potential 138,280 acres of longleaf pine restoration is dominated by loblolly pine. Most of the loblolly pine forest provides foraging habitat and breeding clusters for the endangered red-cockaded woodpecker, so extensive conversion of loblolly pine was not practical. However, other steps could be taken to move toward the desired longleaf ecosystems. These steps included favoring longleaf pine in thinning operations, introducing fire into portions of the Francis Marion that had not been recently prescribed burned since Hurricane Hugo hit the area in 1989, and providing fire during the growing season to mimic historic fire patterns.

Next, the team looked at where we had been burning and then where we could add fire onto the landscape. This information was used to the develop management areas 1 and 2. Management area 1 in alternative 3 reflects the current prescribed burn program, while management area 1 in alternative 2 introduces prescribed burning into portions of the Francis Marion that have not been recently burned. In alternative 2, three additional areas of the Francis Marion were identified that could address longleaf pine restoration (off U.S. Highway 17 northeast of McClellanville and north of U.S. Highway 17A and Moncks Corner) and habitat needs for at-risk, fire-adapted species (near the town of Wando and State Highway 41).

The team also had to consider how fire could be reintroduced into these smoke sensitive areas. To reintroduce fire on the portions of the Francis Marion near major roads and towns requires the use of a combination of techniques that not only reduce hazardous fuels, but will eventually create a grassy understory. This reintroduction of fire may start with mechanical treatments followed by prescribed burning in burn blocks that may be a few hundred acres. Prescribed burning in these more smoke-sensitive areas requires specific weather conditions, such as relative humidity and

wind direction and speed. Herbicides may be used to help develop the grassy understory in the longleaf pine ecosystems as well. This focused approach may have to be repeated for many cycles in order to reduce the fuel loading. Once the native grasses and forbs are well established in understory, the smoke-management concerns drop because the grassy understory generates less smoke.

Alternative 2 focuses on introducing fire into the designated critical habitat for the threatened frosted flatwoods salamander and some additional areas for longleaf pine restoration, using the reintroduction approach described above. Alternative 3 focuses on using primarily mechanical techniques to maintain the designated critical habitat for the frosted flatwoods salamander and the longleaf pine forest. The mechanical treatments are less effective and more costly, but have fewer smoke-management concerns. Alternative 3 has less prescribed burning than alternative 2.

Prescribed burning was also used to develop the resource integration zones and how they vary between alternatives 2 and 3. Plan direction under alternative 2 includes four zones: Coastal, Wando, Wambaw, and Santee. Alternative 3 includes only three zones: Coastal, Wambaw, and Santee. The Coastal and Santee Resource Integration Zones are the same in alternatives 2 and 3, with similar management direction. In alternative 3, the Wambaw Resource Integration Zone is larger and has an emphasis on using mechanical treatments to reduce hazardous fuel loading and maintain the designated critical habitat for the frosted flatwoods salamander. In alternative 2, the Wambaw Resource Integration Zone is smaller and the Wando Resource Integration Zone emphasizes the use of prescribed burning to reduce fuel loads and maintain the designated critical habitat for the frosted flatwoods salamander.

To respond to significant issue 2d on providing opportunities for solitude, the team considered the following information when developing a range of alternatives on recommending additional areas for wilderness designation: the level of political and public interest on recommending additional areas, options to providing opportunities for solitude besides wilderness designation, and the management needs in the inventoried areas.

- Since wildernesses are designated by congress, the level of political and public interest is critical on what to recommend for inclusion in the wilderness preservation system. During scoping and the 90-day comment on the draft forest plan, only one email expressed interest in seeing additional wilderness. The Wilderness Society did not express any interest in recommending any areas for wilderness designation, so an alternative to include all inventoried areas that were eligible was considered, but eliminated from detailed study.
- In alternative 2, wilderness character is improved by emphasizing semiprimitive, motorized conditions near Hellhole Swamp, Little Wambaw, and Wambaw Creek Wildernesses by identifying two semiprimitive areas that include two inventoried roadless areas. Some Forest Service areas would be closed to public access, but maintained for administrative use. These road closures would require site-specific analysis and decisions. These semiprimitive areas include two inventoried roadless areas. Also, one of the semiprimitive areas connects Little Wambaw and Wambaw Creek Wilderness.
- In alternative 3, expansions to the four existing wilderness areas are proposed to enhance the wilderness experience.
- Alternatives 1 and 2 address management needs. Specifically, mechanized equipment and roaded access are needed to (1) maintain foraging habitat and active nest sites for red-

cockaded woodpecker; (2) control Japanese climbing fern and other non-native invasive species; (3) restore hydrologic function and historic water flows; and (4) improve aquatic passage. No management activities are proposed in alternative 1 or 2 that would preclude a future recommendation on wilderness designated in the inventoried areas.

2.2 Alternatives Considered in Detail

In response to issues raised by the public, the Forest Service developed three alternatives, including the alternative 1 (no action; 1996 forest plan), alternative 2 (proposed action; preferred alternative) and alternative 3. The tables at the end of this chapter summarize the responses to the significant issues described in chapter 1.

2.2.1 Alternative 1. No Action (1996 Forest Plan)

Under alternative 1, the 1996 forest plan would continue to guide management of the plan area. No priority watersheds are identified alternative 1.

The 1996 forest plan did restore longleaf pine, but did not recognize the wet pine savanna ecosystem for potential longleaf restoration. Management area 26 emphasizes prescribed burning.

The 1996 forest plan has limited forest plan direction to improve hydrologic function or restore historic water flows.

2.2.2 Alternative 2. Proposed Action (Preferred Alternative)

Restoration of fire-maintained ecosystems and hydrologic function of wetlands is the foundation of this alternative. Three sixth-level watersheds (Guerin Creek, Headwaters Wambaw Creek, and Turkey Creek-East Branch Cooper River) are priority for restoration efforts.

Two management areas provide direction on restoration of fire-maintained ecosystems. Restoration of longleaf pine ecosystems is a major focus of this alternative. Management activities used to restore and maintain the longleaf pine ecosystems include frequent, low-intensity fire and timber harvesting in management area 1. These activities would improve habitat for the threatened and endangered red-cockaded woodpecker. In management area 2, where frequent, low-intensity fire cannot be used on a landscape scale, alternative methods to control fuels are used.

The forest plan increases opportunities to improve hydrologic function during project-level planning. Management activities may include plugging ditches to re-isolate depressional wetlands and adding culverts under dikes to restore water flows. During project-level planning, existing dikes may be retained to limit saltwater influx where hydrologic modifications are causing salt water entry beyond historic conditions (such as at lower Santee River). Hydrologic restoration would improve habitats for aquatic species and at-risk amphibians.

Plan direction under alternative 2 includes four integrated resource management zones: Coastal, Wando, Wambaw, and Santee. These zones are geographic areas that not only define and focus recreation opportunities in existing settings, but also include social/cultural components and multiple uses. These four zones would help frame the discussion about how the Francis Marion is connecting people to nature.

Landownership adjustment has an emphasis on improving the efficiency of management and connecting ecosystems and habitats, but recognizes the coordination and connection with private lands under a conservation easement.

Under this alternative, the Santee Experimental Forest would be a partner on the restoration of longleaf pine.

2.2.3 Alternative 3

This alternative is a modification of alternative 2. It emphasizes alternative methods to frequent landscape-level prescribed burning in smoke sensitive areas where human health can be impacted. The plan clarifies how prescribed burning would be conducted in the wildland-urban interface. This reduction in landscape-level prescribed burning would result in a smaller management area 1. Use of treatments, such as mastication, herbicides, or smaller burn blocks, would address smoke management and human health concerns along the Highway 17 corridor, west of Highway 41 to Highway 402, and north of Highway 17A in management area 2. In addition, fewer burns would be conducted during the growing season within management area 1.

2.3 Alternatives Considered but Eliminated from Detailed Study

NEPA requires Federal agencies to rigorously explore and objectively evaluate all reasonable alternatives 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 achieving the purpose and need. Some of these alternatives may have been outside the scope of the forest plan, duplicative of the alternatives considered in detail, or determined to be components that would cause unnecessary environmental harm. Therefore, a number of alternatives were considered, but dismissed from detailed consideration for reasons summarized below.

- Custodial (no timber management, prescribed burning, mining, fishing or hunting). This alternative was not considered in detail because it did not meet law or policy requirements to provide multiple uses. Restoration of native ecosystems would not be possible under this alternative.
- Due to its importance and the amount of public concern, the restoration of native longleaf ecosystems and amount of prescribed burning needed was recognized as a significant issue, specifically, significant issues 1a and 1b. The planning team considered a much higher amount of prescribed burning and longleaf pine restoration, but eliminated it from further study because was currently outside the “fiscal or technical capabilities of the unit”, as stipulated under the 2012 planning regulations. However, the final forest plan does direct managers to ascertain whether fiscal or technical capabilities have changed, and if so, then greater use of prescribed fire to maintain or restore ecosystems would be allowed.
- Recommending for wilderness all areas inventoried as “may be suitable for wilderness consideration.” This alternative was not considered in detail for the following reasons:
    - It lacked the needed public and political interest for to recommend wilderness designation for all the inventoried areas;
    - The areas contain ecological conditions that need to be restored;

- It includes foraging clusters for red-cockaded woodpeckers; and
- People would still like to have motorized access to these areas.

2.4 Comparison of Alternatives

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

Restoration of fire-maintained ecosystems and hydrologic function of wetlands are the foundations of alternatives 2 and 3. Alternatives 2 and 3 were developed to display tradeoffs of certain management actions needed to address the significant issues including:

- How much and where longleaf pine should be restored, while considering our technical and fiscal capability to prescribed burn. In addition, restoration of longleaf pine on the Francis Marion is coordinated with the longleaf restoration efforts of the Sewee Longleaf Conservation Cooperative in order to connect longleaf ecosystems across the landscape.
- Closely connected to the first item is how much and where to increase the prescribed burning program near major roads and towns to improve habitat for fire-adapted, at-risk species. Additional developments are projected in the southeastern corner of the Francis Marion where many at-risk species occur.
- How much and where historic water flows can be restored. Extensive hydrologic modifications occurred, such as ditching, that diverted streams or drained wetlands; construction of dams that altered the amount of water flowing; construction of dikes that altered overland flow of water, and the installation of culverts that diverted water flows.
- How much and where additional areas should be recommended for inclusion in the Wilderness Preservation System, balancing the need to restore hydrologic function, control non-native invasive species (notably Japanese climbing fern), and maintain red-cockaded woodpecker clusters and foraging habitat.

2.4.1 Alternative 1. No Action (1996 Forest Plan)

2.4.1.1 Response to Issue 1

1a. The 1996 plan accurately defines the need for prescribed burning across the Francis Marion and recognizes the importance of prescribed burning to restore longleaf pine on dry upland sites. However, direction on restoration of longleaf pine in wetter areas that were historically longleaf pine savannas is missing (Figure 2-1). Management area 26 addresses restoration of longleaf pine on approximately 40,000 acres on sandy ridges and side slopes. Management area 26 includes smoke-sensitive areas along major roads (see Figure 2-2).

1b. Forest Plan direction recognizes the need to use frequent growing season fire to restore longleaf pine ecosystems in management area 26, and includes an objective to increase the amount of growing season burns to 40,000 acres over a decade.

1c. The 1996 forest plan recognizes the protection of riparian areas and wetlands, but provides no direction on restoration of hydrologic function. Management area 27 (Loamy Ridges, Flats and River/Creek Bottoms) and management area 29 (Swamps and Swampy Flats) include direction that addresses riparian areas.

2.4.1.2 Response to Issue 2

2a. Changes in private land uses on the southern portion of the Francis Marion National Forest were a concern in 1996. The need to control the buildup of hazardous fuels near communities and roads was a priority. However, smoke management was not emphasized like it is today.

2b. The 1996 forest plan states, “greater public involvement in decision making. More partnerships between the Forest Service and other Federal agencies, as well as with State and private organizations and groups are expected.” Since 1996, new policy and guidance emphasizes using an “all lands” approach to address concerns that cross national forest boundaries. The 1996 plan mentions reducing fuel build up in smoke-sensitive areas, but does not address using community wildfire protection planning.

2c. Although the 1996 plan addresses threatened and endangered species, additional at-risk species have been identified near the Town of Wando since. Today, more than 1,700 acres of critical habitat are designated for frosted flatwoods salamander near the Town of Wando. This species, and Carolina gopher frog, are not addressed in the 1996 plan.

2d. Management area 2 (Wilderness) in the 1996 plan includes direction on managing four congressionally designated wilderness areas totaling more than 13,000 acres (see Figure 2-3). No areas were recommended for wilderness in the 1996 forest plan.

The four existing wilderness areas are Hellhole Bay, Wambaw Swamp, Little Wambaw Swamp, and Wambaw Creek. They are located within the very poorly drained flats and river/creek bottoms. Little Wambaw Swamp Research Natural Area (60 acres) is located entirely within the Little Wambaw Swamp Wilderness. Recreation opportunities within each wilderness are listed below:

- Hellhole Bay Wilderness: canoeing and hiking.
- Wambaw Creek Wilderness: canoeing and motorized boating.
- Wambaw Swamp and Little Wambaw Swamp: wilderness recreational experiences, primarily during drought conditions.

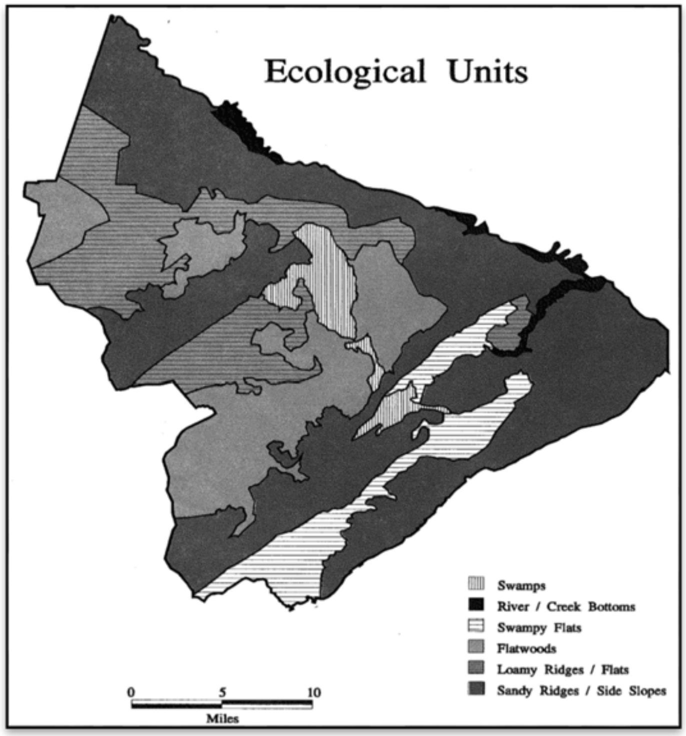

Figure 2-1. Ecological units in the 1996 Francis Marion Forest Plan

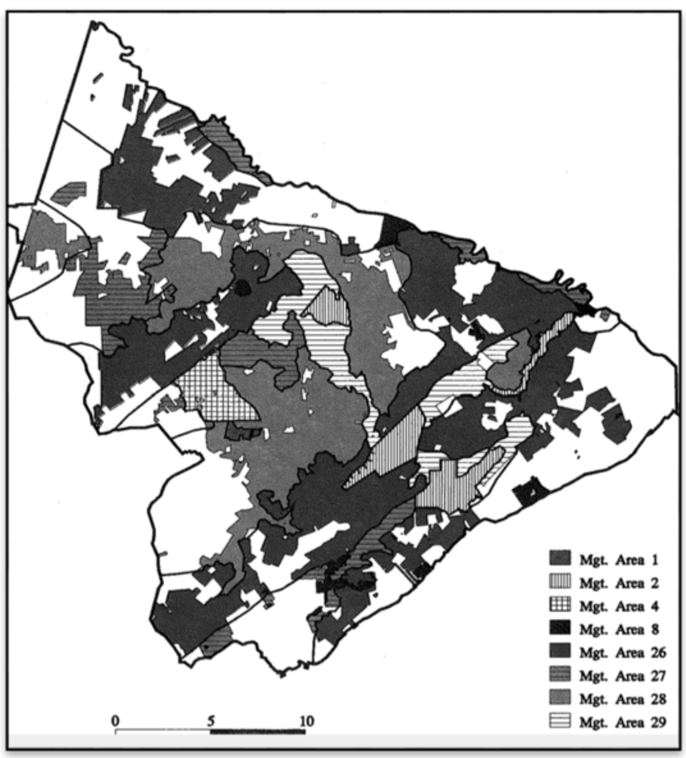

Figure 2-2. Management areas in the 1996 Francis Marion Forest Plan

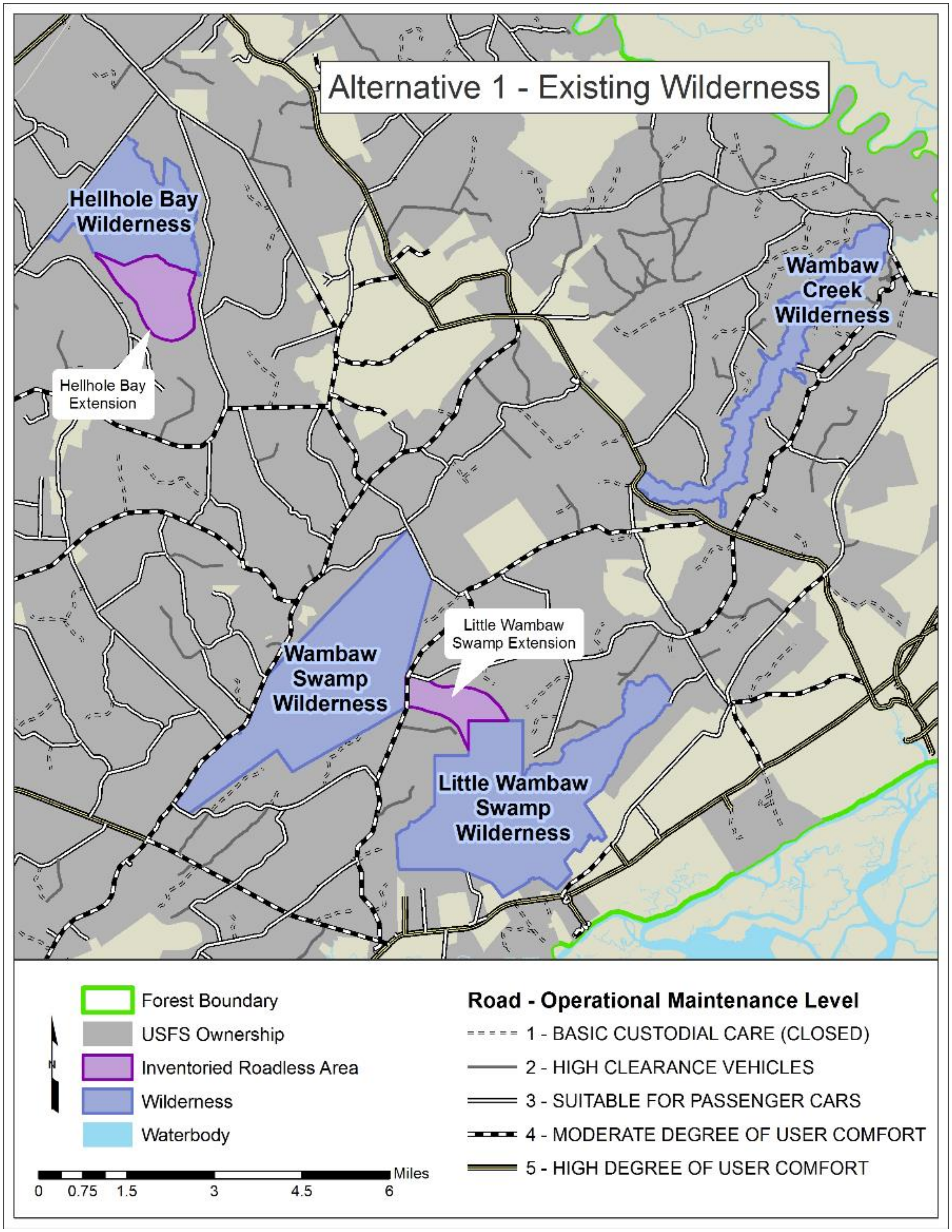

Figure 2-3. Wilderness areas in the 1996 Francis Marion Forest Plan

2.4.2 Alternative 2. (Proposed Action)

2.4.2.1 Response to Issue 1

1a. The agency's ability to achieve desired conditions for different natural systems varies with its ability to prescribe burn on a 1- to 3-year, fire-return interval across the landscape. Two management areas would provide forest plan direction that focuses on restoration and maintenance of ecosystem groups (see Figure 2-4).

- Management area 1 (lime green in Figure 2-4) emphasizes maintenance and restoration of native fire-maintained ecosystems habitats. Because the agency is best able to manage smoke issues associated with prescribed fire in this area, it is more likely to achieve the desired conditions for the fire-maintained ecosystems.
- Management area 2 (blue in Figure 2-4) addresses fuel reduction and timber management, where frequent prescribed fire is unlikely to be practiced, but where alternative methods for maintaining fire-adapted human communities, fuel reduction, and early successional habitat is desired. Due to the challenges of using fire in the green area, it is anticipated that the Forest Service would not be able maintain the desired conditions for the fire-maintained ecosystems.

1b. Plan direction under alternative 2 recognizes the need to use frequent growing season fire to restore fire-maintained ecosystems in management area 1. Growing season burns more closely reflect when fires historically occurred on the Francis Marion. Tradeoffs on the direct, short-term impacts to wildlife and the long-term improvements to wildlife habitat are analyzed in chapter 3.

1c. Past modifications, such as ditching and road construction, have altered water flows in and out of forested wetlands, riparian areas, and streams. Project-level inventory is needed to identify appropriate restoration measures. Restoration of wetlands, floodplains, or riparian areas may be needed to benefit at-risk species. Guerrin Creek, Turkey Creek, and Headwaters of Wambaw Creek are the three priority watersheds identified in alternative 2 (see Figure 2-5).

2.4.2.2 Response to Issue 2

2a. Four resource integrated zones established in alternative 2 would highlight unique areas and focus management direction. Changes in private land uses within the Wando and Coastal Resource Integration Zones would increase the number of homes and businesses adjacent to national forests. Many tracts of national forest land adjacent to developments and major roads have not been burned recently due to smoke management and human health concerns. This has led to build-up of fuels near homes and businesses (see Figure 2-6).

2b. In alternative 2, the Francis Marion would use an "all lands" management strategy to address concerns that cross national forest boundaries. As part of this "all lands" approach, the Forest would use partnerships and collaboration to create fire-adapted human communities through community wildfire protection planning, including Firewise education. To address concerns related to the potential impacts to private lands from using prescribed fire, the plan clarifies how prescribed burning would be conducted in the wildland-urban interface.

2c. The proposed Wando Resource Integration Zone would have the highest density of rare plants and animals on the Francis Marion National Forest. Many of these species are not only dependent on wetlands, but also on frequent, low-intensity fire. The increasing urban development and human use would constrain our ability to maintain these habitats (Figure 2-7).

2d. Alternative 2 increases opportunities for remoteness by emphasizing a semiprimitive, motorized desired condition on national forest land adjacent to three existing wilderness areas. Four existing wildernesses and two inventoried roadless areas are maintained. Three of those wildernesses have additional acres that emphasize a remote experience totaling more than 11,000 acres, but do not restrict mechanical activities in the turquoise-colored area in the following map. Over time, site-specific road closures would improve wilderness character and lower open road density in the turquoise area. Roads that would need to be gated and used only for administrative access are highlighted in red. This road closure would require a site-specific NEPA decision (see Figure 2-8).

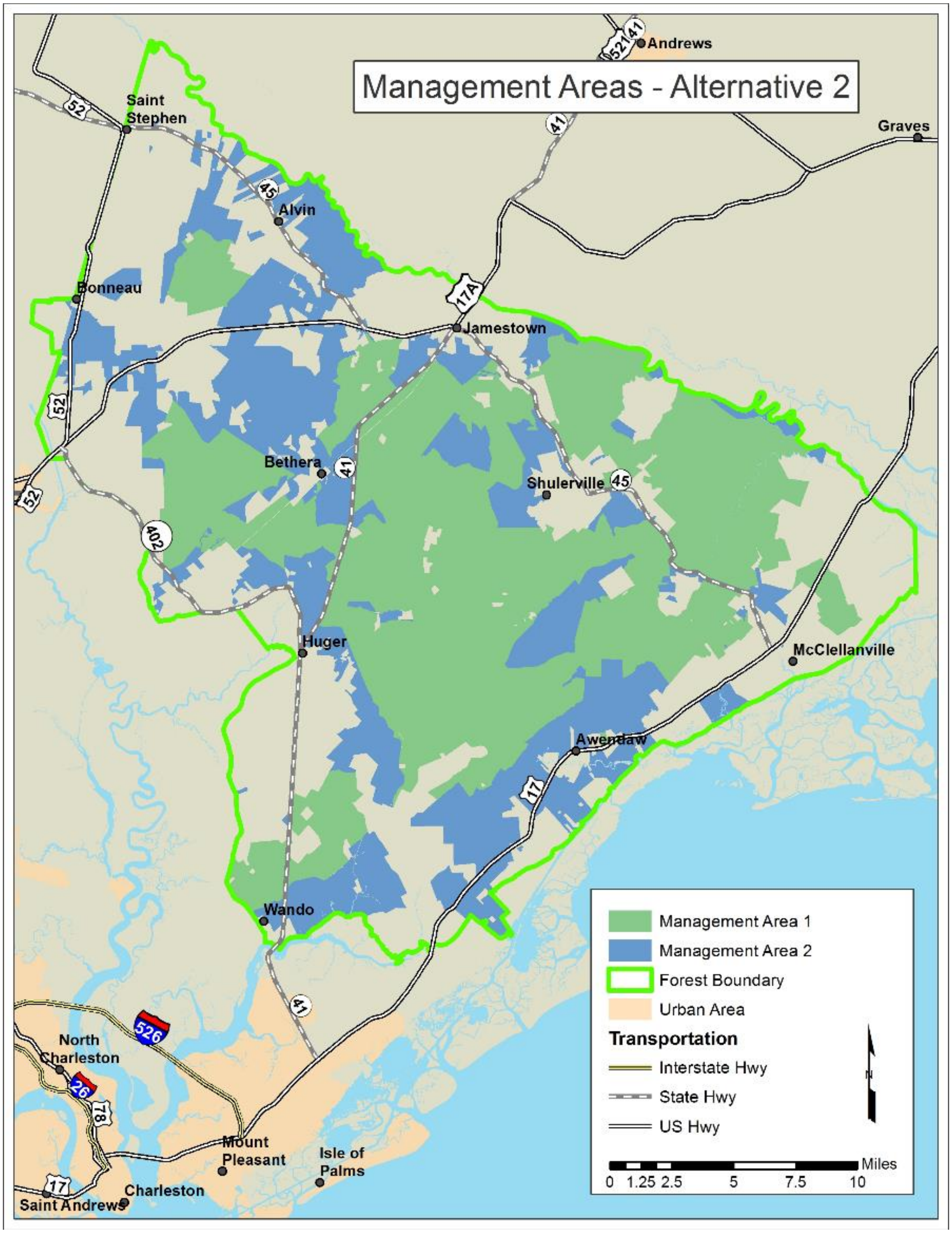

Figure 2-4. Proposed management areas in alternative 2

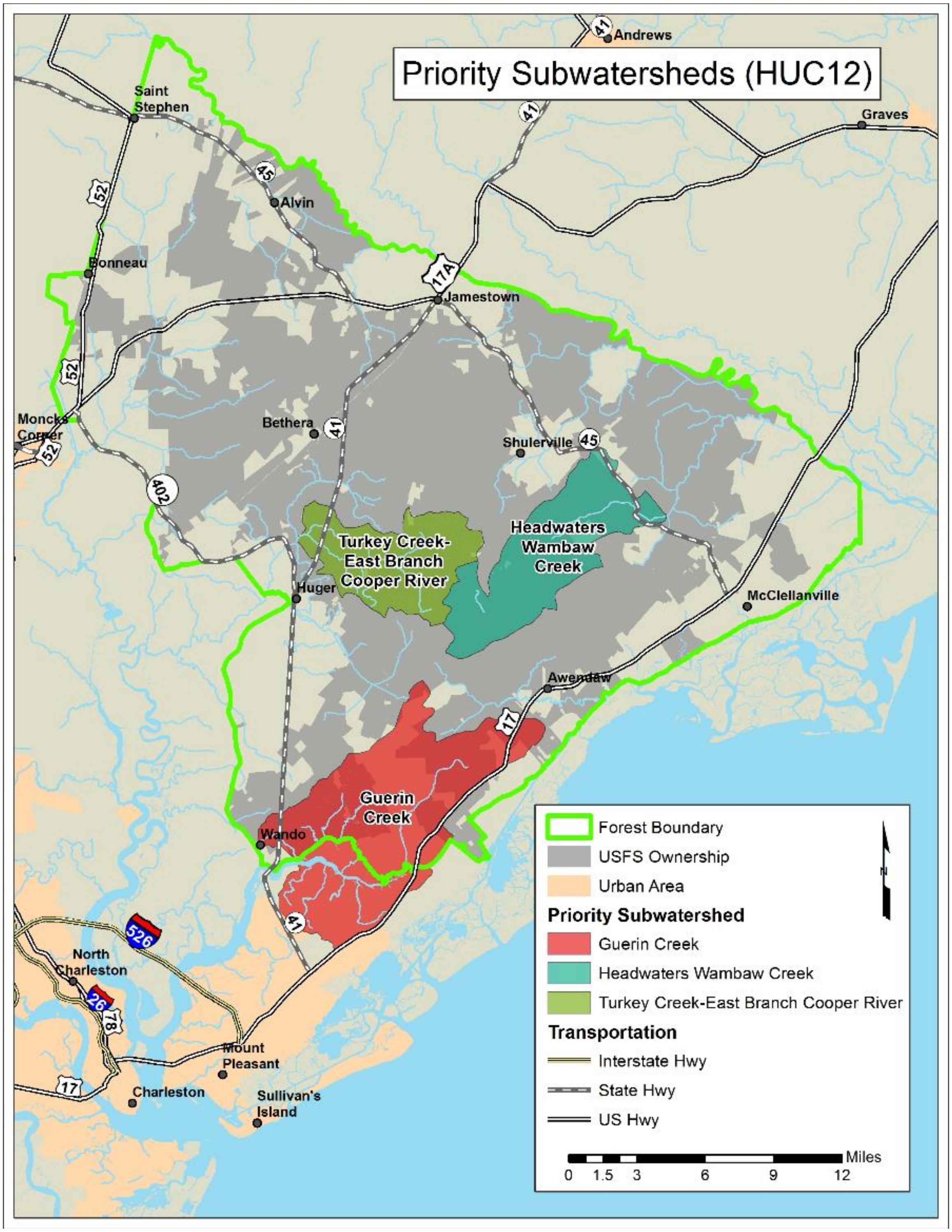

Figure 2-5. Priority watersheds identified in alternative 2

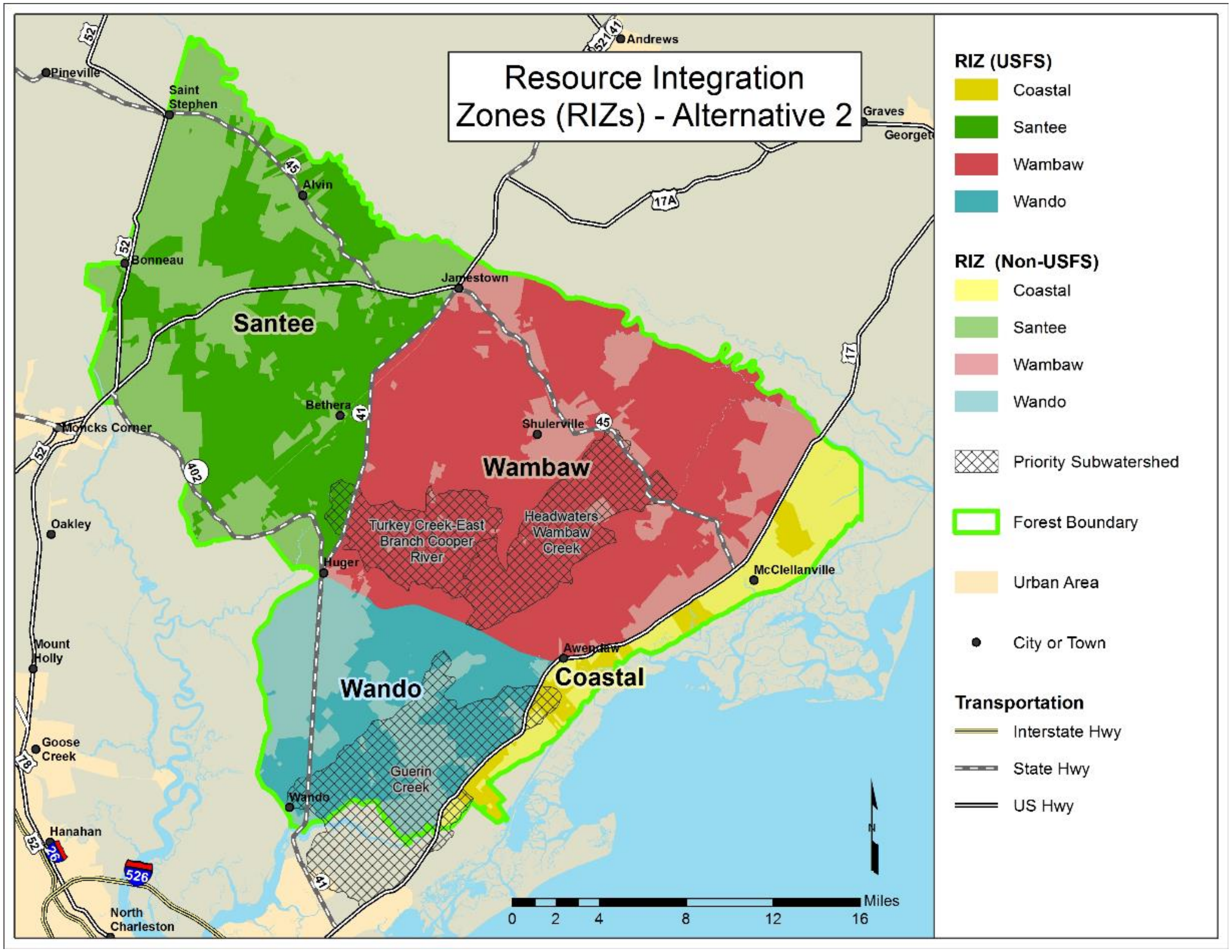

Figure 2-6. Proposed resource integration zones in alternative 2

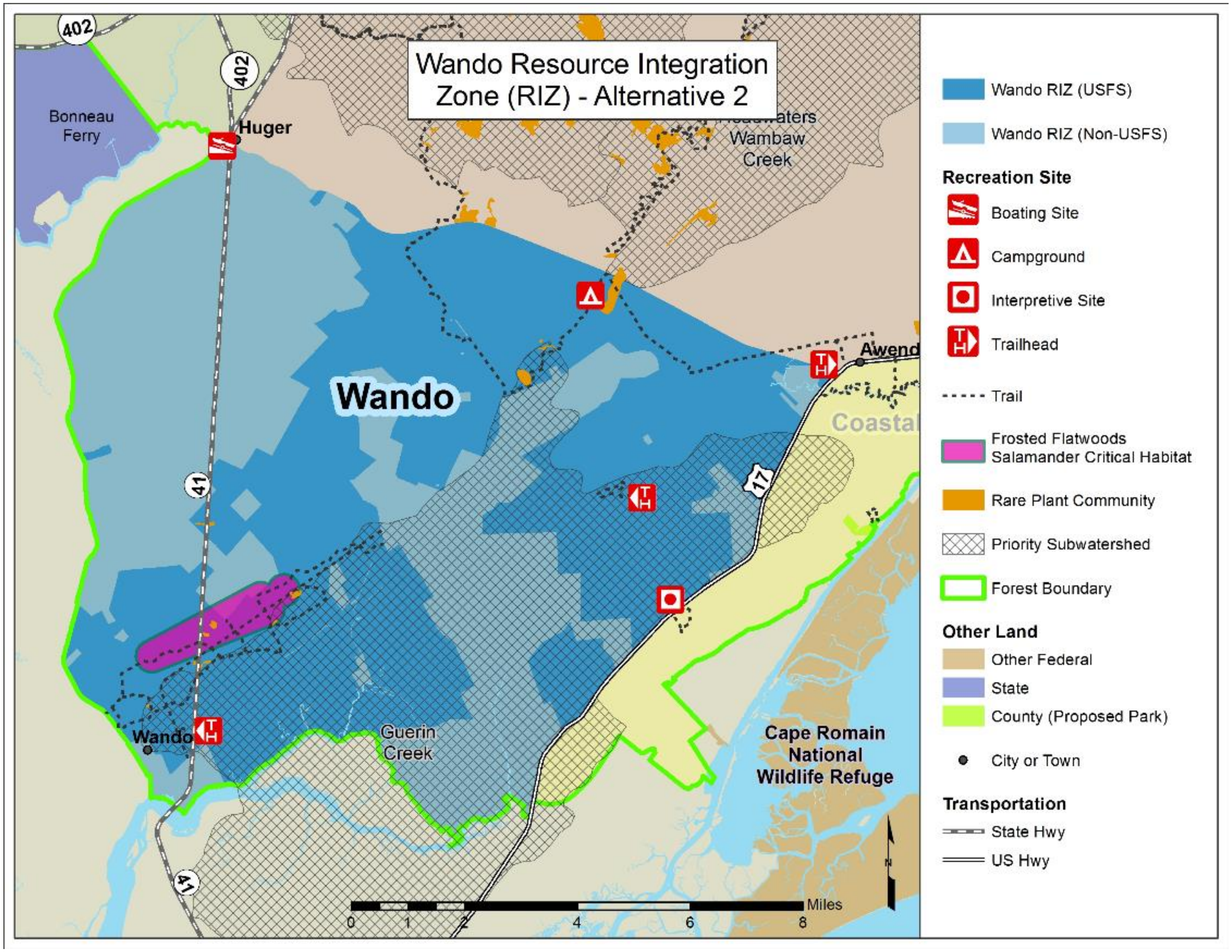

Figure 2-7. Proposed Wando Resource Integration Zone in alternative 2

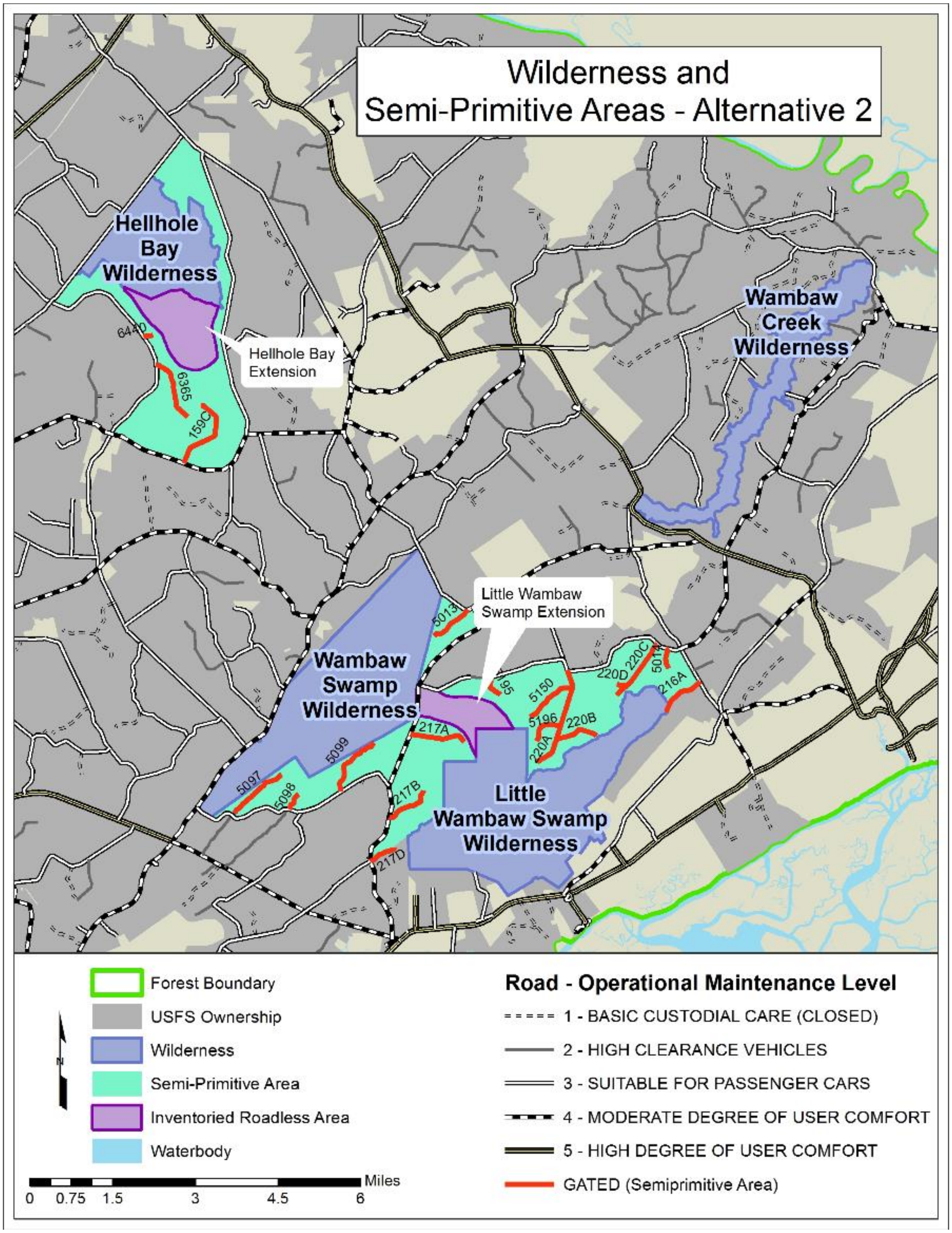

Figure 2-8. Proposed semiprimitive areas in alternative 2

2.4.3 Alternative 3

2.4.3.1 Response to Issue 1

1a. In alternative 3, national forest lands near smoke-sensitive areas would not be prescribed burned on a 1- to 3-year, fire-return interval. As a result, less restoration of the longleaf pine ecosystem would occur across the Francis Marion (see Figure 2-9).

- Management area 1 (lime green in Figure 2-9) emphasizes maintenance and restoration of native fire-maintained ecosystems habitats.
- Manage area 2 (blue in Figure 2-9) addresses fuel reduction and timber management, where frequent prescribed fire is unlikely to be practiced, but where alternative methods for maintaining fire-adapted human communities, fuel reduction, and early successional habitat is desired.

1b. Fewer growing season burns than in alternative 2 would be used for restoration of fire-maintained ecosystems. Tradeoffs on the direct, short-term impacts to wildlife and the long-term improvements to fire-maintained ecosystems are analyzed in chapter 3.

1c. The response to this issue is the same as in alternatives 2 and 3. Tools, such as plugging ditches, breaching dikes, and adding or replacing culverts, could be used to improve hydrologic function after a site-specific evaluation and analysis are completed. Guerrin Creek, Turkey Creek, and Headwaters of Wambaw Creek are the three priority watersheds in alternative 3. Direction for management of riparian areas is embedded into the forestwide desired conditions and objectives and in ecosystem groups.

2.4.3.2 Response to Issue 2

2a. Three resource integration zones highlight unique areas and focus management activities (see Figure 2-10). These three zones reflect an emphasis on using landscape-level frequent fire to reduce the risk of catastrophic wildfire in smoke-sensitive areas. Alternate methods include smaller burn blocks ignited by drip torches, mechanical chipping or mastication, use of herbicides or grazing on national forest lands along Highway 17, west of Highway 41 up to Highway 402 and north of Highway 17A (see management area 2 under 1a.). Prescribed burning may still be used in these smoke-sensitive areas, but it would not be on a 1- to 3-year, fire-return interval on a landscape scale.

2b. In alternative 3, the “all lands” management strategy would be used to address concerns that cross national forest boundaries. Partnerships and collaboration would be critical to creating fire-adapted human communities through community wildfire protection planning, including Firewise education. Additionally, State and Federal agencies require specific weather and fuel conditions that limit smoke impacts and reduce other risks. Prescribed burning activities on national forest land are coordinated with the South Carolina Forestry Commission to ensure that impacts from prescribed burning do not exceed air quality standards.

2c. The use of frequent, low-intensity fire and growing season burns would be emphasized less in the new Coastal Zone in alternative 3. Alternative methods described in response 2a would be needed to maintain habitats for at-risk plants and animals that occur on national forest land near the Town of Wando. Tradeoffs on the quality of habitat for at-risk plants and animals are discussed in chapter 3.

2d. In alternative 3, four existing wilderness areas are expanded with four additions totaling more than 16,000 acres (including two roadless areas). Over time, additional road closures would improve wilderness character and lower open road density (see the tan-colored area in Figure 2-11).

Two inventoried roadless areas are proposed within the wilderness. Roads that would be closed and obliterated are highlighted in red. This road closure would require a site-specific NEPA decision (see Figure 2-11).

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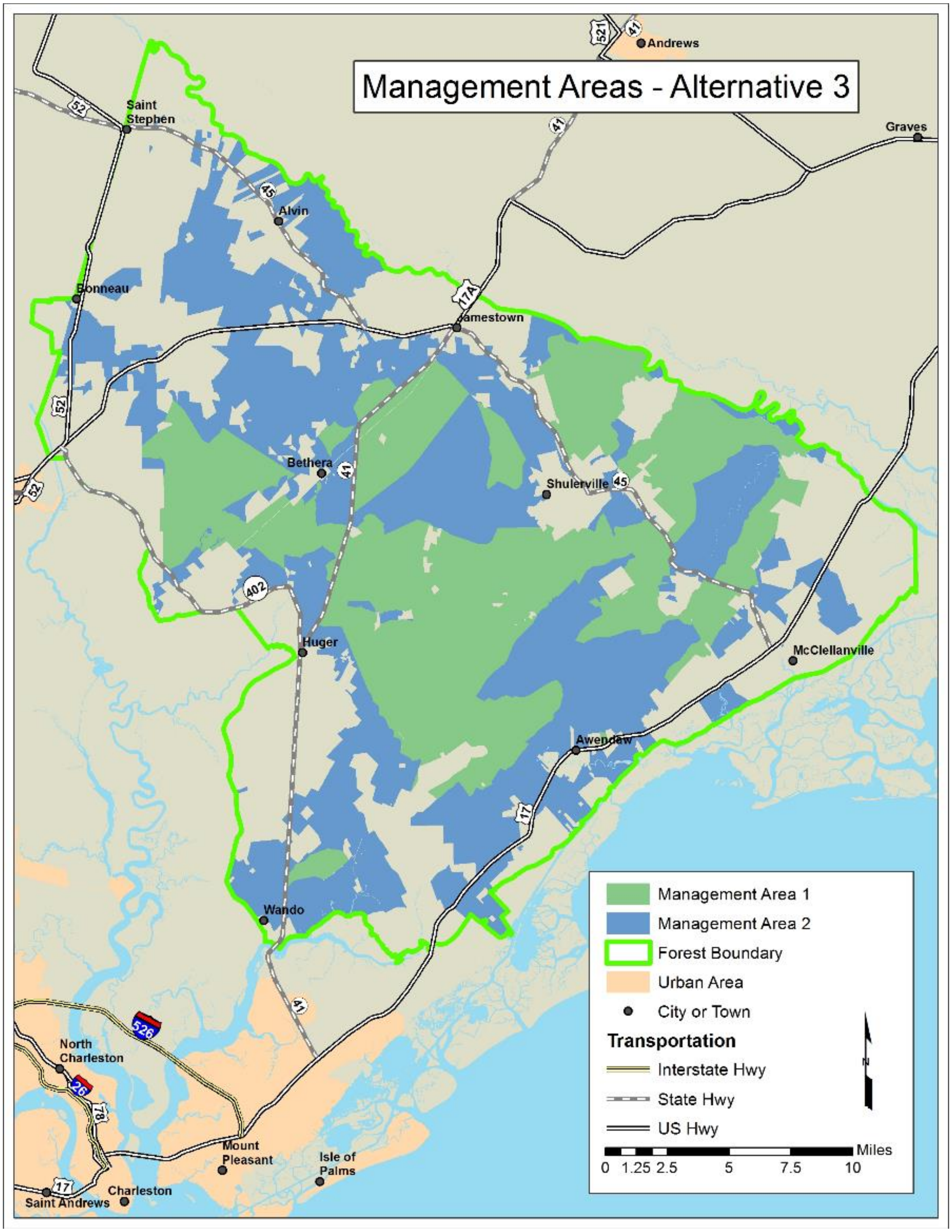

Figure 2-9. Management areas in alternative 3

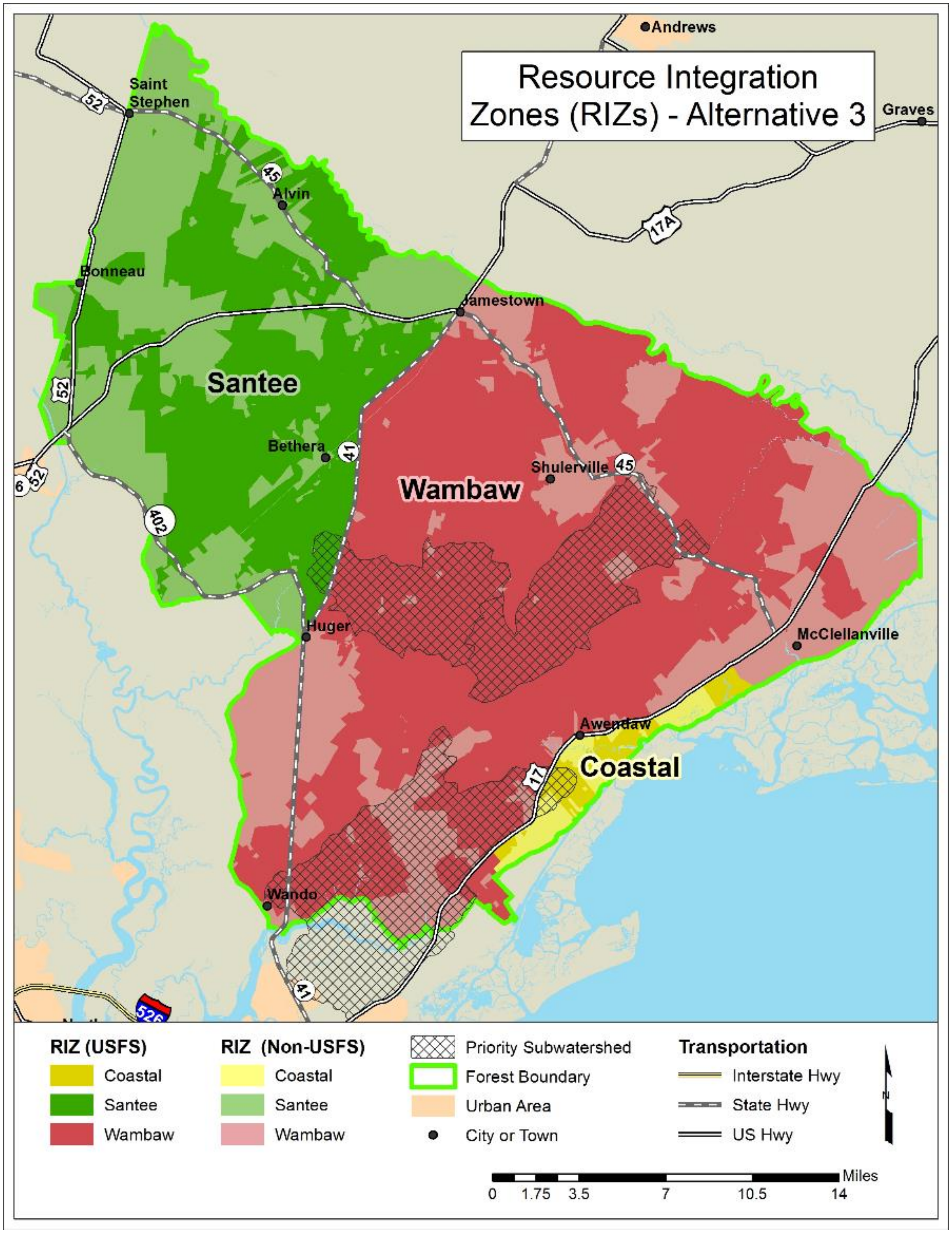

Figure 2-10. Alternative 3 resource integration zones

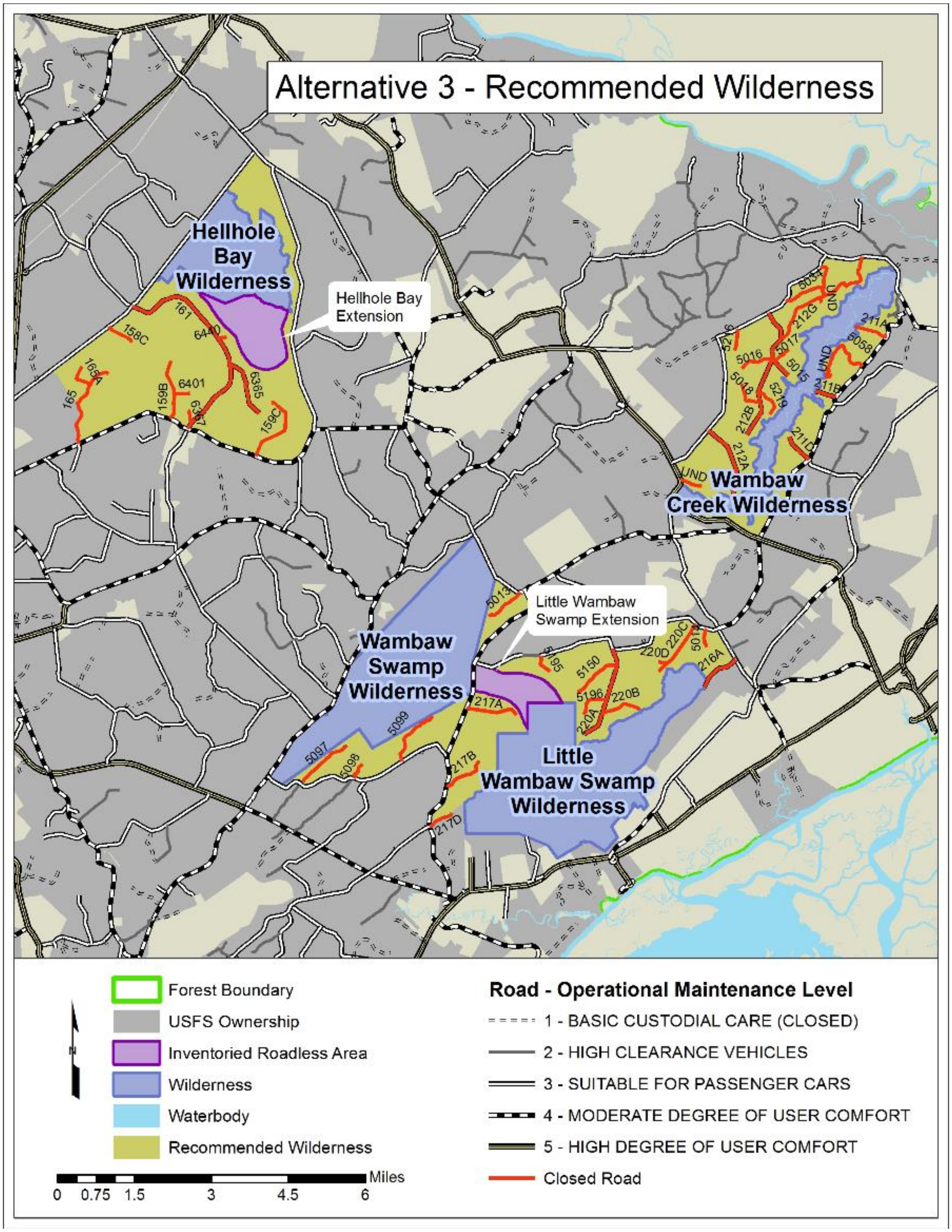

Figure 2-11. Recommended wildernesses in alternative 3

Table 2-2. Comparison of each alternative's response to the issues

Issue	Alternative 1 1996 Forest Plan	Alternative 2 Proposed Action	Alternative 3
Dormant Season Prescribed Burning (acres per decade)	260,000	195,000–325,000	167,000–280,000
Growing Season Prescribed Burning (acres per decade)	40,000	105,000–175,000	90,000–150,000
Upland Longleaf Ecosystem Acres Maintained or Restored (acres)	73.6% = 37,900	64.3% = 33,100	45.4% = 23,400
Wet Pine Savanna Ecosystem Acres Maintained or Restored (acres)	30% = 25,600	67% = 57,300	48% = 41,000
High Risk Prescribed Burn Areas (acres)	95,000	75,000	95,000
Fire Region Condition Class 2 and 3 (acres)	115,000	95,000	115,000
Priority Watersheds (number)	0	3	3
Loblolly Pine Converted to Longleaf Pine (acres)	4,500	26,200	18,000
Projected Timber Sale Quantity (MMCF per decade)	95	98	100
Wild and Scenic Rivers (number of eligible)	1	5	5
Proposed Historic Districts (number)	0	4	4
Management Areas 1 (acres)	N/A	156,256	110,015
Management Area 2 (acres)	N/A	103,160	149,400

Table 2-3. Acres suitable for timber production and estimated 10-year timber volumes sold for the different plan alternatives

Alternative	1	2	3
Land Classified as Suitable for Timber Production (acres)	184,343	193,483	176,875
Percent of Land Ownership Classified as Suitable for Timber Production	71%	75%	68%
	MMCF		
Sustained Yield Limit	113.8		
Projected Wood Sale Quantity, 1st decade	98.6	98.6	100.4
Projected Wood Sale Quantity, 5th decade	87.7	96.2	97.3

MMCF = Million cubic feet

Table 2-4. Projected wood sale quantity (PWSQ) for all products by decade (MCF/decade)

	Decade 1	Decade 2	Decade 3	Decade 4	Decade 5
Alternative 1	95,470	84,244	88,229	79,102	83,846
Alternative 2	98,643	95,439	78,887	78,735	96,187
Alternative 3	100,396	93,455	78,687	81,952	97,337

Table 2-5. Summary of proposed wilderness by alternative[1]

Area	Alternative 1	Alternative 2	Alternative 3
Wilderness	13,812	13,812	13,812
Wilderness Study Area	0	0	16,881
Inventoried Roadless Area	1,420	1,420	0
Semiprimitive, Motorized	0	11,139[1]	0

[1] This acreage included the inventoried roadless areas.

Note: GIS acres are approximate.

Table 2-6. Detailed recommendations by alternative

Existing Designated Area	Other Area Considered	Alternative 1	Alternative 2	Alternative 3
Wambaw Creek Wilderness		1,825	1,825	1,825
	Wilderness Study Area	0	0	5,747
	Semiprimitive Motorized	0	0	0
Total Wilderness or Wilderness Study Area		1,825	1,825	7,572
Wambaw Swamp Wilderness		4,815	4,815	4,815
	Wilderness Study Area	0	0	1,745[1]
	Semiprimitive Motorized	0	1,745[2]	0
Total Wilderness or Wilderness Study Area		4,815	4,815	6,560
Little Wambaw Swamp		5,047	5,047	5,047
Inventoried Roadless Area		530	530	0
	Wilderness Study Area	0	0	4,854[3]
	Semiprimitive Motorized	0	4,324	0
Total Wilderness or Wilderness Study Area		5,047	5,047	9,901
Hellhole Bay Wilderness		2,125	2,125	2,125
Inventoried Roadless Area		890	890	0
	Wilderness Study Area	0	0	4,535
	Semiprimitive Motorized	0	3,650	0
Total Wilderness or Wilderness Study Area		2,125	2,125	6,665
	Area A	0	0	0
	Area B	0	0	3,814[4]
Total Wilderness or Wilderness Study Area		0	0	3,814

[1] Wilderness study area boundaries were refined in some cases to improve manageability by reducing interface with private lands as well as open roads. Therefore, acres will not match inventory acres exactly.

[2] Semiprimitive motorized boundaries were refined to improve manageability by reducing interface with private lands as well as open roads. Therefore, acres will not match inventory acres exactly.

[3] Wilderness study area boundaries were refined to improve manageability by reducing interface with private lands as well as open roads. Therefore, acres will not match inventory acres exactly.

[4] Boundary of area B was refined to improve manageability with interface of private lands; acres changed accordingly. Therefore, acres will not match inventory acres exactly.

Note: GIS acres are approximate.

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Chapter 3. Affected Environment and Environmental Consequences

3.1 Introduction

Chapter 3 describes the existing environment of the Francis Marion National Forest followed by the environmental consequences from the three alternatives. This chapter is organized into four major sections broken down into subsections that focus on different resource areas.

3.2 Physical

3.2.1 Soils

3.2.1.1 Summary

In general, soils have not changed much since the forest plan was revised in 1996. There have been localized changes due to management activities that have disturbed the soil surface, but generally, changes in soil properties have been more static. Management activities most likely to affect the soil resource include timber harvesting, fire and related activities, herbicides, wildlife habitat improvements, recreation management, and road maintenance and construction. Other activities proposed in the alternatives would affect the soil resources minimally. Ground-disturbing activities from forest management practices have the greatest chance of affecting soil productivity through, rutting, compaction, soil displacement, erosion and removal of the organic surface.

Quantifying potential changes in soil productivity is dependent on site-specific data and project-specific variables. The scale of this forest plan makes it infeasible to quantify the impacts. However, impacts can be qualitatively described to indicate relative potential impacts on the soil resource. For all alternatives implementation of best management practices, forest plan standards and guidelines, along with proper mitigation measures and monitoring, would limit the long-term effects to soils.

3.2.1.2 Affected Environment

Soil is a collection of natural bodies that consists of organic matter, minerals and living organisms. It is capable of supporting a wide variety of biological, chemical and physical processes. Soil results from the weathering of parent material over extended periods of time. Physical components of soil include various sizes of a mineral component, organic matter, water and air.

The Francis Marion National Forest lies within the Sea Island section of the Atlantic Coastal Plain Physiographic Region. Soils of this region have formed in marine and fluvial sediments that were deposited during the Quaternary Period and are Pleistocene in age (SCDNR 2013). Within the Francis Marion, soils may encompass any given percentage of organic matter, sand, silt and clay, which may occur in various combinations and depths. Soil horizon development has been influenced by climate, living soil organisms and relief. Also, soils within the Francis Marion have been influenced over time by cultural alterations.

A second order soil survey was used to delineate and identify specific soil series and their boundaries within the Francis Marion National Forest. At this level, the minimum mapping unit

typically ranges from 2 to 8 acres, so local inclusions of other soil types within a mapping unit may be found. Currently, there are 77 map units identified on the Francis Marion (SSURGO 2013). Landforms in which these map units occur include ridges, marine terraces, Carolina Bays, swamps, pocosins (a type of wetland), depressions, flats, and floodplains. Elevations of these landforms range from less than 5 feet below to 81 feet above sea level. Drainage classes of these soils range from excessively well drained to very poorly drained (Figure 3-1).

Soil quality is defined as its ability to provide services important to people. It is useful as a measure because it indicates the extent to which a managed soil is improved or degraded from its natural state or some other selected reference condition (Burger et al. 2010). Although there is no data to compare soil function today to its function in a natural setting, overall soil quality within the Francis Marion National Forest is considered to be adequate. However, soil quality may be less than adequate for the current desired condition in some areas due to soil disturbance from past land management practices.

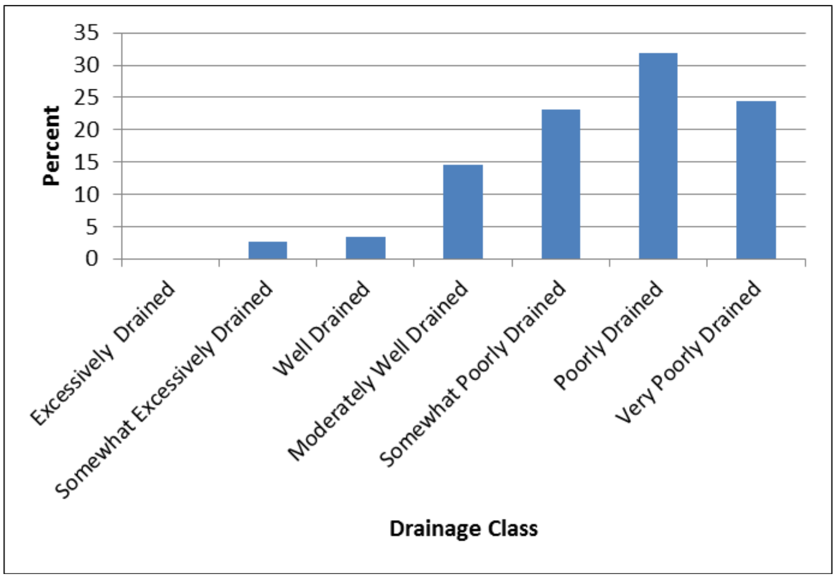


Figure 3-1. Drainage class distribution for soils within the Francis Marion National Forest

Past land management practices most likely altered soil hydrology more than any other soil attribute. Throughout the Francis Marion National Forest water tables are typically close to the surface and soils with restricted drainage are common (NRCS 2010a). Many areas with these characteristics show signs of skid roads, rutting, compaction, and soil displacement. These areas are the remnant effects of Hurricane Hugo salvage and other past operations that occurred when conditions were unsuited for the use of mechanical equipment. The portion of these areas that were compacted and rutted now hold water for extended periods of time. Changes to soils have been found to occur more frequently on hydric soil types, which comprise approximately 56 percent of the total land area of the Francis Marion National Forest. A large portion of hydric soils has had drainage modifications that include channelizing streams, drainage ditches, and forestry bedding.

Occasionally, during dry weather patterns, wildfires and some prescribed fires entered into areas that are normally wet and burned several inches of accumulated organic material. Depending on the degree of change, soils in those areas now function differently than before the fire and may

also be taxonomically different. These changes have not been regularly monitored or documented except in some instances where a wildfire damage assessment associated with a burned area emergency response report was completed. Overall, most soils are adequately fertile; however, the poorly drained soils have low fertility levels and hydrous oxides of iron and aluminum that restrict pine tree growth. Soils within the Francis Marion are stable with little erosion occurring across the area. Soils are intact and serve as a medium for root growth and soil organisms. Soil organisms are vital to decomposition and cycling of plant and animal materials in soils; however, the exact role of soil biological communities in maintaining soil quality is unclear (Levi 2007). The rapid carbon assessment done by the Natural Resources Conservation Service shows soil organic carbon stocks are considered to be between 1,001-1,200 milligrams per hectare to a depth of 100 centimeters (NRCS 2013). In forest soils, nutrient supply and biological activity are closely tied to organic matter and nutrient cycling processes, including rates of input, decomposition and mineralization, storage and release, or uptake. Protection of these processes from soil surface disturbances, displacement of soil organic matter layers and severe burns should maintain function in a given soil of a certain ecosystem.

3.2.1.3 Environmental Consequences

Soil productivity is most likely to be affected from ground-disturbing activities associated with forest management practices through rutting, compaction, soil displacement, erosion, and removal of the organic surface. Other activities proposed in the alternatives would affect the soil resources minimally and are not discussed in detail.

Rutting is the destruction of the soil structure caused by heavy equipment loading and indentation into the soil surface. During dry conditions, rutting is less frequent and occurs mostly in isolated moist areas, or on primary skid trails where repeated skidder traffic gradually compacts the soil into an indentation in the landscape. When soils are moist or wet, rutting can occur from a single pass of heavy equipment. Rutting may also change the native plant communities of an area, especially if natural regeneration methods are planned. Rutting is a highly visible impact of logging and can disrupt the normal hydrological flow of surface and subsurface water. In the normal implementation of forest management activities, heavy equipment operation would be suspended, when conditions are conducive to excessive rutting. During wet or saturated soil conditions, low-ground-pressure equipment, designated activity routes, or other soil protection measures such as mats, bridges, and woody fill would be used. This would limit the extent of rutting when management activities cannot be avoided. Mitigation of soil ruts would reduce long-term effects.

Compaction is the increase in soil bulk density due to an external force. Any activity requiring the use of heavy equipment can cause some degree of compaction, but excessive compaction is often related to certain soil types and moisture levels. Compaction can result in a change to soil chemical and physical properties. Compacted soils have altered structure, which results in a decrease of macro pore space and soil porosity. This reduces productivity by retarding root growth as well as air and water and nutrient transfer in the soil. When soils are moist or wet, highly compacted soil can be a significant problem, especially if natural regeneration methods are planned. Surface soil recovery from compaction is relatively rapid on sandy soils, but it may take decades to recover on soils with clay near the surface unless some form of mitigation is used. Periodic freezing, thawing and fertilization can increase the rate of recovery. In the normal implementation of forest management activities, heavy equipment operation would be suspended, when conditions are conducive to excessive compaction. During periods of high soil moisture levels, low-ground-pressure equipment, designated activity routes, or other soil protection measures such as mats, bridges, or woody fill would limit the extent of compaction when

management activities cannot be avoided. Conducting management activities only during periods of dry soil conditions would prevent or minimize the extent of compaction. Mitigation of soil compaction would reduce the long-term effects to soils affected by compaction.

Soil displacement is the movement of soil material from its original position on the landscape. Displacement typically is small, perhaps a few inches to a few yards, and it often has a vertical and horizontal component from the original location. Displacement can change the rich organic and mineral surface soil layer from one place to another through mechanical means (such as skidding of logs, blade construction of skid roads, fire line construction, landings, temporary and system roads, and ATV trails). This can also accelerate erosion and reduce nutrient supplies, which are all important to plant growth. Soil displacement, depending on the vertical extent, can locally disrupt the normal surface and subsurface hydrologic flow particularly in areas where the water table is close to the soil surface. Rehabilitation of areas where soil has been displaced would limit the extent of the effects and reduce the long-term effects.

When saturated soils reach their plastic limit, displacement occurs under the weight of heavy equipment. Excessive activity on saturated soils can also cause soil puddling, which is the breakdown of the soil structure bonds. This results in soil particle displacement and mixture with water. Puddled soils make a poor growing medium because the pore structure is broken, air permeability is limited, and the soils retain water for extended periods. When dry, puddled soils often develop deep cracks in the soil surface, making a very poor site for plant establishment and growth. Conducting management activities only during periods of dry soil conditions would prevent or minimize the occurrence of soil puddling. Mitigation would reduce the long-term effects.

Erosion is a natural process that dislodges and moves soil particles. Soil exposure can be a result of natural and human-induced conditions. Exposed surface soil particles move during events with external forces such as rainfall, stormflow, and wind. Forested soil is an excellent filtering mechanism that may absorb contaminants, preventing their entry into streams. However, when eroded, soil particles may include contaminants and may add to stream pollution upon delivery. Erosion that reaches the stream network is moved as a portion of the total dissolved solids or precipitates out temporarily to semi-permanently as sediment. Erosion can also precipitate out temporarily or semi-permanently as sediment. Erosion is generally not a concern on the Forest due to the flat terrain. Most erosion is found along roads and road ditches. Careful design, use of best management practices, and mitigation measures can reduce both erosion and sedimentation.

Removal of the organic soil surface can result in disruption to nutrient recycling in the soil and reduced nutrient availability for trees and other plants. Nutrient removal varies with the intensity of activities and degree to which those organic materials are removed. Removal of the surface materials can occur from mechanical operations but the greater extent occurs from fire. Prescribed burning could increase the potential for nutrient loss. Adverse effects from a single light-to-moderate burn would be minimal. Frequent burning (less than a 3-year return interval) can reduce soil organic matter, which subsequently reduces nitrogen mineralization and plant uptake. Return intervals greater than 3 years cause very little change to soil organic matter, and the prescribed burn would temporarily enhance plant nutrient availability and reduce soil acidity. Three-year prescribed burn intervals allow the litter-duff biota to recover between burns and result in minimal nutrient loss because nutrients are quickly immobilized through plant uptake and sorption to soil particle. Light and moderate burns do not heat soil enough to significantly affect soil biota. Litter biota would be reduced but should quickly recover. The risk of affecting the soil productivity is minimal unless sites are burned more often than every 3 years or the burn

results in high burn severity. Organic surface removal can also temporarily increase erosion potential and sedimentation.

The alterations just described affect the physical, chemical and biological processes within the soil. Most of these effects go unnoticed, unless a threshold is reached. The application of forest standards and guidelines as well as national and State best management practices would minimize the impacts on soil quality when implemented properly and in a timely manner. Productivity loss can typically be reclaimed with mitigation treatments, but at a cost. Sometimes it takes years or decades for recovery. With mitigation, impacts to soils would be limited and are not expected to exceed soil productivity thresholds for any alternative.

Vegetation Management

Timber Harvesting and Associated Actions

Vegetation management involves various types and intensities of ground-disturbing activities that can potentially affect the soil resource. Methods needed to maintain, manage or manipulate vegetation densities and types include timber harvesting, silviculture treatments, and prescribed fire.

Soil concerns associated with timber harvesting activities and other connected actions center around rutting, compaction, displacement and erosion, soil exposure and organic surface removal, which can lead to an overall loss in productivity. Soil structure can be altered where skid trails, temporary roads, and log landings are placed due to compaction from repeated traffic of heavy equipment. Recovery of these areas would be slowed unless proper mitigation measures are implemented. While subject to many variables, it is estimated that about 10 percent of a given area harvested by conventional logging equipment (such as rubber tired skidders and forwarders) would be impacted. The potential effects of soil erosion, sediment yield, rutting, and compaction have a spatial and temporal context. The amount produced depends upon the topographic, soil, and climatic characteristics of the affected area along with the intensity of management practices being implemented. Erosion that results from timber harvest would be greatly modified through time. Disturbance would be temporary and a single pulse over a long period of time. Research has repeatedly shown that sediment production during timber harvest may accelerate temporarily to about 0.05 to 0.50 tons per acre per year (Patric 1976, 1994). Soil disturbance and compaction during timber harvest vary depending upon both the type of soil and harvest method (Swank et al. 1989).

Studies indicate that nutrient loss from timber harvest can be comparable to nutrient inputs, resulting in no long-term reduction of the ecosystem’s productive potential (Kimmins 1977; Wells and Jorgensen 1978; Patric 1980; Grier et al. 1989). Nutrient losses from timber harvest were found to be small to negligible, with losses such a small fraction of total nutrient capital that site productivity should not be reduced (Sopper 1975). Nutrient loss would be minimal because the tops of the trees and their branches, which provide the majority of the available nutrients in a tree, would be left on site to provide some short-term nutrient recycling. Biomass removal in the form of timber harvest can result in nutrient deficits (mainly phosphorus). Nutrient depletion, however, is generally only a concern where soils are initially nutrient poor, where whole-tree harvest (total biomass removal) is used, or where stand rotations are short (on the order of 20 to 35 years; Jorgenson and Wells 1986).

Timber harvest practices occur at infrequent intervals and will generally maintain soil productivity with close attention to best management practices. Timber harvesting can increase the following: organic material in localized areas from tree limbs and tops, sunlight on the forest

floor, soil temperatures, and decomposition rates. Areas that are maintained as or converted into savannas or woodlands would increase sunlight to the forest floor. Soil temperatures and decompositions rates would increase, which would lead to a decrease in surface organic matter.

Fire

Fire's effects on soil properties and processes is quite varied and depends largely on fire intensity, fire severity, temperature, fuel type and amount, soil moisture, season, and other factors. Fire generally affects soil erodibility if mineral soil is exposed. Reports show little to no erosion after light to moderate intensity fires in the southeastern United States (Swift et al. 1993). However, burns with previous soil disturbance such as skidding of logs will increase the probability of soil erosion after burning (Swift et al. 1993). Effects to the organic layers and soil organisms depend greatly on heat penetration into the soil. Heat penetration depends upon duration of heating and soil moisture (Swift et al. 1993). Prescribed burn activities have the potential to increase the solubility of some cations in the forest floor, but would not diminish water quality (Knoepp et al. 2004).

In general, prescribed burns are designed to burn with less intensity with minimal effects to soil by removing vegetative cover and litter while protecting the duff and humus layers of the soil. In some cases, prescribed fire may result in a severe burn where all or nearly all of the litter, duff, and humus layers would be consumed and mineral soil exposed. Severe burning can affect the soil biota, structure, organic matter and fertility. Removal of the duff and humus layers can potentially lead to accelerated erosion and a disruption in the nutrient cycling. In contrast to high-severity burns, properly managed light and moderate severity burns generate acceptable or beneficial effects on soil. Light to moderate severity burns result in little to no detectable change in the amount of organic matter in surface soils. These burns do not change the structure of mineral soils because the elevated temperatures are of brief duration. Light to moderate severity burns generally do not expose large areas of bare soil; therefore, there is little chance of excessive erosion. Overall, published scientific studies have concluded that prescribed burns, implemented under managed or controlled conditions, have negligible effects on the physical, chemical and biological properties of soils and soil productivity (Ralston and Hatchell 1971; Johnson and Cole 1977; Kodama and Van Lear 1980; Richter, Ralston, and Harms 1982; Douglas and Van Lear 1982; Van Lear and Johnson 1983; Van Lear 1985; Van Lear et al. 1985; Van Lear and Danielovich 1988; Sanders and Van Lear 1988; Van Lear, Thomas, and Waldrop 1989; Van Lear and Kapeluch 1989).

Areas that are maintained as, or converted into, savannas or woodlands would lead to an increase in sunlight to the forest floor. Soil temperatures would increase as well as decomposition rates, which would lead to a decrease in surface organic matter. These areas would be burned on fairly frequent cycles. Burning coupled with timber harvesting would increase sunlight to the forest floor. Therefore, it would increase the densities of native plants and grasses in the understory. Once developed, native grasses have dense root networks that help to increase soil development, organic content and productivity. Native grasses would help provide erosion control.

Connected actions with prescribed fire include the potential need of bladed or plowed firelines. Blading or plowing firelines exposes the mineral soil by removing vegetation, leaf litter, and duff. Blading or plowing would increase the exposed area's susceptibility to soil erosion and displacement of nutrients and organic matter offsite. Firelines that are rehabilitated can recover quickly when they accumulate litter from a forest canopy or 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 best designed and maintained

on the landscape to provide for both long-term use and ability to control concentrated flow and erosion by employing relatively permanent erosion control measures when not used.

Herbicides

The use of herbicides for controlling vegetation competition and stand development can be beneficial to forest ecosystems, sustainability and water quality. It minimizes off-site soil loss, reduces on-site soil and organic matter displacement and prevents deterioration of soil physical properties (Neary and Michael 1996). Herbicide applications to control competing vegetation do not disturb the nutrient rich topsoil layer, create additional bare soil, or adversely affect watershed condition when used responsibly (Neary and Michael 1996). Soils on recently harvested sites treated with herbicides have higher moisture content due to the reduction of surface runoff and transpiration as compared to other mechanical site preparation methods. Soils are also better able to supply the nutrients needs for early growth of forest crops (Carter et al. 1984; Neary et al. 1990; Smethurst et al. 1993). Maxwell and Neary (1991) concluded that the impact of vegetation management techniques on erosion and sedimentation of water resources occurs in this order: herbicides, fire, and mechanical. They also concluded that sediment losses during inter-rotation vegetation management could be sharply reduced by using herbicides and moderate burning instead of mechanical methods and heavy burning.

Herbicides could affect soil productivity through biotic impacts, soil erosion, and nutrient leaching. Depending on the application rate and soil environment, herbicides can stimulate or inhibit soil organisms. Adverse effects can occur when herbicides are applied at higher rates than the label rate. Use of herbicides at the lowest effective rate required by mitigation measures does not reduce activity of soil biota (Fletcher and Friedman 1986).

Wildlife Habitat Improvements (Wildlife Fields or Openings)

A variety of treatments are used to manipulate vegetation to meet specific wildlife viability and habitat, as well as public hunting or observation activities. Areas where timber harvesting, silviculture treatments, and prescribed fire are used for wildlife management are covered in the previous sections. Effects covered under this section are for wildlife fields or openings.

For wildlife openings and linear wildlife strips, annual to periodic disking is common on some areas. Disking at regular intervals can cause excessive erosion and productivity losses. These adverse effects would remain at acceptable levels by limiting these activities to slopes less than 10 percent. Fertilization would be used to help maintain productivity. Additional measures such as no till, contour farming, or leave strips can be used to further reduce soil exposure or concentrated flow that contributes to erosion. Fewer disturbances, such as disking, would be needed in areas converted to native grasses; therefore the potential to impact the soil resources in those areas would be less.

Recreation Management

Trails

Recreation trails impact soil resources to various degrees depending on location, types of users, maintenance methods, maintenance rotation and amount of use. Findings include rutting, soil compaction, erosion, sedimentation, and loss of vegetation. Surface soil layers and vegetation would be removed in the tread path of new trails, which would increase the potential for erosion to occur within the trail tread. Erosion potential would be greater on sections located in steeper slopes, in areas with coarse or silty soil material, and in areas void of overstory vegetation. Trails should be designed so that the trail contours with the terrain; this would decrease erosion

potential. The trail tread degrades more rapidly if traveled when soil moisture levels are high. Silty and sandy soils are more erodible and rutting can become a problem if traveled while wet. Rutting over time can accelerate erosion by entrenching the trail and concentrating, water which would increase maintenance needs. The trail tread would also become compacted as use increases. Proper trail maintenance is essential to decrease the effects to the soil resource. Horses and off-highway vehicles (OHVs) would cause more soil compaction, rutting and displacement than hikers and bikers. Horse and OHV trails usually degrade more rapidly than hiking and biking trails.

Designated trails are trails planned and designed to minimize impacts by locating them on adequate grades with water diversion structures, proper slopes, and stable soils. They are maintained to minimize entrenchment, erosion and off-site soil movement. Soil compaction, displacement, failure, rutting, and erosion would be minimized by properly designed designated trails.

User-created trails have more potential for erosion and sediment entering the stream because of their location; they also lack design and maintenance. As a result, they are periodically eroded during storm and flood events and become more entrenched over time, as well as more efficient at eroding and delivering sediment. Therefore, soil compaction, displacement, rutting, and erosion would be more likely if user-created trails are allowed to continue.

Recreation Areas

Because developed areas are designed to limit effects to resources within a certain level of use they would have minimal effects on the soil resource. Most impacts would occur during construction.

Dispersed recreation areas would impact soil resources. Concerns with dispersed campsites are associated with the number of sites, and their lack of design and maintenance. In addition, most times they are in close proximity to surface water. Dispersed areas within riparian areas would be more likely to erode during storm events or periods of flooding.

When combined with erosion, soil disturbance and compaction expose vegetation roots, which leaves them susceptible to damage. This leads to vegetation die-back or decline, as well as site expansion over time. Campers prefer to stay off the eroded portion of a site and camp in areas with some ground cover and vegetation. As sites deteriorate, they become less attractive for use. As a result, the potential for other newly created sites increases. As existing or deteriorated areas are abandoned, erosion would continue if mitigation measures are not used. With some extended periods of non-use, some sites might be rehabilitated or restored to levels that they could be re-used for a period of time. Overall, the disturbance from these activities can reduce soil productivity locally. However, these effects are generally limited in extent.

Roads

Roads expose and compact soils, concentrate runoff and alter surface and subsurface water flow patterns. Open roads contribute higher erosion and sedimentation rates due to ongoing maintenance activities.

Road maintenance operations such as blading the road surface and pulling the ditches can lead to increases in soil erosion and increases in sediment production. During road maintenance activities, soil may be displaced and exposed. However, mitigation measures designed to stabilize the road surface would reduce adverse effects. For example, adding aggregate surfacing would

reduce adverse effects by armoring the soil or limiting distance and amount of concentrated flow by installing water diversion devices (dips, reverse grades, outslopes, leadoff ditches, culverts). The detachment and distance that soil particles move would be reduced by limiting water concentration and movement on disturbed surfaces or fill materials.

Some soil types are better suited for road building. Proper location of roads would reduce the risk of road failure. Following forest plan road standards and guidelines would reduce effects on the soil resource.

Decommissioning roads allows the soil building process to begin on the road surface. As soils develop, vegetation growth is enhanced. This process allows decommissioned roads to recover to a more natural state over time.

All Alternatives

All alternatives provide balanced resource management which favors prescribed fire and selective methods of herbicide, plus mechanical methods that cause low to moderate soil disturbances. Most of soil productivity losses are generally associated with areas having greater soil disturbance such as firelines, trails, roads, landings, primary skid trails, and temporary roads. The smaller the percent of area attributed to highly disturbing activities, the less impacts (compaction and erosion) there will be to the site. Trails, roads, and firelines are reused more frequently.

Quantifying potential changes in soil compaction, nutrient loss, soil erosion, soil biota loss, and reduced water infiltration is dependent on site-specific data and project-specific variables. The scale of this forest plan makes it infeasible to quantify the impacts. However, impacts can be qualitatively described to indicate relative potential impacts on the soil resource. Prescribed burning and other treatments to reduce fuel buildup by alternative is displayed in Table 3-1. The acres of annual timber harvest by alternative are shown in Table 3-2. Comparing the frequency and intensity of proposed management activities best illustrates likely effects to long-term soil productivity.

Table 3-1. Comparison of activities to reduce hazardous fuels and to restore ecosystems across all alternatives

Activities	Alternative 1	Alternative 2	Alternative 3
Prescribed Burning in growing season (acres)	40,000	105,000–175,000	90,000–150,000
Prescribed Burning in dormant season (acres)	260,000	195,000–325,000	167,000–280,000
Firelines Refurbished (Maintained) (miles)	98	140	140
Firelines Constructed (miles)	74	40	25
Mid-Story Control (mastication/herbicide/grazing) (acres)	0	10,000	12,500

Table 3-2. Acres of timber harvesting and associated treatments across all alternatives

	Alternative 1	Alternative 2	Alternative 3
Thins	43,299	17,864	27,506
EAM – Regeneration*	10,007	28,257	23,631
UEAM – Regeneration	0	94	86
Harvest Total	53,306	46,215	51,223
Site Preparation, herbicide	4,457	22,757	19,797
Site Preparation, mechanical	937	4,562	3,964

Note: EAM=even-aged management; UEAM=uneven-aged management.

Generally, long rotations, with less frequent harvest entries, are more favorable in terms of maintaining long-term soil productivity. All alternatives have long silvicultural rotations that are needed to provide mature pine forest for red-cockaded woodpeckers. Direct and indirect impacts from vegetation management activities in alternatives 2 and 3 are similar; alternative 2 proposes more prescribed burning near communities, while alternative 3 relies on mechanical treatments.

Forest standards have been developed to ensure that herbicides would be applied correctly, would pose no greater than a minimal risk to soils and soils biota, and would not accidentally contaminate surface waters. Herbicides that are carefully directed and foliar sprayed during late spring to summer (at the minimum recommended application rate) should result in no detrimental effects to long-term soil productivity or impacts to water quality. With these forest standards in place, all alternatives show acceptably low risk with respect to potential herbicide use.

Implementation of the forest plan standards and guidelines, best management practices, and proper mitigation measures, would result in minimal soil effects for alternatives 2 and 3. The cumulative effects of all management actions over time are not expected to reduce soil productivity. Mitigation measures for past, present, and reasonably foreseeable management activities (timber harvesting, site preparation, and prescribed burning) are designed to keep the litter layer in place, or to replace the litter layer on exposed soils by seeding and fertilization. Therefore, impacts associated with any one treatment would be completely recovered within 3 years. Upon completion of these treatments, timber harvesting activities would not occur in this analysis area for about 20 to 30 years, thus providing more than adequate time for the soil to recover. An exception to this could be an insect outbreak or other salvage events.

Cumulative Effects

Effects to soils generally occur because of ground-disturbing activities. Cumulative effects from past and present activities generally result in a localized loss in soil productivity due to compaction, rutting, soil displacement, erosion, and the soil nutrient status. Most soil productivity losses are generally associated with areas with greater soil disturbance such as firelines, trails, roads, landings, primary skid trails, temporary roads, and actively cultivated openings. Most soil effects occur on site or on areas close by. Therefore, the effects concentrate on what is happening to the soils on the national forest and immediately adjacent areas and not at landscape or watershed scales.

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 are expected to be minimal for the majority of harvested areas. Areas that are repeatedly used for logging decks and skid trails in stands that have more frequent entries have the potential to suffer more continuous periods of decreased soil productivity and

decreased water infiltration. Although rehabilitation of these sites decreases the duration of the recovery period for soils and lessens the potential for cumulative degradation of soil conditions, the reopening and use of these areas during successive harvest operations generally results in some decreased soil quality on these sites. Areas having temporary productivity losses would be dispersed across timber harvests and would be a small fraction of the overall area. Coarse sandy soils show limited effects from compaction. Clay soils tend to hold water and displace rather than compact. However, silt-dominated soils tend to be affected the most. 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, and other factors. Effects from compaction can be expected to linger for decades if treatments are not employed to mitigate compaction.

Cumulative impacts on soil productivity is relative to organic surface removal, compaction, displacement, and subsequent erosion from past prescribed burning and connected actions. These types of impacts are minimal for the majority of areas. Soil will recover over time depending on burn severity. Severely burned areas may lose productivity in the short term. Areas with burning, coupled with harvesting, would increase sunlight to the forest floor; therefore, surface organic matter would decrease. However, maintaining an open canopy for a period of time would increase the native grass density on the forest floor, which would increase subsurface organic matter and improve soil productivity.

For roads and rights-of-way, activities would be performed to ensure public safety and to prevent degradation of infrastructure and the environment. Road maintenance operations such as blading the road surface and pulling the ditches can lead to increases in soil erosion and increases in sediment production. However, these operations may be combined with structural improvements and improvements to drainage structures which reduce soil erosion and sediment production from the road surfaces over the long term.

Disking wildlife openings at regular intervals can cause excessive erosion and productivity loss. Limiting these activities to lesser slopes, vegetating, and fertilizing would keep these adverse effects at acceptable levels. These activities would be dispersed throughout the forest and effects would be localized.

Activities that are combined with others, especially when conducted frequently, need careful evaluation and attention to sensitive soil types. These complex combinations can reduce productivity and may go unnoticed unless specifically evaluated. Potential productivity losses can normally be mitigated or minimized if calculations of erosion or nutrient loss indicate that further testing is necessary.

Cumulatively, environmental consequences to soils from past, present, and foreseeable actions would be minimized for all alternatives through the use of best management practices, proper mitigation measures, careful planning, design, implementation and monitoring. Most adverse impacts would be low to moderate. Overall, the cumulative effects of all management actions over time are not expected to reduce soil productivity.

3.2.2 Geology and Groundwater

3.2.2.1 Affected Environment

The Francis Marion National Forest lies within South Carolina’s Coastal Plain, the surface of which consists of unconsolidated marine and fluvial sand and clay deposited during the

Quaternary Period. Elevations on the Francis Marion range from 5 below to 81 feet above sea level. The surface of the exposed Coastal Plain below 100 feet in elevation is characterized mainly by marine features, such as shorelines, bars, and spits that formed during older warm interglacial periods when sea levels were higher than today (Doar 2014). Today, landforms include ridges and marine terraces (see Figure 3-2), as well as many younger features such as Carolina bays, swamps, pocosins, depressions, flats and floodplains.

Geology is the overarching, multiple-component foundation of the Francis Marion National Forest's ecosystems. Geologic processes (such as sea level changes, near shore processes, river processes, flooding, erosion, sedimentation, soil formation, groundwater movement, earthquakes, climate change) act on geologic materials (sand, silt, clay, and rock) and produce a variety of landforms (such as Carolina bays, pocosins, floodplains, and marine terraces). The geologic conditions control or influence a host of ecological factors, such as slope aspect (solar radiation); slope gradient; the distribution and composition of soil parent material and associated vegetation; the characteristics of floodplains, wetlands, riparian areas, and streams; the quantity and quality of surface water and groundwater; natural disturbance regimes; and the nature and condition of watersheds. The geologic processes are active today and are ecosystem drivers that need to be understood to manage ecosystems. Geological diversity is the foundation for biological diversity, and a basis for the ecological systems classification on the Francis Marion (Simon and Hayden 2013, 2014; Doar 2013).

Generalized geology for Berkeley and Charleston Counties includes three broad formations: sand, clay, and shell (Johnson 1964):

- Along the Atlantic coast, sand, clay, and shell are relatively younger deposits that form Silver Bluff. Within this zone, estuaries and wetlands provide habitat for wildlife species. As rivers meet the sea at the coast, they deposit silts in estuaries that mingle with the saltier ocean water to provide an environment abundant in nutrients capable of supporting large amounts of sea life and waterfowl (Murphy 1995). On the northeastern edge of the Francis Marion is the Santee River Delta, which provides habitat for hundreds of wildlife species, including the northern extent of the swallow-tailed kite.
- Inland from the coastal zone to the western national forest boundary are repeating packages of unconsolidated sand and clay that compose the shallow-lying Pleistocene-age geologic deposits. Moving westward these are the Princess Anne, Pamlico, Ten Mile Hill, Ladson, Penholoway, and Wicomico formations (Doar and Kendall 2014). These formations are a thin cover for the Eocene-age Santee Formation (Santee Limestone) in the northern part of the property along the Santee River. As seas transgressed and regressed, deposits of limestone made on the continental shelf created the Santee Formation. It is nearly pure white to creamy-yellow fossiliferous and partly glauconitic limestone and lime sediment.
- To the south phosphate-rich Oligocene and Miocene-age deposits are found overlying the Santee Formation and underlying the Pleistocene formations.

The Francis Marion National Forest also has organic sediments (peat, muck and peaty or mucky clays or sands) that warrant special attention because of their ecological value, paleoecological research value, and their vulnerability to loss such as to severe fire (especially when over-drained). Forest plan direction provides special attention to the Carolina Bays, Pocosins, and wetlands.

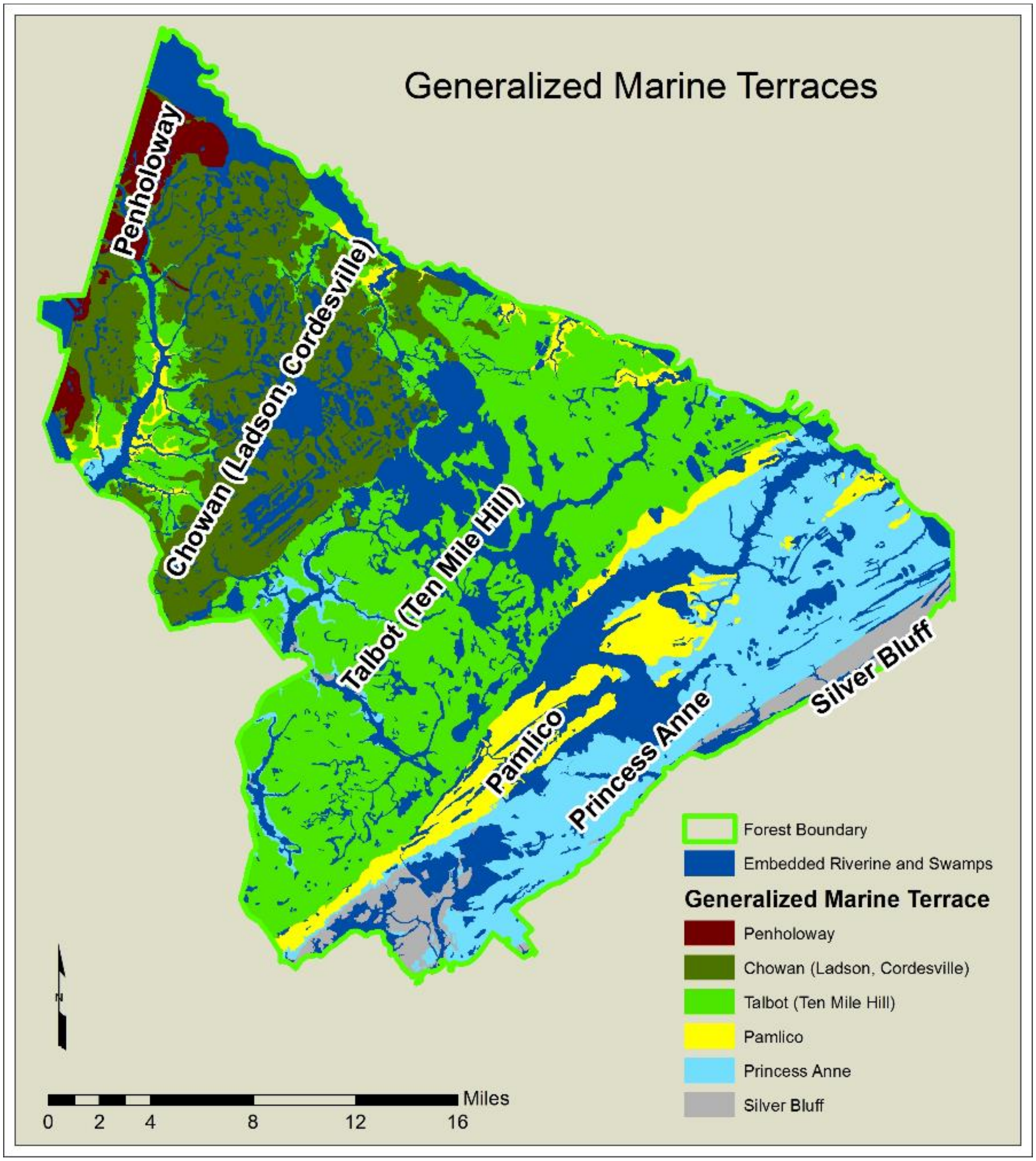


Figure 3-2. Generalized marine terraces on the Francis Marion National Forest
Source: Hansen, Maceyka, and Doar (2014) based on Willoughby and Doar (2006)

Groundwater

Groundwater in the coastal plain is stored in permeable rock and sediment (called aquifers) that are made up of sand and limestone. Most of the groundwater resources of the lower coastal plain consist of moderate to large quantities of freshwater, but some coastal areas are subject to brackish water encroachment. The deepest major aquifers beneath the Francis Marion National Forest may be isolated hydraulically from the surface environment, but the shallow aquifers are connected hydraulically to the surface environment.

The Francis Marion National Forest is dominated by high-water-table forests and wetlands and thus is especially vulnerable ecologically to even very minor lowering of the water table (Stone 2015). It is also susceptible to fire, at least so far as the peaty wetlands are concerned (for example, Wambaw Swamp and Hell Hole Swamp). Many areas of the Francis Marion with wetlands and topographic depressions also serve as recharge areas for groundwater. Groundwater dependent ecosystems are affected by small to moderate changes in the water table whether due to natural fluctuations or human-induced fluctuations from activities on or off the national forest. The connections among geology, paleoecology, water tables, and ecosystems are highly complex. Understanding these connections is critical to achieving desired conditions described in the forest plan.

The Francis Marion National Forest has water wells (groundwater withdrawals) for Forest Service administrative use and recreation facilities. Groundwater withdrawals also occur under State permit in areas near the national forest. Berkeley and Charleston Counties, where the Francis Marion is located, are in the groundwater capacity use areas designated and administered by the South Carolina Department of Health and Environmental Control.

Limestone formations have enough interconnected voids to allow groundwater to pass through readily. The Santee Limestone is part of the northern end of the multi-state Floridian aquifer system and is a major groundwater aquifer in coastal South Carolina for industrial, agricultural and public purposes (Hockensmith 2009).

The limestone in the northern part of the Francis Marion National Forest can produce karst features such as sinkholes and springs. The Honey Hill lime sinks in the Guilliard Lake Research Natural Area show pronounced karstic solution holes. The recent availability of LIDAR (light detection and ranging) imagery provides a much needed tool to identify sinkholes in the national forest’s coastal plain subdued topography. Sinkholes, including infilled sinkholes, store much paleoenvironmental evidence, including paleoclimatic information. Initial investigation of a representative few could help reinforce recognition of their importance. In addition to Honey Hill Lime Sinks, there are other sinks elsewhere in the Francis Marion National Forest. Not all are as clearly visible as at Honey Hill, where high-slope uppermost walls can protrude noticeably above the level sediment and where surface water may be conspicuous most of the year. Lime sinks (that are just as valuable elsewhere) can have infilled peaty sediment nearly to the level of the surrounding forest and thus appear similar to the common shallow sand-bottomed cypress "ponds" of far-lesser paleoenvironmental significance (Stone 2015).

Additionally, a field survey in May 2010 suggests that the area likely has karst features. The survey was conducted on the Francis Marion with four other pilot national forest sites for field training for a level I and II inventory of groundwater dependent ecosystems. A large spring called Blue Spring on the Francis Marion was reported by Hansen (2010; see Figure 3-3). Wider-spread karst may be further supported by the fact that Santee Limestone is blanketed by the Upper Duplin Formation, a combination of clay and quartz pebble beds with sinkholes scattered among

the modern alluvium and swamp deposits throughout the region (Willoughby, 2002). There are no known caves on the Francis Marion National Forest. The potential areas for karst features such as sinkholes, caves, and springs on the north part of the Francis Marion are shown in the Geologic Hazards map (see Figure 3-5) and the Mineral Resources map (see Figure 3-41).

Figure 3-3. Blue Spring (May 2010)

South Carolina depends on a healthy water supply from surface and groundwater. Approximately 482,000 people live in Berkeley and Charleston Counties and the population is growing. Most public supply water uses are from surface water; 334,000 and 81,000 are served from groundwater sources in Berkeley and Charleston Counties, respectively. The South Carolina Department of Natural Resources water assessment (2009) indicated that availability of ground water in the Coastal Plain greatly exceeds the availability found in the Blue Ridge and Piedmont. Six major aquifers are contained in a clay, sand, and limestone wedge that thicken from a featheredge at the fall line to 4,000 feet at the southern end of the state. Well yields are adequate to abundant for supplying domestic and light commercial uses nearly everywhere.

Regulating groundwater and surface water was identified as the most important recommendation in the South Carolina Water Plan (Badr et al. 2004). Surface and groundwater have no limit on water withdrawals and groundwater withdrawals are only regulated in coastal areas.

A number of groundwater withdrawal stations under State permit are located near but not on national forest land. Table 3-3 shows the withdrawal by site numbers, stations, and period of years for the withdrawals. Figure 3-4 provides a map showing the withdrawal sites.

Table 3-3. Groundwater withdrawal stations under State permit near, but not on Francis Marion National Forest

Site number	Station	Years of Withdrawal
08PH001G01	Santee Hydro	1983-2014
10GC013G01	Mount Pleasant	2008-2014
08WS003G08	Monks Corner	1987-2014
08IN002G01	St. Stephens	1984-2014
08IN007G01	St. Stephens	1983-2014
08IN007G02	St Stephens	1983-2014
08IN007G03	St Stephens	2003-2014
08WS006G01	Jamestown	2001-2014
08WS006G02	Jamestown	2001-2014

There are currently 19 wells on the official system within the Francis Marion National Forest administrative boundary. Five of these are not being used at this time and are currently considered excess. Four wells are inactive at this time. Ten wells are actively being used. There are five administrative wells on the Francis Marion that currently supply water to recreational facilities. There are two wells used at the Tibwin Plantation site. There is one flowing (artesian) well available for public and emergency use. The Forest Service administrative sites with current use wells include the seed orchard, helibase, and work center. There are two recreational facilities and one district office served by municipal water sources that come from sources outside the Forest. The water quantities needed for consumptive drinking and associated water uses are not currently available at this time.

There are no known municipal watersheds on the Francis Marion. A minimum of 500 feet is required adjacent to source water protection areas including wells for the Wambaw and Witherbee work centers.

One of the most significant changes in water use during the last two decades has been the conversion from groundwater sources to surface-water sources by many Coastal Plain communities. This trend is expected to continue, which will reduce groundwater withdrawals. In the future, the Francis Marion needs sufficient water to maintain, conserve, and protect resources, and support administrative responsibilities. Water supply has not been evaluated as an issue because current supplies are adequate.

Geologic Hazards

Geologic hazards are geologic processes or conditions (naturally occurring or altered by humans) that are a potential risk to public health and safety, infrastructure, and resources. Potential geologic hazards on the Francis Marion include floods, earthquakes, sinkholes, groundwater contamination, liquefaction, sea level rise, and land subsidence due to groundwater withdrawal.

With much of the Francis Marion containing floodplains, wetlands, and saturated soils, many areas in the national forest are susceptible to flooding. The October 2015 rainstorms caused historic flash flooding across North and South Carolina. The Francis Marion has a long history of flood events. Flooding is part of the natural disturbance regime of the coastal plain ecosystems.

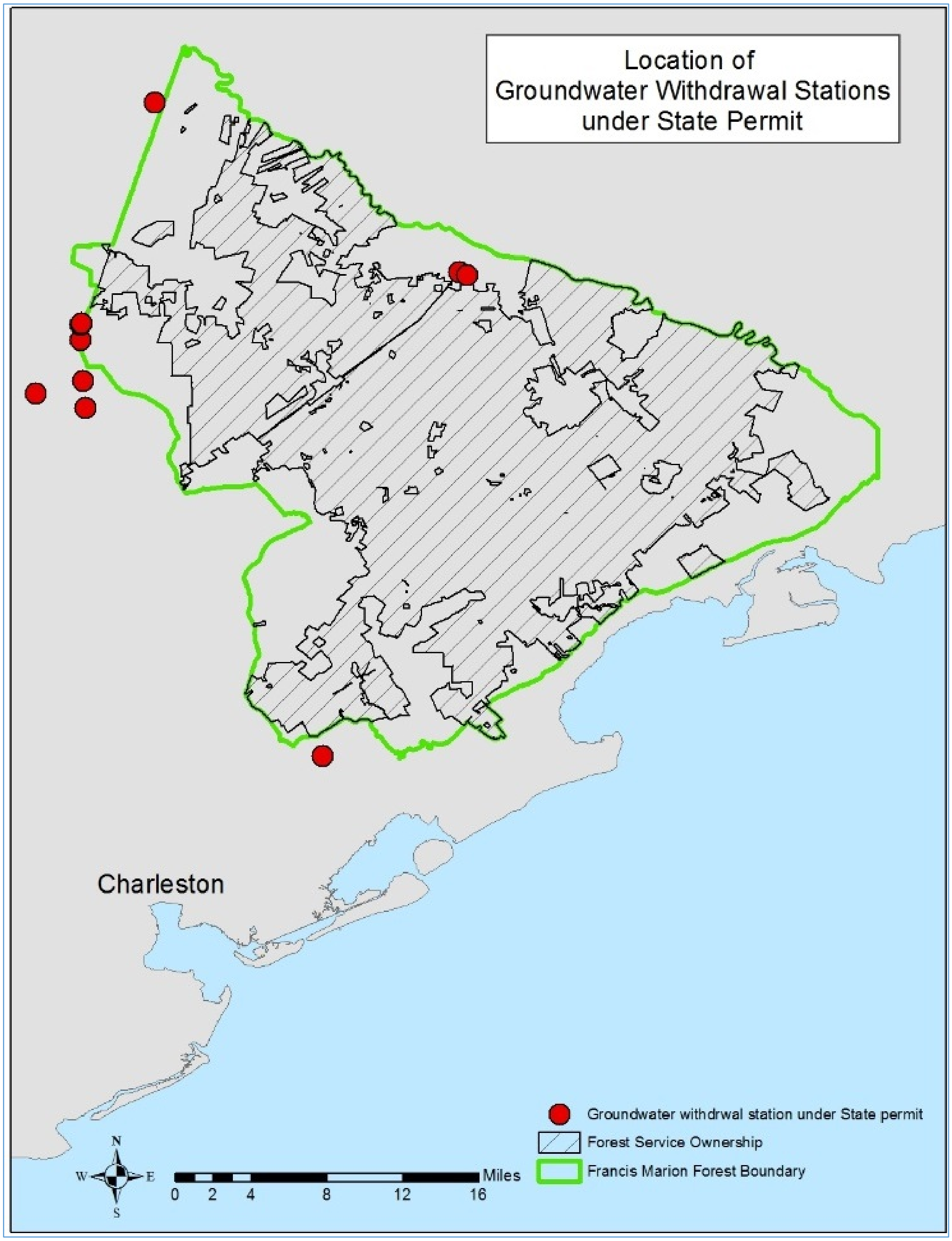


Figure 3-4. Groundwater withdrawal stations under State permit near, but not on the Francis Marion National Forest

The Francis Marion National Forest is in one of the most seismically active zones in the eastern United States. According to the U.S. Geological Survey, the historic 1886 Charleston earthquake is the most damaging earthquake to occur in the Southeast United States and one of the largest historic shocks in eastern North America. "It damaged or destroyed many buildings in the old city of Charleston and killed 60 people . . . Structural damage was reported several hundred kilometers from Charleston (including central Alabama, central Ohio, eastern Kentucky, southern Virginia, and western West Virginia) . . . Effects in the epicentral region included about 80 kilometers of severely damaged railroad track and more than 1,300 square kilometers of extensive cratering and fissuring . . . The formation of sand craterlets and the ejection of sand were widespread in the epicentral area, but surface faulting was not observed" (Stover and Coffman 1993). The seismicity (occurrence or frequency of earthquakes) clusters around the cities of Summerville and Bowman and is known as the Middleton Place-Summerville Seismic Zone (SCDNR 2013). Potential secondary effects of an earthquake include landslides, soil liquefaction, sand blows, and fire (SCDNR 2012):

- The potential for natural landslides is low on the Francis Marion due to the flat topography; however, the potential for human-induced landslides is moderate to high in excavated areas such as borrow pits and dredging areas, especially in unconsolidated deposits such as sand. In addition to earthquakes, excavation (borrow pits, quarries, and dredged slopes) can be another cause for slumps and earth flows, including liquefaction type failures.
- Potential liquefaction areas on the Francis Marion National Forest are noted on the geologic hazard map (see Figure 3-5). This risk of soil liquefaction varies with the magnitude and epicenter of the earthquake. Soil liquefaction primarily affects facilities, such as roads, pipelines, railroad, bridges, and buildings.
- The movement from earthquakes can rupture gasoline and natural gas pipes or damage electrical lines, which can cause fire and groundwater pollution. Where a fire may occur cannot be predicted, but management activities to reduce hazardous fuel buildup can reduce wildfire intensity and spread.
- In limestone areas, rapid changes in groundwater levels—whether from natural processes such as earthquakes or from mining and construction dewatering or groundwater pumping—can cause the sudden or slow local collapse of the ground, forming sinkholes. This is not unusual and has occurred in several areas outside the Francis Marion in recent decades. In addition, older sinkholes within the Francis Marion indicate that sinkholes can occur on the Forest also. The geologic hazards map (Figure 3-5) and the mineral resources map (Figure 3-41) show the limestone (carbonate bedrock) areas susceptible to karst ground collapse.

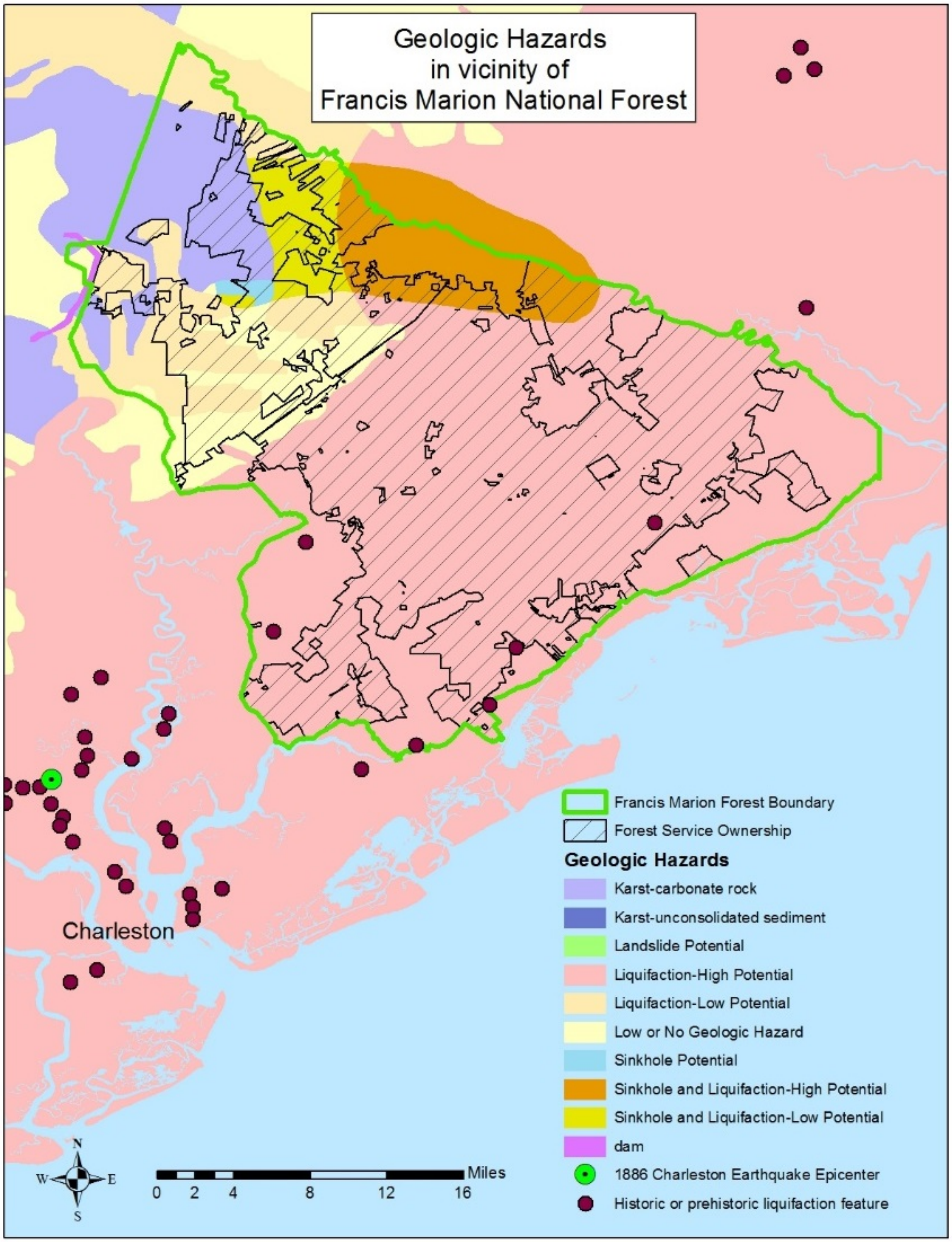


Figure 3-5. Geologic hazards on the Francis Marion National Forest
Note: Data modified from South Carolina Geological Survey (SCNDR 2012).

Paleontological Resources

Sedimentary units ranging in age from late Precambrian age to Quaternary have the potential to contain paleontological resources. All Francis Marion rocks and sediments are much younger than Precambrian and thus may contain fossils. Notable fossils from the Santee Formation are *Ostrea sellaformis*, *Ostrea carolinensis* (first collected from the old Santee Canal) and *Protoscutlla conradi*. Many of the species that produced Pleistocene fossils are extant and can be found in modern deposits on beaches today. Several examples of these are *Oliva sayana* (lettered olive) large *Mercenaria mercenaria* and *Mercenaria campechiensis* (northern and southern quahog), and various echinoderms (sand dollar, sea urchin, and sea biscuit).

Due to the area's geological history, the chance exists for pockets of preserved Oligocene and Miocene fossils on top of the Santee Formation and beneath the Pleistocene deposits. If these deposits exist, the notable fossils would be teeth from various species of shark.

The Francis Marion National Forest has scattered postglacial freshwater sediment deposits that are already known or strongly suspected to contain microfossil records that can reveal the nature of past environments, including the development and fluctuations (from changing fire regimes) of the modern pinewoods-and-wetland vegetational mosaic.

While the Francis Marion has known potential for paleontological resources, the discovery and inventory of paleontological resources is hampered by a scarcity of natural exposures of the subsurface or fossil beds. First, the Francis Marion is a relatively flat coastal plain that lacks the topographic relief to expose the subsurface, with few exceptions such as along a river bank. Secondly, the Francis Marion has a surface cover of dense vegetation and wetlands which hamper finding paleontological resources on the surface, let alone in the subsurface. Thus, excavations such as borrow pits and ditches provide opportunities to discover and inventory paleontological resources.

In 2009 Congress passed the Paleontological Resources Preservation Act (Public Law 111-11). In 2015, the Forest Service established regulation to implement the Act (36 CFR Parts 214, 261, and 291). The Act provides for the management of paleontological resources and encourages the scientific, educational, and where appropriate, the casual collection of these resources.

3.2.2.2 Environmental Consequences

Groundwater in the Coastal Plain

Potential impacts to groundwater include: (1) groundwater withdrawals, (2) dewatering of groundwater dependent ecosystems, (3) land subsidence, and (4) potential contamination of groundwater.

All alternatives would continue existing groundwater withdrawals for Forest Service use (administrative and recreation facilities). Groundwater withdrawals for Forest Service use are relatively modest compared with groundwater withdrawals under State permit near the Francis Marion National Forest for major water users. Because of increased demand for water supplies from the growing and urbanizing coastal plain, the Francis Marion may receive requests for a Forest Service special use permit for substantial withdrawals. The request for withdrawal would also require a State permit under groundwater capacity use areas designated and administered by the South Carolina Department of Health and Environmental Control. All alternatives have the potential for consideration and approval or disapproval of requests for special use permits for groundwater withdrawals for use outside the national forest. If a special use permit for

groundwater withdrawals were approved, a potential effect would be a lowering of groundwater levels and reduction of groundwater supply in aquifers. The magnitude of the effect and the duration (short term and long term) would depend on the quantities withdrawn, years of withdrawal, aquifer depth, and geologic nature of the aquifer and recharge.

All alternatives would have the potential of dewatering of a groundwater dependent ecosystem if a mine or quarry were to be excavated near a groundwater dependent ecosystem or if special use permits for substantial groundwater withdrawals for use outside the national forest were approved. Such effects include not only dewatering but also any substantial reductions in groundwater sufficient to adversely affect the groundwater dependent ecosystem. The deepest major aquifers beneath the Francis Marion National Forest may be isolated hydraulically from the surface environment so that they might be pumped safely and even heavily without harm to the surface environment. However, it is the shallower aquifers that will be more coveted due to their lesser salt content (and possible other constituents, like dissolved boron that can harm lawn and golf course grasses). The Forest is dominated by high-water table forests and wetlands, and thus is especially vulnerable ecologically to even very minor lowering of the water table. It is also susceptible to fire, at least in the peaty wetlands (for example, Wambaw Swamp and Hell Hole Swamp).

All alternatives (to the extent special use permits for substantial groundwater withdrawals for use outside the national forest might be approved) would have the potential for pumping-induced aquifer compression, ground-surface subsidence, and pumping-induced salt water encroachment. In such a case, the heavy pumping of the aquifer could cause the surface environment to become wetter by becoming physically lower. Such potential effects may takes decades to develop and become noticeable.

Threats to groundwater include toxic pollutants and overuse. For example, agricultural runoff, industrial and urban sewage, and leaking underground storage tanks are among the many potential sources that threaten the purity of underground water reserves. Once polluted, these aquifers are difficult, if not impossible to clean. The South Carolina Department of Natural Resources Water Resource Program monitors the state’s water supply. Water can be pumped out of underground aquifers quickly, but it can take may many years to replenish them.

None of the forest management activities proposed in alternatives 1, 2, and 3 would include toxic pollutants or overuse of groundwater. No direct or indirect impacts to groundwater are anticipated.

Sinkholes in karst areas are a special concern because pollutants entering sinkholes have a direct path to groundwater. If conducted in areas that drain into sinkholes, some Forest Service operations have the potential to contaminate groundwater; for example, spraying to control plants or insects, or accidental oil leaks from vehicles and machinery conducting operations. The areas where sinkholes may be present (limestone – carbonate rock) are identified on geologic maps such as the geologic hazards map (Figure 3-5) and the mineral resources map (Figure 3-41). As part of project-specific environmental analysis, projects would be screened with a geologic map and LIDAR imagery for karst formations, and in karst areas, a field inventory for the presence of sinkholes. Operations would avoid sinkholes in alternatives 1, 2, and 3, and no direct or indirect impacts to groundwater are anticipated.

Previous discussions indicated that groundwater withdrawals have resulted in a drop in water tables. South Carolina lists the regulation of groundwater as a top priority, given the demands on water, and effects of droughts. Additionally, predicted population growth will create greater

demand (Badr et al. 2004). Vegetation management activities under all alternatives should not have a measureable effect on groundwater. Forests serve as recharge areas, especially in depressions, riparian areas and wetlands. Current and future land disturbance caused by timber sales, road construction, recreation, and other planned actions should not have direct, indirect, or cumulative impacts on groundwater. Water withdrawals on non-federal lands near the Francis Marion may impact groundwater on the Francis Marion. Groundwater effects are a concern on private land due to population growth and increased demand for water. Wells would be protected under all alternatives.

Mining of minerals, particularly limestone mining, has the potential to impact groundwater and is discussed below in more detail.

Mineral Operations

All Alternatives

The housing industry impacts the amount of mineral materials sold in the higher-population centers near the Francis Marion. Growth in the Charleston and Georgetown areas is expected to continue. As new houses are built and the demand for road, building, or fill materials increases, the demand for limestone or sand materials also may increase. However, South Carolina Department of Health and Environmental Control's Mining and Reclamation Section conducts the administrative and technical review on all applications for mining permits. The time spent conducting the review depends on the type of permit, complexity of the proposed operation, potential for environmental impact and proposed reclamation (SCDHEC 2013a). All mining permits in South Carolina Coastal Zone Area must be certified by the Department's Office of Ocean and Coastal Resource Management as being consistent with the South Carolina Coastal Zone Management Act (SCHDEC 2013b).

Mining does remove resources from the site, and therefore has the potential to impact ecological sustainability. Any mineral operations on national forest land would go through required environmental analysis and the Forest Service mineral material regulation process (36 CFR 228 C) or Bureau of Land Management Federal leasable minerals regulation process. If a mining operation is approved, then the permit would require a site plan that would limit impacts to the environment and limit impacts to ecological sustainability of the area.

Alternative 1

There is limited direction in the 1996 forest plan on where it is suitable to mine limestone on the Francis Marion. Existing laws withdraw some lands from mining activities, such as wilderness areas. Plan designations and standards and guidelines protect red-cockaded woodpecker foraging clusters and other sensitive resources. The Forest Service mineral material regulation (36 CFR 228 C) or Bureau of Land Management Federal leasable minerals regulation review process and State laws provide further protection of the resources, so direct and indirect effects to groundwater should meet the requirements of laws and policy.

Alternatives 2 and 3

Similar to alternative 1, adherence to Federal and State laws, regulations, and policy should ensure compliance with meeting requirements to protect certain resources and designated areas. Suitability determinations outlines areas on the Francis Marion that are suitable or not suitable for mineral development. The suitability analysis is designed to limit impacts to natural resources and address policies and laws. Under alternative 3, more of the Francis Marion would be wilderness and fall under the protection of the Wilderness Act. Therefore, effects from mineral operations

would likely be less in alternative 3, and projects in this alternative would be subject to site plans that would limit effects.

Paleontological Resources

All Alternatives

In 2009 Congress passed the Paleontological Resources Preservation Act (Public Law 111-11). In 2015 the Forest Service established regulations to implement the Act (36 CFR Parts 214, 261, and 291). The Act provides for the management of paleontological resources and encourages the scientific, educational, and where appropriate, the casual collection of these resources. All alternatives would be implementing this Act and the regulation.

The Act calls for inventory of paleontological resources. Due to flat land, dense vegetation, and large wetlands, the discovery and inventory of paleontological resources on the Francis Marion National Forest is hampered by a scarcity of natural exposures of the subsurface or fossil beds. Thus, excavations such as borrow pits and ditches provide opportunities to discover and inventory paleontological resources. So, while excavations may remove some paleontological resources from a site, on balance, excavations provide beneficial opportunities for the discovery and inventory of paleontological resource, especially on the Francis Marion where there is a scarcity of natural exposures of the subsurface.

Moreover, the Act states:

> Nothing in this subtitle shall be construed to (1) invalidate, modify, or impose any additional restrictions or permitting requirements on any activities permitted at any time under the general mining laws, the mineral or geothermal leasing laws, laws providing for minerals materials disposal, or laws providing for the management or regulation of the activities authorized by the aforementioned laws including but not limited to the Federal Land Policy Management Act (43 U.S.C. 1701-1784), Public Law 94-429 (commonly known as the `Mining in the Parks Act') (16 U.S.C. 1901 et seq.), the Surface Mining Control and Reclamation Act of 1977 (30 U.S.C. 1201-1358), and the Organic Administration Act (16 U.S.C. 478, 482, 551);
>
> (2) invalidate, modify, or impose any additional restrictions or permitting requirements on any activities permitted at any time under existing laws and authorities relating to reclamation and multiple uses of Federal land.

Any alternative that allows surface disturbance of bedrock or sediments with the potential to contain paleontological resources may have adverse impacts due to removal of such resources as well as beneficial impacts due to opportunities for discovery and inventory of such resources. In regard to such resources in organic sediments, any future peat or muck mining would be the main threat, though artificial drainage and severe fire could also have adverse impacts.

In alternatives 1, 2 and 3, surface-disturbing activities in areas with fossils would include, as part of the project-specific environmental analysis, a disclosure of potential effects on paleontological resources and discussion of potential mitigation of adverse impacts that may be identified. Therefore, effects would be limited in all three alternatives. However, under alternative 3, more of the Francis Marion would be wilderness, where paleontological resources are preserved, but where discovery and inventory by excavation is not allowed.

Geologic Hazards

The effects for geologic hazards are twofold: first, there are effects of geologic hazards on the national forest; second, there are effects of forest management on some geologic hazards.

Effects of Geological Hazards on the Forest

Geologic hazards (earthquakes, flooding, soil liquefaction, sinkholes, groundwater contamination, sea level rise, and land subsidence due to groundwater withdrawal) may affect forest resource investments (such as restoration projects), roads, recreation facilities, special use permit facilities, and public safety on the national forest. National forest management can reduce risks to investments, facilities, and public safety by recognizing the geologic hazards specific to project sites, and then mitigating risks through the siting, design, operation, and maintenance of the project. Updated plan revision alternatives 2 and 3, based on the environmental impact statement recognizing geologic hazards, are more likely to reduce risks to investments, facilities, and public safety than alternative 1. The prescribed fire regime outlined in alternatives 1 and 2 would reduce hazardous fuel buildup more than in alternative 3. As a result, implementing alternatives 1 or 2 would be more likely to reduce the intensity and spread of wildfires potentially resulting from geological hazards than alternative 3.

Effects of Alternatives on Geologic Hazards

While management activities under all alternatives would not directly or indirectly affect many geologic hazards such as earthquakes, management activities may affect some geologic hazards in some areas of the Francis Marion. Groundwater is close to the ground surface and the soils are sandy and porous in many areas of the national forest. Groundwater can be affected by activities such as spraying to control plants or insects, or accidental oil leaks from vehicles and machinery conducting forest operations. In karst areas of the Francis Marion, there is potential not only for groundwater contamination, but ground collapse (sinkhole formation) due to groundwater withdrawals (for example, by special use permits). National forest management activities that restore hydrologic functions on the landscape have the potential to reduce flood hazards. Updated plan revision alternatives 2 and 3, recognize the need to screen projects with geologic maps, LIDAR, and field inventory, are more likely to reduce effects of management activities on geologic hazards than alternative 1.

Cumulative Effects

The effects of groundwater withdrawals on the Francis Marion National Forest are part of the effects of past, present, and future groundwater withdrawals in Berkeley and Charleston Counties. Groundwater withdrawals for Forest Service use are relatively modest compared with groundwater withdrawals under State permit near the Francis Marion for major water users. Because of increased demand for water supplies from the growing and urbanizing coastal plain, the Francis Marion may receive requests for a Forest Service special use permit for substantial withdrawals that would also require a State permit under groundwater capacity use areas designated and administered by the South Carolina Department of Health and Environmental Control. All alternatives have the potential for consideration and approval or disapproval of requests for special use permits for groundwater withdrawals for use outside the national forest. If a special use permit for groundwater withdrawals were approved, a potential effect would be a lowering of groundwater levels and reduction of groundwater supply in aquifers. The magnitude and duration (short term and long term) of the effect will depend on the quantities withdrawn, years of withdrawal, aquifer depth, and geologic nature of the aquifer and recharge.

All alternatives, to the extent special use permits for substantial groundwater withdrawals for use outside the national forest might be approved, would have the potential for pumping-induced aquifer compression, ground-surface subsidence, and pumping-induced salt water encroachment. In such a case, the heavy pumping of the aquifer could cause the surface environment to become wetter by becoming physically lower. Such potential effects may takes decades to develop and become noticeable.

All alternatives would have the potential of dewatering a groundwater dependent ecosystem if a mine or quarry were to be excavated nearby or if special use permits for substantial groundwater withdrawals for use outside the national forest were approved. Such effects include not only dewatering but also any substantial reductions in groundwater sufficient to adversely affect the groundwater dependent ecosystem.

Mining for mineral material could impact the quality and recharge of groundwater. Proposals for mining must go through a site-specific analysis and additional mitigation measures may be required if impacts to resources including groundwater are anticipated.

Mining for limestone is occurring on private land near Dutart Creek within the proclamation boundary for the Francis Marion. South Carolina Department of Health and Environmental Control monitors for potential groundwater impacts. If any impacts to groundwater occur, it could potentially impact groundwater dependent ecosystems, but no known impacts have been reported. Instream dredging of channel and sand materials outside the national forest could impact channel stability on national forest lands. Sand materials acquired in the past are typically upland borrow sites of suitable materials both on the national forest or sometimes adjacent areas. The effects for these are more localized, but may impact groundwater, hydrologic patterns or indirectly affect other sensitive habitats.

Past activities on the Francis Marion and adjacent areas may have a degree of effects on geologic resources, such as hydrologic modifications, mining of materials, dams and diversion of rivers, and the use of groundwater. Most of these are difficult to quantify and explain, and have little or no bearing on the proposed actions being considered to manage the national forest.

All alternatives would likely have minor effects on other geological or paleontological resources.

3.2.3 Air Quality

3.2.3.1 Affected Environment

Prescribed fire activities on Francis Marion National Forest have the potential to impact air quality in the area. Since air masses are constantly moving across the landscape and gathering pollution in one area and transporting it to another, the potential impacts on nearby communities, air quality monitoring sites, and other areas of interest from prescribed burning on the Francis Marion are addressed in this section. The primary concerns with air quality from prescribed fire activities are the effects that emissions would have on human health and visibility—both in terms of safety on roadways as well as regional haze which affects scenic vistas. Concerns also include impacting forest visitors and adjacent landowners who may have respiratory ailments. Emissions from prescribed fire include carbon dioxide, water, carbon monoxide, particulate matter, hydrocarbons or volatile organic compounds, and nitrogen oxides.

Air Pollution Emissions and Standards

Congress directed the U.S. Environmental Protection Agency (EPA) to set national ambient air quality standards for six criteria air pollutants: lead, sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen oxides (NO_x), ozone (O_3) and particulate matter (PM). As documented in the annual Forest Plan Monitoring Report as well as in EPA's GreenBook[1], ozone and particulate matter levels across the state of South Carolina have remained below the national ambient air quality standards. This section analyzes these six criteria pollutants relative to the three proposed alternatives.

Lead and Sulfur Dioxide

The lead and sulfur contents of forest fuels is negligible; therefore, the effects of emissions from these pollutants from prescribed burning are not considered.

Carbon Monoxide

Carbon monoxide is the most abundant pollutant emitted from prescribed fire. It concerns human health because it binds to hemoglobin in place of oxygen. This leads to oxygen deprivation and all of the associated symptoms—from diminished work capacity to nausea, headaches and loss of mental acuity. Carbon monoxide concentrations can be quite high adjacent to a burn unit, but they decrease rapidly as they move away from the burn unit toward cleaner air. The effects of carbon monoxide can be significant for those working the line on a prescribed fire, but due to rapid dilution, carbon monoxide is not a concern to urban and rural areas even a short distance downwind. Fortunately, most of the carbon monoxide effects on human health are reversible because carbon monoxide is rapidly removed from the body once the person is in cleaner air.

Nitrogen Oxide and Ozone

Nitrogen oxide emissions from prescribed fires are very small; alone they minimally affect human health. However, when combined with hydrocarbons (which are also moderately emitted from prescribed fire), they become precursors to the criteria pollutant ozone. Ozone is formed in the atmosphere when nitrogen oxides and hydrocarbons combine in the presence of sunlight. Fire-related Nitrogen oxide and hydrocarbon emissions become more important to ozone levels only when other persistent and much larger pollution sources already present a substantial base load of precursors. To a limited degree, additional intermittent emissions of Nitrogen oxide and hydrocarbons may aggravate an already bad situation. Increased ozone concentrations are a concern to both human health as well as the environment.

Particulate Matter

The most important pollutant from prescribed fire emissions is particulate matter, specifically the very small particles that are less than 2.5 microns in diameter ($PM_{2.5}$), due to the large amount emitted from prescribed fires and their negative effects on human health and visibility.

Each prescribed burn on the Francis Marion National Forest is planned, designed and implemented to avoid smoke impacts to downwind sensitive areas. The planning and implementation of each burn complies with the Regional Smoke Management Guidelines. The purposes of smoke management programs and guidelines are as follows:

[1] https://www.epa.gov/green-book

1. To mitigate the nuisance (such as impacts on air quality below the level of ambient standards) and public safety hazards (such as visibility on roads and airports) posed by smoke intrusions into populated areas;
2. To prevent significant deterioration of air quality of Class I areas; and
3. To insure compliance with national ambient air quality standards.

The Forest Service evaluates potential smoke emissions from prescribed burns using the Forest Service Fire Emissions Production Simulator (FEPS), as well as the dispersion models VSMOKE-GIS (Forest Service) and HYSPLIT (National Oceanic and Atmospheric Administration) to estimate direction of smoke dispersion and downwind concentrations prior to implementing the burns. These requirements and guidelines are the best practices available to avoid and minimize impacts to public health and visibility impairment on highways.

On the Francis Marion, prescribed burns are conducted when the forecasted wind direction is favorable for directing smoke away from smoke sensitive areas identified in each burn plan. Fire personnel monitor the impact of smoke throughout the course of a prescribed burn, often with assistance from an aerial detection plane. Smoke warning signs are posted along impacted roads, and Forest Service vehicles with flashing red lights are stationed to slow or stop traffic when necessary. On rare occasions, conditions may indicate a need for law enforcement personnel to assist with managing traffic during a burn.

Duration of air quality impacts from each prescribed burn is generally short (one day or less); smoke disperses within a few hours. Burn ignition is normally completed within 4 to 6 hours; active burning is complete within an hour or 2 after ignition is stopped.

If burning continues or residual smoke is present into the night when dispersion conditions are generally poor, smoke can accumulate (especially in low lying areas) and linger until late morning. Early morning smoke and high relative humidity can create poor visibility conditions sometimes resulting in zero visibility. However, when the sun comes up and temperature and air movement increase, smoke dispersion and visibility improve rapidly. Prior to implementing burns, the Francis Marion National Forest assesses the risks associated with nighttime visibility and takes appropriate mitigations to avoid these situations. Smoke management planning has been successful in protecting health and safety.

3.2.3.2 Environmental Consequences

Effects are based on prescribed fires being implemented in compliance with the Forest Service Region 8 Smoke Management Guidelines and any smoke dispersion modeling completed before implementation. Specifically, burns are planned when meteorological conditions are favorable for dispersing smoke so that smoke-sensitive areas and people are not impacted. Appropriate notifications are made to adjacent homeowners and communities; necessary signs and other means are used to warn motorists of smoke on highways.

Alternative 1: Direct, Indirect and Cumulative Effects

In alternative 1, the prescribed burn acreage would remain the same as current management. This alternative would have no new direct, indirect or cumulative impacts on air quality since no additional actions outside the 1996 forest plan would be implemented. When added to all other pollution sources in the state, the effects of implementing prescribed burning in alternative 1 would still meet acceptable air quality standards.

Alternative 2: Direct, Indirect and Cumulative Effects

Alternative 2 would increase prescribed burn acreage from the 1996 forest plan. When added to all other pollution sources in the state, the effects of implementing prescribed burning in alternative 2 would still meet current air quality standards.

The direct, indirect and cumulative effects to air quality from proposed prescribed burning in alternative 2 would be short in duration (less than 24 hours) for a few days each year. However, at times, smoke from the proposed prescribed fires may cause short-term respiratory discomfort, be a nuisance or reduce visibility for those near the burn units. Although burns are planned to minimize these impacts, the potential for the smoke plume to change direction and temporarily affect those in its path would exist. These impacts usually would be short lived and last less than 24 hours.

Alternative 2 incorporates additional fuels reduction techniques with no additional smoke production. Alternative treatments, such as mechanical, chemical, and biological treatments would be used to mimic the historical role of wildland fire without increased smoke production. Refer to the "Creating Fire Adapted Human Communities" section for further information. A tangent objective of these alternative type treatments is to reduce the fuel loading in close proximity to human communities which should result in less severe wildfire and less smoke production.

Alternative 3: Direct, Indirect and Cumulative Effects

Alternative 3 would reduce prescribed burn acreage from the 1996 forest plan. Therefore, it would have no new direct impacts on air quality since no additional actions beyond the 1996 plan would be implemented. In addition, when added to all other pollution sources in the state, the effects of implementing prescribed burning in alternative 3 would still meet acceptable air quality standards.

Indirectly, alternative 3 could impact air quality later due to the resulting forest fuels buildup, which could cause more smoke over long durations if wildfires occurred in untreated areas.

The cumulative effects of this alternative would result from indirect effects over time from forest vegetation and litter (fuel loadings) and the resulting effect on wildfires. In the absence of prescribed burns, brushy species replace grasses causing fuel loading to increase. Wildfires occurring in areas with increased fuel loadings produce more smoke and are more difficult to contain; therefore, they often burn for a longer duration. Wildfires may occur at times when wind carries smoke into sensitive areas and when smoke dispersal is poor. On a short-term basis, air quality could degrade under this alternative.

3.2.4 Climate Change

3.2.4.1 Introduction

All Federal agencies must consider the effects of greenhouse gas emissions (carbon, methane, nitrous oxide, and fluorinated gases) and climate change in the evaluation of all proposed Federal actions, including revising forest plans. This analysis considers the following when addressing climate change: The potential impacts of climate change on the Francis Marion National Forest as indicated by a qualitative discussion of climate change impacts on natural resources.

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 more frequent and intense heat waves, more severe wildfires, degraded air quality, more heavy downpours and flooding, increased drought, greater sea-level rise, more intense storms and harm to water resources, agriculture, wildlife and ecosystems. This section includes a summary of potential effects (for a detailed discussion on potential changes to the climate, see the “Climate Change” section of the Francis Marion National Forest Plan Assessment).

3.2.4.2 Affected Environment

Carbon

Forests represent the largest sink of terrestrial carbon. Maintaining forests as forests is one of the best methods to store carbon and help offset greenhouse gas emissions. In addition, the wood products store carbon and keep it out of the atmosphere.

Over the past century, the Francis Marion National Forest has transitioned from a period of deforestation to reforestation and regrowth, which has resulted in the Francis Marion becoming a carbon sink. Future carbon accumulation on the Francis Marion can be impacted by the combined effects of:

1. Changes in forest growth rates;
2. Forest management;
3. Mortality-inducing events such as insect epidemics;
4. Other disturbances such as wildfires and hurricanes; and
5. The direct and indirect effects of climate change.

The combined effects of forest aging, disturbance, and land management activities will determine the overall rate of carbon accumulation on the Francis Marion. Drought, for example, provides simultaneous influences on wildfire extent and severity, insect dynamics, and tree mortality. Coulston, Wear and Voise (2015) note that the forest’s age structure affects potential future carbon accumulation. In unharvested areas, the carbon accumulation rate (megagrams of carbon per hectare per year or MgC/ha/yr) for the Southeast region peaks at age classes 10-15 years and 15-20 years and then declines with age. The carbon accumulation rate drops by more than 50 percent by age class 35-40 and by more than 75 percent by age class 65-70. A detailed discussion on Forest Carbon on the Francis Marion is contained in the “Carbon” section of the Francis Marion Plan Assessment (USDA Forest Service 2013).

The most recent inventories indicate that the Francis Marion National Forest is a carbon sink, with most recent 5-year accumulations at the rate of about 14 percent. Although this increase is within the sampling error for the inventory, the trends reflect that a continued increase at this rate is likely.

This trend includes the effects of current management, including annual timber harvests averaging about 33,000 hundred cubic feet (Forest Service Cut and Sold Reports 2008–2012) and annual average prescribed burning on 35,000 acres. The 2014 ecosystem carbon stock estimates for the Francis Marion National Forest total 19.8 teragrams (Tg or million metric tons) ± 1.6 Tg of carbon. The average density of forest carbon is about 71.5 metric tons per acre. On average 22 thousand metric tons of carbon, 0.12 percent of the standing total stocks of carbon, have been harvested each year. Approximately 30 percent of harvested wood remains sequestered in durable wood products and landfills after 50 years. About 0.149 Tg of carbon dioxide has been emitted

annually by prescribed fire. Annual prescribed burning emits carbon at the rate of about 8.4 percent of the carbon in down wood and litter, but only 0.8 percent of the total standing carbon stocks. Additional annual emissions of greenhouse gases from prescribed burning are estimated to be 0.010 Tg metric ton carbon dioxide equivalent of Methane and 0.006 Tg carbon dioxide equivalent of Nitrogen dioxide. The 2011 estimates for the Francis Marion National Forest total 18.5 teragrams (Tg or million metric tonnes) ± 2.8 Tg of carbon, which represents about 0.04 percent of the total of approximately 45,278 Tg of carbon in forests of the coterminous United States (EPA 2012). The average density of forest carbon is about 71.5 metric tons per acre.

Management practices, such as timber harvesting and prescribed burning affect the above-ground carbon stocks. Annual harvests from the Francis Marion National Forest average 33,132.8 hundred cubic feet (Forest Service Cut and Sold Reports, 2008-2012). On average 0.12 percent of the standing total stocks of carbon are harvested each year. Of this annual harvest, an estimated more than 30 percent will remain in a sequestered state (wood products in use or in landfills) after 50 years. Annual prescribed burning emits carbon at the rate of about 8.4 percent of the carbon in down wood and litter, but only 0.8 percent of the total standing carbon stocks.

Carbon Storage

The February 10, 2015 Baseline Estimates of Carbon Stocks in Forests and Harvested Wood Products for National Forest System Units, provided by the USDA Forest Service Climate Change Advisor’s Office (USDA Forest Service 2015) indicates that the total forest ecosystem carbon stocks and density have steadily increased for at least the past 20 years on the Francis Marion and Sumter National Forests.[2] The highest percent change in carbon storage occurred in the above-ground carbon pool, due to net growth of the forest, and the lowest was in the understory pool, probably due to near equilibrium between new additions and emissions due to fire and decomposition. Most of the carbon is concentrated in the above-ground and soil organic carbon pools.

The baseline estimates for the Southern Region national forests show that carbon in durable wood products and wood in landfills have accumulated to a large pool. Timber harvests over years of management have contributed to this stock of sequestered carbon, although it is not possible to determine the proportion of this pool that was contributed by Francis Marion harvests.

Historic and Current Climate

In evaluating historic climate, two estimates are made for temperature and precipitation. One is based on observed historic data (Gibson et al. 2002; Parameter-elevation Relationships on Independent Slopes Model (PRISM)), the other is based on predictive global climate models. The intent of providing multiple representations of current climate is to establish a chain of logic-enabling analysis of future projections at coarser scales (about 12 kilometers) with respect to historic reference conditions that are observationally based and available at finer scales (about four kilometers). Having both representations of current climate available supports an understanding of the strengths and weaknesses of current and future projections and limitations related to scale. The Girvetz et al. (2009) representation of current climate serves as the baseline for comparison with future climate projections in subsequent sections of this report.

Long-term monitoring on the Santee Experimental Forest found:

[2] Includes live and dead standing trees, soil carbon, down woody material and forest floor leaf litter.

- A statistically significant increase in air temperatures over the 63-year period from 1946 to 2008, with an average increase of about 0.3 degrees Fahrenheit per decade (Dai et al. 2011). Mean annual daily minimum temperatures were found to increase at an even greater rate of about 0.5 degrees Fahrenheit per decade (Dai et al. 2011).
- Changes in precipitation were small over the 63-year period; however, seasonally there was a slight increase in fall and winter rainfall and a decrease in spring and summer rainfall (Dai et al. 2011).

Global climate models and PRISM models estimate:

- Annual average temperature estimates from 1980 to 2009 differ by 0.8 degrees Fahrenheit with PRISM estimating 64.7 degrees Fahrenheit and the median global climate model estimating 65.0 degrees Fahrenheit. Global climate models and PRISM seasonal average estimates temperature over the same time period are quite similar in the summer, winter, and fall (less than 0.2 degrees Fahrenheit difference) and most different in the spring (differ by 0.8 degrees Fahrenheit).
- Annual average precipitation estimates for the time period 1980 to 2009 differ by 0.5 inches with PRISM estimating 50.6 inches and the median global climate models estimating 51.1 inches. Global climate models and PRISM historic estimates of seasonal average estimates precipitation over the same time period are most similar in the winter and spring (differ by less than 0.3 inches) and most different in the summer and fall (0.6 inches and 1.1 inches, respectively).

Future Climate Projections

Accounting for uncertainty is an essential step when considering future climate projections. Uncertainty comes from model uncertainty, uncertainty about future rates of greenhouse gas emissions and uncertainty related to the spatial and temporal scales of analysis. Considering multiple climate models and evaluating model agreement is one approach for addressing model uncertainty. Uncertainty about future greenhouse gas emission rates is addressed by considering high (Special Report on Emissions Scenario A2) and low (B1) emissions scenarios. However, emissions scenarios only begin to differ significantly in the second half of the 21st century; therefore model uncertainty captures the majority of uncertainty in the first half of the century. In addition, considering the high emissions scenario simplifies the analysis while highlighting key trends. Finally, spatial and temporal uncertainty is addressed by comparing results for a given location and time period with results produced for broader geographic areas and longer time periods. This information is available at broader scales from previous published analyses (such as national and regional assessments).

- Annual average temperatures indicate warming with increases of 1.2 degrees Fahrenheit from 2010 to 2039. Even the most conservative ensemble considered (25th percentile) estimates 1.1 degrees Fahrenheit of warming during the same time period, which is greater than the range of uncertainty considered (25 to 75th percentile) of 0.5 degrees Fahrenheit. All seasonal averages show warming, with the greatest change occurring in the fall and the least change occurring in the winter (increase of 1.0 degrees Fahrenheit) for 2010 to 2039. In all cases, the projected changes are greater than the 25th to 75th percentile range, which represent the level of model uncertainty
- Precipitation projections seem to indicate a generally wetter future, with a median increase of 2.8 percent for 2010 to 2039. However, this change is well within the range of uncertainty considered (25th to 75th percentile) of 4.0 inches for 2010 to 2039. Seasonal

precipitation projections seem to indicate a trend toward a wetter fall with less pronounced changes in other seasons. However, this change is well within the range of uncertainty considered (25th to 75th percentile) of 2.3 inches for 2010 to 2039.

Landscape Resilience

The "Resilient Sites for Terrestrial Conservation" (Anderson et al. 2014) models landscape physical characteristics that can buffer an area from changing climate by providing microclimates that allow species to persist. The model is driven by two key landscape characteristics:

- **Landscape Diversity** represents the variety of microclimates present in a landscape, and can be used to estimate the capacity of the site to maintain species and functions. We measured landscape diversity as a function of topography, elevation range, and the density and configuration of wetlands.
- **Landscape Permeability** is a measure of landscape structure (not individual species movements), which characterizes the hardness of barriers, the connectedness of natural cover, the arrangement of land uses that influence ecological processes and the movement of many types of organisms.

Estimated resilience is a composite of the two key landscape characteristics and is calculated as **landscape diversity** (z-score) plus the **local connectedness** (z-score) divided by two. Interpretation and Results for Francis Marion National Forest are as follows:

- Table 3-4 provides an overall summary model of results. The Francis Marion National Forest has a total resiliency that is characterized by the model as slightly above average, with a 0.91 standard deviation. Contributing to the combined total resiliency characterization is landscape connectivity that is above average (1.31 standard deviation) and a landscape diversity that is slightly below average (-0.90 standard deviation).
- Figure 3-6 provides a spatial summary of model results. Patterns of "above average" resiliency are widely distributed Figure 3-6 across the Francis Marion National Forest, with pockets of far above average resiliency in interior areas. The margin of the Francis Marion is ringed with slightly above average and average resiliency, with pockets of below average. Landscape connectivity appears to be the primary driver of resiliency on the Francis Marion, with landscape diversity detracting from the total resiliency, particularly in the north-central extent.

Table 3-4. Characterization of mean total resiliency, landscape connectivity, and landscape diversity within the proclamation boundary of the Francis Marion National Forest

	Total Resiliency	Landscape Connectivity	Landscape Diversity
Francis Marion National Forest	**Slightly Above Average** 0.91 SD	**Above Average** 1.31 SD	**Slightly Below Average** -0.80 SD

Note: The estimated resilience, connectivity, and diversity scores are given as a SD category based on its standard normalized score for the setting and ecoregion.

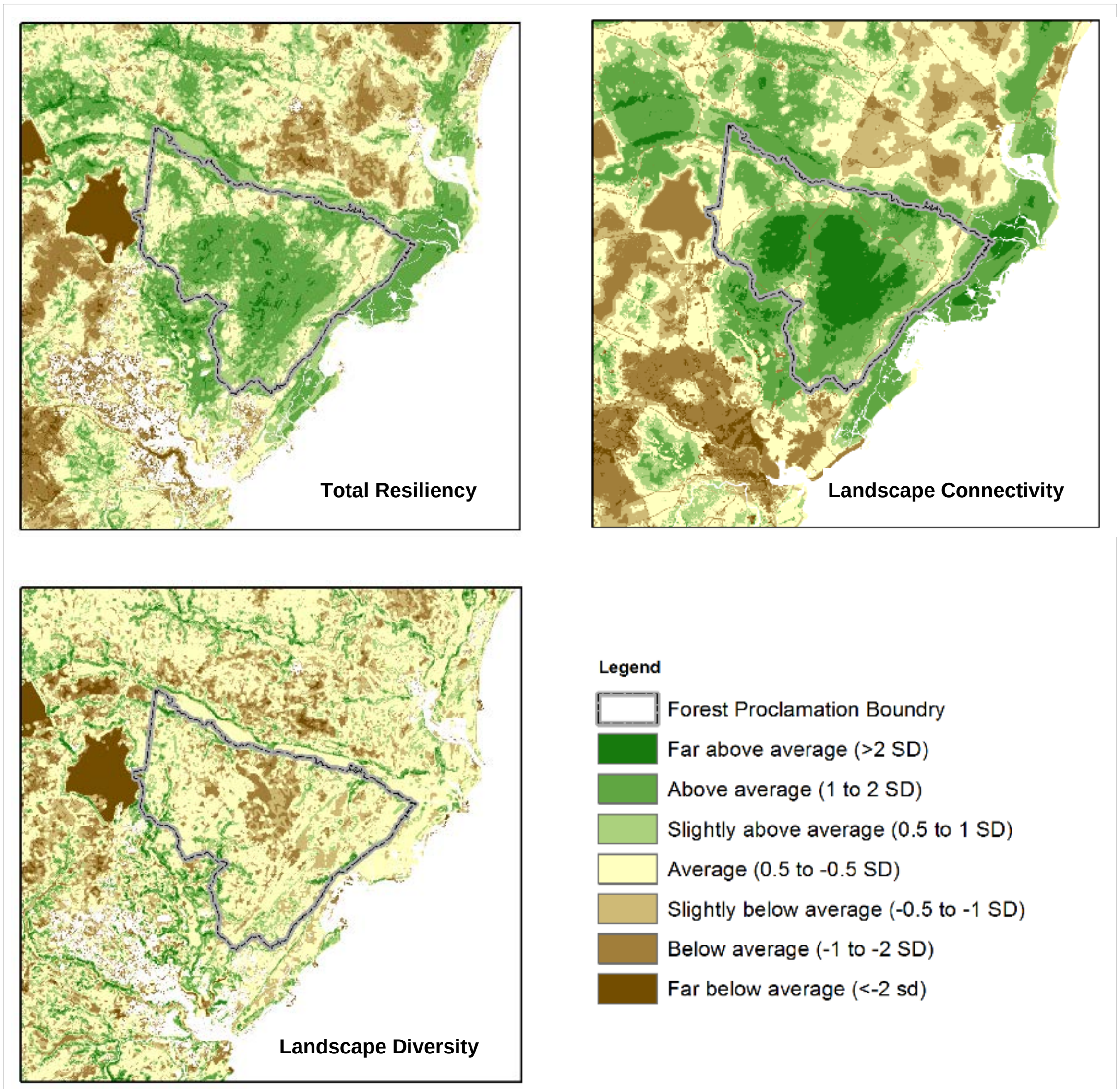


Figure 3-6. Spatial patterns of total resiliency, landscape connectivity, and landscape diversity within and immediately surrounding the proclamation boundary of the Francis Marion National Forest

3.2.4.3 Environmental Consequences

Assessing the Potential Effects of Management Actions on Climate Change

Past National Environmental Policy Act environmental analyses to date have concluded that greenhouse gas emissions from an individual agency action will have small, if any, potential climate change effects. Management actions occur incrementally, program-by-program and step-by-step; climate impacts are not attributable to any single action, but occur incrementally. Diverse individual sources of emissions each make relatively small additions to global atmospheric greenhouse gas concentrations that collectively have huge impacts.

Land management practices such as prescribed burning, timber stand improvements, fuel load reductions, scheduled harvesting, and grazing land management can result in both carbon emissions and carbon sequestration. A prescribed burn of forest or grasslands conducted to limit ecosystem destruction through wildfires or insect infestations may result in short-term greenhouse gas emissions and loss of stored carbon at the same time that a restored, healthy ecosystem provides long-term carbon sequestration through enhanced regrowth and biological sequestration.

Forest Carbon Effects

The Francis Marion National Forest provides an important public service in the form of carbon sequestration—the uptake and storage of carbon in forests and wood products. This service is becoming more valuable as the impacts of greenhouse gas emissions are becoming more fully understood and experienced. Forest management activities will play a critical role in ensuring that the Francis Marion National Forest remains a net carbon sink.

Appropriate forest management and protection can substitute lighter, strategically placed and more recoverable emissions for disturbance emissions that would be more severe, extensive and less reversible; it is risk management on a forestwide scale. Management practices, such as thinning, revegetation, and prescribed fire, which are designed to maintain or restore forests, may reduce total carbon stocks at least over the short- or mid-term. However, not taking action to improve ecological health will likely result in substantially lower carbon stocks and substantially increased carbon emissions in the future as a result of forest decline, severe wildfire and losses from storms, insects and disease ("National Roadmap for Responding to Climate Change," USDA Forest Service 2010).

The February 10, 2015 "Baseline Estimates of Carbon Stocks in Forests and Harvested Wood Products for National Forest System Units" provided by the USDA Forest Service Climate Change Advisor's Office (USDA Forest Service 2015) indicates that the total forest ecosystem carbon stocks and density have steadily increased for at least the past 20 years on the Francis Marion and Sumter National Forests. The highest percent change in carbon storage occurred in the above-ground carbon pool, due to net growth of the forest, and the lowest was in the understory pool, probably due to near equilibrium between new additions and emissions due to fire and decomposition. Most of the carbon is concentrated in the above-ground and soil organic carbon pools.

The baseline estimates for the Southern Region show that carbon in durable wood products and wood in landfills have accumulated to a large pool. Timber harvests over years of management have contributed to this stock of sequestered carbon, although it is not possible to determine the proportion of this pool that was contributed by Francis Marion harvests.

Management practices, such as timber harvesting and prescribed burning affect above-ground carbon stocks. Below-ground carbon stocks, in the roots and soil organic matter can be affected when forests are converted to non-forest, but are not significantly affected if forests remain forests, even when subjected to low-intensity burning. Thinning and prescribed fire may release carbon in the short term, but they focus growth and storage for the future on trees that are at lower risk and/or more resilient to disturbance.

Alternative 1 (Current Management)

Conditions of carbon stocks and emission resulted from this alternative would continue at the rates described in the "Affected Environment" section. Based on forest management effects and background natural disturbance of the past 20 years, rates of forest growth and reductions due to

timber harvest removals and mortality would likely continue for at least the next 20 years at the same rates as the past 20 years, resulting in continued net gains in forest ecosystem carbon stocks. Prescribed burning will continue to create emissions, but a neutral net growth in the understory carbon pool would be expected due to continue near equilibrium levels between new additions from wood and leaf fall and reductions due to fire and decomposition. The Francis Marion National Forest is expected to remain a carbon sink for the foreseeable future, unless uncontrolled catastrophic events occur that cause significant forest mortality.

Alternative 2 (Proposed Action)

Conditions of carbon stocks and emission would increase under this alternative. Carbon mass in annual timber harvests would increase to about 65 thousand metric tons, based on annual harvests of 98,000 hundred cubic feet. Prescribed fire and other fuel reduction (such as mastication), projected at 50,000 acres per year, would emit 0.21 Tg of carbon dioxide, 0.015 Tg carbon dioxide equivalent of Methane, and 0.008 Tg carbon dioxide equivalent of Nitrogen dioxide.

Increased timber harvests would increase carbon removals to 0.35 percent of the standing total stocks of carbon. Rates of net forest growth would continue to significantly offset these harvest removals and forest ecosystem carbon stocks would continue to increase. Prescribed burning will continue to create emissions, but a neutral net growth in the understory carbon pool would be expected due to continued near-equilibrium levels between new additions from wood and leaf fall and reductions due to fire and decomposition. The Francis Marion National Forest is expected to remain a carbon sink under this alternative, unless uncontrolled catastrophic events occur that cause significant forest mortality.

Alternative 3

Conditions of carbon stocks and emission would increase under this alternative. Carbon mass in annual timber harvests would increase to about 65 thousand metric tons, based on annual harvests of 98,000 hundred cubic feet. Prescribed fire and other fuel reduction (such as mastication), projected at 43,000 acres per year, would emit 0.18 Tg of carbon dioxide, 0.013 Tg carbon dioxide equivalent of Methane, and 0.008 Tg carbon dioxide equivalent of nitrogen dioxide.

Increased timber harvests would increase carbon removals to 0.35 percent of the standing total stocks of carbon. Rates of net forest growth would continue to significantly offset these harvest removals and forest ecosystem carbon stocks would continue to increase. Prescribed burning will continue to create emissions, but a neutral net growth in the understory carbon pool would be expected due to continued near-equilibrium levels between new additions from wood and leaf fall and reductions due to fire and decomposition. The Francis Marion National Forest is expected to remain a carbon sink under this alternative, unless uncontrolled catastrophic events occur that cause significant forest mortality.

Assessing Potential Effects of Climate Change on the Francis Marion National Forest

The Francis Marion National Forest is experiencing increased threats from fire, insect and plant invasions, disease, extreme weather, and drought. Scientists project increases in temperature and changes in rainfall patterns that can make these threats occur more often, with more intensity and for longer durations.

Air Quality

Climate change may affect the distribution patterns and concentrations of air pollutants through changing wind and precipitation patterns (Bytnerowicz et al. 2007) as well as increased

temperatures (Bedsworth 2011). Increases in summer temperatures can increase the severity and duration of air pollution episodes potentially offsetting any future reductions in emissions (Wu et al. 2008). Airborne particulate matter is expected to decrease as precipitation increases; however, a climate-driven increase in wildfires could potentially increase both particulate and ozone concentrations (Jacob and Winner 2009). An increase in nitrogen deposition is also predicted (Civerolo et al. 2008), which could lead to acid loading in forest streams (McNulty and Boggs 2010).

Biological Diversity

At-risk plants and animals will respond to environmental changes by adapting, moving or declining (Aitken et al. 2008). Species with high genetic variation will be better able to survive new conditions. Higher temperatures will cause many species to shift ranges, generally moving to track their suitable habit (such as northward or higher in elevation; McKenney et al. 2007; Heller and Zavaleta 2009). 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 (Hitch and Leberg 2007; Pickles et al. 2012). The species most likely to be negatively impacted by climate change will be highly specialized and habitat restricted (Rodenhouse et al. 2009).

Forest Health

With changing climatic variability, invasive and aggressive plant and insect species may increasingly outcompete or negatively affect native species in the future (Dukes et al. 2008; Hansen et al. 2001). Winter freezes currently limit many forest pests; higher temperatures will likely allow them to increase in number (Morrison et al. 2005). Destructive insects, such as bark beetles, will be better able to take advantage of forests stressed by more frequent drought (Duehl et al. 2011; Gan 2004). Certain invasive plant species, including cogon grass (Bradley et al. 2010) are expected to increase dramatically as they can tolerate a wide range of harsh conditions, allowing them to move rapidly into new areas (Hellmann et al. 2008).

Wildland Fire and Fuels

Wildfire frequency is expected to increase across the Southeast in the future (Heilman et al. 1998). More cloud-to-ground lightning due to warming may increase wildfire ignitions (Podur and Wotton 2010), while more frequent droughts and forest stress will lead to drier fuels. These fuels will burn more easily and at hotter temperatures, contributing to more and bigger wildfires (Flannigan et al. 2000). Prescribed burning will remain an important tool to reduce fuels on forest lands, but the number of days when burning is prohibited may increase due to dry, windy conditions (Liu et al. 2012).

Extreme Weather

The potential for severe storms is expected to increase in the future, including less frequent but more intense hurricanes making landfall in the southern U.S. (Emanuel 2005). These hurricanes have the potential to increase both inland flooding and coastal storm surge events (Seneviratne et al. 2012). Hurricane events are likely to become more severe, with increased wind speeds, rainfall intensity and storm surge height (Knutson et al. 2010; Karl et al. 2009). On the other hand, droughts have become more common in the Southeast since the 1970s, and changing climate variability is expected to continue to lead to longer periods of drought in the future (Breshears et al. 2005). As annual temperatures increase, extreme heat events will occur with increasing regularity, while the amount of freezing days will decline (Nicholls and Alexander 2007).

Water Resources

Shifts in rainfall patterns will lead to periods of flooding and drought that can significantly impact water resources (Seager et al. 2009). Increases in heavy downpours and more intense hurricanes can lead to greater erosion and more sedimentation in waterways (Karl et al. 2009; Carpenter et al. 1992). Increased periods of drought may lead to decreasing dissolved oxygen content and poor water quality in some areas (Mulholland et al. 1997). Depressional wetlands, such as Carolina bays, 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 (Stroh et al. 2008; Erwin 2009). Any changes in the hydrology of these wetlands may lead to forest vegetation encroachment into historically herbaceous areas (De Steven and Toner 2004). Higher temperatures will cause increased evapotranspiration that is predicted to further water stress, decreasing the water available to both forests (Lu et al. 2009) and wetlands (Pitchford 2011).

Coastal Ecosystems

Coastal areas in the Southeast have already experienced an average of one inch of sea-level rise per decade during the 20th century (Kemp et al. 2009), a rate that will continue to increase in the future (Pfeffer et al. 2008). Rising seas, combined with more intense hurricanes, will alter the composition of coastal marshes (Day et al. 2008; Voss et al. 2012). As saltwater flooding expands, low-lying coastal wet forests could become marshland where land-use barriers do not exist (Erwin et al. 2006). Tidal forests, including bald cypress swamps, may serve as sentinels for sea-level rise due to their low tolerance to salinity changes. The loss of tidal forests would have potentially negative consequences for wildlife species such as threatened wood storks that often nest in cypress swamps (Craft 2012). Sea-level rise can also increase the potential for saltwater intrusion into coastal freshwater tables. Increasing salinity of coastal aquifers may affect groundwater resources within 3 miles of the coast (Langevin and Zygnerski 2012).

Terrestrial Ecosystems

Heat stress may limit the growth of some southern pines and hardwood species (Iverson et al. 2008). Additional stresses from drought, combined with wide-scale pest outbreaks, have the potential to cause broad-scale forest dieback (Allen et al. 2010). Intensified extreme weather events, such as hurricanes, ice storms and fire, are also expected to lead to changes in natural vegetation succession and plant community composition (Walther 2003). An increase in disturbance may promote the establishment of longleaf at the expense of loblolly pine, as longleaf pine is more resilient to wind damage (Bragg et al. 2003; Johnsen et al. 2009). Populations of bald cypress may be particularly vulnerable to future changes, including higher air and water temperatures (Middleton 2009; Middleton and McKee 2004) as well as increased salinity with sea-level rise (Krauss et al. 2009).

Aquatic Ecosystems

Increases in temperature and changes in precipitation patterns leading to lower baseflows and altered hydrology in streams and lakes will affect both plant and animal species in aquatic environments (Mulholland et al. 1997). Increased drought frequency can lead to poor water quality and habitat squeezes (Ficke et al. 2007), reducing diversity and increasing the incidence of waterborne diseases (Rahel and Oden 2008). Higher temperatures will negatively affect coolwater-adapted fishes, including striped bass (Coutant 1990) and Atlantic and shortnose sturgeons (Waldman 2011), while warmwater-adapted species may expand in range (Meyer et al. 1999). Fish kills due to high summertime temperatures are likely to become more common in shallow waters of the Southeast (Stefan et al. 2001; Fang et al. 2004). Freshwater mussel species

already declining in the region may be most at risk with future changes as impacts from land use changes in combination with drought-induced low water levels and high summer temperatures may potentially extirpate thermally sensitive mussel populations (Galbraith et al. 2010; Golladay et al. 2004).

Wildlife

Wildlife species will be affected in different ways, depending on their needs (Currie 2001). Amphibians may be most at risk due to dependencies on moisture and cool temperatures that could be altered in a future climate (Corn 2005; Blaustien et al. 2010). Birds may see a population decrease as vegetation types change and heat stress makes migration more difficult (Matthews et al. 2004). In order to adapt, arrival date and nesting times of some common birds may start earlier in the year (Torti and Dunn 2005). Species with small population sizes and low genetic diversity, such as the red-cockaded woodpecker, may not be able to adapt, making them susceptible to further population declines (Schiegg et al. 2002). On the other hand, populations of large mammals such as deer and bear may increase with warmer winter temperatures due to a higher winter survival rate (Ayres and Lombardero 2000).

Recreation

Environmental changes may negatively impact recreational experiences due to changes in the plant and animal communities that make those recreational experiences unique (Joyce et al. 2009; Irland et al. 2001). Fishing in coastal marshes could be affected as intense storm events and rising sea levels may lead to degraded habitat conditions for game fish (Najjar et al. 2000). More days above freezing could increase tick and mosquito populations throughout the year (Erickson et al. 2012; Runyon et al. 2012). With more days with extreme heat, recreation areas could see decreased use in the summer if temperatures impact visitor comfort (Richardson and Loomis 2004; Scott et al. 2004).

Management Implications

Federal guidance includes building or maintaining resistance and resilience to disturbances that could potentially affect large areas. The focus of this analysis is on how vegetation (specifically composition and structure) influences disturbance and disturbance influences vegetation (composition and structure). In the context of climate change, management strategies build and maintain resistance and resilience at the stand level and at the forest level (landscape) See Table 3-4 for stand and landscape management actions to build resistance and resiliency to potential climate change impacts and the resulting disturbance.

Predicted climate change impacts may result in drastic alterations in disturbance regimes as follows:

- It is anticipated that fire will occur on the Francis Marion, but the severity and intensity of a wildfire may increase with warmer temperatures and drier conditions;
- In South Carolina, Southern pine beetle outbreaks typically occur every 2 to 7 years, but under a changing climate these outbreaks could occur more frequently or over a larger area; and
- The intensity and severity of storms (hurricanes and tornados), droughts or floods may increase.

Cumulative Effects

Carbon Storage and Sequestration

Keeping forests as forests is one of the most cost-effective carbon storage measures. Restoration of badly disturbed forests and grasslands back to producing a full range of environmental services is another. Ensuring rapid regeneration after disturbance is especially important for retaining carbon in the forest landscape. Maintaining forest health through appropriate fire, insect, disease and invasive species management also has strong carbon storage and protection benefits. Understanding the consequences of harvesting, thinning and other vegetation management practices on forest carbon cycles will become more important as we evaluate options. Even though practices such as thinning and prescribed fire may release carbon in the short term, they focus growth and storage for the future on trees that are at lower risk and more resilient to disturbance.

Climate Change

Maintaining highly functioning ecosystems across the landscape is the most effective response to potential changes in climate. Partnerships with adjacent landowners that create avenues or mitigation corridors for species migration is critical. These corridors may prevent pockets of isolated species. The South Atlantic Landscape Conservation Cooperative, along with partners, is creating a regional plan to promote conservation across a multi-state landscape. The Forest Service is an active partner that links the Francis Marion to the broader landscape.

Another initiative, Green Infrastructure, also creates ecosystem linkages, but at a county level. Currently Berkeley County is completing a green infrastructure initiative. Forest Service personnel are linking the Francis Marion and creating migration corridors to the broader landscape through this effort as well.

3.2.5 Watershed and Water Resources

This section provides information on water resources and disclosure of effects of each alternative. Water resources include a number of resources and habitat within each watershed. The discussion includes: watersheds; rivers and streams; riparian areas, wetlands, and floodplains; water quality; water quantity; and watershed health. Groundwater is discussed in section 3.2.2 “Geology and Groundwater.” The watershed condition framework is explained and discussed in detail at the end of this section under “Watershed Health” (USDA Forest Service 2011c). Much of the information and references for this section are contained in the Francis Marion National Forest Plan Assessment, a companion document with detailed information used to develop the forest plan revision (USDA Forest Service 2013

3.2.5.1 Watersheds: Affected Environment

Watershed boundaries are classified and defined by hydrologic unit codes (Eidson et al. 2005). The unit code numbering system developed by the U.S. Geological Survey classifies watersheds by size from region to subwatersheds. The Francis Marion falls within the Middle Atlantic Coastal Plan Ecoregion in the hydrologic boundaries of the Santee River, Cooper River, and the associated Coastal subbasins, with code numbers 03050112, 03050201, and 03050209 (Eidson et al. 2005).

A comprehensive assessment of Coastal, Cooper, and Santee River subwatersheds provides an overall assessment of watershed condition, historical land use, water impacts from management activities, and physical descriptions of imbedded watersheds. A detailed description of each

watershed is provided in this process paper, titled "Template-Ecological Sustainability Evaluation (ESE) Tool Preliminary Assessment-Coastal Cooper and Santee River Subwatersheds" (Hansen et al. 2013).

Figure 3-7 outlines waters flowing to the Cooper River, Santee and Coastal Waters. Color changes indicate elevation differences (high to low of gray, brown, yellow, green and blue) with abrupt curvilinear coastal features demarking the marine terrace scarps and riverine systems eroded into and embedded within them.

Watershed Health: Watershed Condition Framework

Watersheds on the Francis Marion National Forest were evaluated under the Watershed Condition Framework, a methodology that characterizes watershed condition based on watershed characteristics, and attributes. The purpose of the Framework is to assess, and document watershed health, and conditions across a forest and use this information to establish priority watersheds that require restoration. The Watershed Condition Framework classifies watershed condition, develops restoration in priority watersheds, and monitors accomplishments. (USDA Forest Service 2011a, 2011b, 2011c).

There are 27 6th-level subwatersheds on the Francis Marion National Forest. Of the 27 subwatersheds, 21 were selected for Watershed Condition Framework evaluation—those with a watershed area greater than 5 percent of National Forest ownership. A Forest Service interdisciplinary team then evaluated subwatersheds that contained 20 percent or greater national forest lands to develop a list of priority watersheds that were candidates for restoration (Table 3-5). All watersheds were rated as fair based on moderate geomorphic, hydrologic and biotic integrity relative to their natural condition.

Table 3-5. Watersheds with greater than 20 percent National Forest ownership

6th Level Subwatersheds	12 digit hydrologic unit code (USGS)	National Forest Land	Percent of Total	Total Acres
Awendaw Creek	030502090201	21,948	85	25,676
Cane Pond Branch	030502010202	7,423	69	10,749
Dutart Creek-Santee River	030501120206	10,763	37	29,199
Echaw Creek	030501120205	19,684	69	28,400
French Quarter Creek	030502010305	4,953	26	19,344
Gough Creek	030502010303	6,336	51	12,454
Guerin Creek	030502010401	16,895	42	40,025
Headwaters of Wambaw Creek	030501120301	20,441	95	21,522
Nicholson Creek	030502010302	28,457	97	29,240
Outlet Wambaw Creek	030501120302	21,293	87	24,580
Quinby Creek	030502010304	14,066	62	22,682
Savanna Creek	030501120202	12,833	74	17,238
Turkey Creek-East Branch Cooper River	030502010301	16,159	98	16,508
Wadboo Creek	030502010203	20,840	61	34,413
Walker Swamp	030502010201	8,836	24	37,182
Wedboo Creek	030501120201	8,424	54	15,492

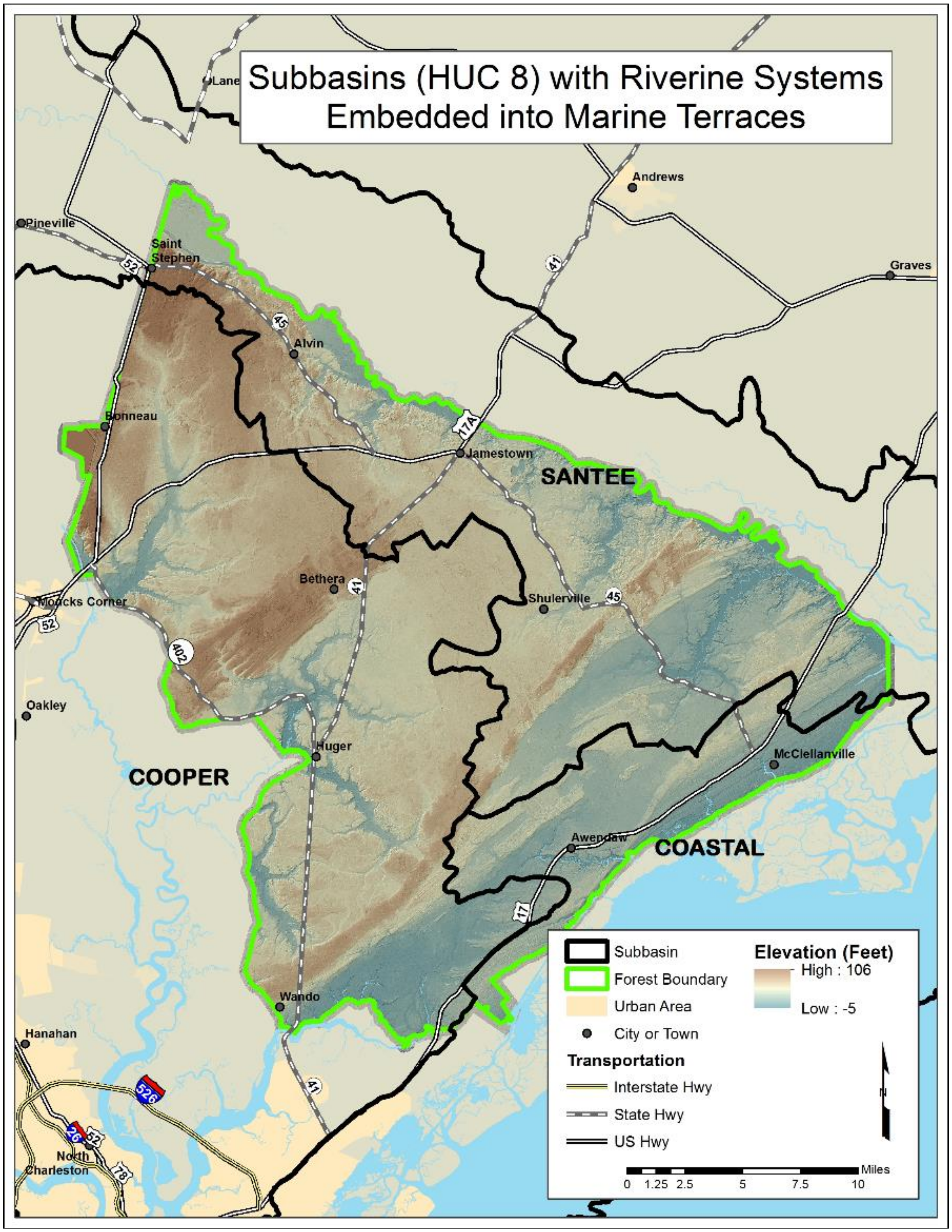


Figure 3-7. Three major subbasins within the Francis Marion National Forest

Priority Watersheds

Three priority watersheds were identified through the Watershed Condition Framework process: the headwaters of Wambaw Creek; Turkey Creek/East Branch of Cooper River, and Guerin Creek (Figure 3-8). A detailed description of each watershed is provided in a process paper, titled "Template-ESE tool preliminary assessment-Coastal Cooper and Santee River Subwatersheds" (Hansen et al. 2013). There is additional information in Francis Marion National Forest Assessment and in Appendix E.

The watershed restoration action plan for each priority watershed would include watershed improvements and restoration of hydrologic function planned in conjunction with road, infrastructure and vegetation management activities. Project-specific plans would be developed to correct many of the known impairments in the following three watersheds.

Headwaters of Wambaw Creek (95 percent National Forest). The Headwaters of Wambaw Creek is a 21,521-acre watershed with 133 miles of streams and 2.2 miles of road per square mile. There are human consumption advisories for most of the streams from methyl mercury contamination. The watershed has been modified by historical and active management that has impacted streams, habitat and hydrologic function. There are at least 56 hydrologic modifications related to road crossings, diking and other drainage interruptions that impair hydrologic connectivity. Restoration will focus on correcting the impairments in the watershed and improving water resources and habitat.

Turkey Creek–East Fork Cooper River (98 percent National Forest ownership). Turkey Creek is a 16,508-acre watershed with 95 miles of streams. There are funding opportunities from a number of planned timber management projects. There are ongoing hydrological and ecological opportunities for partnerships that make Turkey Creek an excellent candidate for successful restoration. These potential partners include the Santee Experimental Forest, U.S. Geological Survey, Clemson University, and the College of Charleston. Santee Experimental Forest has several long-duration climate and hydrologic research studies in this watershed, and the Santee Experimental Forest serves as the Atlantic Coastal Plain reference for hydrologic studies. The study areas are within a core burning area with endangered, threatened, and sensitive species including red-cockaded woodpecker. Restoration therefore benefits water resources and habitat for a number of biological species.

Guerin Creek (42 percent National Forest ownership). Guerin Creek is a large watershed with 40,000 acres, 242 miles of streams and 3.9 miles of road per square mile. This watershed is a priority candidate for hydrologic restoration due to species conversion and the presence of fresh water, brackish water, and salt water marsh areas for many at-risk amphibians. The watershed includes former rice culture fields where tidal action was restricted with dikes and water control structures. Portions of maritime forest and marsh have been bedded or drained and converted to pine plantations. An old railroad tram, which borders wetlands, lacks cross drains. This resulting interruption of hydrologic connectivity impacts breeding wetlands for amphibians. For these reasons, hydrologic restoration is a high priority in this watershed. While Guerin Creek is a priority watershed, designated habitat for the frosted flatwoods salamander is in a small portion of the French Quarter Creek watershed near the border. Therefore, this section of French Quarter Creek watershed will be included in the Guerin Creek watershed restoration action plan. See the Francis Marion Forest Plan, chapter 2 for a map showing the location of frosted flatwoods salamander designated critical habitat.

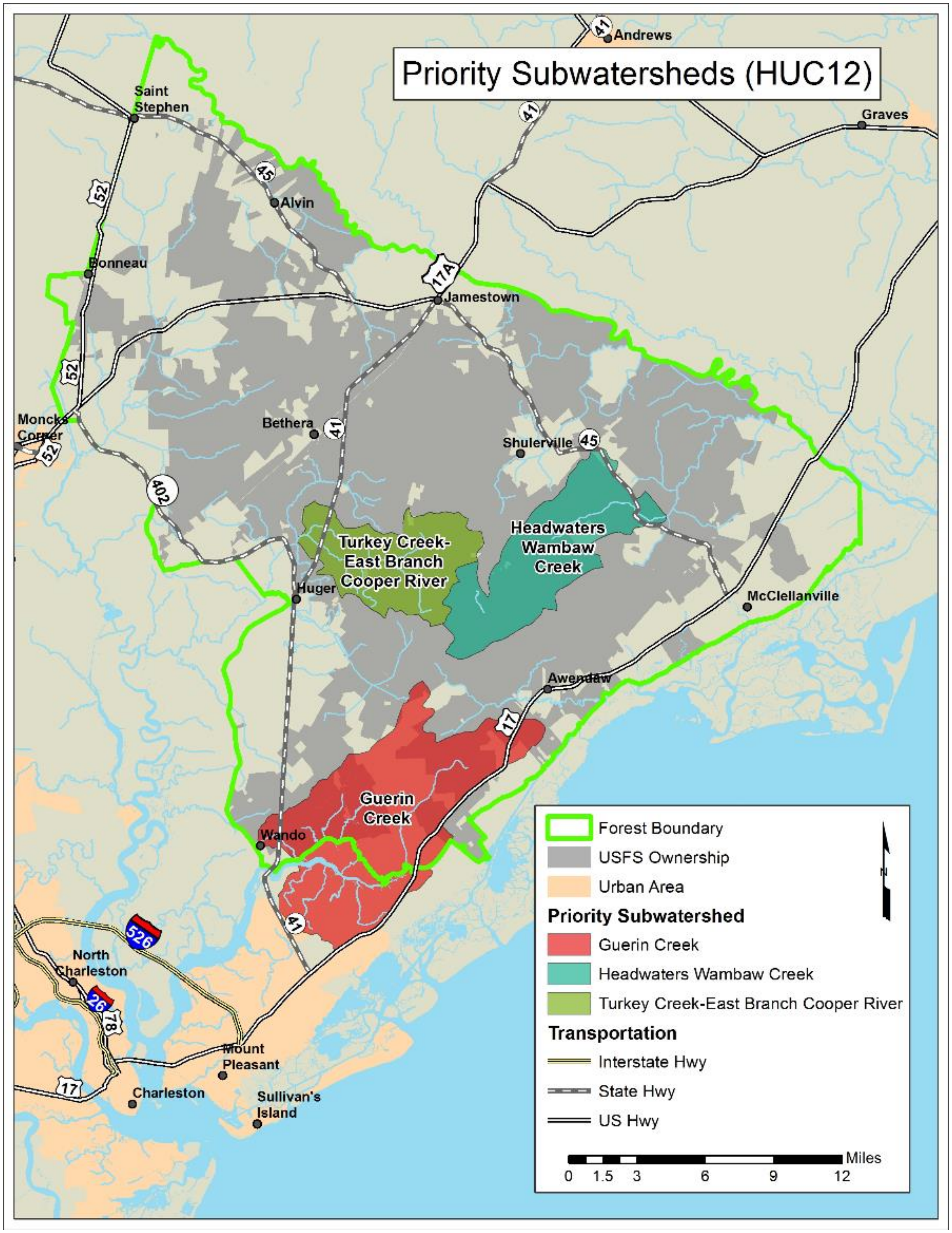


Figure 3-8. Three priority sixth-level sub-watersheds on the Francis Marion

3.2.5.2 Watersheds: Environmental Consequences

For water resources, effects are typically disclosed on an individual watershed basis, with distinct spatial, and temporal bounds that encompass a project or proposed action planned by national forest staff. Direct, indirect, and cumulative effects are disclosed for water resources within the watersheds (such as stream flow, water quality, and riparian areas). For planning purposes, rather than disclosing effects for watersheds as a whole, they are discussed individually in the riparian areas, water quality, and water quantity sections. See Appendix E of this document for additional information by watershed.

3.2.5.3 Rivers and Streams: Affected Environment

Much of the surface and subsurface hydrology on the Francis Marion is affected by the coastal geology, which includes a series of alluvial marine terraces, primarily sandy deposits that consist of scarps, barriers or dune-like structures, beaches, and relatively flat terrace landforms that align with the South Coastal coastal form. The marine terraces were deposited as the ocean levels contracted and expanded over time, leaving a series of relatively flat marine terraces as the defining terrain (Willoughby and Doar 2006; Doar 2013, 2014).

Stream types generally fall within the Rosgen classification system as (DA) low to very low gradient channels, and type (E), a pattern of sinuosity with unrestricted access to floodplains (Rosgen 1996). Descriptions of streams and habitat are discussed in detail in section 2.1.2.4 of the Francis Marion National Forest Plan Assessment (USDA Forest Service 2013).

Large rivers such as the Santee and Cooper had sufficient energy to break through the series of marine terraces. The Santee River borders the north end of the Francis Marion and the West Fork Cooper River is adjacent to the southern end. There are 2,499 stream miles within the administrative boundary and 1,460 miles on national forest land. Of the 2,499 stream miles, approximately 1,274 miles are perennial streams and 1,225 miles are intermittent streams. Rivers and streams and their connectivity to riparian areas, floodplains, and wetlands provide rich diversity of habitat for aquatic species and fauna.

Streams on the Francis Marion are primarily fresh water, with some tributary streams of the Santee, West Cooper, Wando Rivers and smaller coastal streams containing brackish waters during tidal cycles. Coastal Plain blackwater streams are low-gradient warm-water streams consisting primarily of pool habitat and little riffle habitat. They are tannic stained, and generally exhibit slow flows. These stream systems lack the turbidity of systems that originate outside the Coastal Plain area. Stream substrate is primarily sand or organic soils prone to displacement during storms. Historically, the entire national forest has had many hydrological modifications that have reduced habitat quality and connectivity for many aquatic species. The Francis Marion has more than 1,000 non-road hydrological modifications within the 27 subwatersheds associated with forest streams.

Dams are present in each of the 27 subwatersheds that contain national forest land. The number of dams range from 1 to 216 in a single watershed with the majority of watersheds containing more than 10 structures (Francis Marion and Sumter National Forests GIS 2013). The Santee River had sufficient base flow to provide freshwater to the ocean. However, the resultant dams and diversions reduced flows in the Santee River during baseflows (The Nature Conservancy 2005).

The Santee Dam hinders the migrations of native anadromous fish to their historic spawning grounds in the Piedmont. These include shad, striped bass, and sturgeon. In addition to the large

dam on the Santee River, there are numerous smaller dams and dikes throughout Forest watersheds that are barriers to fish movement. These smaller dams also create impoundments in natural stream systems. This results in a loss of habitat through the conversion of lotic habitat to lentic habitat, which favors competitive and often predacious species like largemouth bass and other centrarchids (Palmer et al. 2005).

Tidal Influenced Streams

The South Carolina Department of Natural Resources generally uses U.S. Highway 17 as the dividing line separating freshwater from saltwater. Approximately 179 miles of intermittent and perennial streams on the Francis Marion are estimated to have tidal influence with another 25 miles (mostly along the Santee River and the intra-coastal waterway) that border or are just outside the national forest proclaimed boundary. Tidal waters on the Francis Marion are located in the Salt and Brackish Tidal Marsh, Tidal Wooded Swamp and Maritime Ecosystems (Simon and Hayden 2013; Hansen et al. 2013). The State typically manages tidal lands and waters. They are classified for recreation, crabbing, fishing, shellfish harvesting, and human consumption, and therefore have anti-degradation limits set by the State.

Hydrologic modifications have also resulted in changes to some tidal streams and rivers (Logan 1859; Kemp et al. 2011; Berkeley County et al. 1963; Doar 2013). The largest hydrologic modification to the Santee and Cooper Rivers are associated with Lake Marion (Wilson) and Moultrie (Jeffries) dams, diversions, and re-diversion (St. Stevens). The Santee River Dams have reduced baseflows (The Nature Conservancy 2005) allowing salt water to move in well beyond the Santee Delta. Tributary waters such as Wambaw Creek, and Echaw Creek, once freshwater, have been affected as well. The Atlantic Ocean Intracoastal Waterway borders much of the Atlantic coast including portions of the east side of the Francis Marion National Forest. Awendaw Creek and Tibwin Creek have direct connections and Wando River has indirect connection through the Cooper River to the Intracoastal Waterway.

3.2.5.4 Rivers and Streams: Environmental Consequences

All Alternatives

At the forest plan level, desired actions are proposed to meet forest land management objectives, and effects are disclosed in general terms with estimations of “probable” effects. Direct and indirect effects at the project level, (where implementation occurs), are specific for an action where data related to that action and forest monitoring is more available and site specific. For all alternatives, management activities on national forest land, and continued growth and development on private land, have the potential for direct and indirect impacts to rivers and streams.

On national forest land, timber harvesting, recreation (campgrounds and trails), fire management, and roads all result in land disturbance (direct effect) and potential erosion and sedimentation (indirect effect) to rivers and streams (Swank et al. 1988). Effects from private land activities can generally be projected on the basis of historical impacts, and population growth or known future development. The Clean Water Act objectives of “restoring and maintaining the chemical, physical and biological integrity of the Nation’s Waters” are being carried out voluntarily with best management practices on private lands. National forests have developed standards and guidelines for the protection of rivers and streams. For example, in alternatives 2 and 3, streams are protected with specific riparian management zones that minimize pollution and maintain riparian areas and aquatic habitat. Furthermore, in 2012, the Forest Service published guidelines for “National Best Management Practices for Water Quality Management on National Forest

System Lands" (USDA Forest Service 2012) as guidance in developing protective measures to maintain and improve water quality. All national forests are instructed to follow the National Best Management Practices, including monitoring for compliance.

On state and private forest lands, best management practices have been developed to protect water resources and control nonpoint source pollution, (typically sediment and pollutants, such as oil drips, brake dust, and other factors that are washed from roads, landings, and skid trails), as opposed to point sources from discrete outflow on industrial or urban sites. State monitoring programs have shown best management practices are effective in minimizing and preventing sedimentation and degradation of streams (Aust and Blinn 2004).

Given the effectiveness of these best management practices programs, none of the three alternatives should have long-term direct and indirect impacts to rivers and streams. Most importantly, future impacts will be mitigated by implementing project-specific best management practices and standards and guidelines. Most research indicates that water quality recovers within 2 to 5 years from forestry operations (Adams and Hook 1993; Adams 1994, 1996; Jones 2000; Sabin 2009; Aust and Blinn 2004).

Alternative 1

In alternative 1, the 1996 forest plan would continue to guide management of the forest. Current standards and guidelines would provide protection for riparian areas and wetlands. However, the 1996 plan provides no direction for restoration of hydrologic function. There is little focus or priority in alternative 1 to improve watershed condition or improve aquatic habitat. The effects of a non-focused approach to watershed improvement would result in less improvement to rivers and streams than alternatives 2 and 3. Without a proactive approach to improving hydrologic function, and connectivity, the impacts or effects from alternative 1 would continue at present levels. The effects would be related to erosion, sedimentation, and past impacts from watersheds that are in need of restoration. The 1996 plan does require compliance with the Clean Water Act and implementation of standards and guidelines to protect aquatic resources. However, under the 1996 plan, projects and programs would not emphasize or plan watershed restoration as an integral part of management or established priorities.

Alternatives 2 and 3

Alternatives 2 and 3 are similar regarding improvement of hydrologic function and watershed health. The proactive approach of identifying watershed improvement needs and correcting hydrologic problems caused by past management activities (like construction of roads) will result in overall improvement of streams and rivers. Additionally, using the watershed condition framework, these alternatives have identified priority watersheds for restoration. With a specific focus on watershed condition and improvement of hydrologic function, indicators for watershed health will improve, for instance, historic water flows are improved restored. Indirect and direct effects from vegetation management will be minimized through use of national and State best management practices. Use of best management practices will reduce sedimentation and maintain water quality coming off of national forest lands. Cooperative programs and continued research on management impacts will facilitate and augment watershed restoration.

Cumulative Effects for All Alternatives

Cumulative effects result from the additive impacts of other past, present and reasonably foreseeable future actions. Cumulative effects are difficult to estimate at the forest plan level where no specific project decisions are proposed. Estimates of effects are general and used to

compare alternatives. At the project level, cumulative watershed effects are refined using current information, existing data, past practices, known project effects, and more refined predictions of effects from ownerships besides national forest land.

The watershed serves as the spatial unit for analyzing cumulative effects. Rivers and streams will be somewhat impacted in the future due to private land activities, such as ditching and land use changes. Off-site forest developments can result in water flows being diverted through ditching and road construction, increased pollutants (for instance oil dripped on the road) from paved road runoff or increased sedimentation due to land clearing. They can have indirect effects to the rivers and streams that flow through national forest lands by affecting water quality and quantity. As noted in the affected environment section, regional water quality is already impacted by uses outside the national forest. The general predictions of those effects are based on historical information, existing condition from past actions, and trends.

The implementation of State and Federal regulations, best management practices and forest plan standards and guidelines on vegetation management practices should minimize cumulative effects on rivers and streams that run through national forest land. Private land cumulative effects may or may not follow existing trends of development and population growth, but could have indirect effects to water flows and water quality. Climate change may have synergistic effects as rivers and streams respond to increased development, land use changes and natural disturbance regimes (such as extreme weather events or insect outbreaks). See section 3.2.4 “Climate Change” for additional effects analysis on changing climate conditions, including sea-level rise and impacts to tidal streams. Cumulative effects from off-forest land uses will be lessened under alternatives 2 and 3 due to improving hydrologic function and watershed health.

3.2.5.5 Affected Environment: Riparian Areas (including Floodplains) and Wetlands

Riparian areas include bottomland hardwoods along streams, soils with flooding potential, and the 100-year floodplains along perennial and intermittent streams, including tidal channels that may have a mix of freshwater and brackish water. Hydric soils with linear depressions that have sufficient gradient to transfer flood or surface water during wet periods to streams are indicators as well. Riparian areas are integral to aquatic ecosystems, influencing temperature, habitat diversity, channel morphology, productivity and species diversity. Riparian areas also filter sediment and pollution from upstream disturbance such as road construction, trails and skid trails.

Freshwater wetlands have been modified since European settlement. Many forested wetlands on the Francis Marion were ditched and drained for rice fields prior to the end of the Revolutionary War (Porcher and Rayner 2001). Channeling and ditching for roads, infrastructure, and industrial logging from forested wetlands, were common practices at the turn of the century (Hester 1997; Conner et al. 2011). Soil disturbance that resulted in sediment in streams, wetlands, and riparian areas is evident on the Forest. See the Francis Marion Forest Plan assessment.

Forested wetlands include black water stream floodplains, large river floodplain forests, tidal wooded swamp forests, non-riverine swamp, wet pine or hardwood forests, and non-riverine basin swamp forests. Geographic Information System (GIS) data was used to estimate the extent of riparian areas, wetlands, stream, lake, and tidal margins. In 1996, 143,000 acres of wetlands were identified. More recently, based on GIS data, the estimate is approximately 153,000 acres including embedded streams, riparian, and wetlands.

Riparian areas were not specifically identified in the 1996 forest plan but a riparian management plan was developed with specific standards to protect riparian areas. See a description of Riparian guidelines and maps in the Francis Marion Forest Plan Assessment previously cited. The 1996 plan estimated the extent of potential wetlands as 140,000 acres based on the hydric soil coverage, a major determinant in delineating wetlands (U.S. Army Corps of Engineers 1987).

3.2.5.6 Environmental Consequences: Riparian Areas (including Floodplains) and Wetlands

Direct and Indirect Effects for All Alternatives

Riparian areas and wetlands are sensitive to human uses that are ground-disturbing, especially those activities that cause soil compaction or divert water flows. Activities involving concentrated people or animal uses, heavy equipment, or horses can cause excessive soil compaction or exposure. Indirect effects from these include restricted drainage, surface runoff, and excessive holding of water on the surface. Damage to tree and plant roots from compaction can reduce health and increase plant mortality.

Best management practices that limit impacts to water quality in rivers and streams include measures to protect the adjacent soil and water quality functions in riparian areas. Timing management activities to occur in dry conditions help limit these effects from ground-disturbing activities. Restrictions on soil moisture and proximity to streams may limit soil erosion and compacting. To further minimize impacts careful timing of activities and avoidance of activities during wet periods are required. Riparian timber harvesting can be problematic due to poor access and difficulty in getting equipment to the treatment areas, causing rutting or other issues. Aquatic and riparian restoration measures will, in most instances, time an activity to take advantage of working during dry periods or droughts to limit effects.

Alternative 1

Alternative 1 continues forest management under the 1996 forest plan. As with other resource areas, the 1996 plan did identify desired future conditions, but would provide direction for restoration of hydrologic function. Management would continue under current standards and guidelines but provide protection for riparian areas and wetlands. However, there is little focus or a priority in alternative 1 to improve watershed condition or improve aquatic habitat, although, properly functioning systems were mentioned as a desired condition. The effects of a non-action approach to watershed improvement would result in greater potential detrimental impacts to rivers and streams than alternatives 2 and 3. Without a proactive approach to improving hydrologic function and connectivity the impacts or effects from alternative 1 would likely continue at present levels.

Alternatives 2 and 3

Alternatives 2 and 3 includes more emphasis to restore and monitor water resources on the Francis Marion and would have a beneficial effect that is lacking in alternative 1. Much of the impact to water resources would be from activities outside of national forest land. The focus of alternatives 2 and 3 is on sustaining and improving watershed areas within national forest control while working cooperatively with other agencies and landowners to improve statewide watershed health, water, soil, and air quality. Restoration of fire-maintained ecosystems and wetland hydrologic function is the foundation of alternatives 2 and 3. For projects proposed under these two alternatives, management activities would improve hydrologic function, and water quality. Planned watershed restoration would improve riparian areas, wetlands, and habitats for aquatic

species, as well as at-risk amphibians. Three priority watersheds selected for improvement through the watershed condition framework process are examples of where improvements would be planned over the next decade as funding permits.

Cumulative Effects for all Alternatives

Cumulative watershed effects are predicted using current information, existing data, past practices, known project effects, and more refined predictions from private land actions. Cumulative effects for all three alternatives are not considerably different nor do they result in long term impacts. Past and present management activities on the Francis Marion and private lands have contributed sediment, changed the hydrologic regime, affected riparian areas, and impaired aquatic habitat. However, the watershed condition class of subwatersheds on the Francis Marion National Forest remains condition class 2 (functioning at risk) (USDA Forest Service 2013). Water quality meets State water quality standards except for those streams on the 303(d) list. The impairments causing these streams to be on the 303(d) list are generally not due to forest management but are due instead to off-site contamination from mercury and fecal coliform The 303(d) streams are discussed more fully in a later section.

Impacts to wetlands and floodplains are limited under Executive Orders 11990 (protection of wetlands) and 11988 (floodplain management). During project planning, specific requirements must be met before management activities can be implemented in wetlands and floodplains.

3.2.5.7 Affected Environment: Water Quality

For a discussion on groundwater see section 3.2.2 “Geology and Groundwater.”

The Clean Water Act (33 U. S. C. § 1251 et seq.) establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters. The Act was amended in 1987 to require the control of pollution in stormwater. The Act requires protection of the nation’s waters through required discharge requirements, development of best management practices and dredge and fill limits. National Pollutant Discharge Elimination System (NPDES) permits are required for discharges to the nation’s waters and impaired waters are identified and prioritized to meet total maximum daily loads (TMDLS). Water quality reports are prepared by the States and submitted to the Environmental Protection Agency (SCDHEC 2012c, 2012d). The 303(d) report identifies impaired waters for various water quality attributes or conditions. The 305(b) report describes the State’s water quality programs and reports the conditions of the State’s waters. See State of South Carolina, Integrated Report for 2012, Part I: Section 303(d) for a List of Impaired Streams.

The Environmental Protection Agency developed the NPDES permit system to regulate stormwater quality from publicly owned storm drain systems or point sources. These permits are generally delegated to the States. Non-point sources are regulated under section 319 that requires development of best management practices and monitoring to determine effectiveness.

Section 404 of the Clean Water Act establishes a program to regulate the discharge of dredged or fill material into waters of the United States, including wetlands. Activities in waters of the United States regulated under this program include fill for development, water resource projects (such as dams and levees), infrastructure development (such as highways and airports) and mining projects. Section 404 requires a permit before dredged or fill material may be discharged into waters of the United States, unless the activity is exempt from section 404 regulation (such as certain farming and forestry activities). Permits are under the authority of the Corp of Engineers.

Most of the State’s water is suitable for public-water supply, industrial use, and irrigation use. Aquatic life is supported in most of the State’s lakes, estuaries, and rivers. Across the Southeastern Coastal Plain water quality and habitat is generally poor, but the sources of concern are not related to management activities on the Francis Marion (EPA 2013).

Primary water quality impacts on the Francis Marion National Forest are associated with fecal coliform, methyl mercury, and sedimentation. Many streams in the coastal plains area are listed as impaired due to methyl mercury and fecal contamination. These impaired streams are on the Environmental Protection Agency’s 303(d) list and requires the development of total maximum daily loads (TMDLs) by State and Federal officials.

- Fecal coliform can affect recreational and shellfish gathering waters. Elevated fecal coliform can result from natural sources such as wildlife, as well as from man-made sources such as septic systems, sewage systems, and wastewater transmission and treatment facilities. The following are listed 303(d) stream segments in or near the Francis Marion: Awendaw Creek, Guerin Creek, Wando River, Turkey Creek, Cane Gully Branch, Wadboo Swamp, and Echaw Creek (SCDHEC 2012). Lakes Marion and Moultrie and other major streams are also impaired with fecal coliform.

- Mercury from coal burning in power generation is an air pollutant that can have a negative impact on rivers and streams. Mercury problems are common in the wetland-dominated, blackwater stream systems of the Southeastern and Northeastern United States. Wetlands, which are found throughout the Francis Marion National Forest, are important sinks for mercury, as well as sources of methyl mercury. Once mercury deposition occurs, it may be transformed through sulfate reduction by wetlands into methyl mercury, which bio-accumulates in the food chain and concentrates in fish. Due to the abundance of wetland areas, conversion, and accumulation of mercury may begin on the national forest and continue downstream through the biological food chain. Fish consumption advisories due to methyl mercury are common throughout coastal South Carolina, including rivers and streams on the Francis Marion. The entire coastal marine and estuary areas have been under a water quality advisory for fish consumption by the South Carolina Department of Health and Environmental Control due to mercury levels. Lakes Marion and Moultrie, as well as some major streams, are also included in this advisory. Section 303(d) listings for stream segments in or near the Francis Marion National Forest due to mercury include: East Fork Cooper River near Quinby Creek, Wadboo Creek, Santee River below Wilson Dam, diversion and rediversion canals, and Wambaw Creek.

- There are no State water quality standards for sediment loading of streams, but the state does have turbidity standards. Turbidity can be impacted by sediment. However, no streams within the Francis Marion National Forest are listed as impaired due to turbidity. Water pollution from sediment on the Francis Marion is associated with prescribed burning, timber harvesting, road maintenance, and agriculture. Private land development and urban expansion are sources of sediment that affect water quality in rivers and streams. High suspended sediment loads and contaminants such as trace elements are typically associated with urban areas (White and Tittlebaum 1985).

3.2.5.8 Environmental Consequences: Water Quality

Direct and Indirect Effects for All Alternatives on Water Quality

Watershed improvement varies by alternative. Alternatives 2 and 3 emphasize the restoration of wetlands critical to at-risk amphibian species, and benefits to habitat for at risk species are anticipated. All alternatives would emphasize protection and improvement of riparian areas, wetlands and floodplains. Management activities consistent with best management practices and other protective measures will be implemented as described under the "Rivers and Streams" section.

However, alternative 2 may have greater benefits than alternative 3 with the emphasis on prescribed burning programs that improve overall habitat. In alternative 1, the forest plan would not preclude restoration, but provides no specific direction for improvement.

Water quality should be maintained over the next decade on the Francis Marion National Forest under all three alternatives. With the concern and focus on improving water quality on national forest lands, there should be no impairment to water quality under any of the alternatives. Effects will be determined and controlled at the project level. Timber harvesting, recreation use, prescribed burning, and road construction will continue under all alternatives, but adherence to National and State best management practices and forest plan standards and guidelines should limit impacts:

- Fecal coliform from human sources are controlled at recreation sites and other Forest Service areas that could potentially contribute fecal coliform. Sources of fecal coliform on national forest land, such as wild hogs or possibly livestock, have the potential to impact water quality. Feral hogs tend to concentrate in riparian areas where soil exposure, damage to riparian vegetation, and fecal pollutant delivery to streams is more likely. These impacts can affect recreational uses, such as swimming or the quality of drinking water. If grazing is used on national forest land, then mitigation measures to protect water quality and streams would be required. The level of fecal coliform is especially critical for the streams and tributaries that flow into shellfish gathering waters, but no impacts to shellfishing waters are anticipated. Vegetation management activities do not produce fecal coliform, so no impacts to shell fishing waters are anticipated.

- Wetlands, which are found throughout the Francis Marion National Forest, are important sinks for mercury and also serve as sources for methyl mercury. Once mercury deposition occurs, it may be transformed through sulfate reduction by wetlands into methyl mercury, which bio-accumulates in the food chain and concentrates in fish. Due to the abundance of wetland areas, conversion and accumulation of mercury may begin on the national forest and continue downstream through the biological food chain. Fish consumption advisories due to methyl mercury are common throughout coastal South Carolina, including advisories for rivers and streams on the Francis Marion National Forest.

- Sedimentation is related to logging, roads, trail crossings, and other management activities (Hansen et al. 1994). Potential sources of sediment from Forest Service activities include timber harvesting, recreation use, prescribed burning, and road construction, which will continue under all alternatives. However, implementation of National and State best management practices will serve to minimize non-point source pollution from national forest and private forest lands. Many water quality best management practices focus on techniques to exclude sediment from streams. These

include controlling erosion at its source and trapping sediment in natural barriers such as streamside management zones (Verry et al. 2000).

At the planning level, estimates of sediment are meant for comparison purposes only. For planning purposes sediment modeling was used to calculate background sediment and sediment production from management activities over the next decade. (Hansen, technical report unpublished, 2015). Background sediment yields are presented in Table 3-6 and sedimentation estimates (Table 3-7) by each alternative follow.

The predicted sediment estimates indicate that increased sedimentation over the next decade by each alternative is insignificant with only a 4.6 to 4.9 percent increase over background levels per decade (Hansen 2015). Therefore, the increased sediment in streams should not inhibit the movement of aquatic organisms and impair aquatic habitat. (Hansen 2016, Barnes et al 1997 and Meyer et al 1999). In alternatives 2 and 3, riparian management zones for perennial and intermittent streams, and forestwide standards and guidelines (chapter 4 of the forest plan) will prevent or lessen any direct and indirect effects from erosion and sediment. Alternative 1 follows the 1996 forest plan that mandates the implementation of standards and guidelines and best management practices but does not focus on improvement of watersheds as a priority.

Table 3-6. Estimated sediment delivery to streams from NFS and private lands based on land use activities over the next decade [1]

6th Level Sub-watershed	Total Sediment Yield (tons per decade)	Sediment from NFS Lands (tons per decade [%] of total sediment)	Sediment from non-NFS Lands (tons per decade [%] of total sediment])	Tons per acre per decade NFS Lands	Tons per acre per decade non-NFS Lands
Awendaw Creek	1,962	1177 [60]	785 [40]	0.05	0.21
Cane Pond Branch	1,027	362 [35]	665 [65]	0.05	0.20
Dutart Creek-Santee River	3,870	539 [14]	3331 [86]	0.05	0.18
Echaw Creek	3,427	1377 [40]	2050 [60]	0.07	0.24
French Quarter Creek	3,276	329 [10]	2947 [90]	0.07	0.20
Gough Creek	1,290	307 [24]	983 [76]	0.05	0.16
Guerin Creek	5,533	1132 [20]	4401 [80]	0.07	0.19
Headwaters of Wambaw Creek	1,656	1368 [83]	288 [17]	0.07	0.27
Nicholson Creek	1799	1674 [93]	125 [07]	0.06	0.16
Outlet Wambaw Creek	2,546	1790 [70]	756 [30]	0.08	0.23
Quinby Creek	2,673	1022 [38]	1651 [62]	0.07	0.19
Savanna Creek	1,876	656 [35]	1220 [65]	0.05	0.28
Turkey Creek-East Branch Cooper River	1,773	1683 [95]	90 [05]	0.10	0.26
Wadboo Creek	3,732	1052 [28]	2680 [72]	0.05	0.20
Walker Swamp	11,242	663 [06]	10579 [94]	0.08	0.37
Wedboo Creek	2,806	642 [23]	2164 [77]	0.08	0.31

[1] Information presented is for sub-watersheds with 15 percent or greater National Forest System lands.

Table 3-7. Predicted sediment increases in tons per decade

Alternatives	Alternative 1 (No Action)	Alternative 2 (Proposed Action)	Alternative 3
Predicted increase in from all sources	5,740	6,056	5,918
% Increase of predicted sediment load by alternative	4.6	4.9	4.7

Cumulative Effects

Research and studies have shown that correcting water quality problems is a major issue for the State and for the Francis Marion National Forest (Bard et al. 2004). Mercury from coal burning used in power generation is an air pollutant that can have a negative impact on water quality. Mercury is problematic in black water streams. Streams that are impaired with methyl mercury and fecal coliform are best controlled through interagency cooperation and control of contributing sources. Planned TMDLs will be a useful instrument to deal with mercury and fecal coliform. Because of off-forest land uses, reducing both mercury and fecal coliform effects will best occur through South Carolina State water quality programs. Mercury might also be reduced through cooperative programs with other agencies that control air pollution.

Results of the predicted sediment loads over the next decade show insignificant increases from national and private forest land activities by alternative. Table 3-7 presents the predicted increases in sediment by alternative for the next decade by alternative and includes all sources of sediment, including private land actions. As shown, the percentage of increase over the next 10 years is minor and should have no detrimental effects on water resources.

There are also research opportunities and partnerships with the Santee Experimental Forest, U.S. Geologic Survey, Clemson University, and the College of Charleston that should add to the knowledge base on improving water quality over the next decade.

3.2.5.9 Affected Environment: Water Quantity

The average water balance for the South Carolina Coastal Plains is 50 inches of rainfall, 30 inches of transportation, 10 inches of evaporation, and 10 inches of water yield with some loss due to seepage. Water balances are approximations and vary with land use patterns and year-to-year weather patterns. For example, annual variability in rainfall ranges from 30 inches in a dry year to over 80 inches in a very wet year (Amatya et al. 2008). The baseline for the Francis Marion is approximately 10 inches of water yield a year.

Forest management activities such as timber harvesting usually increase water yield temporarily until vegetation is restored. There are land uses such as urban development where hardened surfaces are permanent, and water yield can be changed permanently, affecting peak flows and timing.

Hydrologic modifications associated with Lake Marion (Wilson) and Moultrie (Jeffries) dams, diversion and rediversion (St. Stevens) have reduced freshwater delivery to the Santee River. In addition, historical agricultural uses have modified hydrologic functions and pathways across the forest (Trettin et al. 2008). Floodplains were historically used for rice cultivation and these areas now support bottomland hardwood forest. These diversion and distribution channels, along with dikes, still remain widespread on the Francis Marion National Forest. These features are affecting upland runoff processes including overland flow paths by directing water to reservoirs and ditches. These ditches can act as retention or storage areas during non-flood periods if the ditches are not linked back to the stream channel.

3.2.5.10 Environmental Consequences: Water Quantity

Forest management effects on water quantity are dependent on a number of factors and can only be generalized at the plan level.

An analysis of water yields for 27 subwatersheds on the Francis Marion calculated water yields from land use (Hansen 2015). The existing condition by subwatershed suggest water yield may increase somewhat. These estimated increases come primarily from roads, including construction and maintenance activities, and also from variances in land use such as agriculture and urban areas.

Modeling of water yield changes due to management activity can be used to generally compare alternatives. Existing water yield increases, and water yield increases from the proposed alternatives were calculated for the three alternatives (Hansen 2015). The highest increases in water yield are found where vegetation management and burning activities are concentrated. Turkey Creek is estimated at having the highest increases in water yield for alternatives 1, 2 and 3, ranging from 4 to 5 percent over the decade. These small increases should have no detrimental effect on water yields.

Most of the increases due to vegetation management should help support baseflow in streams due to lower transpiration during the growing season. In subwatersheds with very little national forest land, future private land uses and effects on water yield can only be generalized or estimated based on development and infrastructure. Activities on national forest lands are normally dispersed over time and across the landscape to minimize impacts to water yield. Based on the analysis of water yields and the use of mitigation measures, all alternatives should have no detrimental effect on water quantity.

3.3 Biological Environment

3.3.1 Ecosystems

To identify, map and describe ecosystems using the newest available information and technology available since 1996, ecosystems on the Francis Marion National Forest were classified at both the landtype association and the landtype levels (Simon and Hayden 2014). Criteria for these classifications follow the national framework of ecological units which the Forest Service developed in 1993 (Cleland et al. 1997) and included consideration of landform, soils, geology, and potential and existing natural vegetation.

Digital LiDAR mapping sampled soils, geology, and native vegetation at more than 1,000 points. Classification units followed NatureServe (2012), and considered land use history, ecosystem drivers, stressors, and natural disturbance regimes. Simon and Hayden, working with the Forest Service and NatureServe, identified and mapped 21 ecological systems on the Francis Marion National Forest, which were then grouped into nine more focused ecosystem groups; these ecosystem groups formed the foundation for developing restoration activities. A crosswalk of ecosystem groups, classification units identified by NatureServe, and ecosystems mapped by Simon and Hayden, is included in Appendix E. The ecosystem groups (hereafter called ecosystems) represent common and rare community types, both of which are important for sustaining ecological and species diversity.

Table 3-8 shows the ecosystems identified for the Francis Marion National Forest. These formed the basis for maintenance and restoration activities, for evaluating forest plan effects on ecosystem and species diversity and for interpretation of the natural range of variability. Desired conditions in the forest plan for ecosystem maintenance and restoration consider related biophysical setting descriptions from LANDFIRE (www.landfire.gov), ecosystem descriptions from NatureServe (2012) and ecozone descriptions from Simon and Hayden (2014). Associated documents in the process record and in Appendix E can be consulted for more detailed information on the composition, structure and function of both ecosystems and ecosystem groups.

Table 3-8. Ecosystems on the Francis Marion National Forest and surrounding areas; acreages shown for lands within the administrative and proclamation boundaries

Ecosystem Groups	Administrative Boundary	Proclamation Boundary
Upland Longleaf and Loblolly Pine Woodlands and Forests	51,500	100,400
Wet Pine Savannas and Flatwoods	86,200	128,400
Depressional Wetlands and Carolina Bays	8,700	11,800
Pocosins	9,200	11,000
Narrow Forested Swamps and Blackwater Stream Floodplain Forests	44,200	75,200
Broad Forested Swamps and Large River Floodplain Forests	49,200	68,100
Oak Forests and Mesic Hardwood Forests	5,800	10,000
Maritime Forests and Salt Marsh	4,000	11,400
Streams and Rivers	2,499 miles	1,460 miles
Total	**259,300**	**416,300**

3.3.1.1 Distribution, Extent and Trends of Ecosystems

Longleaf pine ecosystems once covered 90 million acres from Virginia to Texas (see Figure 3-9) and are the dominant ecosystem on the landscape occupied by the Francis Marion National Forest. By 1900, it was evident that longleaf pine replaced itself only sporadically in a tiny percentage of its former landscape; by 1967, loblolly pine plantations had been established on 12,460,000 acres throughout the southeast (Frost 1993). The near elimination of once dominant longleaf pine ecosystems was perhaps the greatest ecosystem alteration resulting from intensive forest management and land use conversion in the South (Wear and Greis 2012).

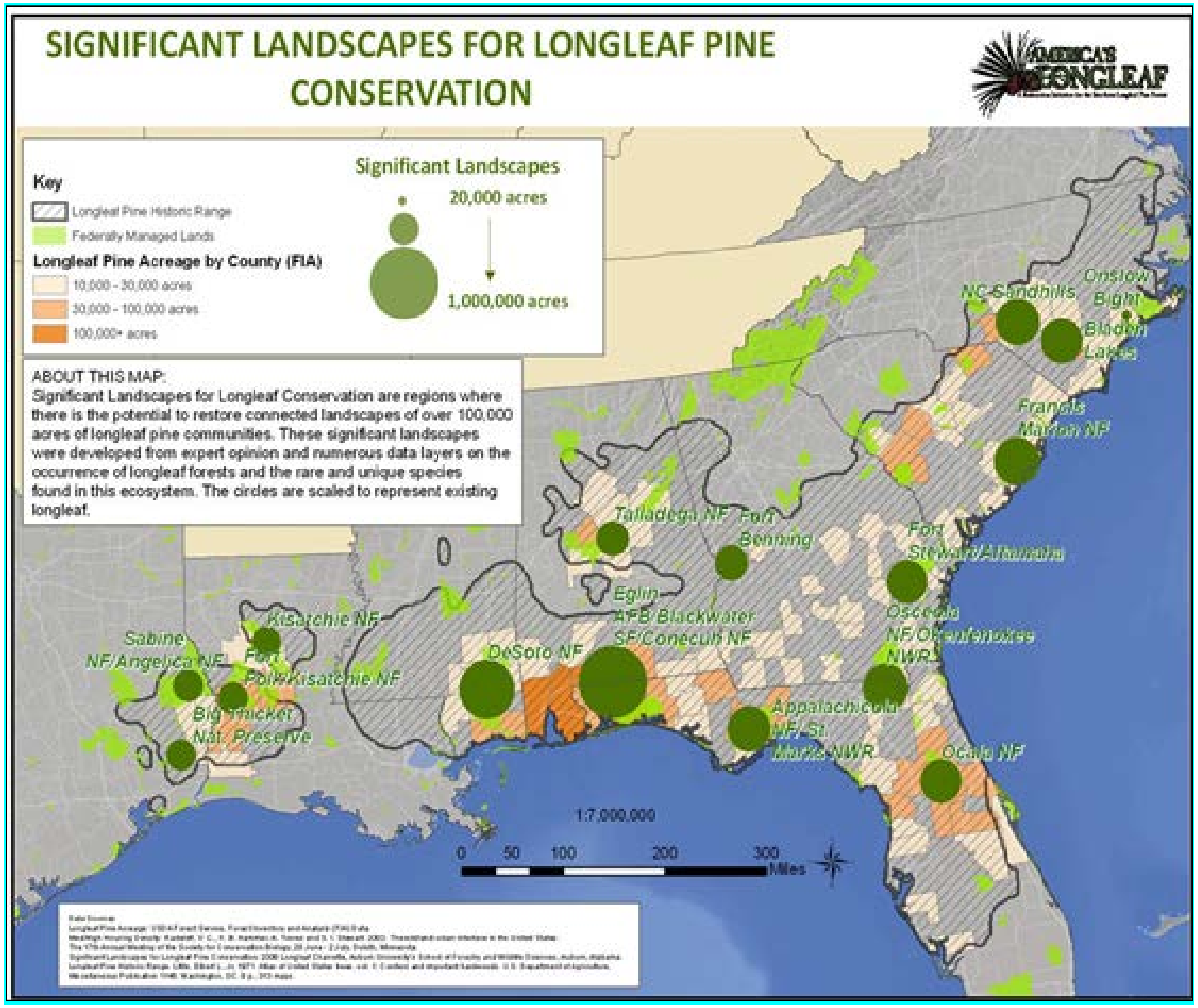


Figure 3-9. Significant landscape for longleaf pine conservation (America's Longleaf Restoration Initiative)

Since 1996, several initiatives have encouraged expansion of longleaf pine and associated fire-adapted ecosystems on the national forest. The Francis Marion is considered a significant landscape for longleaf pine conservation by the America's Longleaf Restoration Initiative (ALRI), a collaborative effort of multiple public and private sector partners that actively supports rangewide efforts to restore and conserve longleaf pine ecosystems (ALRI 2009). In addition, the Sewee Longleaf Conservation Cooperative encourages government agencies, nongovernmental organizations, private landowners, practitioners, and other stakeholders to reestablish, maintain, and enhance the longleaf pine ecosystem in the Sewee landscape (centered in and around the Francis Marion National Forest) through resource sharing, collaboration and applied learning.

Process for Evaluating Effects to Ecosystem Integrity and Sustainability

Steps used to build an ecological sustainability framework are documented within the ecological sustainability evaluation tool and described in Appendix E. Predictions were based on acreage in coarse filter maintenance and restoration management prescriptions, along with trends in those activities at 10- and 50- year intervals. Ecological composite scores were developed by multiplying indicator values by indicator weights then averaging. To evaluate ecological sustainability, planning biologists identified key characteristics for each ecosystem, identified measurable indicators for each key characteristic, weighted them in importance and defined ranges of acceptability for each ecosystem across each alternative, both at 10- and 50-year timeframes. This process is further described in Appendix E and within the ecological sustainability tool.

3.3.1.2 Affected Environment: Upland Longleaf and Loblolly Pine Woodlands and Wet Pine Savannas and Flatwoods

The Francis Marion National Forest is dominated by two longleaf-pine ecosystems, upland longleaf pine woodlands and wet pine savannas and flatwoods. Upland longleaf ecosystems occur on sandy ridges and are typically dominated by longleaf pine, whereas wet pine savanna and flatwoods ecosystems occur on wet, seasonally saturated mineral soils and can be dominated by longleaf pine, pond pine, or loblolly pine on wetter sites. Three upland longleaf variants and two wet pine savanna variants were mapped on the Francis Marion National Forest based on subtle differences in soil moisture and topography. Plant communities within each type differ in structure, in associated understory and woody species, and in moisture regime associated with soils and subtle changes in landform.

The updated ecosystem classification and mapping conducted in 2014 suggests that longleaf pine-dominated ecosystems once occurred on 53 percent of the Francis Marion National Forest (138,287 acres), including 20 percent (52,015 acres) as upland longleaf woodlands and 33 percent (86,272 acres) as wet pine savannas and flatwoods (Simon and Hayden 2014). The 1996 Francis Marion National Forest Revised Land and Resource Management Plan recognizes the importance of longleaf pine ecosystems, but estimates the range of longleaf pine historically on the Francis Marion National Forest at between 37,000 and 75,000 acres and the goal for longleaf pine ecosystem expansion at 21 percent of the forest. Dominant longleaf forest types or mixtures of loblolly pine with longleaf pine based on 2013 forest type data from FSVeg occur on 49,102 acres (19 percent of the forest).

Lack of frequent prescribed fire is a primary threat to longleaf pine ecosystem integrity, particularly to herbaceous understory communities (Glitzenstein et al. 2003, 2012). The Forest Service recognized the importance of frequent prescribed fire in maintaining longleaf ecosystems in the 1996 forest plan and included a standard that Management Area 26 have prescribed burning

on a 2- to 3-year rotation. However, from 2005 and 2012, 19,597 acres (36 percent) of potential and existing upland longleaf woodlands and 27,138 acres (15 percent) of the wet pine savanna and flatwoods ecosystem were burned 3 or more times (2- to 6-year burning rotation). The total acres burned on the Francis Marion have remained fairly constant, but have not met the long-term objectives for total burning and growing season burning within longleaf pine forest types (see section 3.4.2 “Community Wildfire Protection Planning”). Prescribed burning practices in the wildland urban interface have been particularly limited. Prescribed burning within the federally endangered red-cockaded woodpecker habitat management area has remained fairly constant at 50 percent, and the forest has burned approximately 30 percent of Management Area 26 on a 2- to 3-year rotation (USDA Forest Service 2008).

Longleaf pine is predicted to be most suitable species for climate change mitigation for the following reasons:

1. Superior tolerance to both drought and low soil nutrition;
2. Greater resistance to insects, diseases and wind damage;
3. Long rotations and long-term carbon storage; and
4. Less energy inputs relative to more intensively loblolly pine (Samuelson et al. 2012).

Reductions in the frequency of fires and hurricanes associated with climate change may push southeastern pine savannas towards a forested state with an increased overstory density and reduced understory component. Others predict that closed-canopy forests may be converted to savanna, woodland or grassland under temperature-induced drought stress and a significant increase in the intensity of fire disturbance.

3.3.1.3 Environment Consequences: Upland Longleaf and Loblolly Pine Woodlands and Wet Pine Savannas and Flatwoods

Alternative 1

Direct and Indirect Effects. Objectives and probable activities in the 1996 forest plan are listed on pages 2-2, S-3, S-4 and at the landscape level include prescribed burning, thinning and identifying and maintaining existing acreage in pine and pond cypress savanna, forested ponds, maritime forests, pocosins, calcareous mesic forests, and longleaf woodlands. Longleaf restoration activities would continue to emphasize maintenance and restoration of longleaf forest types on 53,500 acres, and dormant season and growing season burning on 260,000 acres and 40,000 acres for the next decade.

Longleaf pine ecosystem maintenance and restoration—including prescribed burning on a 2- to 3-year rotation–would continue within Management Area 26. Within Management Area 26, upland pine woodlands would continue on 38,053 acres (74 percent of the total extent) and wet pine savannas and flatwoods on 34,214 acres (40 percent of the total extent). Stand structure would remain open but range from 70 to 110 square feet, and 60 to 80 square feet in older stands, consistent with the record of decision for the management of red-cockaded woodpecker in the Southern Region (USDA, Forest Service Southern Region. 1995). Connectivity of longleaf ecosystems is fair to poor due to high levels of unpaved road densities. Non-native invasive species would continue to increase, as the 1996 forest plan does not include direction to prevent or treat them.

Indirectly, alternative 1 would benefit upland longleaf and loblolly woodlands, but stand canopies would remain too dense to promote the restoration of wet pine savanna ecosystems to sustainable levels. Although estimates for dormant season burning appear adequate, those for growing season burning fall well below what would be needed to maintain and restore herbaceous groundcover and maintain habitats (100,000 acres would be needed for the decade rather than 40,000 acres). The configuration of Management Area 26 does not promote sustainable levels of wet pine savanna ecosystem acreages; growing season burning objectives would fall below those which mimic natural fire regimes and promote functional ecosystems. Longleaf ecosystems would be stressed by non-native invasive species, and non-native invasive species would be expected to increase with climate change.

Cumulative Effects. Rangewide, pine woodlands, savannas, and prairies were given a “D+” (39-20 percent in good condition), including a score of “F” for low road densities, “D-” for regularly burned habitat, and “D” for structural connectivity (South Atlantic LCC 2015). The wildland-urban interface between the Francis Marion and Charleston will continue to expand and challenge the agency’s prescribed burning activities in the future, particularly in and around state highways. This growth would influence the ability to conduct prescribed burning in Management Area 26. Between 2005 and 2012, only 36 percent of potential and existing upland longleaf woodlands and 15 percent of the wet pine savanna and flatwoods ecosystems were burned at the desired fire frequency, affecting vegetation condition, herbaceous groundcover and structural diversity. Partnership initiatives, such as the Sewee Longleaf Landscape Cooperative, would continue to provide incentives to private landowners in the short term to both burn and plant longleaf, but trends in the long term on private lands would remain uncertain.

Determination of Effects. In the next 10 to 50 years, it is anticipated that the direct, indirect, and cumulative effects of this alternative on the sustainability scores for upland longleaf and loblolly pine woodlands would be fair to poor (see Figure 3-10 and Figure 3-11). These low scores are primarily due to less frequent growing season fire, non-native invasive species prevention and control efforts, and connectivity stressors.

In the next 10 to 50 years, it is anticipated that the direct, indirect, and cumulative effects of this alternative on the sustainability scores for wet pine savannas and flatwoods will be fair to poor, given the following:

1. Less than 50 percent of the Francis Marion’s wet pine savannas and flatwoods occur in management area 26 and would be maintained at 2- to 3-year, fire-return intervals.
2. Savanna structure and composition would be less likely to be restored. These ecosystems would have a less open canopy, based on the management direction associated with the 1995 record of decision for red-cockaded woodpecker management.
3. The lack of more aggressive desired conditions, as well as lower maintenance and restoration objectives for wet pine savannas and associated ground-cover communities.

Alternative 2

Direct and Indirect Effects. Objectives and desired conditions would address the maintenance and restoration of upland longleaf and wet pine savanna and flatwoods ecosystem composition, structure, function, and connectivity. Direct, short-term impacts could result from activities associated with restoration, including prescribed burning, thinning, mastication, hydrologic restoration, and non-native invasive species control. Indirectly, stands restored to longleaf pine may occur at high densities or have a higher percentage of early successional condition. Longleaf and wet pine savanna ecosystems and associated species will be indirectly impacted or at least not

benefitted, and will lack the desired composition, structure, and function in management area 2 where, to supplement burning and reduce fuels away from management area 1, the agency would rely on mechanical and chemical means of woody treatment at wildland-urban interfaces, and selective treatments with herbicides. Recreational uses would continue to increase, but would be maintained at a sustainable and a dispersed level and could indirectly impact these systems on a localized scale.

Indirectly, upland pine woodland composition, structure, function, and connectivity would be maintained and restored on 33,500 acres (64 percent of the total extent) and wet pine savannas and flatwoods would be maintained, improved and restored on 58,100 acres (67 percent of the total extent) within management area 1. Canopies would be open with canopy closure typically less than 60 percent (40 to 70 square feet basal area) and as low as 10 square feet basal area in wet savannas. Groundcover would be predominantly native and herbaceous. Prescribed burning would mimic natural fire regimes within management area 1 and would include a 1- to 3-year interval of prescribed burning, as well as a growing season burn at least every third burn (approximately 360,000 acres of dormant season prescribed burning per decade and 100,000 acres of growing season burning). Flowering native plants are encouraged by frequent burning and result in diverse pollinator function including foraging habitat for a number of wildlife species.

Ecosystem connectivity stressors including unpaved road densities, paved road densities, and off-road vehicle densities, are expected to improve from fair in the next 10 years to good in 50 years, particularly along Cainhoy Ridge and Steed Creek Road, based on “OBJ-MUB-6. Comprehensive Roads Planning and Maintenance,” which would strive to improve ecosystem connectivity and desired conditions associated with “DC-SCC-2. Wildlife Species Sensitive to Road Use Associates.”

Impacts of non-native invasive plant species will be minimized by desired conditions and design criteria for ecosystems including “S34. Require equipment cleaning practices on equipment, using equipment cleaning clauses in contracts, permits and agreements, when moving equipment from areas infested with non-native invasive plants” (FSM 2903); “S36. Use plant materials that contain genetically appropriate native plant species when maintaining and restoring vegetation.” Use of non-native plants is allowed only when in compliance with Forest Service native plant policy (FSM2070), and “DC-THR-1. Non-Native Invasive Species Management.”

Cumulative Effects. Cumulative effects would be similar to those for alternative 1, although the agency would emphasize collaboration with other groups in its prescribed burning and fuel reduction activities. The wildland-urban interface between the Francis Marion and Charleston would continue to expand and challenge the agency’s prescribed burning activities in the future, particularly in and around state highways. The configuration of Management Area 1 would address many of the wildland-urban interface concerns and would allow the agency to focus our restoration efforts away from the wildland-urban interface and into the interior of the forest where the agency has had a history of prescribed burning. The Francis Marion National Forest would continue to be a significant area for longleaf ecosystem maintenance and restoration.

Partnership initiatives such as the Sewee Longleaf Landscape Cooperative would continue to provide incentives to private landowners to improve the structure and function of longleaf ecosystems on private lands. Prescribed burning trends in the long term would remain uncertain as the wildland-urban interface continues to grow and expand adjacent to the national forest.

Determination of Effects. In the next 10 to 50 years in alternative 2, both upland pine woodland and wet pine savanna ecosystems are likely to be maintained and restored at sustainable levels across the Francis Marion, based on management direction and ecosystem extent within management area 1. Estimates of ecosystem integrity show improved conditions under alternative 2 (Figure 3-10 and Figure 3-11).The majority of indicators are ranked good and very good, with the exception of unpaved open road densities, which were ranked poor, and anticipated to remain poor, within upland pine woodland ecosystems, since the existing road network may be needed for restoration and access.

Sustainability indicators are likely to improve after 50 years, for these reasons:

1. Restoration to achieve desired conditions and outcomes is likely to take years to achieve; and
2. The agency is limited in its capacity to implement the restoration of longleaf forest types in the next 10 years alone.

Alternative 3

Direct and Indirect Effects. The primary difference between Alternatives 2 and 3 is the configuration of Management Area 1, where fire-adapted ecosystems such as pine woodland and savanna maintenance and restoration is emphasized, is somewhat smaller under this alternative than alternative 2. Upland pine woodlands would be maintained and restored on 26,283 acres (51 percent of the total extent) and wet pine savannas and flatwoods would be maintained, improved and restored on 49,789 acres (58 percent of the total extent) within Management Area 1. Canopies would be open with canopy closure typically less than 60 percent (40-70 square feet of basal area) and as low as 10 square feet of basal area in wet savannas. Groundcover would be predominantly native and herbaceous.

Cumulative Effects. The wildland-urban interface between the Francis Marion National Forest and Charleston would continue to expand and would challenge the forest's prescribed burning activities in the future, particularly in and around state highways. The configuration of Management Area 1 would address many of the wildland-urban interface concerns and would help to focus restoration efforts away from urban-interfaces and into the interior of the forest where the agency has had a history of prescribed burning. The Francis Marion National Forest would continue to be a significant area for longleaf ecosystem maintenance and restoration.

To supplement burning and reduce fuels, the agency would rely on mechanical and chemical means of woody treatment at the wildland-urban interface, as well as selective treatments with herbicides. Longleaf pine ecosystems, including both upland longleaf and loblolly pine woodlands, and pine savannas and flatwoods, would continue to be threatened on private lands. Partnership initiatives such as the Sewee Longleaf Landscape Cooperative would continue to provide incentives to private landowners in the short-term to both prescribed burn and plant longleaf. Prescribed burning programs and longleaf ecosystem integrity would continue to be threatened by an expanding wildland-urban interface.

Determination of Effects. In the next 10 to 50 years, it is anticipated that the direct, indirect, and cumulative effects of alternative 3 on sustainability of upland pine woodlands would approach be good to very good (see Figure 3-10 and Figure 3-11). Although less restoration would occur under this alternative, the categorical score used is the same as that for alternative 2 (see appendix E for values). Approximately 58 percent of the ecosystem extent would be maintained and restored in this alternative, and connectivity stressors would remain fair.

In the next 50 years, it is anticipated that the direct, indirect, and cumulative effects of alternative 3 on the sustainability of wet pine savannas and flatwoods would approach very good, since the desired condition is that 58 percent of the ecosystem extent would be maintained and restored in this alternative.

Composite Alternative Sustainability Ranking for Upland Longleaf Woodlands and Wet Savannas and Flatwoods

Figure 3-10 compares the sustainability of upland longleaf and loblolly pine woodland ecosystems across all three alternatives. Figure 3-11 compares the sustainability scores for wet savannas and flatwoods systems.

Key characteristics and indicators for evaluating the sustainability of upland longleaf woodlands and wet pine savanna ecosystem groups are described in appendix E and are listed in Table 3-9. The key characteristics and indicators in Table 3-10 were determined to be important, but were not used due to lack of data.

Both alternatives 2 and 3 were ranked good in terms of sustainability both at 10 and 50 year ranges. All indicators are predicted to increase to good or very good after 50 years of implementation based on management direction in alternative 2 and 3, with the exception of unpaved road densities. Alternative 2 would provide desired conditions for maintaining and restoring 64 percent of the total extent of upland longleaf ecosystems on the Francis Marion with prescribed fire and other tools, compared to 36 percent in alternative 1 and 51 percent of the total extent in alternative 3. Ecosystem connectivity stressors including unpaved road densities are expected to only improve slightly under alternative 2, increasing to good on wet pine savanna sites, particularly along Cainhoy Ridge and Steed Creek Road, based on "OBJ-MUB-6. Comprehensive Roads Planning and Maintenance," which would strive to improve ecosystem connectivity and desired conditions associated with "DC-SCC-2. Wildlife Species Sensitive to Road Use Associates," and guideline G32. The allocation of management area 1 in alternative 2 would most closely match the agency's ability to prescribe burn on the Francis Marion within the last decade, and would be anticipated to do so in the next 10 to 50 years of implementation.

In alternative 1, the key characteristics related to connectivity, composition, non-native invasive species, and structure were ranked poor to fair in terms of ecological sustainability across the landscape at both 10- and 50-year intervals.

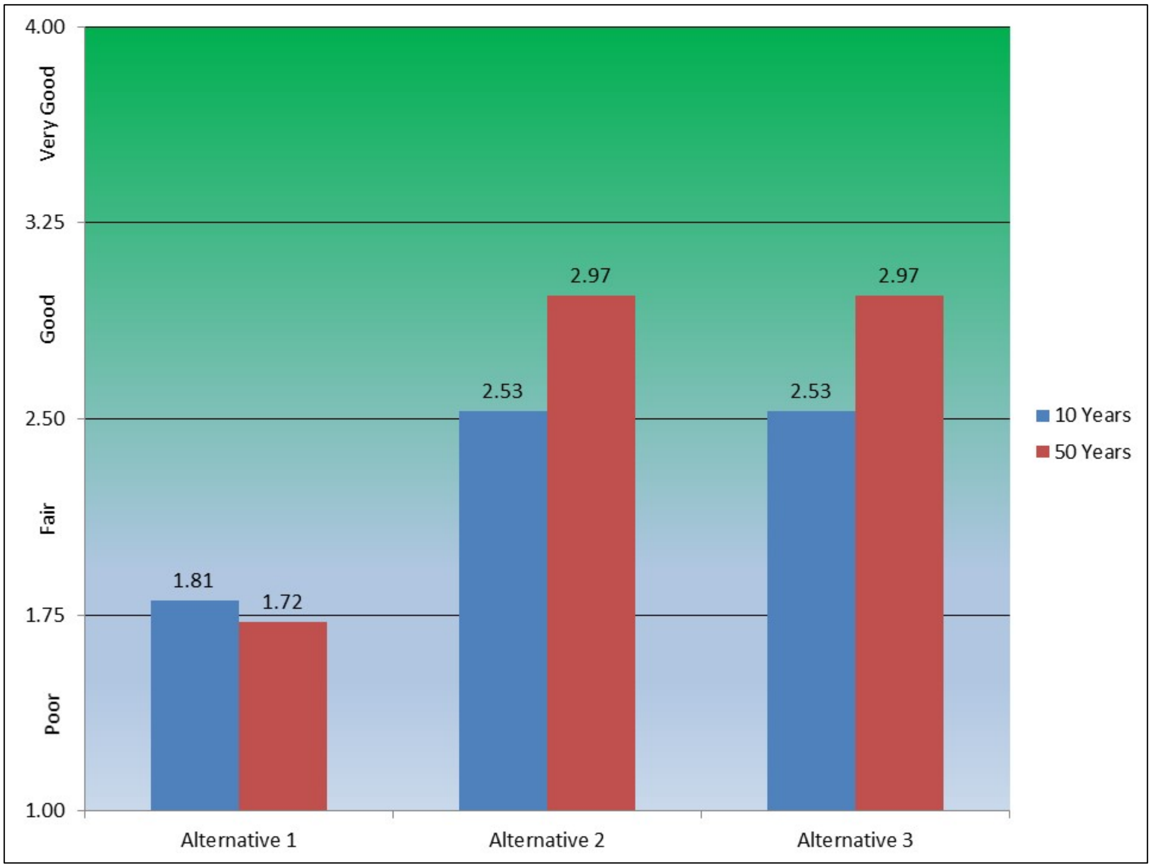


Figure 3-10. Forestwide upland longleaf pine woodland ecological sustainability scores

Table 3-9. Key characteristics and indicators for evaluating the sustainability of upland longleaf woodlands and wet pine savanna ecosystems

Key Characteristic	Indicator
Connectivity	Off-Highway Vehicle (OHV) Trail Density
Connectivity	Paved Open Road Density
Connectivity	Unpaved Open Road Density
Function	Percent of System Acres Burned at Desired Natural Return Interval
Function	Percent of System Acres Burned at Desired Growing Season Fire Return Interval
Stressor	Percent of Ecosystem Extent Impacted by Non-Native Invasive Plants
Structure	Percent of Ecosystem likely to provide for Old Growth
Structure	Percent Landscape Structural Departure from Natural Range of Variation
Structure	Percent of Ecological System in Open Woodland, Savanna, or Grassland
Composition	Percent of Ecosystem in “Maintain” Condition Class
Composition	Percent of Ecosystem Extent in Characteristic Native Forest Types

Table 3-10. Key characteristics and indicators for evaluating the sustainability of upland longleaf woodlands and wet pine savanna ecosystems that were determined to be important but were not used due to lack of data

Key Characteristic	Indicator
Composition	Relative Abundance of Native Herbaceous Groundcover
Composition	Relative Abundance of Native Forbs and Legumes
Stressor	Percent of Ecosystem Extent Impacted by Feral Hogs
Stressor	Percent of Ecosystem Extent Impacted by Fire Ants

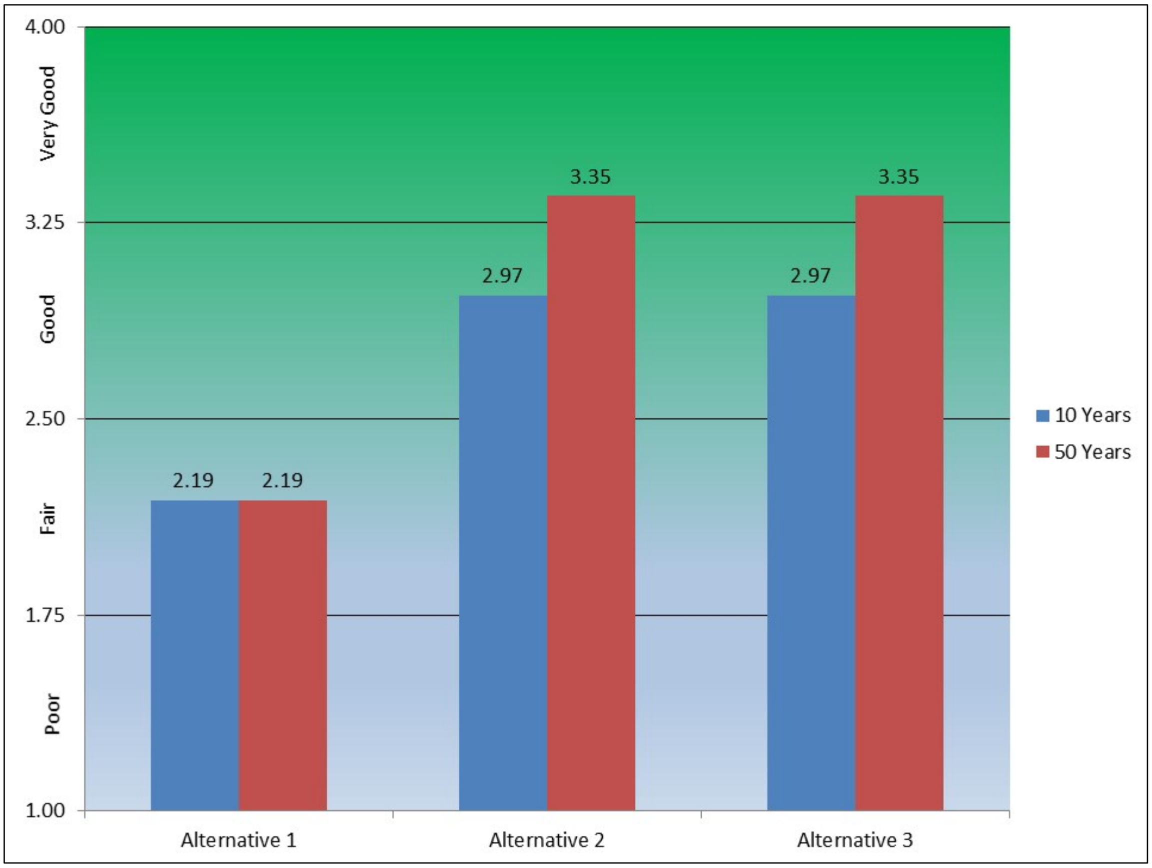


Figure 3-11. Forestwide wet pine savanna and flatwoods ecological sustainability scores

3.3.1.4 Affected Environment: Depressional Wetlands and Carolina Bays

The 1996 forest plan contains an objective to, "[I]dentify and maintain existing acreage in pond cypress/swamp tupelo pond, and pond cypress and pine savannas." With the use of LiDAR, Simon and Hayden (2013) identified 83 Carolina bays and 435 depression ponds within the proclaimed national forest boundary. The condition of select Carolina bays and depression ponds included as designated botanical areas, were monitored in 2012 (Everett 2010). Many are threatened by successional vegetation, lack of frequent prescribed fire, feral hogs and poaching associated pitcher plants and orchids (Everett 2012; Glitzenstein 2012). Other threats to depression ponds and Carolina bays on the Francis Marion include illegal off-highway vehicle use near Halfway Creek Road. On the Francis Marion, 33.5 percent of depressional wetlands and Carolina bays are in grassland, savanna, or woodland canopy cover based on analysis of 2009 LiDAR.

Carolina bays and depressional wetlands are palustrine wetlands, which contain a variety of vegetation types depending on fire regime and flooding depth and duration. Vegetation in Carolina bays and depressional wetlands can be pond cypress and swamp tupelo ponds, pond cypress savannas and non-alluvial swamps; however, in the lower coastal plain, pond cypress ponds and pond cypress savannas are most common (Bennett and Nelson, 1991). DeSteven (2006) found relatively few herb-dominated depression ponds on the Francis Marion; most of them were forested. Open Carolina bays and depression ponds provide critically important habitat for at-risk plant and amphibian species and rare plant communities. Much of the biodiversity is associated with fire-maintained ecotones (Kirkman et al. 1998), as well as open water breeding

habitat for amphibians. Pond cypress savanna vegetation is the most diverse (Bennett and Nelson 1991).

Frequent 1- to 6-year prescribed fire is an important process for maintaining and restoring an herbaceous component within Carolina bays and depression ponds and their ecotones (NatureServe 2012; DeSteven and Toner 2004), which provide habitat for a number of rare plant and animal species. Prescribed fire data for the Francis Marion suggests that 20 percent of Carolina bays and 38 percent of depression ponds are being prescribed burned at natural fire frequencies (three or more times between 2005 and 2012). Numerous depressional wetlands and Carolina bays are imbedded within Pleistocene terraces where fire would have occurred frequently, burning into the ecotones and often through the pond. Isolated wetlands and Carolina bays were historically protected from fire; old firelines can still be seen, fragmenting and decreasing diversity in the ecotone. In the absence of frequent fire, particularly during periods of drought, isolated wetlands acquire an evergreen shrub component and both loblolly pine and swamp tupelo can become established, shading out the herbaceous understory.

Everett (2012) and Glitzenstein (2012) note feral hog damage in many depression ponds and Carolina bays associated with rare plants. Table 3-11 provides a list of non-native invasive plants that have been documented from depressional wetlands and Carolina bays on the Francis Marion National Forest.

Table 3-11. Non-native invasive plants documented in depressional wetlands and Carolina bays on the Francis Marion National Forest (2013)

Latin Name	Common Name	Number of Records Documented
Albizia julibrissin	Mimosa	1
Lespedeza cuneata	Sericea lespedeza	3
Ligustrum sinensis	Chinese privet	11
Lolium arundinaceaus	Tall fescue	4
Lonicera japonica	Japanese honeysuckle	5
Lygodium japonicum	Japanese climbing fern	41
Melia azedarach	Chinaberry	1
Microstegium vimineum	Japanese stiltgrass	3

3.3.1.5 Environmental Consequences: Depressional Wetlands and Carolina Bays

Alternative 1

Direct and Indirect Effects. Under this alternative pond cypress savanna and cypress tupelo pond vegetation occurring within depressional wetlands and Carolina bays, would be maintained, but not restored. Although 80 percent of depressional wetland and Carolina bay ecosystems occur within Management Area 26, many would continue to be threatened by successional vegetation, lack of frequent prescribed fire, and feral hogs. Depressional wetlands and Carolina bays would not likely be directly impacted by restoration activities, but neither would they be benefitted. Indirectly, depressional wetlands and Carolina bays would be maintained on the national forest, but key characteristics of herbaceous groundcover and open canopy structure would be less likely to occur at sustainable levels, particularly in the ecotones. Lack of forest plan direction to restore these ecosystems, including restoration of ecosystem process (prescribed fire and growing season

fire), structure (open canopy structure), composition (many are invaded by shrubs and loblolly pine, and some by non-native invasive species), and connectivity (unpaved road density within 0.5 mile), could result in indirect effects and loss of ecological integrity.

Cumulative Effects. Forested wetlands including Carolina bays and pocosins were ranked “C” with 59-40 percent in good condition, across the central Atlantic coastal plain (South Atlantic LCC 2015). Depressional wetlands and Carolina bays would continue to be threatened on private lands. The majority of depressional wetlands and Carolina bays are not jurisdictional wetlands, and therefore likely to be threatened by non-native invasive species, fragmentation, and urbanization on private lands in the future. Climate change could lead to more forested and fewer herbaceous depressions, although the potential for more fires might be a counteracting force (De Steven and Toner 2004). With changes in climate, annual temperature and drought frequency would expected to increase which could favor succession to forests in these ponds (Stroh et al. 2008).

Determination of Effects. In the next 10 and 50 years, it is anticipated that the direct, indirect and cumulative effects of this alternative on sustainability of depressional wetlands and Carolina bays would be fair at both 10- and 50-year intervals, given that there would be no forest plan direction to restore them, using prescribed fire, nor invasive species and woody species management.

Alternative 2

Direct and Indirect Effects. Under this alternative pond cypress savanna and cypress tupelo pond vegetation occurring within depressional wetlands and Carolina bays would be maintained, improved and restored, particularly within Management Area 1, where frequent and growing-season natural fire regimes are likely to be restored within 73 percent of these ecosystems. Restoration activities, including mechanical or chemical selective control of unwanted or off-site woody vegetation (such as loblolly pine or red maple, wetland restoration, and non-native invasive species control) could modify composition and result in short-term direct impacts to these ecosystems. Restoration activities would be expected to indirectly benefit these ecosystems by improving composition, structure, function, and connectivity, particularly within Management Area 1. In Management Area 2, these ecosystems would be maintained and hydrology restored, but vegetation would be dominated by forests, whereas those in Management Area 1 by pond cypress savannas supporting habitat for at-risk plant and animal species.

Cumulative Effects. Forested wetlands including Carolina bays and pocosins were ranked “C” with 59-40 percent in good condition, across the central Atlantic coastal plain (South Atlantic LCC 2015). The majority of depressional wetlands and Carolina bays are not jurisdictional wetlands, and are more likely to be threatened by non-native species, urbanization and development on private lands in the future. Public lands are critically important to providing for these ecosystems and habitat types across the landscape. Climate change could lead to more forested and fewer herbaceous depressions, although the potential for more fires might be a counteracting force (De Steven and Toner 2004). Changes in climate, annual temperature, and drought frequency would be expected to increase which could favor succession to forests in these ponds (Stroh et al. 2008).

Determination of Effects. In the next 10 and 50 years, it is anticipated that the direct, indirect and cumulative effects of this alternative on the sustainability of depressional wetlands and Carolina bays would be highest in Alternative 2. Alternative 2 would provide desired conditions

for maintaining and restoring 73 percent of the total extent of Carolina bay and depressional wetland ecosystems on the forest with prescribed fire and other tools.

Alternative 3

Direct and Indirect Effects. Under this alternative pond cypress savanna and cypress tupelo pond vegetation occurring within depressional wetlands and Carolina bays would be maintained, improved and restored, particularly within Management Area 1, where natural fire regimes would be restored. Approximately 52 percent of the acreage extent of these ecosystems occur in management area 1 under alternative 3. Associated activities would be expected to directly and indirectly benefit these ecosystems, but over a lesser area than alternative 2. Depressional wetlands in the Wando Area would be threatened by lack of prescribed fire and successional vegetation since they would not occur in Management Area 1 in this alternative. Direct short-term effects to the composition ecosystems could occur as a result of mechanical or chemical selective control of unwanted or off-site woody vegetation, such as loblolly pine or red maple, wetland restoration, and non-native invasive species control. Associated restoration activities would be expected to directly and indirectly benefit the ecosystems particularly within Management Area 1 where prescribed fire would improve composition, structure, connectivity, and function, to include consideration of the ecotone.

Cumulative Effects. Depressional wetlands and Carolina bays would continue to be threatened on private lands. Public lands are critically important in providing for these ecosystems and habitat types across the landscape. Climate change could lead to more forested and fewer herbaceous depressions, although the potential for more fires might be a counteracting force (De Steven and Toner 2004). With changes in climate, annual temperature and drought frequency would be expected to increase which could favor succession to forests in these ponds (Stroh et al. 2008).

Determination of Effects. In the next 10 and 50 years, it is anticipated that the direct, indirect and cumulative effects of alternative 3 will result in depressional wetlands and Carolina bays which are ecologically sustainable, but to a lesser extent than in alternative 2. In alternative 3, 52 percent of the total ecosystem extent will be maintained or restored using prescribed fire and other tools.

Composite Sustainability Ranking

Key characteristic and indicators for evaluating sustainability of the Carolina Bay and depression pond ecosystems are described in Appendix E and are outlined in Table 3-12. The key characteristics and indicators shown in Table 3-13 were determined to be important, but were not used due to lack of data.

Sustainability rankings were highest in alternative 2. The acreage that would be maintained and restored in Carolina bay and depression pond ecosystems scores good in alternative 2 and to a more limited extent in alternative 3. Alternative 2 would provide desired conditions for maintaining and restoring 73 percent of the total extent of Carolina bay and depressional wetland ecosystems on the Francis Marion with prescribed fire and other tools, compared to 52 percent of the total extent in alternative 3. The 1996 forest plan (alternative 1) did not include direction to restore Carolina bays and depressional wetlands, though it did include direction to maintain them. In alternative 1, key characteristics related to unpaved open road density within 0.5 mile, natural fire regime, non-native invasive species at 50-year intervals, open canopy structural diversity, and composition all rank poor to fair. All indicators were predicted to be higher than alternative 1 after both 10 and 50 years based on management direction in alternatives 2 and 3.

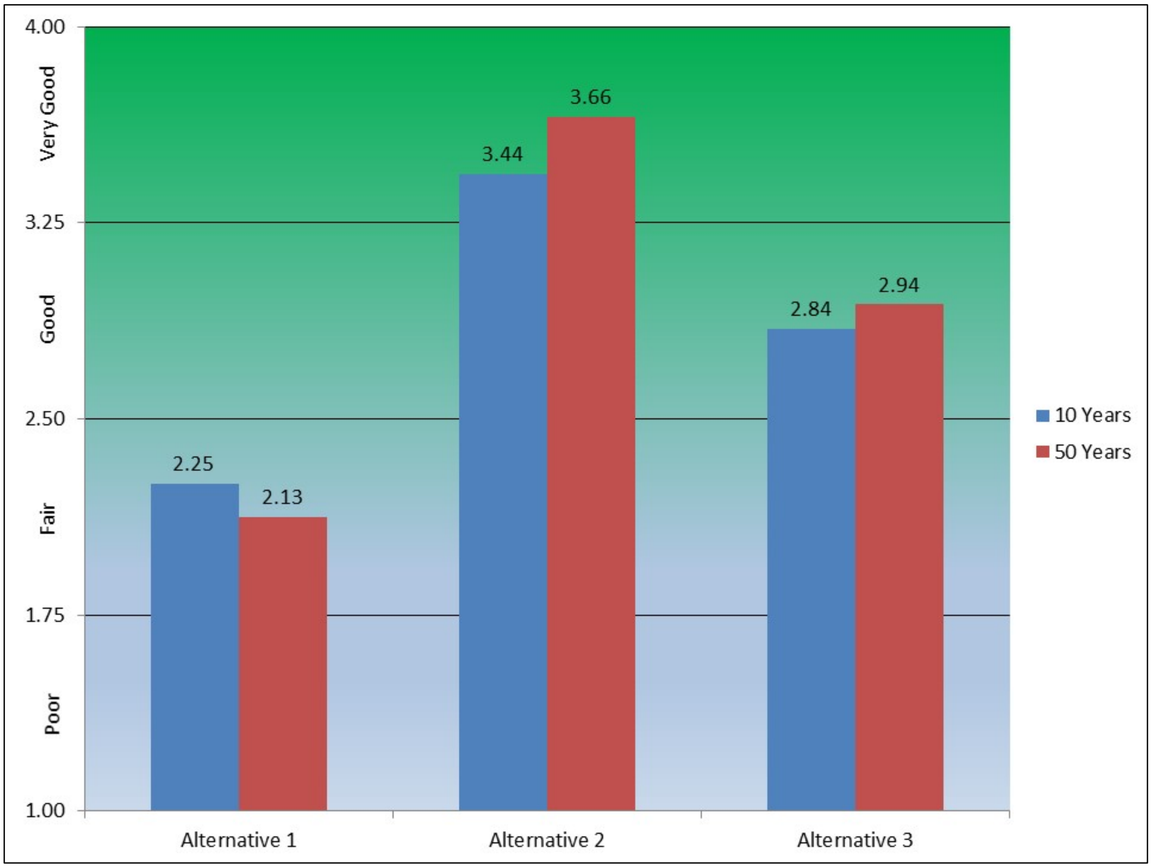


Figure 3-12. Forestwide depressional wetlands and Carolina bay ecological sustainability scores

Table 3-12. Key characteristic and indicators for evaluating sustainability of the Carolina Bay and depression pond ecosystems

Key Characteristic	Indicator
Connectivity	OHV Trail Density
Connectivity	Paved Open Road Density
Connectivity	Unpaved Open Road Density
Function	Percent of System Acres Burned at Desired Return Interval
Function	Percent of System Acres Burned During the Growing Season
Stressor	Percent of Ecosystem Extent Impacted by Invasive Plant Species
Structure	Percent of Ecological System Acres in Open Canopy Structure (Woodland, Savanna or Grassland)
Structure	Percent of Ecosystem likely to provide for Old Growth
Composition	Percent of Ecosystem Extent dominated by characteristic Native Forest Types

Table 3-13. Key characteristics and indicators that were determined to be important, but were not used due to lack of data

Key Characteristic	Indicator
Composition	Relative abundance of native herbaceous groundcover
Stressor	Severity of Hydrologic Control Structures
Stressor	Percent of Ecosystem Extent Impacted by Feral Hogs
Stressor	Percent of Ecosystem Extent Impacted by Fire Ants

3.3.1.6 Affected Environment: Pocosins

Examples of the ecosystems associated with pocosins occur in broad wetland areas, which include some areas on histosol (organic) soils, including peat-filled Carolina bays (Little Ocean Bay, Big Ocean Bay and Pamlico Soil Series). Streamhead seepage swamp, pocosin and baygall occur within dissected landscapes on sites saturated with shallow groundwater. Vegetation is predominantly dense evergreen shrubland and very shrubby open woodlands, ranging to nearly closed forests. Herbaceous associations are present only as small patches. Vegetation is typically zoned. The lowest stature vegetation occurs in the center of the system, with woodlands on the edges and in the smaller occurrences. Stands of switchcane may be common and extensive. Component communities tend to be low in plant species richness; woody species richness exceeds herbaceous in most associations, with herbs being limited to small open patches. Prescribed fire and flooding are the most important processes influencing the composition of these ecological systems. In the absence of prescribed fire, these ecosystems will succeed to tall pocosin, pond pine, and swamp forest ecosystems.

Natural fire return intervals for peatland pocosins range from a decade or two in the wettest areas to 1 to 2 years at ecotones with upland longleaf ecosystems and naturally have averaged 3 years (NatureServe 2012). Prescribed fire data for the Francis Marion suggests that 65 percent of pocosins are being prescribed burned at natural fire frequencies (three or more times between 2005 and 2012).

Select seepage bogs and pocosins were included as designated botanical areas in the 1996 forest plan (Little Ocean Bay, Morgan Creek Bog and Halfway Creek Pocosin) and monitored by Everett (2012). Monitoring of designated botanical areas and associated at-risk herbaceous plant species, including sweet pitcher plant (*Sarracenia rubra*) suggests that select pocosins and associated ecotones are threatened by succession, lack of frequent fire, feral hogs, poaching pitcher plants (Everett 2012) and diking or drainage on soils when wet potentially impacting hydrology. No non-native invasive plants have been documented from pocosins on the Francis Marion (2013).

3.3.1.7 Environmental Consequences: Pocosins

Alternative 1

Direct and Indirect Effects. The majority of pocosin ecosystems would be maintained but not restored based on the 1996 forest plan objective to "[I]dentify and maintain existing acreage in . . . bay swamp pocosin." Based on LiDAR, Simon and Hayden (2014) predict relatively modest acreage in peatland pocosin and canebrakes, pocosin vegetation in Carolina bays and streamhead seepage swamp, pocosin, and baygalls (9,322 acres).

Directly, pocosins are unlikely to be impacted by restoration activities, such as timber harvesting, fireline construction, selective herbicide application, or mechanical chipping. Many pocosins and associated ecotones would continue to be threatened by successional vegetation, lack of frequent prescribed fire, and feral hogs. Directly and indirectly, pocosins would be maintained on the forest, but key characteristics in regard to vegetation composition, herbaceous groundcover, fire regime and open canopy structure would be less likely to occur. In alternative 1, the 10-year predictions are sustainable or ranked “good” though their condition would be expected to decline in the 50-year interval due to lack of forest plan direction to restore them.

Cumulative Effects. Pocosins are typically non-jurisdictional, ephemeral wetlands and will continue to be threatened on private lands in the future. Public lands are critically important in providing for these ecosystems and habitat types across the landscape. Climate change could lead to more forested and fewer herbaceous depressions, although the potential for more fires might be a counteracting force (De Steven and Toner 2004). With changes in climate, annual temperature and drought frequency are expected to increase, which could favor succession to forests in these ponds (Stroh et al. 2008).

Determination of Effect. In the next 10 and 50 years, it is anticipated that the direct, indirect, and cumulative effects of this alternative on sustainability of pocosins under alternative 1 will be fair, given that there was no 1996 forest plan direction to restore them, particularly using prescribed fire.

Alternative 2 – Proposed Action

Direct and Indirect Effects. In alternative 2, pocosins would be maintained forestwide, and improved and restored using prescribed fire on 79 percent of the ecosystem extent within Management Area 1. Short-term direct impacts of restoration activities, such as mastication in the ecotone or wetland restoration, could occur, but the potential for short-term impacts on associated sensitive soils would be mitigated through forest plan design criteria. Dormant and growing season prescribed fire would be expected to directly and indirectly benefit these ecosystems, by improving composition and structure. Under this alternative, pocosins would be maintained, improved and restored, particularly within Management Area 1 where natural fire regimes would be restored. Within Management Area 1, restoration activities would be expected to directly and indirectly benefit these ecosystems. In Management Area 2, these ephemeral wetlands would be conserved but not restored using prescribed fire, which could result in more forested composition on a smaller proportion of the landscape where fire is not being used.

Cumulative Effects. Pocosins are typically non-jurisdictional, ephemeral wetlands and would continue to be threatened on private lands in the future. Public lands are critically important in providing for these ecosystems and habitat types across the landscape. Climate change could lead to more forested and fewer herbaceous depressions, although the potential for more fires might be a counteracting force (De Steven and Toner 2004). With changes in climate, annual temperature and drought frequency would be expected to increase which could favor succession to forests in these ponds (Stroh et al. 2008).

Determination of Effects. In the next 10 and 50 years, it is anticipated that the direct, indirect and cumulative effects of this alternative on sustainability of pocosins would be result in the highest levels of sustainability. Alternative 2 would provide desired conditions for maintaining and restoring 79 percent of the total extent of pocosin ecosystems on the Francis Marion with prescribed fire and other tools within Management Area 1.

Alternative 3

Direct and Indirect Effects. Under this alternative, pocosins would be maintained forestwide, and improved and restored within Management Area 1, where natural fire regimes would be restored. Few activities are likely to occur in pocosin ecosystems, other than frequent dormant and growing-season prescribed fire. These activities would be expected to directly and indirectly benefit these ecosystems. Design criteria would minimize any short-term impacts of wetland restoration or woody species control activities, particularly in the ecotones with upland ecosystems.

Cumulative Effects. Pocosins are typically non-jurisdictional, ephemeral wetlands and would continue to be threatened on private lands in the future. Public lands are critically important in providing for these ecosystems and habitat types across the landscape. Climate change could lead to more forested and fewer herbaceous depressions, although the potential for more fires might be a counteracting force (De Steven and Toner 2004). With changes in climate, annual temperature and drought frequency would be expected to increase, which could favor succession to forests in these ponds (Stroh et al. 2008).

Determination of Effects. In the next 10 and 50 years, it is anticipated that the direct, indirect and cumulative effects of this alternative on sustainability of pocosins would result in good ecologically sustainable conditions across the forest. Alternative 3 would provide desired conditions for maintaining and restoring 63.4 percent of the total extent of pocosin group ecosystems on the Francis Marion with prescribed fire and other tools within Management Area 1.

Composite Sustainability Ranking

The overall sustainability rankings for pocosins under the alternatives are shown in Figure 3-13. Key characteristics and indicators for evaluating sustainability of the ecosystems associated with the pocosin ecosystem group are described in Appendix E and are outlined in Table 3-14. The key characteristics and indicators in Table 3-15 were determined to be important, but were not used due to lack of data.

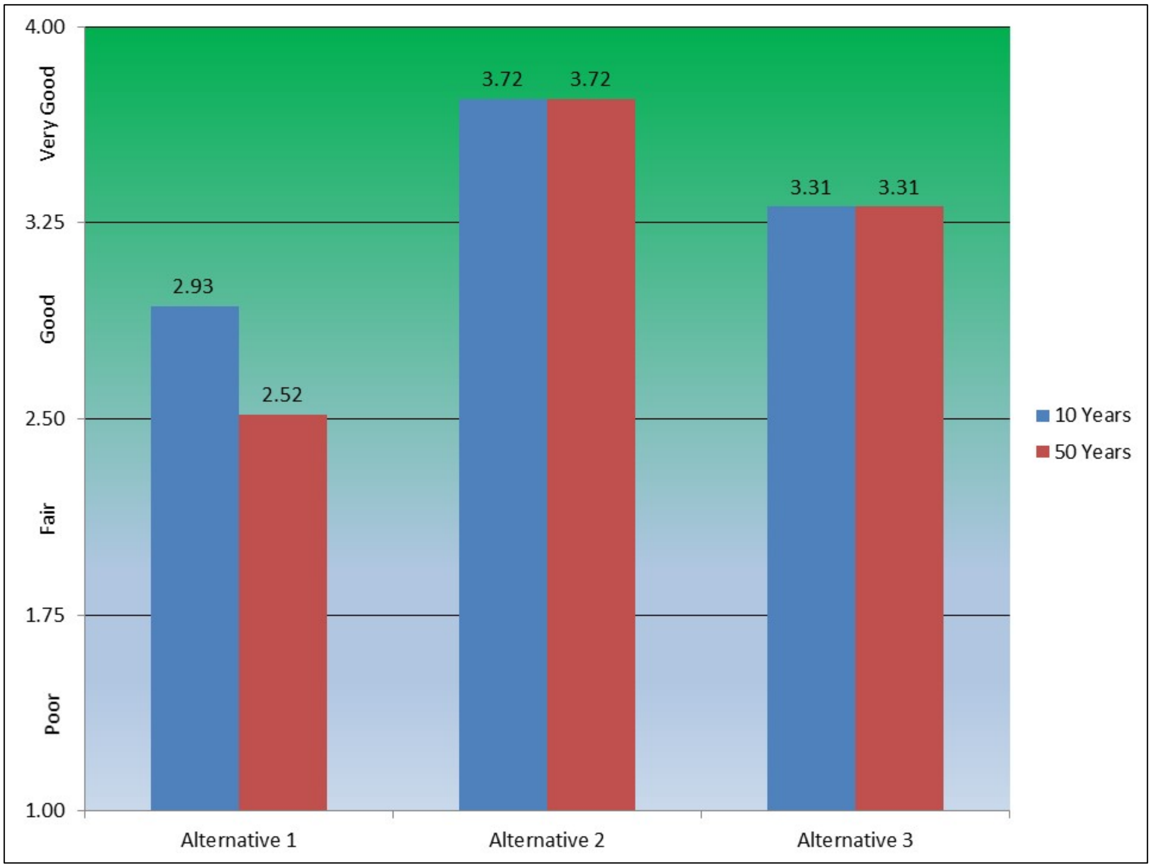


Figure 3-13. Forestwide pocosin ecological sustainability scores

Table 3-14. Key characteristics and indicators for evaluating sustainability of the ecosystems associated with the pocosin ecosystem group

Key Characteristic	Indicator
Connectivity	OHV trail density w/in 0.5 mile
Connectivity	Paved open road density w/in 0.5 mile
Connectivity	Unpaved open road density w/in 0.5 mile
Function	Percent of system acres burned at desired return interval
Function	Percent of system acres burned during the growing season
Stressor	Percent of ecosystem extent impacted by non-native invasive plant species
Composition	Percent of ecosystem extent dominated by characteristic native forest types

Table 3-15. Key characteristics and indicators that were determined to be important but were not used due to lack of data

Key Characteristic	Indicator
Composition	Relative abundance of native herbaceous groundcover
Stressor	Percent of Ecosystem Extent Impacted by Feral Hogs
Stressor	Percent of Ecosystem Extent Impacted by Fire Ants

In alternative 1, the 10-year predictions are sustainable or ranked “fair” though their condition would be expected to decline in the 50-year interval due to lack of forest plan direction to restore them. The acreage in pocosins would be maintained and restored in ecosystems associated with the pocosin ecosystem group scores good in alternatives 2 and 3. Alternative 2 would provide desired conditions for maintaining and restoring 79 percent of the total extent of pocosin group ecosystems on the Francis Marion with prescribed fire and other tools, compared to 63.4 percent of the total extent in alternative 3.

3.3.1.8 Affected Environment: Oak Forests and Mesic Hardwood Forests

Both dry and dry-mesic oak forests and mesic slope forests are relatively uncommon on the Francis Marion. They would have historically been limited in distribution to fire-sheltered areas such as slopes adjacent to river terraces, islands in swamps or on upper terraces adjacent to streams within dissected landscapes, as fire is naturally infrequent in these ecosystems (NatureServe 2012). The 2013 Forest Service Vegetation database show 3,022 acres in upland hardwood. Simon and Hayden (2014) mapped only 5,808 acres in native oak or mesic hardwood ecosystems.

The 1996 forest plan contains an objective to “identify and maintain . . . calcareous mesic forests” and several examples of mesic slope forests are influenced by marl or calcareous geology (McMillan et al. 2001) and were addressed as natural areas in the 1996 forest plan (Everett 2012; Porcher 1995). Mesic slope forests (also known as Southern mixed hardwood forests) occur on slopes or river terraces near the Santee River and Echaw Creek, Awendaw Creek and within dissected landscapes near Nicholson, Huger and Turkey Creeks. Several mapped upland hardwood and mesic slope ecosystems are dominated by loblolly pine (FSVeg 2013). FSVeg data show 939 acres in upland hardwood (100 years or older) including 739 acres in upland oak or oak pine and no mesic slope forests meeting the age criteria. Non-native invasive plant data on the forest suggests that nearly 5 percent of ecosystems in the oak and mesic forest group are occupied by non-native invasive plant species, predominantly Japanese climbing fern.

Natural fire regimes for oak and mesic hardwood forests were relatively infrequent (applicable LANDFIRE models predict a 5- to 10-year return interval for dry mesic oak forests and a 35-year interval for mesic slope forests). Approximately 75 percent of the modeled dry and dry-mesic oak acres have been prescribed burned three or more times between 2005 and 2012 which is a higher frequency than one would predict under natural disturbance regimes. Several mesic and calcareous hardwood forest communities are threatened by non-native invasive plants (Everett 2012; McMillan et al. 2001). Structural departure analysis for the upland hardwood ecosystems suggests that the Francis Marion's upland hardwood forests and mesic slope forests are moderately departed in structure compared to reference conditions (LANDFIRE 2006), with a relatively low percentage in late successional open conditions, and there are no stands qualifying as old growth.

3.3.1.9 Environmental Consequences: Oak Forests and Mesic Hardwood Forests

Alternative 1

Direct and Indirect Effects. Directly and indirectly, mast-producing hardwoods would be expected to increase in the long term in Management Area 27, and mesic slope forests would be maintained but not restored. Directly, activities such as prescribed burning more frequently than every 5 to 10 years, could negatively impact upland hardwood ecosystems identified through more recent mapping efforts. Indirectly, non-native invasive species would be likely to increase in these ecosystems, which would be maintained but not restored on sites where they are likely to occur. Open roads associated with mesic forests would be likely to impact connectivity within these ecosystems in alternative 1.

Cumulative Effects. The Francis Marion National Forest plays a relatively small role in providing for oak and mesic hardwood ecosystems, which are relatively uncommon across the landscape. Oaks are important as hard mast to wild turkey and other game species, and can more commonly occur as components of upland pine woodlands (turkey oak, runner oak, blackjack oak, bluejack oak), narrow forested swamps and blackwater stream forests, and broad non-riverine swamp and large river floodplain forests. Opportunities for oak retention will occur at the project level based on the purpose and need and on site capability.

Determination of Effect. In the next 10 and 50 years, it is anticipated that the direct, indirect and cumulative effects of this alternative on the ecological sustainability and integrity of oak forests and mesic hardwood forests would be poor to fair under alternative 1, given impacts of non-native invasive species, and lack of forest plan direction to restore them on suitable sites.

Alternatives 2 and 3

Direct and Indirect Effects. Under both alternatives 2 and 3, oak and mesic hardwood forests would be maintained, improved and restored on appropriate sites wherever they occur. In some cases, this could take decades to achieve. Activities such as less frequent fire, non-native invasive treatments and loblolly pine thinning or removal could indirectly benefit these ecosystems. The direct and indirect effects of these alternatives would be an improvement in the vegetation composition and the structure of oak and mesic hardwood forests on ecologically suitable sites across the landscape. In some cases, this could take decades to achieve. Ecological sustainability predictions are in the sustainable "good" range at 10- and 50-year intervals (Figure 3-14). All indicators are in the good to very good range in both alternatives.

Cumulative Effects. The Francis Marion National Forest plays a relatively small role in providing for oak and mesic hardwood ecosystems, which are relatively uncommon across the landscape. Oak would be encouraged as a component of forested wetlands forestwide, and on upland pine woodland and wet pine savanna sites within Management Area 2.

Determinations of Effect, Alternative 1. In the next 10 and 50 years, it is anticipated that the direct, indirect and cumulative effects of this alternative on the ecological sustainability and integrity of oak forests and mesic hardwood forests would be poor to fair under Alternative 1, given impacts of non-native invasive species, unpaved road densities, and lack of forest plan direction to restore them on suitable sites.

Determinations of Effect, Alternatives 2 and 3. In the next 10 and 50 years, it is anticipated that the direct, indirect, and cumulative effects of alternatives 2 and 3 on the ecological sustainability and integrity of oak forests and mesic hardwood forests would be good, since associated ecosystems would be maintained and restored on appropriate sites wherever they occur. Restoration of oak and mesic hardwood ecosystems will increase at 50 years compared to the 10-year time interval, given the relatively slow growth rates of oak and mesic hardwood species being restored to ecologically appropriate sites. Both landscape structural diversity and native species composition are predicted to be in the good range at 10 years and very good at 50 years.

Composite Sustainability Ranking

The acreage that would be maintained and restored in ecosystems associated with the oak and mesic hardwood ecosystem group scores good in alternatives 2 and 3 (Figure 3-14). Alternatives 2 and 3 would provide desired conditions for maintaining and restoring 100 percent of the total extent of oak and mesic hardwood ecosystems on the Francis Marion with prescribed fire and other tools, compared to 41.2 percent on appropriate sites in alternative 1. In alternative 1, key characteristics associated with connectivity, non-native invasive species, old-growth forests, and vegetation composition integrity are ranked poor to fair.

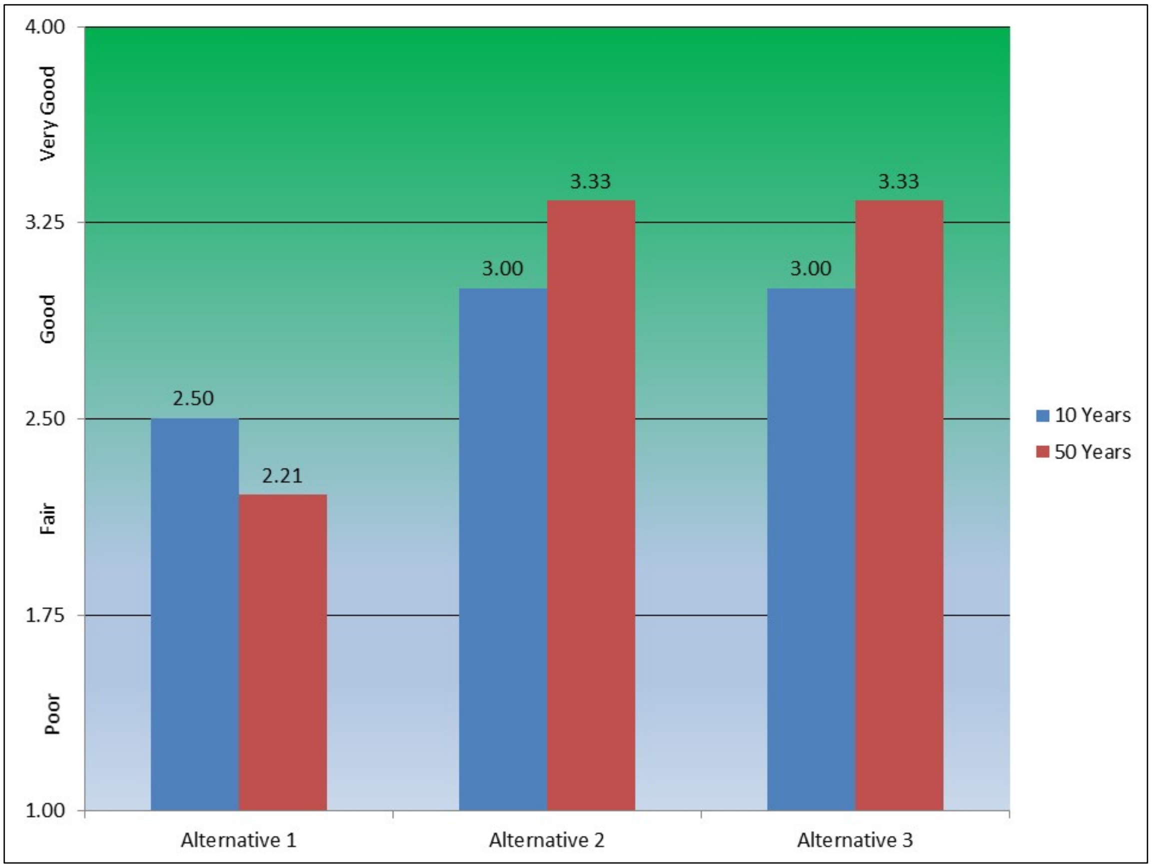


Figure 3-14. Forestwide oak and mesic hardwood ecological sustainability

Table 3-16. Key characteristics and indicators for evaluating sustainability of the ecosystems associated with the oak and mesic hardwood ecosystem group

Key Characteristic	Indicator
Connectivity	OHV Trail Density
Connectivity	Paved Open Road Density
Connectivity	Unpaved Open Road Density
Function	Percent of Ecosystem Acres Burned at Desired Return Interval
Stressor	Percent of Ecosystem Extent Impacted by Non-Native Invasive Plant Species
Function	Percent of Ecosystem Acres Burned at Desired Growing Season Return Interval
Structure	Percent of Ecosystem likely in Old Growth
Composition	Percent of Ecosystem Extent dominated by characteristic Native Forest Types
Structure	Percent Landscape Structural Departure compared to NRV

Table 3-17. Key characteristics and indicators that were determined to be important, but were not used due to lack of data

Key Characteristic	Indicator
Stressor	Percent of Ecosystem Extent Impacted by Feral Hogs
Stressor	Percent of Ecosystem Extent Impacted by Fire Ant

The acreage that would be maintained and restored in ecosystems associated with the oak and mesic hardwood ecosystem group scores good in alternatives 2 and 3. Alternatives 2 and 3 would provide desired conditions for maintaining and restoring 100 percent of the total extent of oak and mesic hardwood ecosystems on the Francis Marion with prescribed fire and other tools, compared to 41.2 percent on appropriate sites in alternative 1. In alternative 1, key characteristics associated with connectivity, non-native invasive species, old growth forests and vegetation composition integrity are ranked poor to fair.

3.3.1.10 Affected Environment: Narrow Forested Swamps and Blackwater Stream Floodplain Forests and Broad Forested Swamps and Large River Floodplain Forests

Forested wetlands were grouped into two ecosystem groups based on similarities in disturbance regimes, landscape position and vegetation dynamics. Collectively, forested wetlands occupy 36 percent of the forest (93,100 acres), occurring predominantly as narrow (10 percent) or broad (15 percent) non-riverine swamps. The planning team grouped narrow forested swamps and blackwater stream floodplain forests to include small blackwater river and stream floodplain forests and narrow non-riverine swamp and wet hardwood forested ecosystems. It also grouped broad forested swamps and large river floodplain forests to include broad non-riverine swamp and wet hardwood forests, large river floodplain forests and tidal wooded swamps. Flooding is the most important ecological factor influencing associated ecosystems, though fire can vary from a minor to a significant influence on vegetation composition and structure. The original vegetation was likely a true shifting mosaic, where prescribed burning influenced peat build-up, hydrology and vegetation (Simon and Hayden 2014).

Vegetation composition and structure varies but is typically good. Bald cypress and pond cypress dominate the wettest sites and are the predominant forest types in the broad forested swamp

group. Bottomland hardwoods and loblolly pine or mixtures with other non-mast hardwood species are common on relatively drier sites in both ecosystem groups. Loblolly pine forests, including mixtures with non-mast hardwoods, occupy 29.3 percent of ecosystems in the narrow forested group and 23.5 percent of forests in the broad forested group. Forests are typically older. Of the narrow forested group, 51 percent is in late successional condition; 15 percent is older than 100 years. Of the broad forested group, 57 percent is in late successional condition and 26 percent of stand acreage is older than 100 years. Based on LiDAR analysis of canopy opening, the primary existing structural class for each ecosystem group is forested (92 percent of the broad ecosystem group and 81 percent of the narrow ecosystem group is forested).

Non-native invasive plant data on the Francis Marion National Forest suggests that less than 1 percent of ecosystems in the broad forested group are occupied by non-native invasive plant species, predominantly Japanese climbing fern along the Santee River floodplain.

3.3.1.11 Environmental Consequences: Narrow Forested Swamps and Blackwater Stream Floodplain Forests and Broad Forested Swamps and Large River Floodplain Forests

Alternative 1 – No Action

Direct and Indirect Effects. Alternative 1 would continue to promote mixed stands, high quality mast and timber producing hardwoods within 27,324 acres in Management Area 27, which contains river and creek bottoms and swampy flats. Additional forested wetlands would be maintained and preserved in Management Area 2 as wilderness (13,800 acres). Direct and indirect effects to associated ecosystems could result from prescribed burning and limited harvest, particularly of loblolly pine trees. However, harvesting on bottomland hardwood and cypress-tupelo would occur at predictably and relatively low levels in this alternative. Saltwater intrusion associated with hurricane storm surges and as predicted by climate change models would be likely to impact species associated with tidal forested wetlands in the future, particularly bald cypress (Krauss et al. 2009).

Forested wetlands, particularly ecosystems in the narrow forested wetland group, and 54 percent of narrow forested ecosystems would continue to occur in Management Area 26, which is subject to frequent fire in this alternative. Frequent prescribed fire in these systems would likely increase the abundance of fire-adapted species, including native cane, pond pine and perhaps even Atlantic White Cedar, although this species is not known to occur here. Non-native invasive species would likely increase in this alternative at 10-year and, to a greater extent, 50-year intervals.

Cumulative Effects. Globally, wetlands are threatened by hydrologic modifications, development and conversion to agricultural production. At the time of European settlement, it is estimated that approximately 80 million hectares of forested freshwater wetlands existed in the coterminous United States, though draining and clearing of forested wetlands for agriculture beginning in the mid-1800s accounts for at least 87 percent of wetland loss (Journal of the Society of Wetland Scientists 1989). Saltwater intrusion associated with hurricane storm surges and as predicted by climate change models are likely to impact species associated with tidal forested wetlands in the future, particularly bald cypress (Krauss et al. 2009). Non-native invasive species such as Japanese climbing fern, Chinese tallow, feral hogs, and laurel wilt would continue to pose the greatest threats to forested wetlands on the Francis Marion.

Determination of Effect. In the next 10 years, it is anticipated that the direct, indirect, and cumulative effects of alternative 1 on the ecological sustainability and integrity of forested

wetlands would be good for broad forested swamps, large river floodplain forests, narrow forested swamps, and blackwater stream floodplain forest; they would drop slightly to fair for narrow forested swamps and blackwater stream floodplain forests in the 50-year interval, given the lack of desired conditions, including prescribed fire. The condition of forested wetlands in the central Atlantic middle coastal plain is ranked “C”, 59-40 percent in good condition, by the South Atlantic LCC (2015).

Alternative 2

Direct and Indirect Effects. The restoration and maintenance of ecosystems associated with both broad and narrow forested groups would occur in both Management Areas 1 and 2, although prescribed fire would be used as a management tool only in Management Area 1, where 59 percent of ecosystems associated with the narrow forested ecosystem and 47 percent of the broad forested ecosystems occur. Direct and indirect effects could result from prescribed burning and limited harvest. Harvesting in bottomland hardwood and cypress-tupelo forests would occur at higher levels to restore these ecosystems or their structure. Although some treatment would occur to manageable levels, due to the remote nature of the broad forested wetland group, non-native invasive species would be likely to increase in this alternative at 10-year, and to greater extent, 50-year intervals.

Saltwater intrusion associated with hurricane storm surges and, as predicted by climate change models are likely to impact species associated with tidal forested wetlands in the future, particularly bald cypress (Krauss et al. 2009). A Sea Level Affecting Marshes Model (SLAMM) model intersected with ecosystems and ecosystem groups on the Francis Marion predicts sea-level rise will affect 13.4 percent of ecosystems in the broad forested ecosystem group in the next 50 years (2020-2070), including 14.8 percent of broad non-riverine ecosystems and 12.2 percent of tidal forested ecosystems (Park et al. 1986).

Cumulative Effects. Globally, wetlands are threatened by hydrologic modifications, development and conversion to agricultural production. At the time of European settlement, it is estimated that approximately 80 million hectares of forested freshwater wetlands existed in the coterminous United States, though draining and clearing of forested wetlands for agriculture beginning in the mid-1800s account for at least 87 percent of wetland loss (Journal of the Society of Wetland Scientists 1989). Saltwater intrusion associated with hurricane storm surges and as predicted by climate change models are likely to impact species associated with tidal forested wetlands in the future, particularly bald cypress (Krauss et al. 2009). Non-native invasive species such as Japanese climbing fern, Chinese tallow, feral hogs, and laurel wilt pose the greatest threats to forested wetlands on the Francis Marion.

Determination of Effect. In the next 10 and 50 years, it is anticipated that the direct, indirect, and cumulative effects of this alternative on the ecological sustainability and integrity of forested wetlands would be good for both narrow forested swamps and blackwater stream floodplain forests and broad forested swamps and large river floodplain forests, given desired conditions and management strategies to improve composition, structure, function and connectivity wherever they would be likely to occur on the Francis Marion.

Alternative 3

Direct and Indirect Effects. The restoration and maintenance of ecosystems associated with both broad and narrow forested groups would occur in both Management Areas 1 and 2, though prescribed fire would be used as a management tool only in Management Area 1, where 43 percent of ecosystems associated with the narrow forested ecosystem and 27 percent of the broad

forested ecosystems occur. Direct and indirect effects could result from prescribed burning and limited harvest, but the influence on fire-adapted species occurring in the narrow forested ecosystem group would be less than in alternative 2 but greater than alternative 1. Harvesting in bottomland hardwood and cypress-tupelo forests to restore these ecosystems or their structure would occur at somewhat lower levels than alternative 2, but higher than in alternative 1. Although some treatment would occur to manageable levels, due to the remote nature of the broad forested wetland group, non-native invasive species would be likely to increase in this alternative at 10-year, and to greater extent, 50-year intervals.

Saltwater intrusion associated with hurricane storm surges and as predicted by climate change models would be likely to impact species associated with tidal forested wetlands in the future, particularly bald cypress (Krauss et al. 2009). A SLAMM model intersected with ecosystems and ecosystem groups on the forest predicts sea-level rise will affect 13.4 percent of ecosystems in the broad forested ecosystem group in the next 50 years (2020-2070), including 14.8 percent of broad non-riverine ecosystems and 12.2 percent of tidal forested ecosystems (Park et al. 1986).

Cumulative Effects. Globally, wetlands are threatened by hydrologic modifications, development and conversion to agricultural production. At the time of European settlement, it is estimated that approximately 80 million hectares of forested freshwater wetlands existed in the coterminous United States, though draining and clearing of forested wetlands for agriculture beginning in the mid-1800s accounts for at least 87 percent of wetland loss (Journal of the Society of Wetland Scientists 1989). Saltwater intrusion associated with hurricane storm surges and, as predicted by climate change models are likely to impact species associated with tidal forested wetlands in the future, particularly bald cypress (Krauss et al. 2009). Non-native invasive species such as Japanese climbing fern, Chinese tallow, feral hogs, and laurel wilt pose the greatest threats to forested wetlands on the Francis Marion.

Determination of Effect. In the next 10 and 50 years, it is anticipated that the direct, indirect and cumulative effects of this alternative on the ecological sustainability and integrity of forested wetlands would be good for both narrow forested swamps and blackwater stream floodplain forests and broad forested swamps and large river floodplain forests, given the desired conditions and management strategies to improve composition, structure, function and connectivity wherever they are likely to occur on the Francis Marion National Forest.

Composite Sustainability Ranking

Key characteristics and indicators for evaluating sustainability of the ecosystems associated with both narrow non-riverine swamp and blackwater stream and broad non-riverine swamp and large river floodplain ecological groups are outlined in Table 3-18. The key characteristics and indicators in Table 3-19 were determined to be important, but were not used due to lack of data.

The acreage that would be maintained and restored in ecosystems associated within both forested wetland ecosystem groups score “good” or “very good” across all alternatives (Figure 3-15 and Figure 3-16). Alternatives 2 and 3 provide desired conditions for maintained and restoring 100 percent of the total extent of forested wetlands, though prescribed fire will be a management tool on less acreage. All indicators ranked good or very good across all alternatives. Connectivity indicators ranked very good across all alternatives.

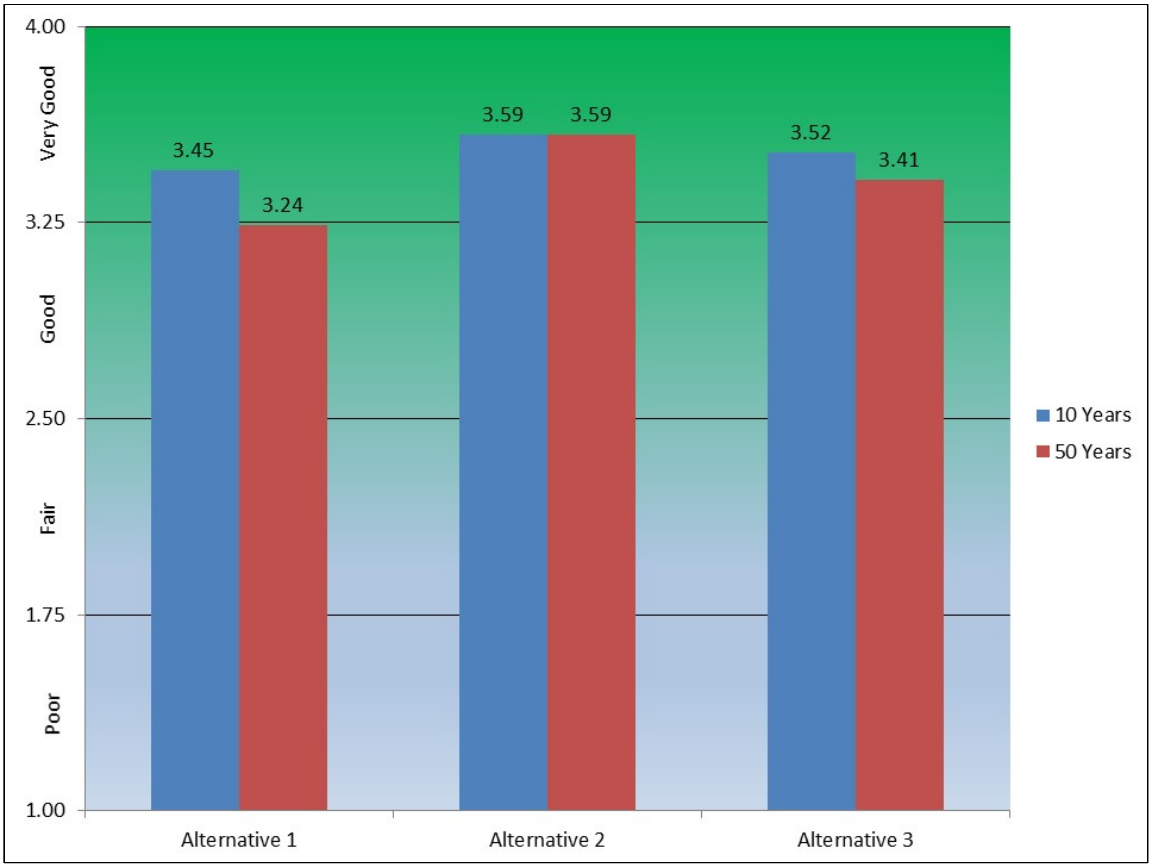


Figure 3-15. Forestwide narrow non-riverine swamp and blackwater stream ecological sustainability scores

Table 3-18. Key characteristics and indicators for evaluating sustainability of the ecosystems associated with both narrow non-riverine swamp and blackwater stream and broad non-riverine swamp and large river floodplain ecological groups

Key Characteristic	Indicator
Stressor	Percent of Ecosystem Extent influenced by Sea-Level Rise predicted as a result of climate change
Function	Percent of Ecosystem Acres Burned at Desired Return Interval
Connectivity	OHV Trail Density
Connectivity	Paved Open Road Density
Connectivity	Unpaved Open Road Density
Stressor	Percent of Ecosystem Extent Impacted by Non-Native Invasive Plant Species
Structure	Percent of Ecosystem likely to be in Old Growth Forest
Structure	Percent of Landscape Structural Departure compared to NRV
Composition	Percent of Ecosystem Extent dominated by characteristic Native Forest Types

Table 3-19. Key characteristics and indicators that were determined to be Important but were not used due to lack of data

Key Characteristic	Indicator
Stressor	Percent of Ecosystem Extent Impacted by Feral Hogs
Stressor	Percent of Ecosystem Extent Impacted by Fire Ant

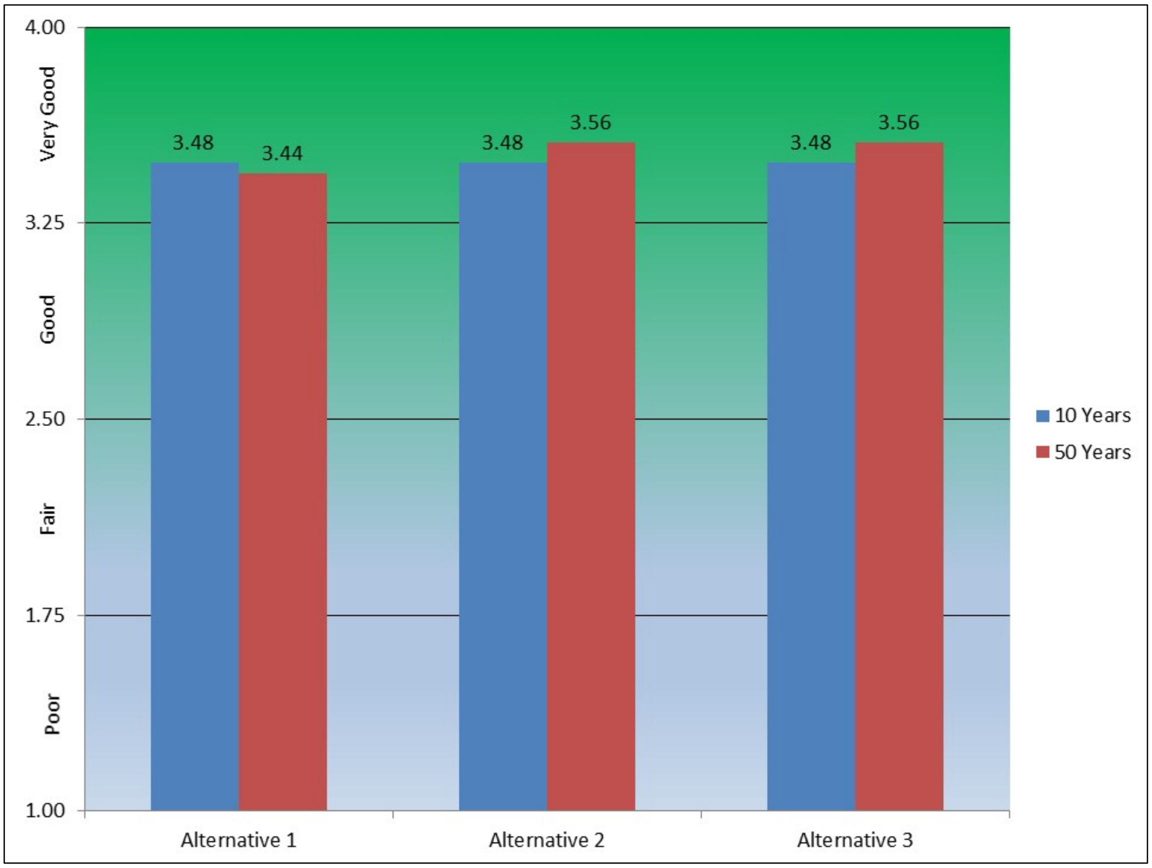


Figure 3-16. Forestwide broad non-riverine swamp and large river floodplain ecological sustainability scores

3.3.1.12 Affected Environment: Maritime Forests and Salt Marsh

The 1996 forest plan contains an objective to, "[I]dentify and maintain existing acreage in maritime forest." Several areas containing maritime fringe and salt marsh have been acquired by the forest since 1996 in the vicinity of Guerin Bridge Road, much in bedded loblolly pine (Porcher 2005). Only a coastal fringe of maritime forest is identified through current mapping efforts (1,200 acres) and both freshwater marsh and saltwater marsh on national forest lands are relatively uncommon (2,800 acres). Many maritime fringe forests are threatened by past management practices, which included ditching and diking for rice production (Porcher 2005), planting of loblolly pine, non-native invasive species, and hurricanes. Approximately 21 percent of our maritime forests are dominated by loblolly pine. In the future, they will be threatened by sea-level rise and climate change.

Maritime forests on the Francis Marion have a higher percentage of early succession and mid-closed conditions and less in late-closed conditions than would be expected compared to reference conditions from LANDFIRE (2006d). This is in part due to the severity of Hurricane Hugo, which impacted the forest in 1989. Many of these maritime forests are threatened by non-native invasive plants such as Chinese tallow and phragmites; none of them qualify as possible old growth.

The forest's maritime forests are moderately departed structurally from reference conditions; 49 percent are in mid-successional closed forests and 10 percent are 100 years or older.

3.3.1.13 Environmental Consequences: Maritime Forests and Salt Marsh

Alternative 1

Direct and Indirect Effects. Ecosystems in this group would be maintained in alternative 1 but not restored, and would continue to be impacted by non-native invasive species. Direct effects of prescribed fire regimes which are too frequent, or management practices which favor pine, could directly and indirectly affect maritime forests and salt marsh ecosystems within this alternative. Maritime forests and salt marsh ecosystems are fragmented by paved roads on the national forest, and threatened by hurricanes and sea level rise. Key characteristics, including the percent in old growth forests and the percent structural departure from the natural range of variation, are expected to remain fair at both 10- and 50-year intervals. Impacts due to sea level rise and non-native invasive plant species are expected to rank good at 10 years but poor at 50 years of implementation.

Cumulative Effects. A SLAMM model intersected with ecosystems and ecosystem groups on the forest predicts sea level rise will affect 6.4 percent of extent of ecosystems in the this group in the next 10 years (2020-2030) and 32.7 percent in the next 50 years (2030-2070), including 28.7 percent of maritime forests and 34.7 percent of salt marsh (Park et al. 1986). Sea level rise and non-native invasive species are expected to impact these coastal ecosystems in the future. Overall, the condition of maritime forests across the middle South Atlantic landscape were ranked "C" by the South Atlantic LCC, or 59-40 percent in good condition, mostly driven by poor scores on low road density, low-urban historic landscapes, and connectivity (2015).

Determination of Effects. It is anticipated that the direct, indirect and cumulative effects of this alternative on the ecological sustainability and integrity on maritime forests and salt marsh systems would be fair in alternative 1 in both the next 10 and 50 years due to impacts from non-native invasive species and lack of desired conditions and management direction to restore them.

Alternative 2 – Proposed Action

Direct and Indirect Effects. All maritime forests and salt marsh ecosystems on the Francis Marion would be maintained and restored in alternative 2. Probable activities including non-native invasive species control, plugging of ditches, or restoration of vegetation to species composition typical of maritime forests could directly impact these ecosystems are expected to indirectly benefit these ecosystems in the future.

Cumulative Effects. Climate change would result in sea-level rise that would affect these ecosystems in the future. A SLAMM model intersected with ecosystems and ecosystem groups on the forest predicts sea-level rise will affect 6.4 percent of extent of ecosystems in the this group in the next 10 years (2020-2030) and 32.7 percent in the next 50 years (2030-2070), including 28.7 percent of maritime forests and 34.7 percent of salt marsh (Park et al. 1986). Overall, the

condition of maritime forests across the middle South Atlantic landscape were ranked "C" by the South Atlantic LCC, or 59-40 percent in good condition, mostly driven by poor scores on low road density, low-urban historic landscapes, and connectivity (2015).

Determination of Effect. It is anticipated that the direct, indirect and cumulative effects of this alternative on the ecological sustainability and integrity on maritime forests and salt marsh systems would be good in the next 10 to 50 years in alternative 2, given that they would be maintained and restored wherever they occur.

Alternative 3

Direct and Indirect Effects. All maritime forests and salt marsh ecosystems on the forest would be maintained and restored in alternative 3. Probable activities, including non-native invasive species control, plugging of ditches, or restoration of vegetation to species composition typical of maritime forests, could directly impact these ecosystems but are expected to indirectly benefit these ecosystems in the future. Fragmentation due to paved road densities are largely outside of Forest Service control and would be expected to impact connectivity in the future.

Cumulative Effects. Climate change will result in sea-level rise to affect these ecosystems in the future. A SLAMM model intersected with ecosystems and ecosystem groups on the forest predicts sea-level rise will affect 6.4 percent of extent of ecosystems in the this group in the next 10 years (2020-2030) and 32.7 percent in the next 50 years (2030-2070), including 28.7 percent of maritime forests and 34.7 percent of salt marsh (Park et al. 1986). Overall, the condition of maritime forests across the middle South Atlantic landscape were ranked "C" by the South Atlantic LCC, or 59-40 percent in good condition, mostly driven by poor scores on low road density, low-urban historic landscapes, and connectivity (2015).

Determination of Effects. It is anticipated that the direct, indirect and cumulative effects of this alternative on the ecological sustainability and integrity on maritime forests and salt marsh systems would be good in the next 10 to 50 years, given they would be maintained and restored wherever they occur in alternative 3.

Composite Sustainability Ranking

Key characteristics and indicators for evaluating sustainability of the ecosystems associated with the maritime forest and salt marsh ecosystem group are described in Appendix E and are outlined in Table 3-20. The key characteristics and indicators in Table 3-21 were determined to be important, but were not used due to lack of data.

Alternatives 2 and 3 would provide desired conditions for maintaining and restoring 100 percent of the total extent of this ecosystem group (Figure 3-17). In alternative 1, maritime forests would be maintained but not restored and would be ranked poor or fair for non-native invasive species, landscape structural diversity and old growth. Negative direct, indirect and cumulative impacts to ecological sustainability associated with sea level rise and connectivity stressors would be likely to increase in the 50-year interval. Sea level rise was the primary contributor to decreased conditions in the longer time interval across all alternatives.

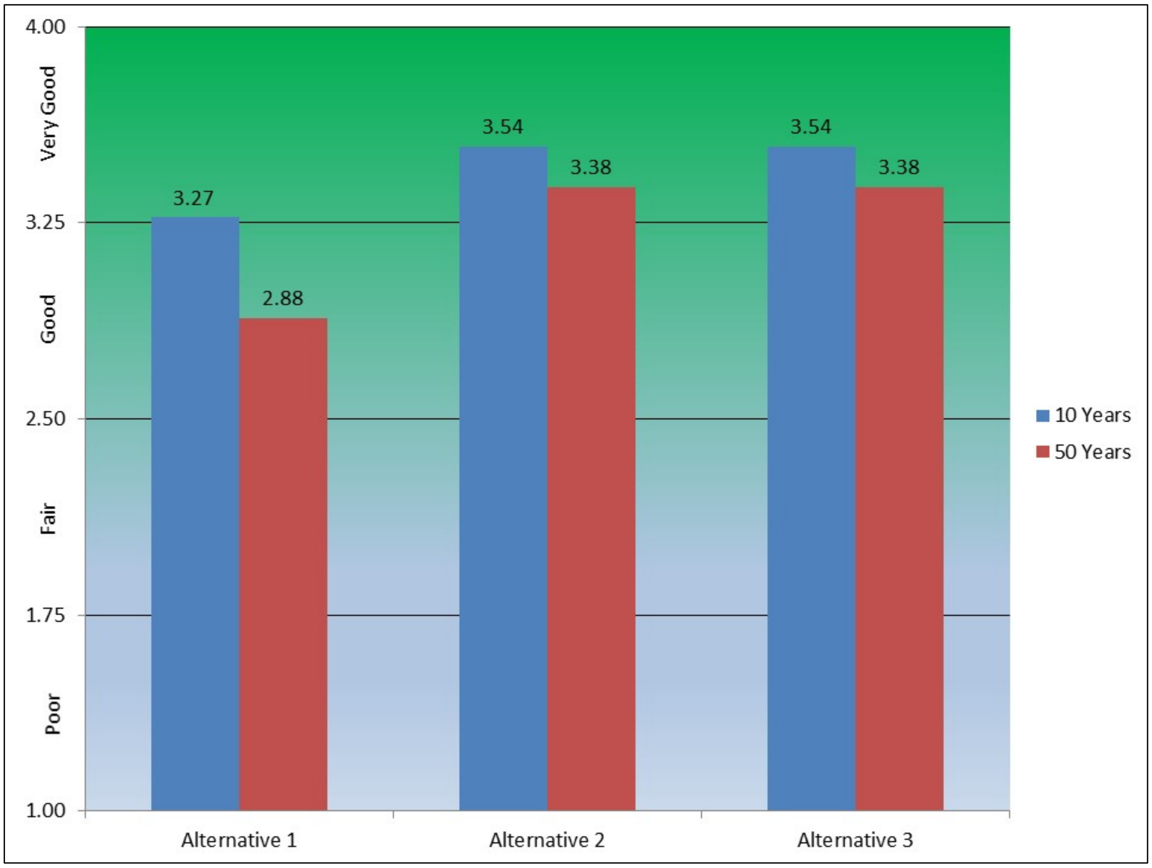


Figure 3-17. Forestwide maritime forest and salt marsh ecological sustainability scores

Table 3-20. Key characteristic and indicators for evaluating sustainability of the ecosystems associated with the maritime forest and salt marsh ecosystem group

Key Characteristic	Indicator
Stressor	Percent of Ecosystem Extent influenced by Sea Level Rise predicted as a result of climate change
Connectivity	OHV Trail Density
Connectivity	Paved Open Road Density
Connectivity	Unpaved Open Road Density
Stressor	Percent of Ecosystem Extent Impacted by Non-Native Invasive Plant Species
Structure	Percent of Ecosystem Extent likely to be in Old Growth Forest
Structure	Percent of Landscape Structural Departure compared to NRV
Composition	Percent of Ecosystem Extent dominated by characteristic Native Forest Types

Table 3-21. Key characteristics and indicators that were determined to be important, but were not used due to lack of data

Key Characteristic	Indicator
Stressor	Percent of Ecosystem Extent Impacted by Feral Hogs
Stressor	Percent of Ecosystem Extent Impacted by Fire Ants

3.3.1.14 Affected Environment: Rivers and Streams

The Francis Marion contains portions of 27 6th-level subwatersheds that drain to the Atlantic Ocean. National forest acreage is greatest within the Nicholson Creek and Headwaters Wambaw Creek watersheds at 97 percent and 95 percent respectively. The national forest lands are disjunct with private inholdings throughout the watersheds.

Table 3-22. Summary of desired conditions for streams and rivers in management areas 1 and 2

Component	Description of Desired Conditions
Biological	Aquatic community and species diversity, density and distribution
Physical	Riparian management zones with diverse, multiple canopies of predominately hardwood trees. Streams are stable with sustainable water quality and quantity for resources; Diverse in stream habitat structure.
Chemical	Meet State water quality standards for aquatic species, drinking water and contact recreation.

Habitat Structure

Aquatic ecosystems consisting of fresh, brackish and tidal rivers and streams including ephemeral streams occur across the Francis Marion National Forest. Tannic stained blackwater streams are the most common stream type on the Francis Marion and originate in the coastal plain, primarily on the national forest. The Santee River is considered a brown water system as it originates in the mountain region of South Carolina. There are 27 subwatersheds associated with forest streams. These systems provide critical habitats for fish, mollusks, crayfish, benthic macroinvertebrates, reptiles, and amphibians. Associated riparian areas are 3-dimensional ecotones of interaction that include terrestrial and aquatic ecosystems that extend down into the groundwater, up above the canopy, outward across the floodplain, up the near-slopes that drain to the water, laterally into the terrestrial ecosystem and along the water course at variable widths.

There are 2,499 stream miles within the administrative boundary of the Francis Marion and 1,460 miles on Federal ownership. The majority of the streams are classified as black water habitats, with headwaters consisting of warm water fish species. These streams have a variety of habitat and qualities of habitats. Large wood, which is lacking in some stream systems and reaches, is the key source of quality habitat for fish and macro-invertebrates. In a recent inventory of prescribed burning effects on large wood loading on the Francis Marion, data reveal that in more than 20 kilometers of headwater stream sections, the largest, most stable instream wood was deficient (USDA SRS Center for Aquatic Technology Transfer). Lack of necessary cover or habitat variation reduces the species richness and refugia during dry periods. Woody debris is naturally added to these systems by blowdown from seasonal storms and beaver. Approximately 73 species of fish, 5 species of crayfish, and 11 mollusk species occur among these watersheds. A forest species of conservation concern includes the American eel.

Habitat Connectivity

The physical structure of aquatic habitats is a major factor in the continuity between and heterogeneity within aquatic habitats that supports the local diversity of fauna and flora. Dams, culverts and roads can act as barriers to aquatic organism movement within and among streams, as well as movement into the respective floodplain. The physical configuration of streams and rivers provides a rich diversity of habitats such as undercut banks, riffles, and deep pools where fish and other fauna feed, rest, and breed. Alterations to the hydrologic and energy regimes of streams or rivers affect the physical structure of aquatic habitats (Palmer et al. 2005).

The entire national forest has had various hydrological modifications (see “Stream Channel Morphology”). These modifications to the streams have reduced habitat quality and connectivity to many aquatic species. The Francis Marion has more than 1,000 non-road hydrological modifications within the 27 subwatersheds associated with forest streams.

Changes in aquatic communities will be used to assess forest management activities on the aquatic ecosystem. Fish populations are monitored on a rotational basis across the national forest in warm water stream habitats. Species composition and abundance reflect changes that may occur in stream populations. In addition, the aquatic insect community will be used as a monitoring tool to determine management activity effects on stream systems. Warm water pond habitats are monitored on an annual basis for the purpose of managing a recreational fishery for the public (for additional information on aquatic ecosystems see the Francis Marion National Forest Plan Assessment 2015).

As noted previously, the Francis Marion contains portions of 27 6th-level watersheds that drain to the Atlantic Ocean. National forest land acreage is greatest within the Nicholson Creek and Headwaters Wambaw Creek subwatersheds at 97 percent and 95 percent, respectively. National forest lands are disjunct with private inholdings throughout the watersheds.

3.3.1.15 Environmental Consequences: Rivers and Streams

Alternative 1

Direct and Indirect Effects. Soil disturbance and loss of riparian vegetation remain the largest threats to aquatic habitats in watersheds of the Francis Marion. Soil disturbance adds sediments to streams that were highly impacted by past farming and logging practices. Road and trail crossings contribute sediments to streams and can inhibit the movement of aquatic organisms within the stream system. Loss of riparian vegetation compromises large wood and leaf litter contribution to the aquatic system, shading for stream temperature maintenance and the filtering capacity of the riparian area for sediments. Direction in the forestwide standards and guidelines (FW-94 thru FW-114) included in alternative 1 are designed to ensure that water quality is maintained. Additionally, the staff of the Francis Marion would follow specific recovery plans for each listed species.

Prescribed fires maintain many ecosystems on the Francis Marion. These activities would include firelines that, if improperly placed, could alter habitat. These fire activities would have the potential to enter the riparian area and cross streams. During this activity the beneficial woody debris would potentially be consumed by fire if the intensity and severity are uncontrolled. With proper ignitions and controls, fire would benefit the streams by maintaining native vegetation and introducing woody debris to the stream system. Intense fires that destroy much of the

groundcover and increase sedimentation in small stream would cause negative effects to aquatic ecosystems.

Roads affect the timing and volume of stream discharges by intercepting and concentrating surface and subsurface flows, expanding or decreasing channel networks, and reducing infiltration. The historic hydrological patterns within a watershed are altered affecting the functions and processes to which the riparian and its inclusive aquatic communities have adapted.

Migration and movement of aquatic species are primarily restricted at road crossings by hanging culverts, high water velocity, inadequate swimming depths, or any combination of these factors. Migration and movement barriers would potentially be desirable (in rare cases) to protect a native species and habitats from a non-native competitor or saltwater. During watershed-level analysis, road crossings should be assessed to determine if they are barriers to aquatic organisms, and a decision should be made to either restock the unoccupied habitat through seining or electrofishing or replace the culvert to facilitate natural movement back into the area.

Riparian areas and aquatic resources would be managed to encourage the processes that maintain or lead to a desired future condition for fisheries and aquatic habitats. Riparian habitats and fisheries would be sustained in a healthy condition. Soil disturbance would be minimized and road and trail crossings would be maintained to protect aquatic resources and allow movement of aquatic species in the stream system. Vegetation management would occur only when needed to protect or enhance riparian-associated resources. Large wood would not be removed from streams, but there would be no direction to improve the existing habitat. Current management practices such as aquatic species stocking and restoration and habitat improvement and enhancement may be suitable. These practices incorporate low soil disturbance activities and any negative effects should be minimal and short term. Implementation of riparian direction should have beneficial effects on aquatic resources.

Ground-disturbing management activities, such as timber harvesting, prescribed burning and trail and road construction would have the potential to affect fisheries management. These actions would be analyzed during project-level planning.

Determination of Effects. In the next 10 and 50 years, it is anticipated that the direct, indirect, and cumulative effects of this alternative on sustainability of rivers and streams would be poor under alternative 1, given the presence of private lands across the Francis Marion. Under the 1996 forest plan, there is lack of direction to consider composition, structure, function, and connectivity stream habitats. The only aquatic direction under the 1996 forest plan is management of ponds. However, following standards and guidelines do protect the resources. Stream habitats on national forest lands, in particularly those areas intermixed with low private ownership, would be improved through specific management activities.

Alternatives 2 and 3

Direct and Indirect Effects. Soil disturbance and loss of riparian vegetation would remain the largest threats to aquatic habitats in watersheds on the Francis Marion. Soil disturbance would add sediments to streams that were highly impacted by past farming and logging practices. Road and trail crossings would continue to contribute sediments to streams and could inhibit the movement of aquatic organisms within the stream system. Loss of riparian vegetation would compromise large wood and leaf litter contribution to the aquatic system, shading for stream temperature maintenance, and the filtering capacity of the riparian area for sediments. The riparian management zone, which addresses perennial and intermittent streams, and the

forestwide standards (chapter 3, S19 and S20) specific to ephemeral channels should mitigate most direct and indirect effects associated with aquatic resources in both alternatives. Riparian area mapping would occur on a site-specific basis and would address aquatic habitat improvement needs. Implementation of guidelines associated with the riparian area should further minimize effects of land management activities.

Prescribed fires would maintain many ecosystems on the Francis Marion National Forest. These activities would include firelines that, if improperly placed, could alter habitat. These fire activities would have the potential to enter the riparian area and cross streams. During this activity the beneficial woody debris would potentially be consumed by fire if the intensity and severity were uncontrolled. With proper ignitions and controls, fire would benefit the streams by maintaining native vegetation and introducing woody debris to the stream system. Intense fires that destroy much of the ground cover and increase sedimentation in small streams would cause negative effects to aquatic ecosystems.

As stated previously, roads affect the timing and volume of stream discharges. The historic hydrological patterns within a watershed are altered, affecting the functions and processes to which the riparian and its inclusive aquatic communities have adapted. Migration and movement of aquatic species are primarily restricted at road crossings as described in alternative 1. Migration and movement barriers would potentially be desirable (in rare cases) to protect a native species and habitats from a non-native competitor or saltwater. During watershed-level analysis, road crossings should be assessed to determine if they are barriers to aquatic organisms, a decision should be made to either restock the unoccupied habitat through seining or electrofishing or replace the culvert to facilitate natural movement back into the area.

The riparian management zone is a component of both alternatives. Riparian areas and aquatic resources would be managed to encourage the processes that maintain or lead to a desired future condition for fisheries and aquatic habitats. Riparian habitats and fisheries would be sustained in a healthy condition. Soil disturbance would be minimized and road and trail crossings would be maintained to protect aquatic resources and allow movement of aquatic species in the stream system. Vegetation management would occur only when needed to protect or enhance riparian-associated resources. Large woody debris input would increase stream habitat diversity as riparian vegetation matures. Current management practices such as aquatic species stocking and restoration and habitat improvement and enhancement may be suitable. These practices incorporate low soil disturbance activities and any negative effects should be minimal and short term. Implementation of riparian direction should have beneficial effects on aquatic resources.

Other management would have the potential to affect fisheries management. In alternative 3, which proposes additional recommended wilderness study area acreage; there should be no effect on fish management in the watersheds in wilderness areas.

Determination of Effects. In the next 10 and 50 years, it is anticipated that the direct, indirect, and cumulative effects on the sustainability of rivers and streams will be fair under all alternatives, given presence of private lands across the Francis Marion National Forest. Desired conditions in alternatives 2 and 3 maintain, improve, and restore streams composition, structure, function, and connectivity.

The areas within national forest lands, specifically those in areas with less private ownership, would improve over the length of the plan.

Cumulative Effects. River and streams would continue to be threatened on private lands. Public lands are critically important to providing for these ecosystems and habitat types across the landscape. Climate change could lead to warmer waters and saltwater intrusion. With changes in climate, annual temperature and drought frequency are expected to increase which could favor more tolerant brackish and some saltwater species.

Riparian areas outside of national forest land could decrease, limiting habitat and changing stream temperature and hydrology. High densities of roads and non-porous surfaces would increase threats to fish passage and flow-regime.

Composite Sustainability Ranking

Key characteristics and indicators for evaluating sustainability of the ecosystems associated with the rivers and streams ecosystem group are described in Appendix E and are outlined in Table 3-23.

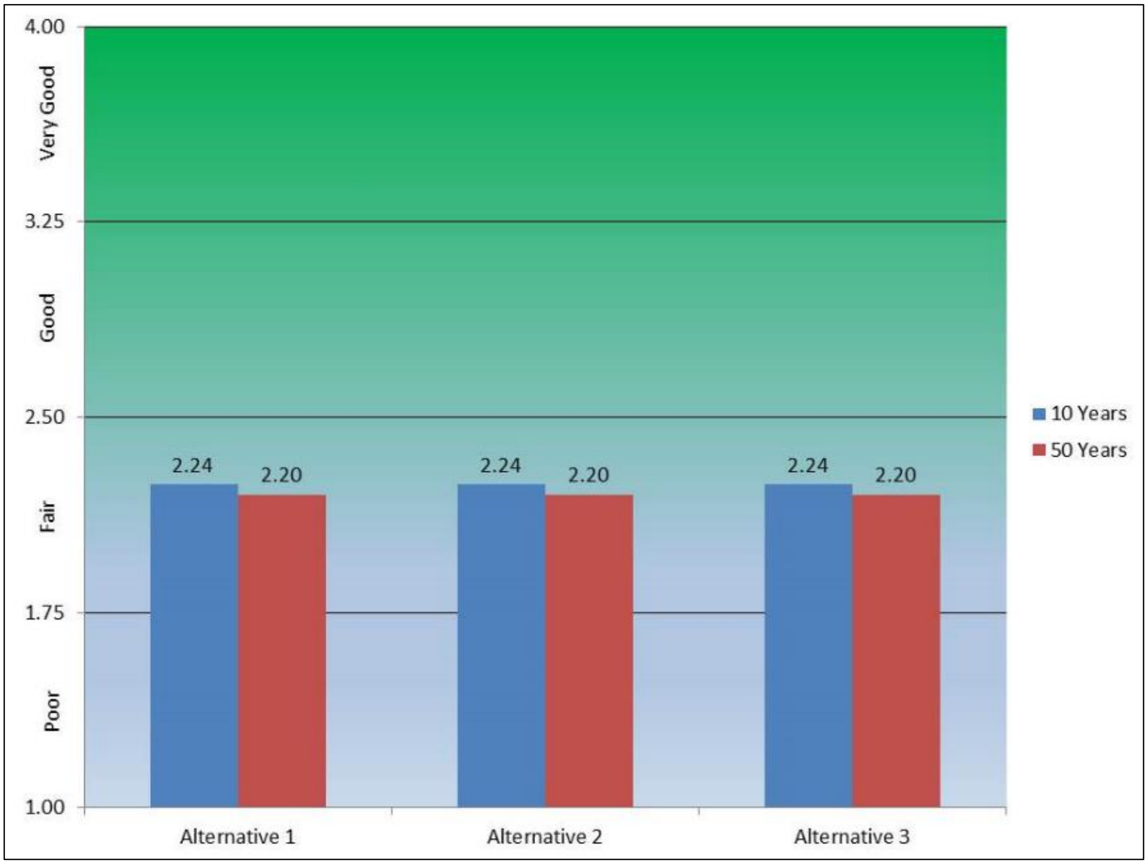


Figure 3-18. Forestwide rivers and streams ecological sustainability scores

Table 3-23. Key characteristic and indicators for evaluating sustainability of the ecosystems associated with the rivers and streams ecosystem group

Key Characteristic	Indicator
Potential for Coarse Woody Debris Abundance	Percent Riparian Forested
Hydrologic Function	Major Hydroelectric Dam Proximity/Influence
Hydrologic Function	Riparian Road Density
Hydrologic Function	Road Crossing Rating
Hydrologic Function	Severity of Hydrologic Control Structures
Non-Native Invasive Species	Presence/Absence of Non-Native Invasive Species in the Watershed
Water Quality	Sediment Risk Rating
Water Quality--Toxics	Point Source Rating
Water Quality -- Toxins	Non-Point Source Rating
Water Temperature Regime	Riparian Land Use Rating

3.3.1.16 Affected Environment: Essential Fish Habitat

While the Francis Marion National Forest includes over 6,000 acres of essential fish habitat designated under the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act), portions of the Francis Marion include tidal freshwater palustrine forests, tidal freshwater wetlands, estuarine emergent wetlands (salt marsh), tidal creeks, intertidal and subtidal flats, and unconsolidated bottom.

The South Atlantic Fishery Management Council identifies these habitats as essential fish habitat for penaeid shrimp, including white shrimp (*Litopenaeus setiferus*) and brown shrimp (*Farfantepenaeus aztecus*), and/or estuarine-dependent species of the snapper-grouper complex. Salt marshes are essential fish habitat because larvae and juveniles concentrate and feed extensively and shelter within these habitats. As a consequence, growth rates are high and predation rates are low, which make these habitats effective nursery areas. The South Atlantic Fishery Management Council provides additional information on essential fish habitat and its support of federally managed species in Volume IV of the “Fishery Ecosystem Plan of the South Atlantic Region.”

Freshwater Wetlands. In addition to habitats designated as essential fish habitat, the Francis Marion National Forest is rich with freshwater wetlands providing nutrients and organic material to downstream estuaries and affecting the water quality of those estuaries. Past modifications, such as ditching and road construction, have altered water flows in and out of forested wetlands, riparian areas, and streams.

3.3.1.17 Environmental Consequences: Essential Fish Habitat

Direct and Indirect Effects. To address these issues, the Francis Marion National Forest would restore hydrology in wetlands, which should benefit downstream essential fish habitat. Alternatives 2 and 3 include restoration of wetlands, floodplains, or riparian areas to benefit at-risk species within three target watersheds, Guerin Creek, Turkey Creek, and the headwaters of Wambaw Creek. Specific activities include plugging ditches and adding culverts under dikes to restore water flows. However, existing dikes may be used to limit saltwater influx where hydrologic modifications are causing saltwater entry beyond recent historic conditions, such as those within the lower Santee River. Hydrologic restoration would improve habitats for freshwater aquatic species and at-risk amphibians.

The draft environmental impact statement stated there are approximately 6,546 acres of tidal waters on the Francis Marion and 179 miles of intermittent and perennial streams receiving tidal influence. The designation of these habitats as essential fish habitat is discussed below and the actual amount of essential fish habitat within the Francis Marion is likely greater because these numbers are based on using South Carolina Highway 17 as the saltwater/freshwater boundary and do not consider tidal freshwater wetlands designated essential fish habitat.

With the exception of using dikes to limit saltwater flow, the restoration of freshwater wetlands within the Francis Marion National Forest would likely have indirect beneficial impacts to essential fish habitat by improving the flow of nutrients and organic matter; however, there are opportunities to directly restore and enhance essential fish habitat within and adjacent to the Francis Marion. The revised forest plan includes desired conditions and standards and guidelines to maintain water quality and quantity that should limit any impacts to essential fish habitats. The National Marine Fisheries Service is available to assist the Forest Service with identifying and designing essential fish habitat conservation and restoration projects.

3.3.2 Threatened and Endangered Species

This section covers federally threatened and endangered species that require protection or consultation under the Endangered Species Act (36 CFR 219.16). The Forest Service cooperates with both the U.S. Fish and Wildlife Service and National Oceanic and Atmospheric Administration’s National Marine Fisheries Service in the identification and evaluation of species likely to be affected and in the development of forest plan components that contribute to their recovery.

3.3.2.1 Affected Environment

Ten species of federally listed threatened and endangered plant and animal species with ranges occurring in Berkeley and Charleston Counties were included and evaluated in the ecological sustainability evaluation process (see Table 3-24). Throughout the Francis Marion, threatened and endangered species protection and habitat enhancement is a priority, so their needs are particularly emphasized.

We determined, and the U.S. Fish and Wildlife Service agreed, that the following species were neither likely to occur on the Francis Marion National Forest nor be impacted by Forest Service actions: piping plover, red knot, finback whale, humpback whale, right whale, seabeach amaranth, green sea turtle, Kemp’s ridley sea turtle, leatherback sea turtle, and loggerhead sea turtle. The bald eagle will be treated as a species of conservation concern and will be protected under the Bald and Golden Eagle Protection Act.

At the time of this analysis, no species were proposed for Federal listing that occur on the Francis Marion National Forest or could be affected by implementation of the forest plan. The U.S. Fish and Wildlife Service did not identify any candidate species that are likely to be listed and would require inclusion in this analysis. Future listing of species that occur on the Francis Marion National Forest would require reinitiating consultation with the U.S. Fish and Wildlife Service on the effects of the forest plan.

Table 3-24. List of federally threatened and endangered species on the Francis Marion National Forest

Common Name	Scientific Name	Category	Status	Associated Ecosystem(s) on the Forest
American chaffseed	*Schwalbea americana*	Vascular Plant	Endangered	Fire-maintained upland longleaf and loblolly pine-dominated woodlands
Canby's dropwort	*Oxypolis canbyi*	Vascular Plant	Endangered	Fire-maintained Carolina bays and depressional wetlands
Pondberry	*Lindera melissifolia*	Vascular Plant	Endangered	Fire-maintained Carolina bays and depressional wetlands
Red-cockaded woodpecker	*Picoides borealis*	Bird	Endangered	Fire-maintained upland longleaf and loblolly pine woodlands and wet pine savannas and Flatwoods
Bachman's warbler	*Vermivora bachmanii*	Bird	Endangered	Broad and Narrow Forested Wetlands
Wood stork	*Mycteria americana*	Bird	Threatened	Foraging only in streams and rivers; and depressional wetlands
Frosted flatwoods salamander	*Ambystoma cingulatum*	Amphibian	Threatened, Critical Habitat	Fire-maintained upland longleaf woodlands; wet pine savannas and Flatwoods, Carolina bays and depressional wetlands. Designated Critical habitat in the Wando area
West Indian manatee	*Trichechus manatus*	Mammal	Endangered	Streams and Rivers, primarily Cooper and Santee
Atlantic sturgeon	*Acipenser oxyrinchus*	Fish	Endangered	Streams and Rivers, primarily Cooper and Santee
Shortnose sturgeon	*Acipenser brevirostrum*	Fish	Endangered	Streams and Rivers, primarily Cooper and Santee

3.3.2.2 Environmental Consequences

Forest planning is a two-tier system consisting of:

- A forest plan that provides broad management direction for the next 10-15 years and
- Project-level decisions that implement forest plan direction.

Forest plan components, such as desired conditions, standards, guidelines, and objectives provide broad management direction. These forest plan components comply with the requirements of the Endangered Species Act of 1973 and the associated recovery plan for each federally listed species. Consultation with the U.S. Fish and Wildlife Service on the forest plan does not evaluate site-specific activities, but the process can provide a framework for future analysis and establish a common understanding about the potential effect of plan implementation on federally listed species.

Project-level analysis evaluates site-specific impacts, based on on-the-ground conditions. Additional mitigation measures to prevent, reduce or compensate for effects to listed species may be developed, if it is determined that they are needed. Project-level consultation is generally within the scope of effects consulted on for the forest plan.

Direct and Indirect Effects Common to All Alternatives

In general, all federally threatened and endangered species would continue to be managed and protected across the Francis Marion National Forest in accordance with Forest Service policy, recommended protection measures in recovery plans, and all applicable State and Federal laws. Individual projects proposed during the next planning period may result in adverse effects to threatened and endangered species, and effects analysis and consultation will take place at the project level when this situation occurs.

The following sections provide ecological information and describe effects of the forest plan alternatives for each of the federally listed species.

Cumulative Effects Common to All Alternatives

Public lands play a critical role in the conservation of rare species and native habitats, which sometimes receive little formal protection or conservation on private lands. This is especially true for federally listed plants, which receive no legal protection on private lands. During the next 10 to 50 years of forest plan implementation, human populations are likely to expand, affecting urbanization, roads and associated traffic, and prescribed burning and smoke management (see Figure 3-19). These trends suggest not only that public land will play an increasingly important role in the conservation of threatened and endangered species in the future, but also that management to ensure recovery and prevention of federal listing of species will be an increasingly difficult challenge.

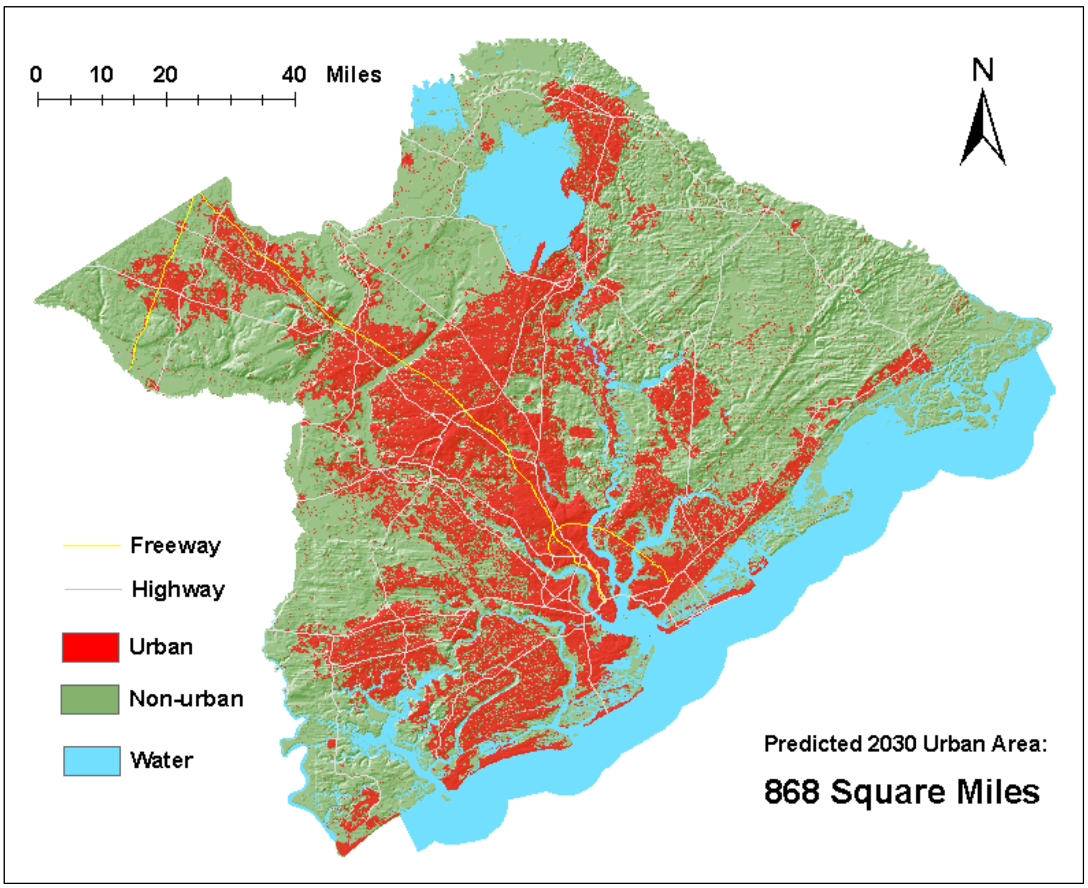


Figure 3-19. Estimated urban development in the vicinity of the Francis Marion National Forest (2030)

The southwest portion of the Francis Marion is near one of the most rapidly urbanizing areas in South Carolina; it also supports some of the highest densities of threatened and endangered species and proposed species of conservation concern on the national forest. In terms of management for habitats for federally listed species, the area on either side of State Highway 41 near the Community of Wando (see Wando Resource Integration Zone in alternative 2) is the top priority area on the Francis Marion to be concerned about during the next 10 to 15 years. Because it has been so difficult for the Forest Service to adequately burn the area west of Highway 41 since Hurricane Hugo, conditions are only expected to deteriorate unless adequate fire return intervals occur in this area.

For some species such as the red-cockaded woodpecker, the Forest Service consistently works beyond the plan area boundary to collaborate and cooperate with the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, state and tribal governments, other partners, landowners, and land managers to support an all-lands approach to species recovery. The Forest Service has worked and continues to work with partners to reintroduce at-risk species into historical habitat on National Forest System lands where appropriate.

Determinations Made in the Biological Assessment

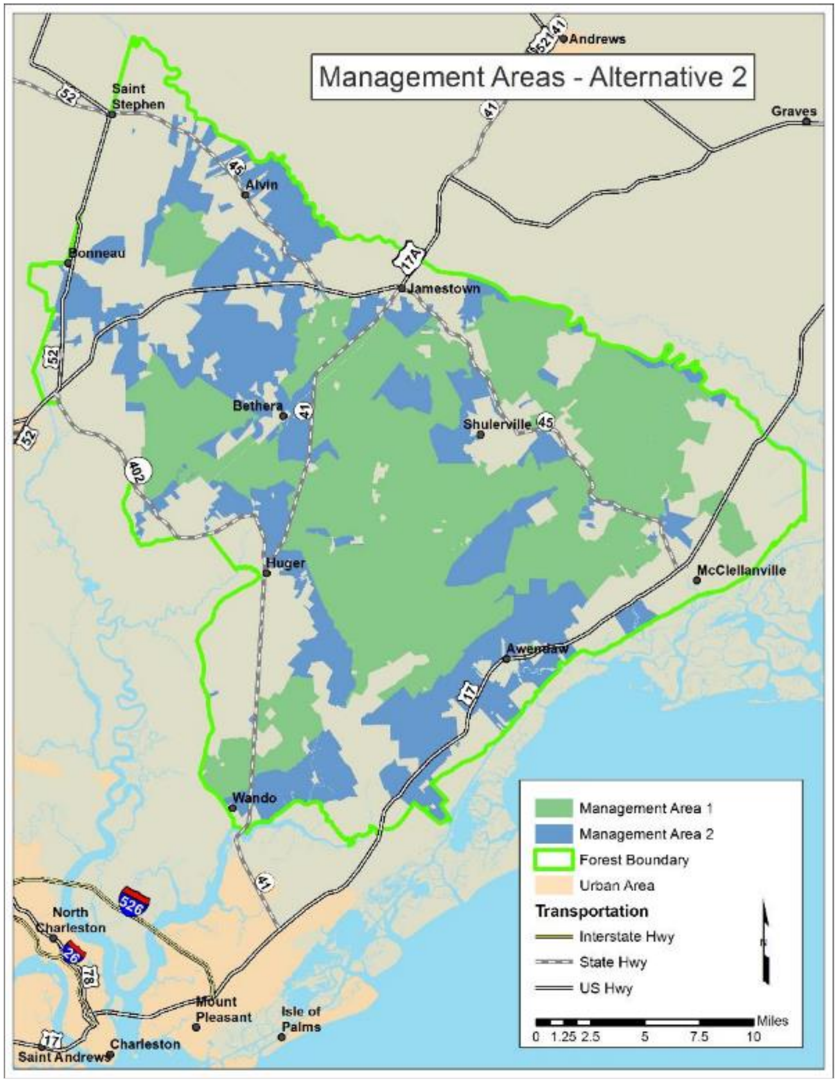
A biological assessment evaluating the effects of alternative 2 on the 10 threatened or endangered species listed above was submitted to the U.S. Fish and Wildlife Service, Charleston Ecological Services Office, to meet interagency consultation requirements under section 7 of the Endangered Species Act. The biological assessment is in Appendix G, and a summary of the effects determinations are in Table 3-25.

Table 3-25. Effects of alternative 2 on federally threatened and endangered species on the Francis Marion National Forest

Common Name	Scientific Name	Effects of Alternative 2
American chaffseed	*Schwalbea americana*	The revised plan may affect, and is likely to adversely affect individuals of this species. The active management required to maintain high-quality habitat conditions may harm individual plants over the 10-year period of plan implementation. Despite potential effects to a small number of individual plants, implementing the plan will result in maintenance and restoration of at least nine viable populations for the federally endangered American chaffseed at known or historic locations.
Canby's dropwort	*Oxypolis canbyi*	The revised plan may affect, and is likely to adversely affect individuals of this species. The active management required to maintain high-quality habitat conditions may harm individual plants over the 10-year period of plan implementation. Overall, ecosystem and species desired conditions and objectives will benefit populations and habitats resulting in the maintenance and restoration of at least three self-sustaining populations and associated habitat for the federally endangered Canby's dropwort at known or historic locations.
Pondberry	*Lindera melissifolia*	The revised plan may affect, and is likely to adversely affect individuals of this species. There are potential short-term impacts to individuals as a result of restoration activities, which indirectly improve structure or composition, or less than optimal prescribed burning regimes, particularly at undocumented locations, which could influence reproduction. Forestwide objectives will result in the maintenance and restoration of at least five viable populations for the federally endangered pondberry at known or historic locations, and potential expansion to suitable habitat in coordination with the U.S. Fish and Wildlife Service.

Common Name	Scientific Name	Effects of Alternative 2
Red-cockaded woodpecker	*Picoides borealis*	The revised plan may affect, and is likely to adversely affect individuals of this species. Prescribed fire may harm red-cockaded woodpecker through accidental ignition of cavity trees, though there is no basis to estimate the number of trees or birds that may be affected. Management for loblolly pine timber production in Management Area 2 may reduce foraging habitat for red-cockaded woodpecker clusters below the recovery plan guidelines or may disturb red-cockaded woodpecker during the breeding season (average of up to 4 clusters per year). In Management Area 1, restoration of open wet savanna habitats and conversion of loblolly stands to longleaf are also likely to reduce short-term foraging habitat or disturb clusters during the breeding season (average of up to 11 clusters per year). Together, these timber management activities may adversely affect up to 15 red-cockaded woodpecker clusters per year, but based on recent population growth the total number of active clusters would still likely increase (though more slowly) over the next 10 years. The number of active clusters and potential breeding groups would remain well above recovery goals for the population.
Bachman’s warbler	*Vermivora bachmanii*	The revised plan will have no effect on this species because it is likely extinct.
Wood stork	*Mycteria americana*	The revised plan may affect, but is not likely to adversely affect, this species. Wood storks are not currently known to nest on the forest, but the U.S. Fish and Wildlife Service guidance to avoid harm would be followed if rookery sites are found.
Frosted flatwoods salamander	*Ambystoma cingulatum*	The revised plan may affect, and is likely to adversely affect individuals of this species. Potential harm to individuals, if present, could result from prescribed fire and heavy equipment use associated with typical forest management and restoration activities. Revised Plan implementation will primarily result in discountable, insignificant, or completely beneficial effects to frosted flatwoods salamander designated critical habitat.
West Indian manatee	*Trichechus manatus*	The revised plan will have no effect on this species.
Atlantic sturgeon	*Acipenser oxyrinchus*	The revised plan will have no effect on this species.
Shortnose sturgeon	*Acipenser brevirostrum*	The revised plan will have no effect on this species.

Because the effects of alternative 2 are described in detail in the biological assessment and summarized above, only the effects of alternatives 1 and 3 are presented here. Alternative 3 differs from alternative 2 primarily in the larger area designated as Management Area 2 (Figure 3-20) and the reduced emphasis on prescribed fire and ecological restoration. Therefore, when these differences are relevant for federally threatened or endangered species, the analysis below notes how the effects of alternative 3 would compare to those of alternative 2.



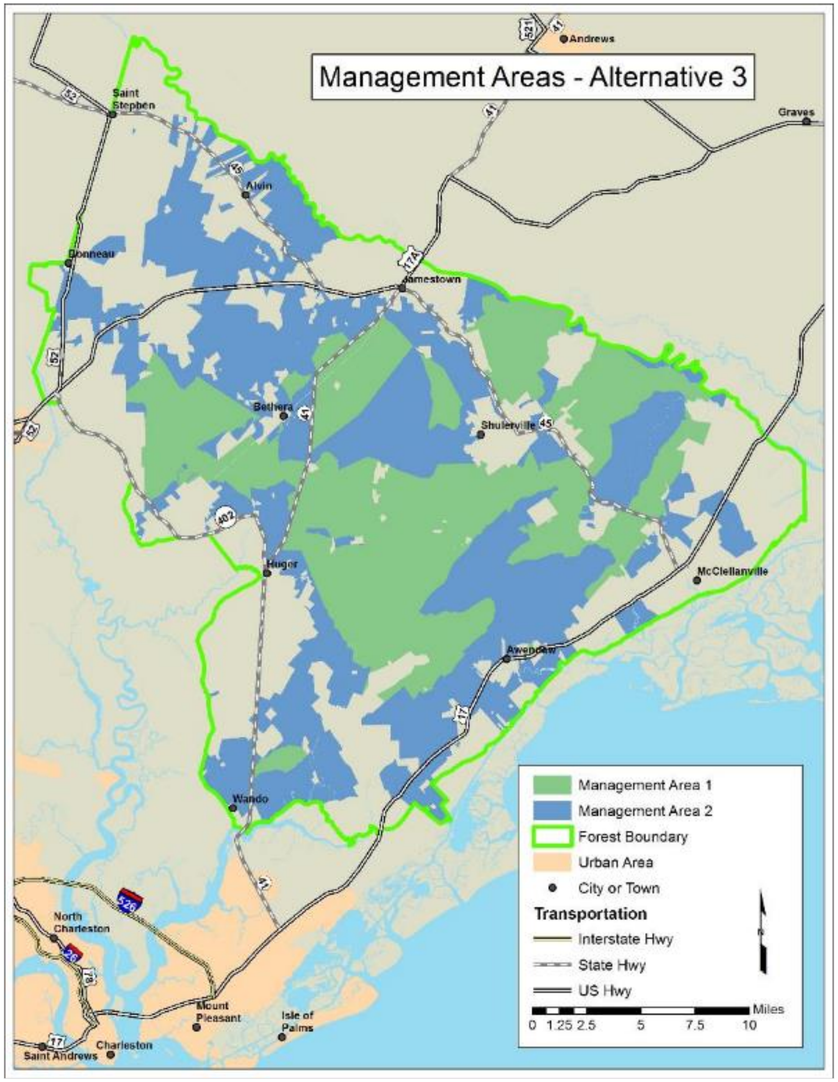


Figure 3-20. Comparison of management areas 1 and 2 between alternatives 2 and 3

3.3.2.3 American Chaffseed (*Schwalbea americana*)

American chaffseed is a perennial herbaceous plant in the figwort family (*Scrophulariaceae*). Recovery criteria include “[B]iennial monitoring shows that 50 protected populations are viable as well as stable or increasing over a 10-year period”, and “[L]ong-term protection is achieved for 50 geographically distinct, self-sustaining populations.” The U.S. Fish and Wildlife Service conducted a 5-year review for American chaffseed in 2010, and identified 1 site in each of Alabama, Florida, and Louisiana, 2 in New Jersey, 11 in North Carolina, and 33 in South Carolina. The Francis Marion National Forest supports 4 existing American chaffseed populations in 2014, of 9 populations and 20 occurrences once documented. Numbers of American chaffseed plants on the Francis Marion declined by 64 percent between 2001 and 2014, and three populations have likely become extirpated (at Ballfield, Highway 41, and Cordesville). Two new experimental populations were established or enhanced with plants from an adjacent seed source in 2014. All recently documented populations are shown in Figure 3-21. There have been numerous plant surveys on the Francis Marion since 2000 documenting results of plant surveys for American chaffseed, as well as other rare and non-native invasive plants, particularly in proposed timber sale areas.

Several studies have documented the dependence of American chaffseed on frequent prescribed fire and on the Francis Marion National Forest declines are evident after 2 years without fire (Kirkman et.al. 1998; Streng and Glitzenstein 2004). In addition, the species may benefit from late summer burns that expose mineral soil (Glitzenstein, personal observations). Additional threats to the species include destruction and adverse changes to habitat through development and incompatible agriculture and silviculture practices, illegal pine straw raking, incompatible right-of-way activities, non-native invasive plants, drought, genetic bottlenecks, and herbivory (USDI 1995, 2010). Two of the existing four populations on the Francis Marion include individuals that occur along state-maintained road rights-of-way, sometimes threatened by inappropriate mowing regimes, though signs direct that mowing occur outside the timing of seed set.

Optimal habitat for American chaffseed on the Francis Marion National Forest is upland longleaf or loblolly pine woodlands, which is abundant on the national forest, maintained very open with frequent prescribed fire or mowing and a diverse herbaceous component. Fire-maintained upland woodland habitat for the plant is abundant on the Francis Marion, and all known and historic populations for the species occurred in a longleaf restoration area in the 1996 forest plan. Nevertheless, stands containing American chaffseed on the Francis Marion would benefit from canopy or mid-story thinning and shrub reduction, and some have been proposed. Others would likely benefit from more growing season or late summer burning. Population monitoring also suggests that habitats are negatively impacted by bracken fern, which persists under a dormant season burning regime. Some individuals have been impacted by inappropriate mowing regimes along associated State maintained rights-of-ways, and several meetings to better coordinate appropriate mowing activities with the South Carolina Department of Transportation.

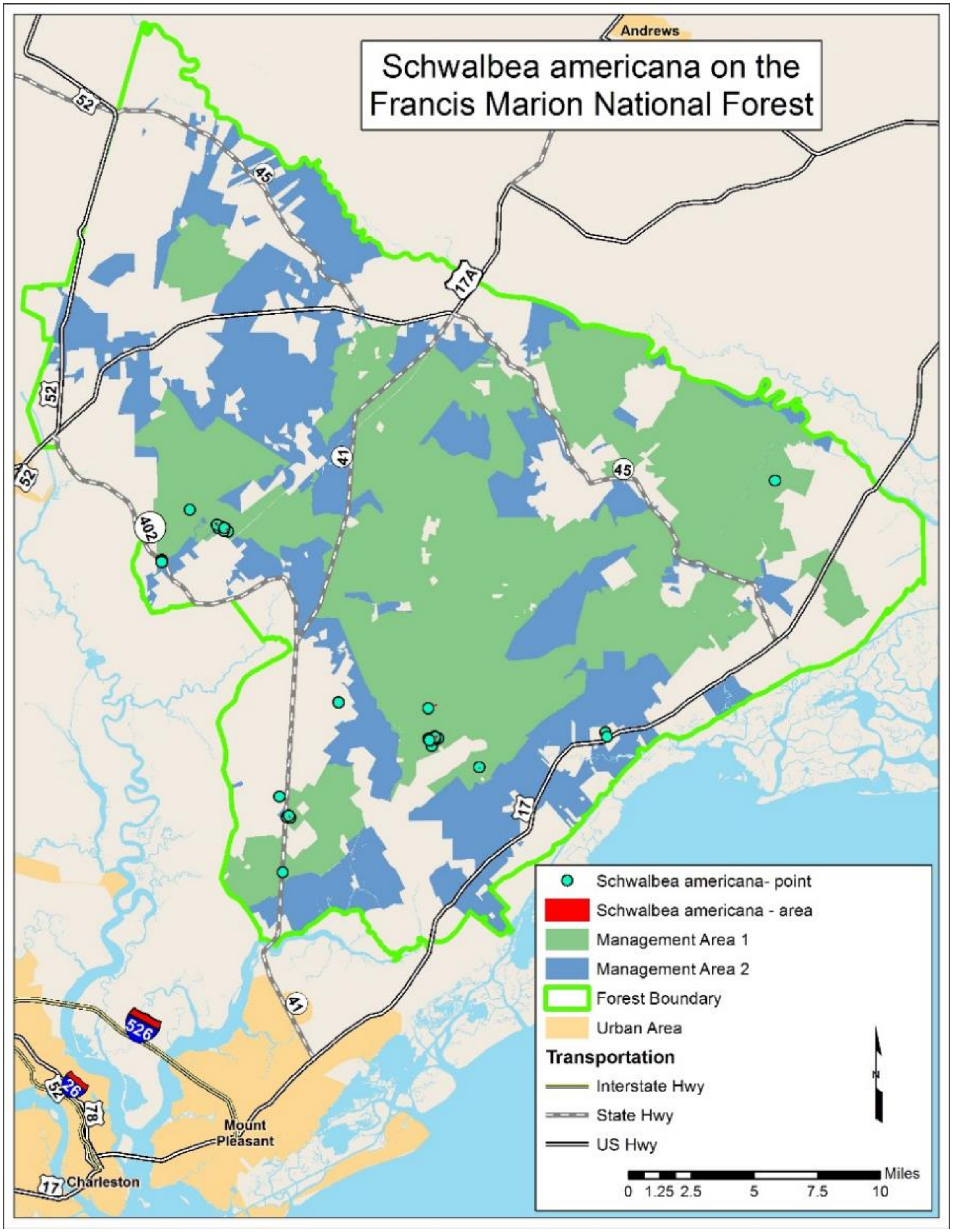


Figure 3-21. Locations of American chaffseed on the Francis Marion National Forest in relation to management areas in alternative 2

Alternative 1

Direct and Indirect Effects. The Forest Service recognized the importance of frequent prescribed fire in longleaf ecosystems for maintaining populations and occurrences for American chaffseed in 1996, and includes all populations in Management Area 26, as well as a standard to prescribed burn them on a 2- to 3-year rotation. The desired condition for rare plant species in danger of becoming extinct is that they would be thriving.

The desired conditions and standards associated with Management Area 26 would indirectly continue to facilitate the restoration of upland longleaf habitat for American chaffseed by creating longleaf ecosystems maintained with frequent prescribed fire, though lack of more specific desired conditions for low canopy cover and low levels of non-native invasive species could threaten them in the future.

Alternatives 2 and 3

Direct and Indirect Effects. Most existing and historic populations for American chaffseed would be included within Management Area 1 in both alternatives 2 and 3. The desired conditions and standards associated with Management Area 1 in alternatives 2 and 3 would indirectly facilitate the restoration and maintenance of key characteristics associated with upland longleaf ecosystems and habitat for American chaffseed by creating open conditions maintained with frequent prescribed fire. Even the populations in the Wando area that would be in Management Area 2 under alternative 3 would be protected according to protection measures aligned with the species' recovery plan.

Direct effects to American chaffseed would be unlikely across all alternatives, since locations are well-known and threatened and endangered species would be addressed and conserved through site-specific analysis. Restoration activities to achieve desired conditions for upland longleaf woodlands are expected to benefit the plant in Management Area 1. Although all attempts are made to survey and flag individuals prior to the onset of activities, due to the cryptic nature of this plant, individuals could go undetected, particularly if the species were to occur in Management Area 2.

Forest management activities would be implemented with protection measures to avoid impacts to this species, but active management required to maintain high-quality habitat conditions may harm individual plants over the 10-year period of plan implementation. This determination is a result, primarily, of management activities within Management Area 1, which maintain and restore associated upland longleaf woodland ecosystems and habitats with open mid-story, shrub, and tree canopies and desired 1- to 3-year fire regimes, including a growing season burn every third burn. Activities could include mastication, selective herbicide application, timber harvest, and fireline and road reconstruction. Additionally, reduced fire in Management Area 2 in the Wando area could result in habitat degradation. Despite potential effects of alternative 3 to a small number of individual plants, implementing the plan will result in maintenance and restoration of at least nine viable populations for the federally endangered American chaffseed at known or historic locations.

Cumulative Effects. Recovery criteria for American chaffseed include, "[B]iennial monitoring shows that 50 protected populations are viable as well as stable or increasing over a 10-year period," and "[L]ong-term protection is achieved for 50 geographically distinct, self-sustaining populations." The U.S. Fish and Wildlife Service conducted a 5-year review for American chaffseed in 2010 and identified one site each in Alabama, Florida and Louisiana; 2 in New Jersey; 11 in North Carolina; and 33 in South Carolina. Because of the beneficial effects to

American chaffseed habitat and projection measures for known populations, the cumulative effects of alternatives 2 and 3 should benefit the species and contribute to recovery efforts.

No additional cumulative effects are anticipated beyond those identified in the section "Cumulative Effects Common to All Alternatives" above.

3.3.2.4 Canby's Dropwort (*Oxypolis canbyi*)

Canby's dropwort is a perennial herbaceous plant in the carrot family (*Apiaceae*). In the 5-Year Species Review (2010a), the U.S. Fish and Wildlife Service concluded that 8 sites for the species are currently managed and protected rangewide, including 5 in South Carolina (Tibwin Savanna on the Francis Marion National Forest, Monkey Meadow Bay in Clarendon County, Crosby Oxypolis Heritage Preserve in Colleton County, Longleaf Pine Heritage Preserve in Lee County, and Lisa Mathews Bay in Bamberg County), 3 sites in Georgia, and 1 in Maryland. The recovery goal is that at least 14 sites are currently extant self-sustaining populations and that necessary management actions are being undertaken by landowners to ensure their continued survival. On the Francis Marion National Forest, one population containing 10 plants for Canby's dropwort was confirmed from a depressional wetland pond dominated by pond cypress savanna in 2000. Only one plant was located there by Gaddy in 2006 (USDI 2006), who described the habitat at that time (Tibwin cypress savanna) as excellent. No Canby's dropwort plants have been found at this site, nor at another unconfirmed, pond cypress depression, since 2006. Glitzenstein (2012) found that locations for the plant on the Francis Marion National Forest were impacted by succession, lack of prescribed fire, woody competition from red maple and loblolly pine, and feral hogs. However the Forest Service is working with the U.S. Fish and Wildlife Service to enhance or establish an additional population at known or historic sites for the plant on the forest (see Figure 3-22).

One of the most significant threats to the species rangewide is loss or alteration of rare wetland habitat (USDI 2010). Optimal habitat for Canby's dropwort is depressional wetlands or Carolina bays maintained open and herbaceous with frequent prescribed fire (USDI 2006). Climate change could jeopardize the existence of isolated populations and associated habitat in the future and are more likely to have low genetic diversity to adapt to change. Woody control to maintain and restore pond cypress competition in known ponds is likely to occur as a result of revised forest plan implementation. All known and historic populations and most potential habitat occur in Management Area 1, where associated depressional ponds and Carolina bay vegetation will be managed with frequent prescribed fire, including a growing season component.

Alternative 1

Direct and Indirect Effects. Indirectly, the desired conditions and standards associated with Management Area 26 would continue to facilitate the restoration and maintenance of habitat for Canby's dropwort, though lack of restoration guidance, including desired conditions and fire regimes for depressional wetlands would be less likely than alternatives 2 and 3 to result in indirect benefits to habitat for the species.

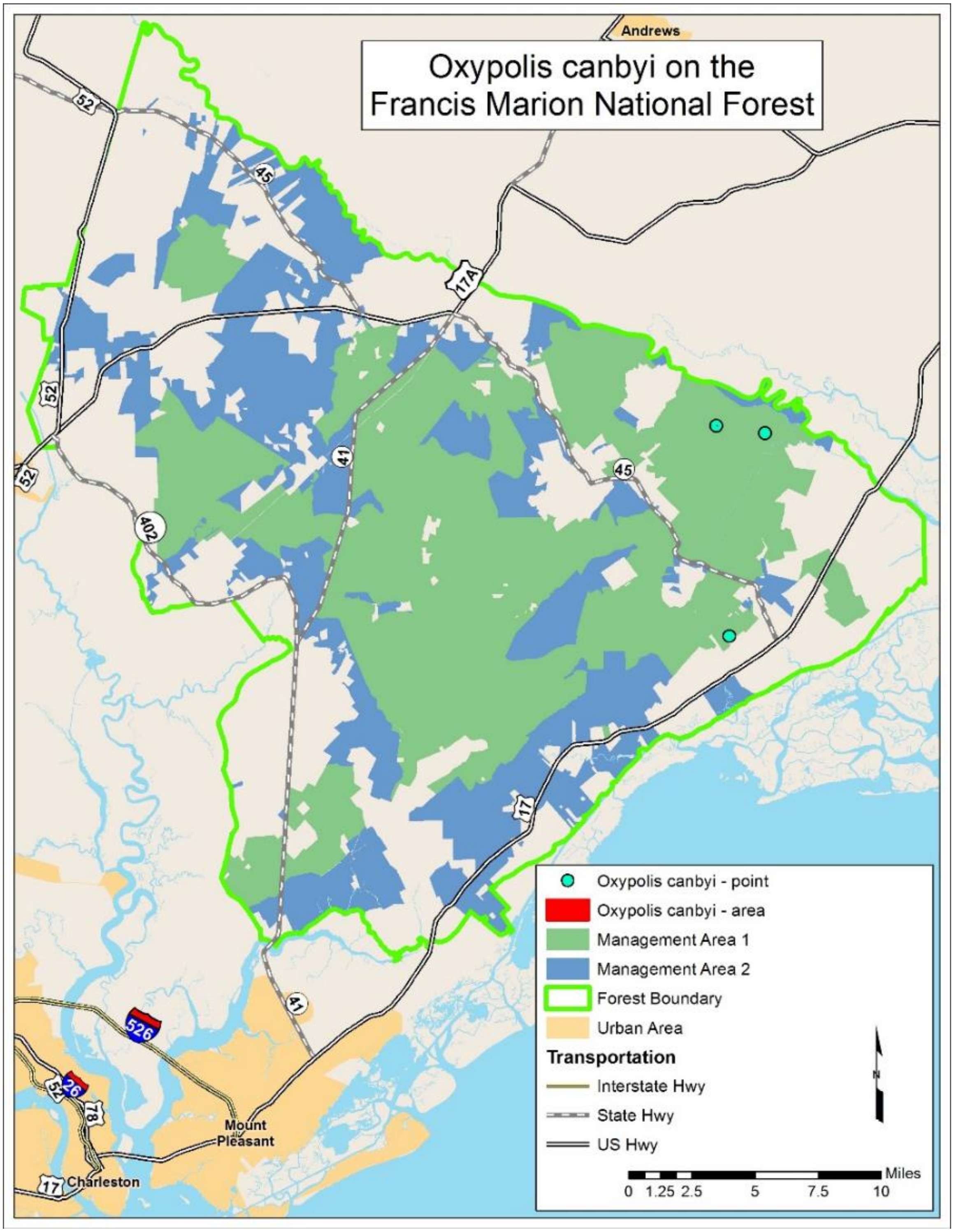


Figure 3-22. Locations of Canby's dropwort on the Francis Marion National Forest in relation to management areas in alternative 2

Alternatives 2 and 3

Direct and Indirect Effects. Indirectly, the desired conditions and standards associated with depressional ponds and Carolina bay ecosystems in Management Area 1 in both alternatives 2 and 3 would facilitate the restoration of habitat for Canby's dropwort by creating open conditions in the uplands maintained with frequent prescribed fire. The known Canby's dropwort population occurs in the proposed Management Area 1 in both alternatives 2 and 3. Alternative 2 includes provision to maintain and restore 78 percent of the forest's depressional wetlands and Carolina Bays using prescribed fire and other tools. Alternative 3 includes provisions to maintain and restore 52 percent of the forest's Carolina bays and depressional wetlands.

Direct effects to Canby's dropwort would be unlikely across all alternatives since threatened and endangered species would be addressed and conserved through the site-specific biological assessment process. There would likely be beneficial effects to Canby's dropwort and associated depressional wetland and Carolina bay ecosystems and habitats in Management Area 1 to the greatest extent in alternative 2, followed by alternative 3 and then alternative 1. Despite implementing activities with protection measures to avoid impacts to this species, the active management required to maintain high-quality habitat conditions may harm individual plants over the 10-year period of plan implementation. Specifically, activities associated with the restoration of depressional wetland and Carolina Bay ecosystems and associated habitats, which could include woody species control, selective herbicide application, wetland restoration, and prescribed fire to include a growing season burn every third burn, could damage individual plants. Overall ecosystem and species desired conditions and objectives will benefit populations and habitats resulting in the maintenance and restoration of at least three self-sustaining populations and associated habitat for the federally endangered Canby's dropwort at known or historic locations.

Cumulative Effects. In the Five-Year Species Review (2010a), the U.S. Fish and Wildlife Service conclude that 8 sites for the species are currently managed and protected, including 5 in South Carolina (Tibwin Savanna on the Francis Marion National Forest, Monkey Meadow Bay in Clarendon County, Crosby Oxypolis Heritage Preserve in Colleton County, Longleaf Pine Heritage Preserve in Lee County and Lisa Mathews Bay in Bamberg County), 3 sites in Georgia and one in Maryland. The recovery goal is that at least 14 sites are currently extant self-sustaining populations and that necessary management actions are being undertaken by landowners to ensure their continued survival. Because of the beneficial effects to Canby's dropwort habitat and projection measures for known populations, the cumulative effects of alternatives 2 and 3 should benefit the species and contribute to recovery efforts.

One of the most significant threats to the species range-wide is loss or alteration of rare wetland habitat (USDI 2010). Climate change could jeopardize the existence of isolated populations and associated habitat in the future, which are more likely to have low genetic diversity to adapt to change. This species is likely to continue to be rare and threatened both on the Francis Marion and throughout the range of the species in the future.

3.3.2.5 Pondberry (*Lindera melissifolia*)

Pondberry is a woody shrub in the Lauraceae family. As of 2007, there were 54 potential populations for pondberry including 2 in Alabama, 19 in Arkansas, 7 in Georgia, 16 in Mississippi, 1 in Missouri, 2 in North Carolina, and 7 in South Carolina. According to the Recovery Plan (USDI 1993), pondberry may be downlisted to threatened when 15 self-sustaining populations are protected, and delisted with the permanent protection of 25 self-sustaining populations. Based on long-distance flight distances of ground-dwelling bees that pollinate

pondberry, a more recent definition of a pondberry population is "colony or colonies separated by at least one mile from other colonies" (Devall et al. 2001; USDI 2007). Given this definition, the Francis Marion harbored five natural populations for pondberry in 2013, plus one introduced population (French Quarter Creek Road). Recovery plans emphasize that first priority be given to management and enhancement of populations at known and historic sites for the species, where possible. Since 1996, 11 new occurrences for the plant have been found and as of 2010, at least 9 of those contained 200-1,000 stems, though little fruit production has been observed (Gustafson 2012; Glitzenstein 2004). As of 2013, there were 24 documented occurrences on the Francis Marion National Forest (GIS and monitoring data; see Figure 3-23).

In South Carolina, pondberry may be easily outcompeted by woody vegetation (USDI 2010b; Glitzenstein 2007; Glitzenstein and Streng 2004). The Forest Service has worked with the South Carolina Native Plant Society to reverse pondberry declines at Honey Hill, as a result of drought and woody mid-story and canopy competition (Glitzenstein 2007). Other threats to the species include a fungus that causes die back of stems, factors that draw down the hydrology of associated ponds, genetic bottlenecks associated with isolated populations (Gustafson 2012), and lack of fire (USDI 2010b), which may influence hydrology or light availability. Although laurel wilt occurs on the Francis Marion and is a threat to species in the Lauraceae family, pondberry stems are typically too small to be infected (Fraedrich 2011). The Forest Service, working with the U.S. Fish and Wildlife Service under the guidance of Gustafson (2012), enhanced two of the pondberry populations on the Francis Marion, one with female plants (Hoover-Brick Church-Highway 41) and the other at Echaw Road with both males and females (this population had declined to less than 10 stems).

Optimal habitat for pondberry on the Francis Marion National Forest is depressional wetlands, including lime sinks and associated herbaceous ecotones. All known pondberry occurrences and populations occur in proposed Management Area 1 in alternative 2 (Figure 3-23). A small number of populations in the Wando area would be in Management Area 2 under alternative 3. Shrub cover is high at many associated pond ecotones, particularly at wildland-urban interfaces within the Wando area, where prescribed fire has been less frequent, and contain not only pondberry, but also frosted flatwoods salamander and Carolina gopher frog, and at Honey Hill.

Alternative 1

Direct and Indirect Effects. Indirectly, the desired conditions and standards associated with Management Area 26 would continue to facilitate the restoration and maintenance of habitat for pondberry, though those at Honey Hill would continue to decline under more conservative management recommended for associated botanical area within Management Area 8. The lack of restoration guidance, including desired conditions and fire regimes for depressional wetlands would be less likely to result in indirect benefits to habitat for the species.

Alternatives 2 and 3

Direct and Indirect Effects. Indirectly, the desired conditions and standards associated with depressional ponds and Carolina bay ecosystems in Management Area 1 would facilitate the restoration of habitat for pondberry by creating open conditions in the uplands maintained with frequent prescribed fire.

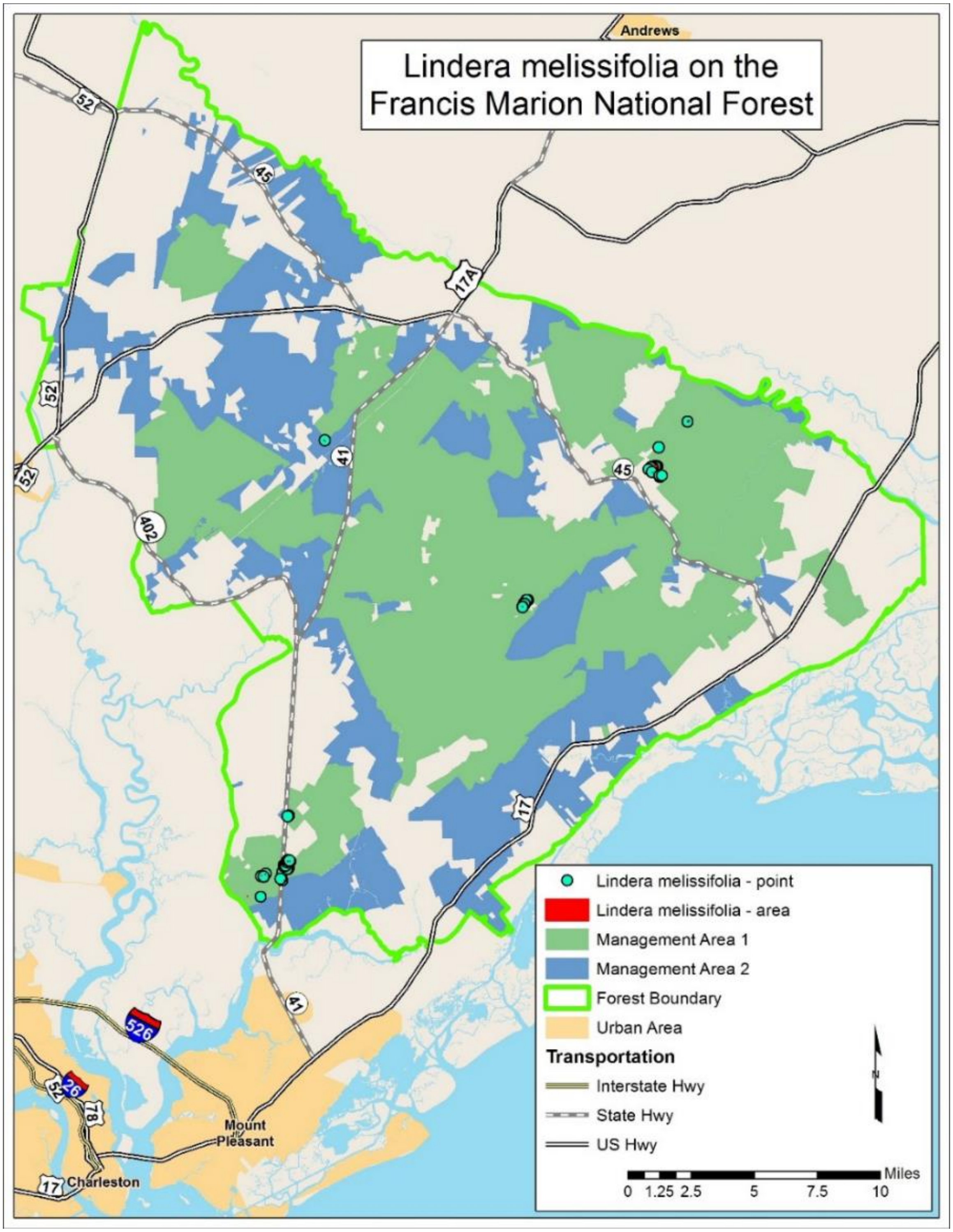


Figure 3-23. Locations of pondberry on the Francis Marion National Forest in relation to management areas in alternative 2

However, in alternative 3, three occurrences and one introduced population occurring in the Wando Zone would not be included in Management Area 1 and associated depressional wetlands would not be maintained with prescribed fire. There are likely to be beneficial effects to pondberry and associated habitat in alternatives 2 and 3, but benefits would be somewhat greater in alternative 2 due to the somewhat greater acreage in depressional wetland and Carolina bay ecosystems being restored. Alternative methods of woody species control could maintain the species in these areas, but indirect benefits to habitats would be greater in alternative 2 than alternative 3.

Short-term impacts to individuals could result from restoration activities, which indirectly improve structure or composition, or less than optimal prescribed burning regimes, particularly at undocumented locations, which could influence reproduction. Forestwide objectives will result in the maintenance and restoration of at least five viable populations for the federally endangered pondberry at known or historic locations, and potential expansion to suitable habitat in coordination with the U.S. Fish and Wildlife Service.

Cumulative Effects. As of 2007, there were 54 potential populations for pondberry as noted in the “Affected Environment” section. According to the recovery plan (1993), pondberry may be downlisted as threatened when 15 self-sustaining populations are protected and delisted with the permanent protection of 25 self-sustaining populations. Based on long-distance flight distances of ground-dwelling bees that pollinate pondberry, a more recent definition of a pondberry population is, "colony or colonies separated by at least one mile from other colonies" (Devall et al. 2001; USDI 2007). Because of the beneficial effects to Canby’s dropwort habitat and projection measures for known populations, the cumulative effects of alternatives 2 and 3 should benefit the species and contribute to recovery efforts.

3.3.2.6 Red-cockaded Woodpecker (*Picoides borealis*)

The Francis Marion supports the third largest population of the federally endangered red-cockaded woodpecker in the U.S. and is one of 13 designated core recovery populations. Prior to Hurricane Hugo in 1989, the red-cockaded woodpecker population consisted of approximately 477 groups and was one of the only known naturally expanding populations. In one night, Hurricane Hugo killed an estimated 63 percent of the red-cockaded woodpecker population, destroyed 87 percent of the cavity trees and 59 percent of the foraging habitat across the Francis Marion (Hooper et al. 1990, 1991). Due to extensive habitat management and installation of more than 2,800 artificial cavities, the red-cockaded woodpecker population has rebounded to approximately 477 active clusters including 460 breeding groups, and 4,596 cavity trees in active foraging partitions (GIS data as of May, 2016). Population growth has been particularly strong during the past 10 years as the post-Hugo forest has grown into better red-cockaded woodpecker habitat (Figure 3-24).

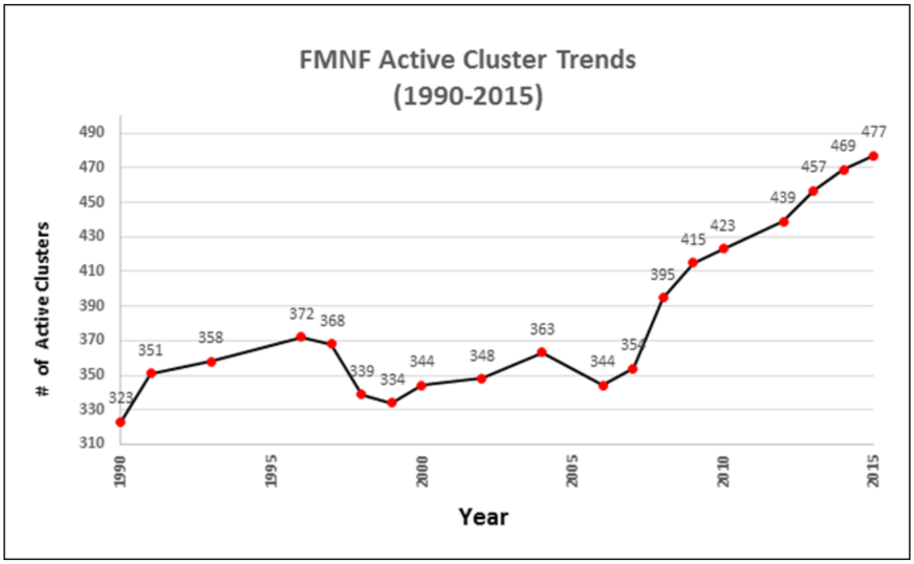


Figure 3-24. Active red-cockaded woodpecker clusters on the Francis Marion National Forest

Since 2007, the Francis Marion National Forest’s red-cockaded woodpecker population has exceeded the recovery goal of 350 potential breeding groups as described in the Red-cockaded Woodpecker Recovery Plan (Figure 3-25). Despite that the majority of clusters on the Francis Marion have foraging habitat that does not meet standards described in the recovery plan, the Francis Marion supports one of the most robust populations in the country. Based on intensive monitoring conducted in 2009, the average group size on the Francis Marion is greater than 3 birds per group and reproductive success averages approximately 2.2 to 2.3 fledglings per successful nest.

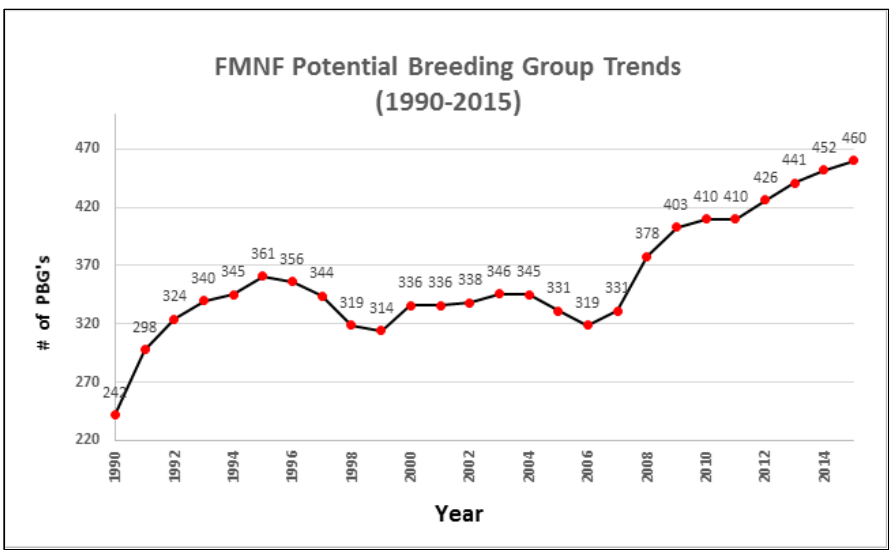


Figure 3-25. Potential red-cockaded woodpecker breeding groups on the Francis Marion National Forest

The Francis Marion red-cockaded woodpecker population is expanding in some areas of the national forest, especially in those that are consistently burned on a 2- to 3-year fire return

interval. Areas that have been consistently burned on a 2- to 3-year fire return interval are lumped together and called the “core burn” area. There are some areas on the Francis Marion where clusters are becoming inactive or reduced to single bird groups. These clusters tend to be concentrated in the wildland-urban interface or areas where minimal forest management has allowed undesirable mid-story succession to occur.

The highest densities of active red-cockaded woodpecker clusters are found within the portions of the national forest that have been burned the most frequently. However, there are some exceptions to this trend. The southwest portion of the forest, in the vicinity of Mount Pleasant, supports some of the highest densities of red-cockaded woodpeckers. Unfortunately, this area, particularly along Highway 41, has numerous wildland-urban interface issues, which have severely limited the Forest Service’s ability to prescribed burn this area frequently.

The revised forest plan would address the maintenance and restoration of nesting and foraging habitat in terms of upland longleaf, wet pine savanna and flatwoods ecosystem composition, structure, function and connectivity, particularly on ecological suitable areas within Management Area 1. The treatments used to accomplish the desired conditions would include prescribed burning, thinning, hydrologic restoration and non-native invasive species control. Restoration of longleaf pine forest types would occur on suitable upland and wet pine sites. To supplement burning and reduce fuels away from Management Area 1, the agency would rely on mechanical and chemical means of woody treatment at wildland-urban interfaces, and selective treatments with herbicides. Recreational uses would continue to increase but would be maintained at a sustainable and a dispersed level.

Upland pine woodlands would be maintained and restored on 33,500 acres (64 percent of the total extent) and wet pine savannas and flatwoods would be maintained, improved and restored on 58,100 acres (67 percent of the total extent) within Management Area 1. Canopies would be open with canopy closure typically less than 60 percent (40-70 square feet of basal area) and as low as 10 square feet of basal area in wet savannas. Groundcover would be predominantly native and herbaceous. Prescribed burning would mimic natural fire regimes within Management Area 1 and would include a 1- to 3-year prescribed burning regime, as well as a growing season burn at least every third burn (approximately 360,000 acres of dormant season prescribed burning per decade and 100,000 acres of growing season burning).

The differences in management direction between Management Areas 1 and 2 are particularly relevant because red-cockaded woodpecker occur across the Francis Marion National Forest in a range of habitat conditions.

Alternative 1

Direct and Indirect Effects. The Forest Service recognized the importance of frequent prescribed fire in longleaf ecosystems for maintaining populations and occurrences of fire-dependent species such as the red-cockaded woodpecker in the 1996 forest plan. The long-term objective in the 1996 forest plan is 450 active clusters. As of 2015, the Francis Marion exceeded this objective.

Direct effects to the red-cockaded woodpecker would be likely to occur because prescribed burning would continue to be used. Although the red-cockaded woodpecker is dependent upon fire maintained ecosystems for its survival, the red-cockaded woodpecker is sensitive to fire injury. Red-cockaded woodpecker cavity trees are highly flammable due to the amount of sap and resin that covers the main tree stem. As such, the woodpecker can be injured by effects of direct

fire. Fire also can harm red-cockaded woodpecker cavity trees and nestlings. The latter are especially susceptible if the cavity tree catches on fire.

The desired conditions and standards associated with Management Area 26 in the 1996 forest plan would continue to indirectly facilitate the restoration of upland longleaf habitat for species like the red-cockaded woodpecker by creating and maintaining longleaf ecosystems with frequent prescribed fire. Although the woodpecker population has done well on the Francis Marion during the 1996 forest plan planning period, red-cockaded woodpecker management will be needed for many years to come (for example, artificial cavity installation and replacement, mechanical mid-story control, and annual monitoring). Without more specific desired conditions for low canopy cover, control of non-native invasive species, and overall ecosystem restoration, Alternative 1 would not produce the amount of direct and indirect benefits that alternatives 2 or 3 are expected to produce for the red-cockaded woodpecker.

Alternative 2

Effects to red-cockaded woodpecker habitat are addressed in the biological assessment in Appendix G of this document.

Alternative 3

Direct and Indirect Effects. Direct effects to red-cockaded woodpecker would be the same as alternative 1, namely that cavity trees could be damaged and individual birds may be injured or killed by fire. However, the potential for negative impacts to the red-cockaded woodpecker and its habitat would be greatest under this alternative.

Increased fire exclusion and suppression in some of the highest red-cockaded woodpecker density areas on the forest (such as the Wando Area), coupled with increased wilderness designations in alternative 3 would be expected to lead to negative indirect effects for red-cockaded woodpecker habitat (see Figure 3-26). Although fire may sometimes still be used in the Wando Area under alternative 3, this area would not be prescribed burned on a 1- to 3-year fire return interval; alternative silvicultural practices would have to be relied upon much more than prescribed burning (for example, mechanical, herbicide, and even possible use of grazing). As a result, species that are dependent upon fire maintenance would be indirectly affected by the anticipated decline in habitat quality and, depending upon the activity being used, may lead to cascading indirect effects throughout the ecosystem. This would be especially true if there were an increased use of herbicides and potential grazing. Based on these indirect effects, many clusters could become inactive during the next 10 to 50 years under alternative 3.

Similar to the analysis for alternative 2 (see Appendix G), forest management activities to implement alternative 3 would likely affect red-cockaded woodpecker in both Management Areas 1 and 2. Management for loblolly pine timber production in Management Area 2 may reduce foraging habitat for red-cockaded woodpecker clusters below the recovery plan guidelines or may disturb red-cockaded woodpecker during the breeding season. In Management Area 1, restoration of open wet savanna habitats and conversion of loblolly stands to longleaf are also likely to reduce short-term foraging habitat or disturb clusters during the breeding season. Despite the differences between the two alternatives, the scope of short-term effects would likely be similar; (individuals and clusters could be disturbed but the total number of active clusters would still likely increase, though more slowly, over the next 10 years). However, the reduced emphasis on ecological restoration and prescribed fire in alternative 3 would not result in as much long-term habitat improvement as alternative 2.

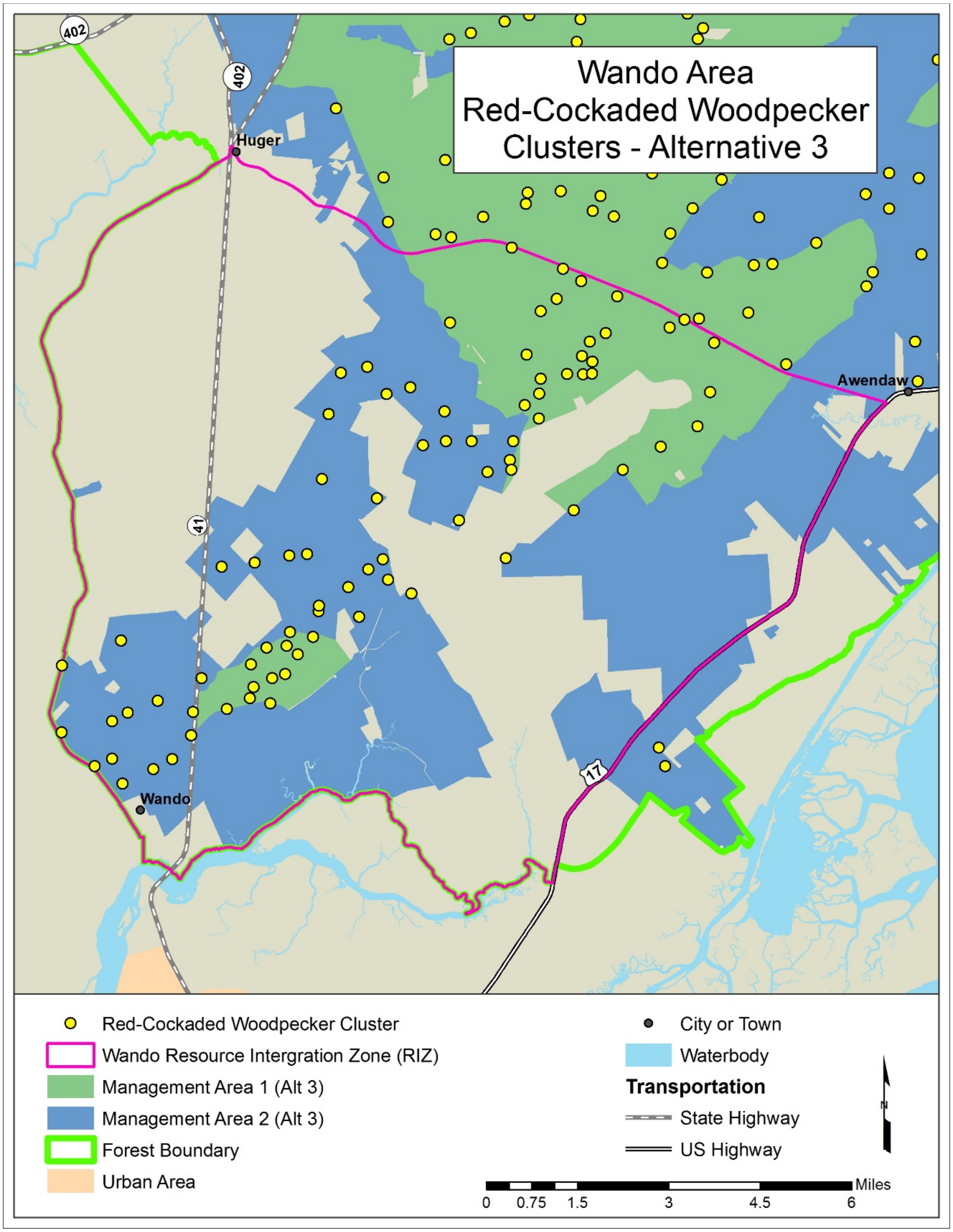


Figure 3-26. Red-cockaded woodpecker clusters that fall within Management Area 2 under alternative 3

Note: MA 1 is green; MA 2 is in brown.

Cumulative Effects

Negative cumulative effects would not be expected for the red-cockaded woodpecker under any alternative. Red-cockaded woodpecker habitat would continue to be maintained and enhanced as it has been since the 1996 forest plan was implemented. Even in the context of increased urbanization, their population growth, the number of active clusters, and potential breeding groups would remain well above recovery goals for the population under all alternatives.

3.3.2.7 Bachman’s Warbler (*Vermivora bachmanii*)

Although suitable habitat for the Bachman's warbler can be found on the Francis Marion National Forest, the last confirmed sighting was in 1963 on private lands. Bachman’s warbler (*Vermivora bachmanii*) was discovered in July 1832 in Cardin Bridge Swamp, South of Charleston on the Edisto River. In South Carolina, Bachman’s warbler was not seen again until A.T. Wayne collected a specimen on May 15, 1901 near Mt. Pleasant in Charleston County (Wayne 1901; Forsythe 1991). On May 13, 1905, Wayne discovered and described the nest and young of Bachman’s warbler (Wayne 1907; Forsythe 1991). Wayne saw more than 70 individuals, collected 21 and located 35 nests between 1901 and 1919 (Wayne 1910; Hamel and Hooper 1979). Almost all of Wayne’s field work was conducted in I’On Swamp, in Fairlawn Plantation and in the Francis Marion National Forest near the headwaters of the Wando River in Charleston County.

Since 1920, reported occurrences of Bachman’s warbler have occurred erratically throughout coastal South Carolina. According to Forsythe (1991), the reports that have been recorded are reviewed in Burton (1970), Chamberlain (1958), Cutts (1964), Hamel (1986), Shuler (1977a) and Sprunt and Chamberlain (1949). The bulk of these sightings were reported between 1949 and 1962 from Charleston County mainly at Fairlawn Plantation, Moore’s Landing (now known as Garris Landing), Orange Grove Road, or near McClellanville.

During 1975-1977, several sightings of Bachman’s warblers were reported in the I’On Swamp area of the Francis Marion National Forest (Shuler 1977b; Shuler et al. 1978; Forsythe). However, repeated attempts by Hamel and others to relocate these individuals failed (Forsythe). Hamel (1978) concluded that his inability to locate any of the birds reported in I’On Swamp, along with the lack of documentation on these sightings, makes these records questionable (Forsythe). Hamel (1978) considered the last documented Bachman’s warbler sighting to be the single male from Moore’s Landing Road (also known as Bulls Island Road, which leads to Garris Landing), which was seen by many in April 1962 (Forsythe).

The Bachman’s warbler is likely one of the rarest songbirds in the world. Based on the literature, Bachman’s warbler has not been officially observed in Berkeley or Charleston counties in approximately 53 years. As previously mentioned, many species experts believe that the Bachman’s warbler is now extinct in South Carolina. Extensive surveys conducted throughout the South Carolina Coastal Plain in 1991 also failed to document the species. Therefore, it is highly unlikely that the species occurs on the Francis Marion.

Effects Common to All Alternatives

Direct and Indirect Effects. Historical accounts of Bachman’s warbler habitat are neither plentiful nor specific, and there was considerable disagreement among experts as to what actually constituted preferred nesting habitat (Forsythe 1991). Hooper and Hamel (1977) stated, “The overstory of areas chosen for nesting appeared to have been subjected to disturbance, either natural or man caused, that stimulated development of a relatively dense understory.” Widmann

(1897) found the birds nesting in areas that had been selectively harvested. Others have argued that the birds preferred habitat was “relatively mature, dense-canopied swamp forest” (Schulre 1977) or dense thickets of cane under a relatively open canopy of large trees (Remsen 1986). Hamel (1986) concludes the following, “A possible synthesis of the various opinions on breeding habitat may be that the birds’ original habitats were secondary successional (gap-phase) openings in the swamp forest canopy, such as might be caused by storms or insect damage. However, we will never have a satisfactory explanation until breeding birds can be found and studied” (Forsythe 1991).

Regardless of which habitat the species truly prefers, all of the aforementioned conditions would be created and maintained under all alternatives. Management activities proposed under the three alternatives would create and maintain suitable habitat for Bachman’s warbler based on the forested ecosystems where the species would be most likely to occur.

Because of the extreme rarity of this species, the lack of recent sightings and the maintenance of suitable habitat conditions, none of the alternatives would have direct or indirect effects to Bachman’s warbler.

Cumulative Effects. Direct, indirect, and cumulative effects to Bachman’s warbler and associated habitat would be unlikely across all alternatives, since this species has not been confirmed from the forest and is unlikely to occur.

3.3.2.8 Wood Stork (*Mycteria americana*)

Since the 1996 forest plan was written, the wood stork has been downlisted from endangered to threatened. The wood stork may occasionally be seen in swamps and wetlands across the Francis Marion, but is currently not known to nest on the national forest. However, wood stork rookeries are known from adjacent private properties in Charleston County, including The Nature Conservancy’s Washoe Reserve. Due to the amount of ideal wetland habitat for rookeries, it is highly conceivable that wood stork rookeries may form on the Francis Marion during the next 10 to 50 years.

Direct, Indirect and Cumulative Effects. Habitat for the wood stork would not vary greatly among the alternatives. The greatest threat to habitat is draining wetlands and swamps. No alternatives propose to drain wetlands or swamps, but efforts are planned to restore hydrologic function. Therefore, effects would be expected to be similar for all alternatives.

Direct, indirect, and cumulative effects to wood stork and associated habitat would be unlikely across all alternatives, since no known wood stork rookeries are documented from the Francis Marion National Forest, and habitat would be expected to be maintained and improved across all alternatives.

3.3.2.9 Frosted Flatwoods Salamander (*Ambystoma cingulatum*)

The frosted flatwoods salamander (*Ambystoma cingulatum*) was designated as a federally threatened species in 1999 (*Federal Register* Vol. 64, No. 62: 15691-15704). The frosted flatwoods salamander is a mole salamander which breeds within seasonally flooded isolated wetlands embedded within fire-maintained pine woodlands and savannas. This salamander burrows near water or moves about under debris on the forest floor. It is carnivorous and an opportunistic feeder, primarily eating earthworms and arthropods. The species needs shallow winter flooded isolated wetlands to breed and for larvae to develop. It also needs fire maintained pine uplands for the remainder of its life cycle. As with most pond breeding amphibians, the

species does not do well in wetlands that contain fish. The timing and frequency of rainfall is critical to the successful reproduction and recruitment of flatwoods salamander (Final Rule for Listing, 1999). Surviving populations are currently threatened by habitat loss and degradation from agriculture, urbanization, and various silviculture practices (Final Rule for Listing 1999). The flatwoods salamander is extremely rare in South Carolina; the Francis Marion is home to one of only four known populations in the entire state.

Most known, historic and potential frosted flatwoods salamander breeding wetlands on the Francis Marion (as identified by Harrison in monitoring report dated 2004 and internal surveys since 2004) occur in designated critical habitat near the community of Wando located on the southwest corner of the national forest (see Figure 3-27 and Figure 3-28). The August 13, 2008 *Federal Register* (Volume 73, Number 157) designated critical habitat for *A. cingulatum*. Critical habitat on the Francis Marion was given the unique identifier of Unit FFS-6. The Federal Register stated the following for Unit FFS-6:

> Unit FFS-6 occupied at the time of listing, encompasses 1,300 ac (526 ha) on Federal and private land in Berkeley County, South Carolina. This unit is bisected by State Highway 41 approximately 10 mi (16 km) south of the town of Huger. Within this unit, 1,176 ac (476 ha) are in the Francis Marion National Forest and 124 ac (50 ha) are on private land.

The August 13, 2008 Federal Register provides the following, “Food, Water, Air, Light, or Other Nutritional or Physiological Requirements” within breeding wetlands, “An unpolluted wetland with water free of predaceous fish, sediment, pesticides, and the chemicals associated with road runoff, is important to maintain the aquatic invertebrate fauna eaten by larval salamanders.” In breeding wetlands, developing larval frosted and reticulated flatwoods salamanders hide in submerged herbaceous vegetation during the day (Palis and Means 2005) as protection from predators. An abundant herbaceous understory within these breeding wetlands is extremely important.

Numerous isolated breeding wetlands have been severely altered by previous land management practices prior to establishment of the Francis Marion. Some of the best examples of frosted flatwoods salamander breeding wetlands on the Francis Marion are bordered by a former tram bed that was used to transport lumber in the early to mid-1900s (Figure 3-28). The Tuxbury Horse Trail in compartments 114, 115 and 116 is located on this historic tram bed. Some of the potential impacts created by the tram bed include the following:

- Since there are no culverts or bridges on this horse trail/tram bed, this artificial land feature could serve as a barrier to sheet flow impacting the hydrology of adjacent wetlands. The tram bed is ditched on both sides and was intentionally built up to traverse through wetlands.
- Additionally, the ditches on either side of the tram bed drain adjacent wetlands could serve as vectors for undesirable aquatic organisms such as predatory fish.

Generally, flatwoods salamander breeding ponds and upland habitats are separated by an ecotone (area of transitional habitat) through which salamanders must move during pre- and post-breeding events (Palis 1997). The grass-like ecotone represents a distinct habitat type and is important for maintaining connectivity between aquatic and terrestrial habitats. When the ecotone provides cover and appropriate microclimatic conditions, survival of migratory salamanders is enhanced. Studies of migratory success in post-metamorphic salamanders have demonstrated the importance of high levels of survival of these individuals to population maintenance and persistence (Rothermel 2004). Post-larval and adult frosted and reticulated flatwoods salamanders occupy upland flatwoods sites where they live underground in crayfish burrows, root channels, or

burrows of their own making (Goin 1950; Neill 1951; Mount 1975; Ashton and Ashton 2005). The occurrence of these belowground habitats is dependent upon protection of the soil structure within Flatwoods salamander terrestrial sites."

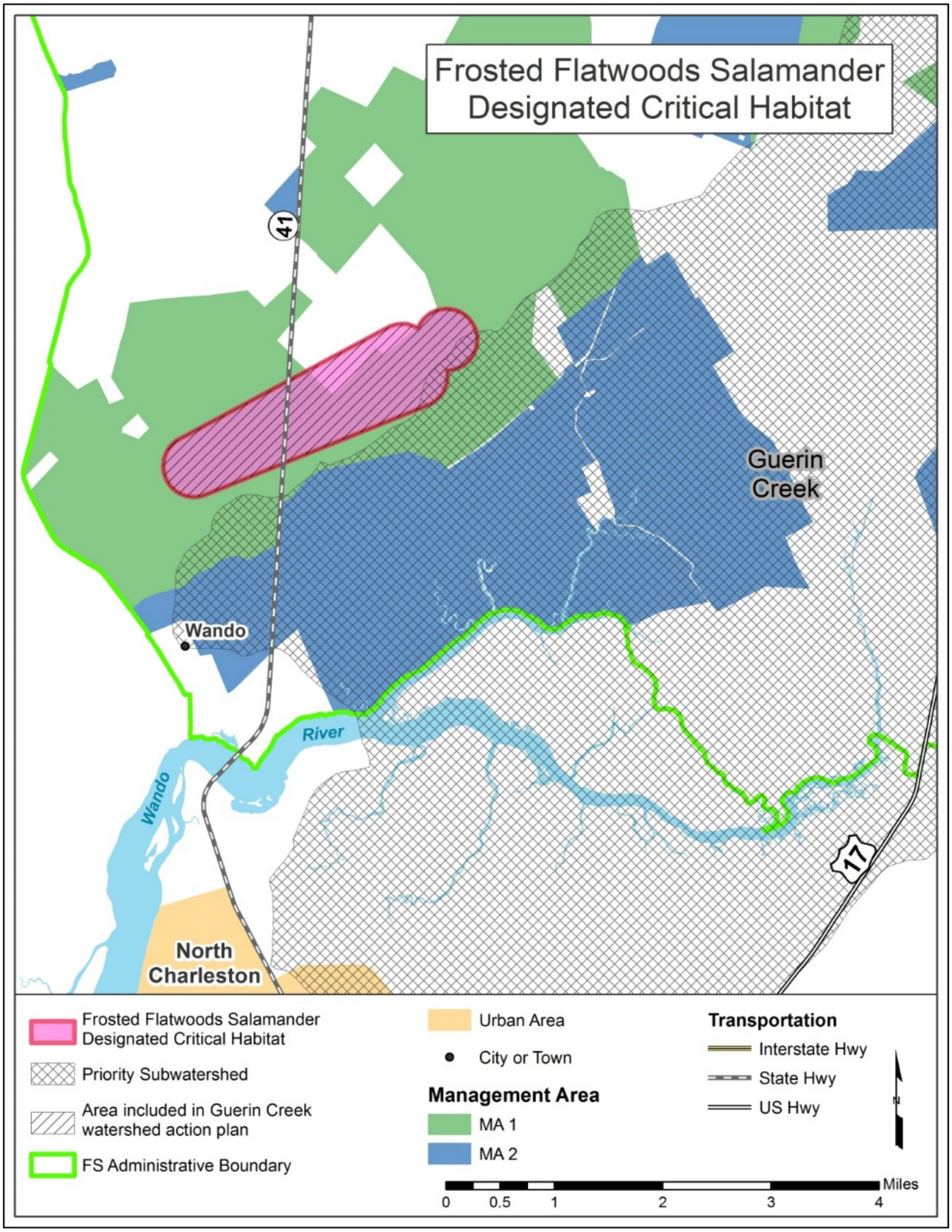


Figure 3-27. Frosted flatwoods salamander critical habitat on the Francis Marion National Forest

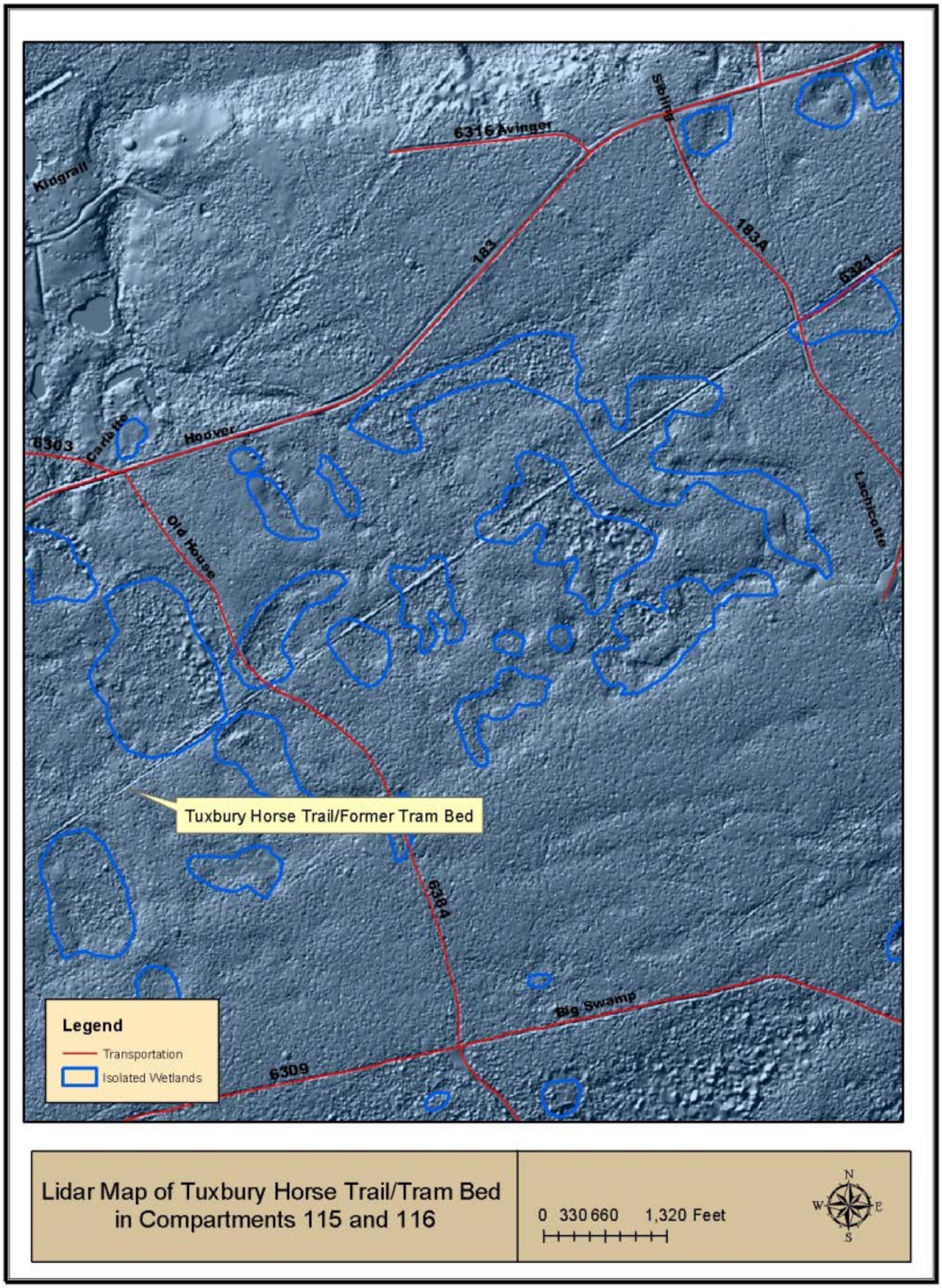


Figure 3-28. Hillshade map derived from LiDAR showing tram bed impacts to breeding wetlands within the designated critical habitat for the frosted flatwoods salamander

Only eight adults and approximately 12 larvae have been captured on the Francis Marion in the past 20 years (Harrison 2004; Harrison 2005; Palis 2009; Palis 2010; and internal Forest Service records). Julian Harrison made the initial observations of flatwoods salamanders on the Francis Marion in the early 1950s through 1970 (Harrison 2003). Subsequent observations were made during flatwoods salamander surveys by Moulis and Seyle (1987) and Moulis and Williamson (1998). John Fauth captured four adults in October 1995 and a single larva in 2003 (Harrison 2003), William Resetarits encountered an adult on Hoover Road in June 1997 (internal Forest Service documentation) and a single adult was captured in Hoover Pond in 2002 (Harrison 2003). Unsuccessful surveys for Flatwoods salamanders on Francis Marion were conducted by Forest Service employees (1991), Bennett (1995), Humphries (2000), Harrison (2001), Waldron (2001), Harrison (2003) and Palis (2009). The species was documented on the Francis Marionin 2010 (Palis 2010). The majority of sampling on the national forest is conducted via dip-netting and deployment of minnow traps for larval salamanders.

Since 2006, the Francis Marion has attempted monitoring of breeding ponds every year, but with the exception of 2009 and 2010 breeding ponds were dry. During 2010, John Palis and Joyce Marie Klaus conducted surveys on the Francis Marion. Nineteen wetlands were surveyed and *Ambystoma cingulatum* was documented on the national forest for the first time since 2003. Six larvae were collected from a previously undocumented breeding wetland during March 2010. Three larvae were taken to Riverbanks Zoo in Columbia, SC where Scott Pfaff (Curator of Herpetology) successfully raised them to metamorphosis. At the time of collection, the larvae were too small to collect tail tissue, so the zoo reared them until they were big enough to collect tissue. DNA analysis was performed; results indicate that individuals from the Francis Marion do not represent a distinct species and are closely related to other populations of the frosted flatwoods salamander. This was the first genetic material available from South Carolina. The individuals from the Francis Marion National Forest maintained at Riverbanks Zoo in Columbia have since died.

Direct Effects from All Alternatives

Negative effects to individual frosted flatwoods salamanders could occur under all alternatives because this species is highly susceptible to injury. Direct mortality from prescribed burning is anticipated to be less likely under alternatives 2 and 3, as mitigation measures specifically designed to minimize impacts to the frosted flatwoods salamander would be planned. The 1996 forest plan does not include any specific management measures to protect and enhance habitat for the frosted flatwoods salamander.

Indirect Effects from All Alternatives

Conservation measures for this species are included in the final rule for listing (*Federal Register* Vol. 64, No. 62, p. 15703) and limit management activities (such as roads, skid roads, and log decks) within a 450 meter radius of known flatwoods salamander breeding ponds. National forest land within the designated critical habitat would remain protected from agricultural and urban development. However, threats remain to frosted flatwoods salamander habitat that may require special management.

Restoration of Upland Habitats and Migration Routes. Carefully performed, mechanical treatments (timber harvesting and mastication) can improve habitat for the frosted flatwoods salamander:

- Thinning and restoration treatments can reduce densely stocked pine stands and provide structural characteristics that are important for the species. These treatments can also

create underground refugia when stumps and large woody debris are left intact. Coarse woody debris, root mounds and stump holes provide critical refugia for numerous species of wildlife, and can allow species such as the frosted Flatwoods salamander to have critical escape cover from fires and the elements.

- Silvicultural thinning treatments have been used to reduce stocking levels in densely stocked pine stands across the Francis Marion, but it is critical to follow mechanical treatments with frequent low intensity fires.

Unfortunately, mechanical treatments only provide short term habitat benefits lasting 2 to 3 years, especially if the residual basal areas are fairly high (residual basal area of pine more than 50 square feet per acre). If thinning is not followed with repeated prescribed burning operations every 2 to 3 years, then desirable mid-story conditions quickly deteriorate.

In alternatives 2 and 3, objectives would include providing stump and root mounds. If adequate underground refugia is not provided, then guidelines would include creating habitat by knocking over trees.

Restoration of Breeding Wetlands. Restorative activities need to be implemented in areas such as compartments 114, 115 and 116 to improve habitat conditions for the frosted flatwoods salamander and other isolated wetland-dependent organisms. All known current and historic frosted flatwoods salamander breeding wetlands are found in the designated critical located on the southwest corner of the Francis Marion.

Frequent fire is needed to keep succession occurring in breeding wetlands. Some compartments on the Francis Marion (compartments 113 and 114 between Highway 41 and Cainhoy Road) have not been burned in more than 20 years allowing encroachment of trees into the wetlands. A grass-like cover is preferred in these wetlands. Figure 3-29 depicts a historical Carolina gopher frog breeding wetland that has only seen prescribed fire once in the past 24 years. In contrast, Figure 3-30 depicts a known Carolina gopher frog and potential frosted flatwoods salamander breeding wetland within the *A. cingulatum* critical habitat.

Activities to restore historic water flows along the historic tram could include installation of culverts, bridges or crossings.

All alternatives would be expected to indirectly benefit the frosted flatwoods salamander by creating, maintaining and enhancing desirable habitat conditions through restoration of the longleaf pine ecosystems. In terms of indirect effects, differences are anticipated for the 3 alternatives.

Figure 3-29. Potential breeding wetland negatively impacted by fire exclusion and the resulting tree encroachment

Figure 3-30. Potential breeding wetland maintained by fire with desired herbaceous cover

Alternative 1

In alternative 1, *A. cingulatum* habitat would continue to be maintained and enhanced as it has been since the 1996 forest plan was written. The direction in Management Area 26 would continue to create and maintain longleaf ecosystems with frequent low-intensity prescribed fire. However, without more direction to provide low canopy cover, control of non-native species and overall ecosystem restoration, alternative 1 would not produce the amount of direct and indirect benefits that alternative 2 would provide.

Alternative 2

Effects from alternative 2 are addressed in the biological assessment in Appendix G of this document.

Alternative 3

Habitat conditions would decline under alternative 3. Only 482 acres of the designated critical habitat would be located in Management Area 1 in this alternative. This means that approximately 63 percent of the 1,300 acres that have been designated as critical habitat fall within Management Area 2 in alternative 3. As such, this portion of the critical habitat would not be expected to be adequately maintained with prescribed burning. Alternative methods to reduce hazardous fuel loadings (such as herbicide application and grazing) may be detrimental to the frosted flatwoods salamander. Mechanical and herbicide activities would not be a substitute for fire and, in the case of the latter, can be lethal for amphibians like the frosted flatwoods salamander. Increased use of herbicides, grazing, and mechanical activities would compound the potential for negatively impacting the species.

Cumulative Effects

The frosted flatwoods salamander is extremely rare in South Carolina and the Francis Marion is home to one of only four known populations in the entire state. Additionally, the national forest provides the largest acreage of designated critical habitat in South Carolina. The only other public land where the species is known to occur in South Carolina is the Santee Coastal Reserve. Due to its potential for maintaining and increasing the number of metapopulations, the Francis Marion is the most important landscape for the frosted flatwoods salamander in South Carolina.

Due to the predicted amount of urbanization, habitat conditions are only expected to deteriorate in the future unless adequate fire return intervals occur in this area. As a result of the increased reliance on mechanical treatments and nontraditional techniques such as herbicides and grazing in alternative 3, habitat conditions for the frosted flatwoods salamander would decline. Under alternatives 1 and 2, frosted flatwoods salamander habitat would be maintained and enhanced, but increased urbanization would increase the likelihood for negative impacts to the species.

Due to the potential threats that exist in the designated critical habitat, the Francis Marion would need to examine opportunities for translocation and reintroduction of species such as the frosted flatwoods salamander and Carolina gopher frog in the future. Translocation and reintroduction of *A. cingulatum* to other suitable habitats would increase the number of metapopulations on the Francis Marion, and could offset the potential impacts of continued habitat deterioration in the designated critical habitat. It is highly likely that the frosted flatwoods salamander and Carolina gopher frog once occurred across the entire Francis Marion especially along the Cainhoy Ridge and Bethera Ridge. However, due to their highly specialized habitat requirements and environmental sensitivity, past destructive land practices likely would lead to the demise of virtually all metapopulations on the Francis Marion.

3.3.2.10 West Indian Manatee (*Trichechus manatus*)

The West Indian manatee is federally and state endangered in South Carolina. Manatees are protected under the Marine Mammal Protection Act, which prohibits the take (can't harass, hunt, capture or kill) of all marine mammals. Manatees are found in marine, estuarine, and freshwater environments. The West Indian manatee includes two distinct subspecies, the Florida manatee (*Trichechus manatus latirostris*) and the Antillean manatee (*Trichechus manatus manatus*). Potential threats to the species include habitat loss and degradation, death from boat collisions, entanglement in fishing gear, entrapment in water control structures and exposure to cold temperatures.

In South Carolina, the Florida manatee is known or believed to occur in the following counties: Beaufort, Berkeley, Charleston, Colleton, Dorchester, Georgetown, Horry and Jasper. Although Florida manatees are present throughout the year in Florida, they are migratory in South Carolina. Manatees begin migrating up the east coast of Florida, Georgia, and South Carolina each spring when water temperatures begin to rise into the upper 60s. They can be found in tidal rivers, estuaries, and near-shore marine waters throughout Georgia and the Carolinas during the summer months. Manatees return to Florida in September and October as water temperatures begin to cool.

Manatee sightings in Berkeley and Charleston County, most of which have come from the Cooper River, have been reported to South Carolina Department of Natural Resources. However, it could be possible that the species occasionally swims in state waters on or adjacent to the Francis Marion National Forest in areas such as Wambaw Creek, Tibwin Creek, Awendaw Creek, Guerin Creek and Huger Creek. The species was documented in the Santee River next to the Francis Marion in 1993 and has been repeatedly reported from the Cooper River and Wando River. Manatee sightings have been reported on the Cooper River as far north as Moncks Corner. During 2012, one manatee made it through locks on the Santee Cooper Lakes and wound up becoming trapped in Lake Marion. Unfortunately, this manatee was eventually found dead near Camp Bob Cooper on Lake Marion during November 2012.

Direct, Indirect, and Cumulative Effects

Management activities proposed in the forest plan are not expected to impact habitat for West Indian manatee as soil and water guidelines described for all alternatives are designed to minimize impacts to water quality; therefore, no effects are expected for all alternatives. Analysis and consultation with applicable State and Federal entities would be conducted at the project level when projects have the potential to impact the West Indian manatee.

No direct, indirect and cumulative effects to West Indian Manatee are expected.

3.3.2.11 Shortnose and Atlantic Sturgeon (*Acipenser brevirostrum*) and (*Acipenser oxyrinchus*)

Shortnose sturgeon was once widely distributed throughout coastal rivers from St. John River, Canada to the St. Johns River, Florida. Occurring primarily in large river mainstreams and just off shore where the species can access other river systems. There are currently five distinct populations in South Carolina. The Santee and Cooper populations are adjacent to the Francis Marion. This fish is anadromous, with adults spawning at or above head-of-tide in most rivers. Spawning occurs in late winter to early spring based on water temperature rise and delayed high flows (National Marine Fisheries Service 1998). Historically, shortnose sturgeon would have migrated much further upstream in the spring to spawn. Migration is now hindered by major

hydroelectric dams. However, besides seasonal migrations to estuarine waters these fish rarely occur in marine environments.

Of the two adjacent populations, the Cooper River has an estimated population of 200 adult, spawning-run individuals (Cooke 2004). However, little is known about population size. There is an additional landlocked population in the lakes upstream. The Santee River does not allow for passage of sturgeon. Habitat management for large river species is not within the authority or capability of the Forest Service to maintain viable populations, but management of forest lands in those watersheds that maintain or restore biological, chemical, and physical attributes would contribute to the protection of large river habitats.

Atlantic sturgeons occur from St. Croix, Maine to the Saint Johns River in Florida, primarily in the near shore ocean. During breeding season, they migrate to freshwater rivers for spawning. The Carolina distinct population segment ranges for the Santee-Cooper River to the Albemarle Sound and consists of seven extant subpopulations. Over 60 percent of the habitat available is impeded due to the presence of dams. Currently, the existing spawning populations in each of the rivers in the Carolina distinct population segment have less than 300 adults spawning each year (Cooke 2004).

Pollution, loss of upstream habitat, and over fishing are the primary causes of the species listing of the shortnose sturgeon in 1967 and the Atlantic sturgeon in 1998. The Santee Dam hinders migrations of native anadromous fish to their historic spawning grounds in the piedmont (some passage has been observed, but very little). These include shad, striped bass, and sturgeon (Francis Marion National Forest Draft Forest Plan Assessment 2013). Overall threat impacts to these species include population decline due to dams, which cut off upriver spawning areas; altered stream flow; temperature; and water quality. Habitat degradation remains a threat. Other factors include siltation, habitat disruption from dredging, and overharvest.

Direct, Indirect, and Cumulative Effects

The two federally listed sturgeon species occur only in the large rivers draining national forest land and the surrounding areas. Most of the lands immediately adjacent to these rivers are in private ownership. The Santee and Cooper Rivers are dammed and habitat within these two rivers is very dependent on the dam management. Habitat management for these large river species is not within the jurisdiction of the Forest Service, but management activities that reduce impacts to water quality and instream habitat would contribute to the protection of large river habitats in those watersheds.

To avoid duplication, Section 3.3.3.8 Rivers and Streams Associates in the Species Diversity section includes a complete description of direct, indirect and cumulative effects to Atlantic and shortnose sturgeon. Also the BA in Appendix G includes effects analysis on these two fish. No direct impacts to these two sturgeons are anticipated. Management activities proposed in the forest plan would not be expected to impact habitat for shortnose or Atlantic sturgeon as soil and water guidelines described for all alternatives are designed to minimize impacts to water quality. Analysis and consultation with applicable State and Federal entities would be conducted at the project level when projects have the potential to impact the shortnose or Atlantic sturgeon. These populations are primarily influenced by hydroelectric dams and land management upstream.

No direct, indirect or cumulative effects to sturgeons would be expected.

3.3.3 Species of Conservation Concern

To assess revised forest plan impacts to species diversity, a comprehensive list of plant and animal species was compiled as part of the Francis Marion National Forest Plan Assessment by combining species lists from a variety of sources.

The 2012 National Forest Planning Rule requires that species of conservation concern be identified that are “known to occur in the plan area” and that the Regional Forester identify the species of conservation concern for which “the best available scientific information indicates substantial concern about the species’ capability to persist over the long term in the plan area.”

During the assessment phase of forest plan revision, a team consisting of a botanist/ecologist, wildlife biologist, and aquatic biologist developed a comprehensive list of 140 plant, wildlife, and aquatic species with the potential to occur on the Francis Marion National Forest. This list was based on a variety of sources, including: federally listed threatened and endangered species occurring in Charleston and Berkeley Counties obtained from the U.S. Fish and Wildlife Service, State Species of Conservation obtained from the South Carolina Natural Heritage Program, species included in the State Comprehensive Wildlife Conservation Strategy, the Birds of Conservation Concern list compiled by the U.S. Fish and Wildlife Service, and the Forest Service’s list of sensitive species.

Of the 140 species evaluated, **76** at-risk species, including **67** potential species of conservation and **9** federally listed species were known to occur on the Francis Marion National Forest, and met rarity rankings for inclusion as at-risk species. The 67 species of conservation concern were recommended in a letter to the Regional Forester from the Forest Supervisor for the Francis Marion and Sumter National Forests dated February 17, 2016. A complete listing of all species considered and recommended as species of conservation concern (including criteria used in their designation, rankings, threats, and number of known occurrences) both on the Francis Marion and within the state, is posted on the Francis Marion and Sumter National Forest Web Site at http://www.fs.usda.gov/detail/scnfs/landmanagement/planning/?cid=stelprdb5393142.

Forest plan components for ecological conditions that provide for ecosystem integrity and ecosystem diversity are the primary context for the evaluation of at-risk species, including species of conservation concern. At-risk species were grouped by ecosystems, and considered in the development of key characteristics based on forest digital data on occurrences, survey and monitoring input, and the opinions of personnel from the Forest Service, biological contractors, local Universities, the South Carolina Department of Natural Resources and Heritage Programs, U.S. Fish and Wildlife, NatureServe, and other species experts. Table 3-26 displays the species groups identified and their relationship to ecosystem or geographic management area, followed by tabular lists of species of conservation concern associated with each species group at the coarse-filter scale.

Anticipated direct, indirect, and cumulative effects of forest plan coarse and fine filter provisions to species viability, within the context of each species group, is 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).

Table 3-26. At-risk species groups and associated ecosystems and acreage on the Francis Marion National Forest, by alternative*

Species Group	Ecosystems	Acres – Alt. 1	Acres – Alt. 2	Acres – Alt. 3
Forested Wetland Associates	Forestwide - Narrow Forested Swamps and Blackwater Stream Floodplain Forested Ecosystems; Broad Forested Swamps and Large River Floodplain Forested Ecosystems	44,209 49,248 93,100	44,209 49,248 93,100	44,209 49,248 93,100
Pine/Wetland Ecotone Associates	Pocosins; Narrow Forested Swamps and Blackwater Stream Floodplain Forested Ecosystems - within Fire-Adapted Management Area	6,845 23,834 30,679	7,239 26,073 33,312	5,818 19,146 24,964
Mesic and Wet Pine Savanna Associates	Wet Pine Savanna and Flatwoods Ecosystems – within Fire-Adapted Management Area	34,244	58,062	41,585
Pond Cypress Savanna Associates	Depressional Wetlands and Carolina Bay Ecosystems – within Fire-Adapted Management Area	6,830	6,385	4,580
Upland Pine Woodland Associates	Upland Longleaf Pine Woodland Ecosystems – within Fire-Adapted Management Area	38,228	33,407	23,596
Calcareous Mesic Hardwood Associates	Forestwide – Mesic Slope Forests	4,235	4,235	4,235
River and Stream Associates	Forestwide - Rivers and Streams	2,499 miles	2,499 miles	2,499 miles

*Alternatives differ in acreage in fire-adapted management area prescriptions (Management Area 26 in alternative 1, Management Area 1 in alternatives 2 and 3)

3.3.3.1 Terrestrial and Aquatic Species Covered by Ecosystem Components (Coarse Filter Analysis)

Direct and Indirect Effects Common to All Alternatives

In general, pine/wetland ecotone associates, mesic and wet pine savanna associates, pond cypress savanna associates, and upland pine woodland associates, are threatened by woody competition, dense canopies or shrub cover, and invasive species. Prescribed fire and timber harvest would maintain and restore associated ecosystems and improve desired habitat conditions in all three alternatives. Active restoration management activities also have the potential to directly impact species of conservation concern associated with these ecosystems. Forested wetland associates, calcareous mesic hardwood associates, and river and stream associates are less likely to be directly impacted by management activities in all three alternatives. Restoration of hydrologic function would remain unaddressed in alternative 1; however, alternatives 2 and 3 would place an emphasis on restoring hydrologic function, which could improve habitats for species associated with forested wetlands and rivers and streams.

Cumulative Effects Common to All Alternatives

Public land plays a critical role in the conservation of rare species and native habitats, which receive little formal protection or conservation on many private lands. During the next 10 to 50 years, human populations are likely to expand, which will lead to increasing roads and the associated fragmentation, as well as the spread of non-native invasive plant species. Urban growth is expected to dramatically increase in the tri-county area of Berkeley, Charleston and Dorchester Counties during the next 10 to 50 years, resulting in increasing pressures to maintain this habitat on national forest land. By 2030, the total urban area around the Francis Marion is anticipated to potentially increase from 468 square miles in 2008 to 868 square miles in 2030 (see Figure 3-31). The incidence of non-native invasive species is expected to increase, particularly as a result of implementing alternative 1.

Our management strategy for dealing with these challenges is to strengthen collaboration with Federal, State, and nongovernment agencies, and private partners to maintain and restore populations and associated habitats for at-risk species using an all-lands approach, including:

a. Collect and share inventory and monitoring information that documents locations, trends, habitat condition, threats, and management responses.

b. Conduct propagation and population enhancement activities to maintain and enhance genetic diversity, encourage gene flow, and improve resistance to climate change and population resilience.

c. Conduct widespread inventories for at-risk species populations to improve our understanding of distribution, habitat condition, threats, and management needs.

d. Maintain up-to-date digital databases of species occurrences and trends to share with State Wildlife and Heritage Programs, U.S. Fish and Wildlife Service, the South Atlantic Landscape Cooperative, NatureServe, and others.

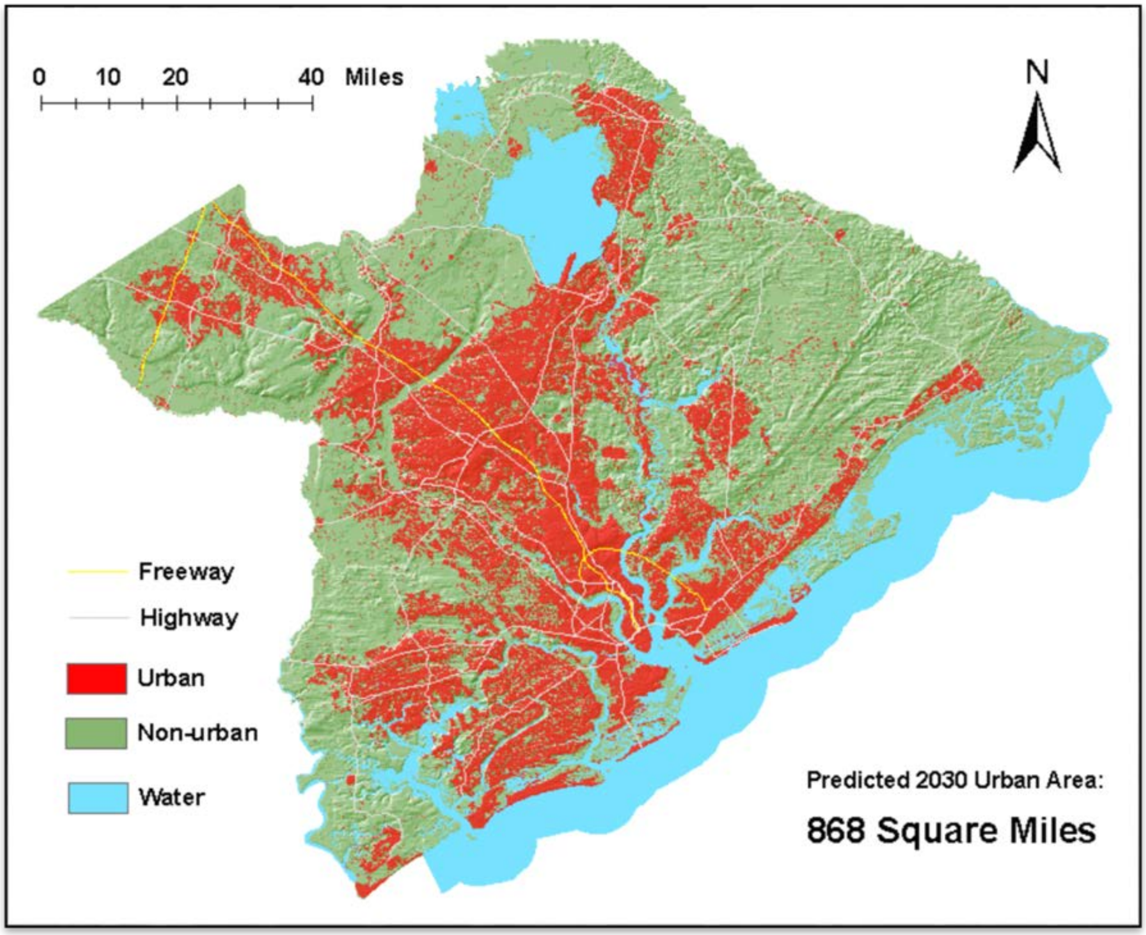


Figure 3-31. Potential urban area of Berkeley, Charleston, and Dorchester counties in 2030

Partnerships to facilitate introduction in known and historic habitats could lead to increased connectivity of these populations and enhanced genetic diversity. The revised forest plan is likely to have cumulative benefits to populations and habitats for species of conservation concern through ecosystem level direction and improved collaboration to include an all-lands approach to conservation of plant and animal species.

Due to the interaction of climate change and other factors such as sea-level rise, the Francis Marion National Forest is experiencing increased threats from fire, insect and plant invasions, disease, extreme weather, and drought. Scientists project increases in temperature and changes in rainfall patterns that can make these threats occur more often, with more intensity and/or for longer durations. These impacts are discussed in more detail in Chapter 3, Climate Change. Some notable impacts include:

1. 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.
2. With changing climatic variability, invasive and aggressive plant and insect species may increasingly outcompete or negatively affect native species.
3. Wildfire frequency is expected to increase across the Southeast region.

4. The potential for severe storms is expected to increase, including less frequent but more intense hurricanes making landfall in the South.
5. Shifts in rainfall patterns will lead to periods of flooding and drought that can significantly impact water resources.
6. Coastal areas in the Southeast have already experienced an average of one inch of sea-level rise per decade during the 20th century (Kemp et al. 2009), a rate that will continue to increase in the future.
7. Heat stress may limit the growth of some southern pines and hardwood species. Additional stresses from drought, combined with wide-scale pest outbreaks, have the potential to cause broad-scale forest dieback.
8. Increases in temperature and changes in precipitation patterns leading to lower base flows and altered hydrology in streams and lakes will affect both plant and animal species in aquatic environments.
9. Increased frequency of droughts can lead to poor water quality and habitat squeezes. Fish-kills due to high summertime temperatures are likely to become more common in shallow waters of the Southeast.

3.3.3.2 Forested Wetland Associates

Threats to at-risk species associated with forest wetlands include reforestation practices that favor pine, desired fire return intervals that are too frequent, and non-native invasive species. The number of documented occurrences as of July 2007 for species of conservation concern associated with this forest group are shown below (Table 3-27). Of these species, bald eagle, Rafinesque’s big-eared bat, and southeastern myotis are Forest Service sensitive species (2001).

Before Hurricane Hugo, John Cely with South Carolina Department of Natural Resources estimated 60 nesting pair of swallow-tailed kites on the Francis Marion National Forest. In 1997, Cely estimated a 22 percent reduction for a total estimate of 47 nesting pairs. The Amphibian and Reptile Conservancy documented four spotted turtles in 2015 (ARC 2016), and were told of multiple sightings by Forest Service personnel. One location is documented on the Francis Marion for both Rafinesque’s bat and southeastern myotis and there are seven bald eagle territories (see Table 3-27). The known location for Rafinesque’s bat was under a bridge. Two populations for shadowwitch orchid are documented from within natural areas in the Santee Experimental Forest in the 1996 revised forest plan, and four are in rare communities in the 2016 revised forest plan. One extensive population for ravenfoot sedge is protected along the Echaw Creek Natural Area, which is a rare community and eligible Wild and Scenic River in the 2016 revised forest plan. One population for Carolina birds-in-a-nest (a U.S. Fish and Wildlife Service at-risk species) occurs as an experimental population on the Francis Marion, transplanted from a population on a nearby right-of-way. The one documented occurrence for limestone petunia contained 30 to 50 plants when discovered in 2011 (GIS data). The Okefenokee zale moth has been documented approximately ¾ mile apart from two locations in bald cypress swamps in areas containing their host plant, climbing fetterbush, a species protected as a Forest Service sensitive species.

Table 3-27. Species of conservation concern associated with forested wetlands

Taxa	Latin Name	Common Name	Number of Documented Occurrences*
Bird	*Elanoides forficatus*	American swallow-tailed kite	47 nesting pair
Bird	*Haliaeetus leucocephalus*	Bald eagle	7
Insect	*Zale perculata*	Okefenokee Zale moth	2
Mammal	*Corynorhinus rafinesquii*	Rafinesque's big-eared bat	1
Mammal	*Myotis austroriparius*	Southeastern myotis	1
Reptile	*Clemmys guttata*	Spotted turtle	4
Vascular Plant	*Carex crus-corvi*	Ravenfoot sedge	1
Vascular Plant	*Macbridea caroliniana*	Carolina birds-in-a nest	1
Vascular Plant	*Ponthieva racemosa*	Shadowwitch orchid	5
Vascular Plant	*Ruellia strepens*	Limestone petunia	1

*Forest Digital Geographic Information Systems as of 7/2016. UNK = Unknown number documented.

Forested wetland associates benefit from desired conditions and management strategies associated with key characteristics of narrow non-riverine swamp and blackwater stream floodplain forests, and broad forested swamps and large river floodplain ecosystems (see Appendix E, Forested Wetland Ecosystems). Total Francis Marion National Forest ownership within these systems is approximately 93,457 acres (Table 3-28).

Table 3-28. Ecosystem acreage used by forested wetland associates, all alternatives

Ecosystem	National Forest Acreage
Narrow non-riverine swamp and blackwater stream floodplain forests	44,209
Broad forested swamps and large river floodplain forests	49,248

The following description of these habitats on the Francis Marion National Forest is consistent with the Affected Environment for Section 3.3.1.10 Narrow Forested Swamps and Blackwater Stream Floodplain Forests and Broad Forested Swamps and Large River Floodplain Forests, and the current condition of key characteristics (Appendix E). Flooding is the most important ecological factor influencing associated ecosystems, though fire can vary from a minor to a significant influence on vegetation composition and structure. The original vegetation was likely a true shifting mosaic, where prescribed burning influenced peat build-up, hydrology, and vegetation (Simon and Hayden 2014).

Vegetation composition and structure on the Francis Marion National Forest varies but is typically good. Loblolly pine forests, including mixtures with non-mast hardwoods, occupy 29.3 percent of ecosystems in the narrow forested group and 23.5 percent of forests in the broad forested group. Forests are typically older. Of the narrow forested group, 51 percent is in late successional condition; 15 percent is older than 100 years. Of the broad forested group, 57 percent is in late successional condition and 26 percent of stand acreage is older than 100 years. Based on LiDAR analysis of canopy opening, the primary existing structural class for each ecosystem group is forested (92 percent of the broad ecosystem group and 81 percent of the narrow ecosystem group is forested). Non-native invasive plant data on the Francis Marion suggests that less than 1 percent of ecosystems in the broad forested group are occupied by non-

native invasive plant species, predominantly Japanese climbing fern along the Santee River floodplain. Connectivity stressors, including off-road vehicle trail density, paved open road density, and unpaved open road density, are ranked good (0.5 to 0.74 miles per square mile).

Current ecological sustainability scores for key characteristics associated with forested wetland ecosystems are good to very good in terms of ecological sustainability, with the exception of non-native invasive plant species, which is ranked on the upper end of fair (Appendix E).

Alternative 1

Direct and Indirect Effects. The 1985 forest plan classified 37,650 acres as wetlands, and contained a desired condition that streams, ponds, wetlands, and riparian areas of the national forest reflect healthy, functioning ecosystems. Three standards in the 1996 forest plan protect swallow-tailed kite nests and habitat, along streamside zones and transition zones, within a 1-mile radius of active kite nests. The 1987 Habitat Management Guidelines for the Bald Eagle in the Southeast Region are followed.

Habitat for the forested wetland associates is maintained as large, relatively undisturbed hardwood swamp ecosystems as wilderness in Management Area 2 (13,812 acres), as special areas in Management Area 8 (1,520 acres as I'on Swamp), and 20,815 as swamps and swampy flats in Management Area 29. The desired condition in Management Area 27 would contain a mix of wetland and upland hardwood habitats and address species composition and age classes as follows:

> . . . mixed pine/hardwood stands . . . on a variety of sites. Mast–producing hardwoods are common in hardwood stands, mixed stands and scattered throughout pine stands. Pine stands in close proximity to red-cockaded woodpecker clusters have fewer hardwoods. Low–intensity fire is occasionally seen in pine stands, usually in the dormant season. A variety of age classes and conditions are found in the hardwood, pine and mixed forest types. This area provides a visually diverse scene in contrast to other areas of the forest containing the open, park-like stands.

Directly, restoration activities to restore characteristic mast-producing hardwood forests and swamps could occur through thinning of pines or longer rotations needed to restore forested wetlands dominated by mixed pine/hardwood forests, bottomland hardwood forest, or bald cypress and swamp tupelo swamp forests. There is a chance that individuals of bald eagle, American swallow-tailed kite, Okefenokee Zale moth, spotted turtle, and ravenfoot sedge could be directly impacted by restoration activities, although bald eagle and American swallow-tailed kite will be protected through forest plan standards, and the known population for ravenfoot's sedge will be conserved in a natural area. Direct impacts to individuals of Rafinesque's big-eared bat, Southeastern myotis, Carolina birds-in-a-nest, shadowwitch orchid, and limestone petunia could occur as a result of pine thinning either through damage to roost trees, or uprooting of plants at the pine/hardwood transition zone. Okefenokee Zale moth and spotted turtle, which occur in forested swamp wetland habitats, would be less likely to be directly affected by restoration activities. Indirectly, the abundance, composition, structure, and connectivity of forested wetland habitats is predicted to be good, though non-native invasive species including plants and hogs will threaten them in the future given lack of forest plan direction needed to address stressors related to these ecosystems. It is anticipated that the forest plan could directly impact individuals of species of conservation concern associated with forested wetlands, but indirectly the viability of species of conservation concern associated with forested wetlands is likely to be good, due to the abundance and condition of forested wetlands habitats.

Alternatives 2 and 3

Direct and Indirect Effects. Under alternatives 2 and 3, plan components could impact individuals but will not likely affect viable species populations and habitat for associated species of conservation concern. Direction in the revised forest plan addresses specific habitat needs including, but not limited to: **S28**. Survey for at risk bats before buildings, bridges, wells, cisterns and other man-made structures are structurally modified or demolished. If bats are found, then consider installing bat gates and/or erecting bat houses. Once the bat houses are being used, then demolish or replace structures. **S31**. Conduct no logging within 300 feet of known active American swallow-tailed kite nests from April 1 through June 30 or until fledging is completed. When nests are found in active sales, logging will be coordinated with timber purchasers to protect the kite nesting site. Inactive nest-site trees may be harvested. Given our forest plan standards and management strategies, the forest plan could impact individuals but is not likely to impact forested wetland species populations or viability in the future.

Desired conditions, objectives and management strategies in alternatives 2 and 3 would emphasize ecological conditions that maintain and restore forested wetlands and habitat for the associated species group through desired conditions, objectives, management strategies, and design criteria associated with ecosystems, ecological sustainability, species groups, rare communities, at-risk species, watersheds, soil and water, aquatic habitats, and riparian zones, and eligible wild and scenic rivers.

Based on current conditions, the ecological ranking for the ecosystems associated with this species group would be expected to remain good during the next 10 years for all alternatives (Figure 3-32 and Figure 3-33). However, alternative 1 would likely result in a fair ranking for this group during the next 50 years. This small difference is due to lack of non-native invasive species desired conditions in alternative 1. Because alternatives 2 and 3 will continue to directly and indirectly provide habitat for species in this group, the sustainability ranking for this group is expected to remain in the good category during the next 10 to 50 years.

Cumulative Effects. Management strategies in alternatives 2 and 3 are designed to improve our collaboration with partners to collect inventory and monitoring information which documents locations, trends, habitat condition, threats, and management responses over the life of the forest plan. Public lands play a critical role in the conservation of species prior to federal listing, particularly plant species which receive little to no protection on private or state lands. The increased urbanization and population growth of the tri-county area is anticipated to result in negative cumulative effects for species in this group. Increased urbanization would be expected to lead to increases in the following: road densities and associated traffic; non-native invasive species; fire exclusion and suppression; and use of insecticides in and around the forest. These negative cumulative impacts to species would likely be offset by all-lands approach to species conservation under alternatives 2 and 3.

All alternatives are expected to directly impact individuals and indirectly benefit populations and habitat for species in this group by providing large intact areas of forested wetlands. Because alternative 1 would continue to provide habitat for species in this group on the forest, the sustainability ranking for this group is expected to remain fair to good during the next 10 to 50 years, though non-native invasive species are likely to increase;

Because alternatives 2 and 3 would improve partnerships and continue to directly and indirectly provide habitat for species in this group on the forest, the sustainability ranking for this group is expected to remain good during the next 10 to 50 years.

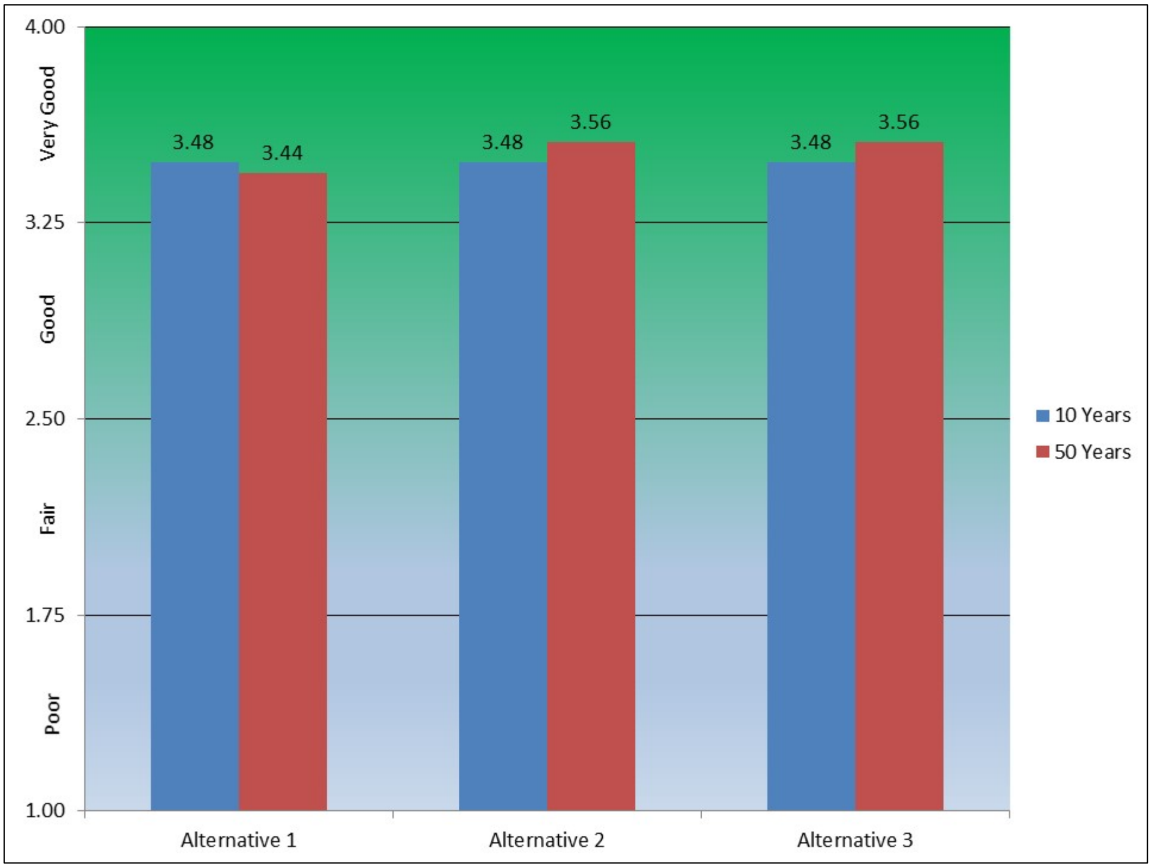


Figure 3-32. Estimated ecological sustainability rankings for broad forested swamps and large river floodplain forests under the three alternatives for 10 and 50 years

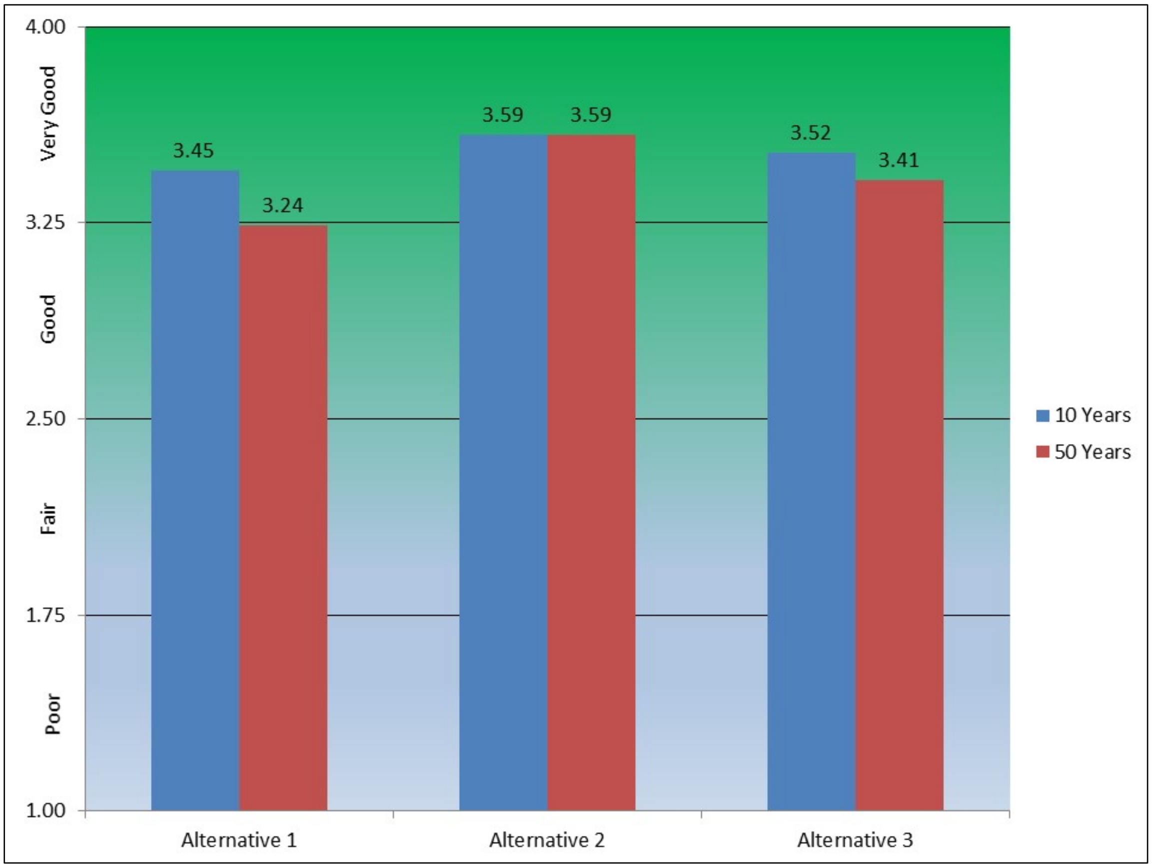


Figure 3-33. Estimated ecological sustainability rankings for narrow forested swamps and blackwater stream floodplain forests under the three alternatives for 10 and 50 years

3.3.3.3 Pine Upland/Wetland Ecotone Associates

Threats to species of conservation concern associated with pine upland/wetland ecotones include successional woody vegetation, plant poaching, lack of frequent and growing season fire, and canopy closure. Species of conservation concern associated with ecotones between upland woodlands and savannas and pocosins and narrow forested non-riverine swamps and blackwater stream forests are listed in Table 3-29. Of these species, savanna milkweed and Loomis' loosestrife are Regional Forester sensitive species (2001).

Table 3-29. Species of conservation concern associated with Pine Upland/Wetland ecotones

Species Group	Latin Name	Common Name	Number of Documented Occurrences*
Bird	*Elanoides forficatus*	American Swallow-tailed Kite	47 nesting pair
Insect	*Amblyscirtes alternata*	Dusky Roadside Skipper	1
Insect	*Danaus plexippus*	Monarch butterfly	38 (2015)
Insect	*Euphyes berryi*	Berry's Skipper	1
Mammal	*Corynorhinus rafinesquii*	Rafinesque's big-eared bat	1
Mammal	*Myotis austroriparius*	Southeastern myotis	1
Reptile	*Crotalus adamanteus*	Eastern Diamondback Rattlesnake	20+
Vascular Plant	*Andropogon mohrii*	Mohr's Bluestem	1
Vascular Plant	*Asclepias pedicillata*	Savanna Milkweed	1
Vascular Plant	*Carex elliottii*	Elliott's Sedge	2
Vascular Plant	*Coreopsis integrifolia*	Ciliate-leaf Tickseed	1
Vascular Plant	*Eupatorium anomalum*	Florida thoroughwort	1
Vascular Plant	*Lysimachia loomisii*	Loomis' loosestrife	3
Vascular Plant	*Rhynchospora cephalantha* var. *attenuata*	Small bunched Beak Sedge	1
Vascular Plant	*Rhynchospora oligantha*	Few-flowered beaked-rush	4
Vascular Plant	*Rhynchospora stenophylla*	Chapman Beakrush	2

*Forest digital geographic information systems as of 7/2016.

Known locations for all vascular plants and diamondback rattlesnake occur in Management Area 26 in the 1996 revised forest plan and occur in Management Area 1 in the 2016 revised forest plan, which is the fire-adapted management area in both alternatives 2 and 3. Two vascular plant species, few flowered beaked-rush and Chapman beakrush, occur on the Francis Marion at the following locations: Morgan Creek Bog, designated botanical/natural areas in the 1996 plan, and rare communities in alternatives 2 and 3 of the forest plan. Additionally, few-flowered beaked-rush occurs in Wardfield Savanna. Two populations for Loomis' loosestrife were confirmed in 2013 and one for savanna milkweed in 2012. All vascular plant species in this group are known from less than five occurrences on the Francis Marion National Forest. Chapman beakrush was monitored in Morgan Creek Bog in 2012 by Dr. Jeff Glitzenstein and not found (GIS database).

Pine upland/wetland ecotone associates benefit from desired conditions and management strategies associated with pocosins and narrow non-riverine swamp and blackwater stream floodplain forests within Management Area 1 in alternatives 2 and 3, and to some extent Management Area 26 in alternative 1, and include their fire-maintained ecotones with associated pine upland woodland and savanna habitats, and associated key characteristics with these ecosystems. Total estimated national forest land acreage within associated fire-adapted restoration management area across each of the alternatives is shown below.

Table 3-30. Estimated ecosystem acreage used by upland/wetland ecotone associates

Ecosystems	Alternative 1 (acres)	Alternative 2 (acres)	Alternative 3 (acres)
Pocosins and narrow non-riverine swamp and blackwater stream floodplain forests	**30,679**	**33,312**	**24,964**

Alternative 1

Direct and Indirect Effects. Fire-adapted ecosystems and natural areas are emphasized in Management Area 26 and natural areas, including Morgan Creek Bog and Awendaw Savanna, though burning of upland/wetland ecotones is not emphasized. Directly, forest plan activities, including but not limited to timber harvesting, prescribed burning, and trail and road construction could have direct impacts on individuals within this species group. American swallow-tailed kite, savanna milkweed, and Loomis's loosestrife could be conserved through forest plan direction related to both sensitive species and American swallow-tailed kite standards. Indirectly, ecological sustainability scores for component pocosins and narrow forested swamps and blackwater stream ecosystems are ranked fair to good currently and at 10- to 50- year intervals. Current ecological indicators for associated ecosystems are poor for percent of ecosystem burned at desired growing season fire return interval, and fair for percent of ecosystem in woodland, savanna, and grassland structure and percent of ecosystem acres burned at desired growing-season burn interval. Lack of frequent or growing-season fire, which burns into the wetlands and reduced the competing shrub and canopy, have had indirect negative impacts to habitats for associated species in this group. Indirectly, non-native invasive species, including feral hogs, would likely increase under alternative 1. Alternative 1 could directly impact individuals in this species group and is unlikely to benefit habitats or species viability due to lack of 1996 forest plan direction to maintain and restore upland/wetland ecotones using prescribed fire.

Alternatives 2 and 3

Direct and Indirect Effects. Under both alternatives 2 and 3, desired conditions for this species group would be consistent with DC-SCC-3 (Pine Upland/Wetland Ecotones Associates), DC-ECO-5 (Pocosins), and DC-ECO-7 (Narrow Forested Swamps and Blackwater Stream Floodplain Forests). High quality habitat for a number of at risk species is maintained and restored at the fire-maintained ecotone between pine-dominated ecosystem and wetland ecosystems within Management Area 1. Restoration and maintenance of known locations and rare plant communities provide habitat important to species in this group, including but not limited to Morgan Creek Seepage Bog. Open habitat conditions are maintained and restored with frequent and growing-season fire, which begins in the uplands and burns into the wetlands, creating open conditions with patches of intact herbaceous groundcover. Directly, species of conservation concern will receive additional conservation through forest plan standards and guidelines, including S35 (No new permanent roads, trails, or recreational sites are allowed in population sites for at-risk plant species).

Habitats for upland/wetland species associates would be indirectly maintained and restored by applying a 1- to 3-year prescribed fire regime including growing-season burns approximately every third burn or when ponds are dry. Direct and indirect effects from ground-disturbing management activities, such as timber harvesting, prescribed burning and associated fireline construction and trail and road construction, could impact individuals but are unlikely to impact viable populations or habitat due to standards and guidelines contained in alternatives 2 and 3. The direct and indirect effects of these alternatives would be beneficial impacts to the viability of

the species group including an improvement in the vegetation composition, structure, function and connectivity of pine/wetland ecotone species and associated habitat.

Cumulative Effects. Management strategies in alternatives 2 and 3 are designed to improve our collaboration with partners to collect inventory and monitoring information, which documents locations, trends, habitat condition, threats, and management responses over the life of the forest plan. Public lands play a critical role in the conservation of species prior to Federal listing, particularly plant species that receive little to no protection on private or State lands. The increased urbanization and population growth of the tri-county area is anticipated to result in negative cumulative effects for species in this group. Increased urbanization would be expected to lead to increases in road densities and associated traffic, non-native invasive species, fire exclusion and suppression, and use of insecticides in and around the national forest. These negative cumulative impacts to species would likely be offset in part, by an all-lands approach to species conservation and improved partnerships under alternatives 2 and 3.

Alternative 1 would likely have negative impacts to species and habitats associated with this species group, given the lack of 1996 forest plan direction to restore upland/wetland ecotones using prescribed fire. As a result of implementing alternatives 2 and 3, there would likely be beneficial impacts to the viability of species associated with upland/wetland ecotones. The ecological sustainability of species in this group would likely be good in both the next 10 and 50 years in alternative 2, and slightly less but still good at both 10 and 50 year intervals in alternative 3, due to the lower relative amount of fire-adapted ecosystem restored in alternative 3.

3.3.3.4 Mesic to Wet Pine Savanna Associates

Threats to species of conservation in this species group include successional woody vegetation, lack of frequent and growing-season prescribed fire and overly dense canopies, which can play a role in both shading and modifying site hydrology. Bachman's sparrow, Carolina gopher frog, many-flowered grass-pink, yellow fringeless orchid, shortbristle sedge, and pineland and Carolina dropseed were addressed as sensitive species in 2001. Shortbristle beaksedge, lance-leaf seedbox, globe beaksedge, yellow fringeless orchid, Carolina dropseed, pineywoods dropseed, pineland yellow-eyed grass, and Mohr's bluestem occur in designated natural areas in the 1996 revised forest plan and in rare communities in the 2016 forest plan. Twig-rusk and tussock sedge also occur in designated rare communities. Some of the species in this group are in decline (*Sporobolus curtisii*, *Sporobolus pinetorum*, *Platanthera integra*), particularly at the wildland-urban interface (Glitzenstein and Streng 2012).

The North American Butterfly Association documented 38 monarch butterflies on the Francis Marion in 2015, and the Carolina Butterfly Society documented 41 monarchs in 2005, 19 in 2007 and 2011, 20 in 2010, and 5 in 2015 (reports available upon request). Populations and trends of forest birds in Southern forests from 1992-2004 show a decreasing trend in habitat usage by Bachman's sparrow from 42 point counts. The Amphibian and Reptile Conservancy (2016) documented 1 dwarf siren, 12 diamondback rattlesnakes, and 7 Southern hognose snakes.

Mesic to wet pine savanna associates benefit from desired conditions, key characteristics, and management strategies associated with wet pine savanna and flatwoods ecosystems within Management Area 1. The 1996 forest plan did not address restoration of mesic and wet pine savanna and flatwoods habitats and ecosystems, and the 2010 longleaf condition assessment identified that 22 percent of the total extent of these ecosystems on the Francis Marion was in the "maintain" condition class (Appendix E). Potential habitat acreage for species in this group is shown below for fire-adapted management areas within each alternative.

Table 3-31. Estimated ecosystem acreage used by mesic to wet pine savanna associates

Ecosystems	Alternative 1 (acres)	Alternative 2 (acres)	Alternative 3 (acres)
Wet Pine Savanna and Flatwoods Ecosystems	34,244	58,062	41,585

Table 3-32. Species of conservation concern associated with mesic to wet pine savannas and flatwoods

Species Group	Latin Name	Common Name	Number of Documented Occurrences*
Amphibian	*Lithobates capito*	Gopher frog	13
Amphibian	*Pseudobranchus striatus*	Dwarf Siren	1
Bird	*Aimophila aestivalis*	Bachman's sparrow	42 point counts
Insect	*Danaus plexippus*	Monarch butterfly	38 (2015)
Reptile	*Crotalus adamanteus*	Eastern Diamondback Rattlesnake	20+
Vascular Plant	*Agalinis aphylla*	Coastal plain false-foxglove	1
Vascular Plant	*Anthaenantia rufa*	Purple silkyscale	2
Vascular Plant	*Andropogon mohrii*	Mohr's Bluestem	1
Vascular Plant	*Calopogon barbatus*	Bearded grass-pink	2
Vascular Plant	*Calopogon multiflorus*	Many-flower grass-pink	1
Vascular Plant	*Carex stricta*	Tussock Sedge	1
Vascular Plant	*Chasmanthium nitidum*	Shiny spikegrass	2
Vascular Plant	*Cladium mariscoides*	Twig-rush	1
Vascular Plant	*Eryngium aquaticum*	Ravenel's Eryngo	2
Vascular Plant	*Lachnocaulon minus*	Small's Bog Button	1
Vascular Plant	*Ludwigia lanceolata*	Lance-leaf seedbox	1
Vascular Plant	*Lysimachia hybrida*	Lance-leaf loosestrife	4
Vascular Plant	*Platanthera integra*	Yellow fringeless orchid	13
Vascular Plant	*Rhynchospora breviseta*	Short-bristle baakrush	3
Vascular Plant	*Rhynchospora globularis var. pinetorum*	Globe Beaksedge	3
Vascular Plant	*Sporobolus curtisii*	Pineland dropseed	21
Vascular Plant	*Sporobolus pinetorum*	Carolina dropseed	4
Vascular Plant	*Xyris brevifolia*	Short-leaved yellow-eyed grass	2
Vascular Plant	*Xyris flabelliformis*	Savannah yellow-eyed grass	1
Vascular Plant	*Xyris stricta*	Pineland yellow-eyed grass	1

*Forest digital geographic information systems as of 7/2016.

Alternative 1

Direct and Indirect Effects. Directly, effects associated with restoration activities, including timber harvest, prescribed burning, and selective herbicide application, could result in harm to

individuals of species of conservation concern in this group, and could also negatively impact viable species habitats and populations, particularly those that aren't sensitive species. At the national forest level, the current ecological sustainability ranking of wet pine savanna and flatwoods ecosystems were ranked fair, and predicted to be fair at 10-year and poor at 50-year intervals. This is based on ranking of poor for key characteristic values for composition (percent of the ecosystem in the maintain condition class, percent of ecosystem dominated by characteristic forest types), process (percent of ecosystem burned during the growing season), and the connectivity stressors (unpaved open road density) as well as fair values for process (percent of ecosystem acres burned at desired fire return interval), structure (percent structural departure from natural range of variation; percent ecosystem extent in woodland, savanna, and grassland; percent of ecosystem meeting age criteria for old growth). High quality habitats such as Awendaw and Wardfield Savannas for species of conservation concern would continue to be maintained within designated natural areas. Indirectly, non-native invasive species, including feral hogs, would likely increase in alternative 1, creating negative impacts to these ecosystems at 10-year, and even greater impacts at the 50-year intervals. Canopy opening, structural diversity, fire seasonality and frequency, and the condition of mesic and wet pine savanna habitats would be negatively impacted at the national forest level, at 10 years and to a greater extent at the 50-year interval. Desired conditions and objectives would not address restoration needs for ecosystems and viable species for this habitat group at the landscape scale.

Alternatives 2 and 3

Direct and Indirect Effects. Direct effects to species of conservation concern associated with mesic to wet pine savannas could occur as a result of timber harvest, mechanical treatments, or selective herbicide application, and will be minimized by S35 (No new permanent roads, trails, or recreational sites are allowed in population sites for at-risk plant species).

Indirectly, desired conditions to maintain, improve, and restore the desired composition, structure, function, and connectivity of wet pine savannas and flatwoods within Management Area 1 along with DC-SCC-5 (Mesic to Wet Pine Savanna and Flatwoods Associates) and DC-SCC-12 (Rare Plant Communities), will benefit the species populations and associated habitats. Within both alternatives 2 and 3, habitats and species in this group would be maintained and restored on a 1- to 3-year prescribed fire regime, including growing season burns every third burn. All known locations for species in this group would occur in the fire-adapted ecosystems of Management Area 1 or would be given priorities through rare community consideration. Adaptive monitoring and management of these habitats would occur to ensure that desired conditions for wet pine savannas and flatwoods are maintained and restored, and provide for viable populations to occur across the landscape.

Proposed management strategies in alternatives 2 and 3 would emphasize ecological conditions that provide both the continuity of habitat over a large area, historic fire regimes, and maintaining preferred habitats.

As a result of implementing alternatives 2 and 3, there are likely to be direct impacts to individuals but beneficial effects to species populations and habitats associated with mesic to wet pine savannas. Beneficial effects are likely to be greater in alternative 2 than 3, given the larger quantity of fire-adapted ecosystems including wet pine savannas and flatwoods, maintained and restored, in alternative 2. The ecological sustainability of species in this group was predicted to be fair in both the next 10 and the next 50 years in alternative 2, and fair in alternative 3 in both the 10- and 50-year timeframes. Alternative 2 provides desired conditions for maintaining and restoring 67 percent of the total extent of wet pine savanna and flatwoods ecosystems on the

forest with prescribed fire and other tools, 48 percent of the total extent in alternative 3. The fair ranking was based on connectivity stressors, which are less likely to impact many of the plant species in this group, but could impact amphibians and reptiles.

Cumulative Effects. Management strategies in alternatives 2 and 3 are designed to improve our collaboration with partners to collect inventory and monitoring information which documents locations, trends, habitat condition, threats, and management responses over the life of the forest plan. Public land plays a critical role in the conservation of species prior to Federal listing, particularly plant species that receive little to no protection on private or state lands. The increased urbanization and population growth of the tri-county area is anticipated to result in negative cumulative effects for species in this group. Increased urbanization would be expected to lead to increases in road densities and associated traffic, non-native invasive species, fire exclusion and suppression, and use of insecticides in and around the national forest. These negative cumulative impacts to species would likely be offset in part, by an all-lands approach to species conservation and improved partnerships under alternatives 2 and 3, as compared to alternative 1.

Alternative 1 would likely have negative impacts to species and habitats associated with this species group, given the lack of 1996 forest plan direction to restore these ecosystems. As a result of implementing alternatives 2 and 3, there would likely be beneficial effects to species associated with mesic to wet pine savannas. Beneficial effects would likely be greater in alternative 2 than 3, given the larger quantity of fire-adapted ecosystems that would be maintained and restored in alternative 2. The ecological sustainability of species in this group was predicted to be highest in both the next 10 and 50 years in alternative 2 and fair at 10- and 50-year intervals in alternative 3 due to the lower relative amount of wet pine savanna and flatwoods ecosystems that would be maintained and restored with prescribed fire in alternative 3.

3.3.3.5 Pond Cypress Savanna Associates

Species of conservation concern associated with pond cypress savannas are threatened by lack of frequent or growing season prescribed fire, succession by woody species, feral hogs, drought or damage off-trail from off-road vehicles. Past management actions in these areas may have resulted in woody plant encroachment and hydrologic alteration of the wetlands. Up until the early 1990s, firelines were installed around many depressional wetlands to try to prevent fire from entering the systems during prescribed burns. In some cases, these plow lines may continue to impact the hydrology of isolated wetland. Some remaining examples are vulnerable to off-highway vehicle use, ditching and drainage, and invasion by non-native plants and animals. Many of these wetlands are small in size, seasonally flooded, and typically lack predatory fish, making them crucial breeding sites for amphibians.

Species of conservation concern that are 2001 sensitive species include Carolina gopher frog, pond spice, Boykin’s lobelia, loose watermilfoil, and coastal beaksedge. In the designated critical habitat for frosted flatwoods salamander, the depressional wetlands and the fire-maintained uplands that surround them are important for Carolina gopher frog breeding and survival. In fall of 2015, the Amphibian and Reptile Conservancy estimated that over 70,000 Carolina gopher frog eggs from 13 breeding ponds were deposited after huge rain events. Although they were unsure how this may affect population, it’s likely it will result in an increase in a few years. Several high-quality pond cypress savannas and herbaceous meadows containing sensitive plant species are designated natural areas in the 1996 revised forest plan, of which some have documented declines (such as beakrushes at Florida Bay), Boykin’s lobelia at Echaw Road Bay, Tibwin Bay and McConnell Sink.

The species of conservation concern in this group can be linked to the fire-maintained desired conditions and associated key characteristics of depressional wetlands and Carolina bays in Management Area 1 within alternatives 2 and 3, and to some extent Management Area 26 within alternative 1 (see “Depressional Wetlands and Carolina Bays”). Potential habitat for species in this group is estimated to occur on 6,385 acres on the Francis Marion National Forest. The current ecological condition for these ecosystems is ranked fair, since key characteristics for both percent of ecosystem acres burned at desired return interval and desired growing season return interval are highly rated and ranked poor (see Appendix E, Key Characteristics, Indicators, and Ecological Sustainability Values for Depressional Wetlands and Carolina Bays). Potential habitat acreage for species in this group is shown below for fire-adapted management areas within each alternative (Management Area 1 in alternatives 2 and 3 and Management Area 26 for alternative 1).

Table 3-33. Estimated ecosystem acreage used by pond cypress savanna associates

Ecosystem	Alternative 1 (acres)	Alternative 2 (acres)	Alternative 3 (acres)
Depressional Wetlands and Carolina Bay Ecosystems	6,830	6,385	4,580

Table 3-34. Species of conservation concern associated with pond cypress savannas

Species Group	Latin Name	Common Name	Number of Documented Occurrences*
Amphibian	*Lithobates capito*	Carolina gopher frog	13
Amphibian	*Pseudobranchus striatus*	Dwarf Siren	1
Reptile	*Clemmys guttata*	Spotted turtle	4
Vascular Plant	*Andropogon gyrans* var. *stenophyllus*	Elliott's bluestem	1
Vascular Plant	*Anthaenantia rufa*	Purple silkyscale	4
Vascular Plant	*Burmannia biflora*	Northern burmannia	2
Vascular Plant	*Helenium pinnatifidum*	Southeastern sneezeweed	10
Vascular Plant	*Lobelia boykinii*	Boykin’s lobelia	13
Vascular Plant	*Myriophyllum laxum*	Piedmont water-milfoil	3
Vascular Plant	*Rhynchospora harperi*	Harper beakrush	3
Vascular Plant	*Rhynchospora pleiantha*	Coastal beaksedge	1
Vascular Plant	*Rhynchospora scirpoides*	Long-beaked beaksedge	3
Vascular Plant	*Spiranthes laciniata*	Lace-lip ladies’-tresses	9
Vascular Plant	*Utricularia macrorhiza*	Greater bladderwort	1
Vascular Plant	*Xyris difformis* var. *floridana*	Florida yellow-eyed grass	2

Alternative 1

Direct and Indirect Effects. Pond cypress savanna ecosystems would continue to be maintained wherever they occur including in designated natural areas. Management activities, such as timber harvesting, prescribed burning, and trail and road construction are unlikely since restoration is less likely to occur. Indirectly, associated natural areas would continue to be maintained with frequent fire, though this fire would not likely occur with the seasonality and frequency needed to maintain and restore pond cypress savannas for species associated with this group. Indirectly, non-native invasive species, including feral hogs, would likely increase in alternative 1. Pond cypress savannas would continue to be maintained but not likely restored, and ecological sustainability rankings are likely to be fair at 10- and 50-year intervals, due to inadequate prescribed fire and restoration drivers. Alternative 1 would not result in the continued viability of populations and habitat for species of conservation associated with this species group. Key characteristics ranked poor at 10- and 50-year intervals and include percent of ecosystem burned at desired fire return interval and percent of ecosystem burned during the growing season.

Alternatives 2 and 3

Direct and Indirect Effects. All known locations for species in this group would occur in the fire-adapted ecosystems of Management Area 1 or would be given priorities through rare community consideration. Direct and indirect effects from management activities, such as timber harvesting, prescribed burning and associated fireline construction, and trail and road construction, could impact individuals but are not likely to impact species viability and habitat sustainability. Direct impacts to individual species of conservation concern should be minimized through revised forest plan standards and guidelines, including S35 (No new permanent roads, trails, or recreational sites are allowed in rare plant communities and population sites for at-risk plant species).

Indirectly, desired conditions to maintain, improve, and restore the desired composition, structure, function, and connectivity of depressional wetlands and Carolina bays, and DC-SCC-6 (Pond Cypress Savannas Associates within Management Area 1) and DC-SCC-12 (Rare Plant Communities) will benefit all associated species populations and habitats.

Cumulative Effects. Management strategies in alternatives 2 and 3 are designed to improve our collaboration with partners to collect inventory and monitoring information, which documents locations, trends, habitat condition, threats, and management responses over the life of the forest plan. No cumulative effects would be expected beyond what is described at the beginning of this section. Alternative 1 would likely have negative impacts to species and habitats associated with this species group, given the lack of 1996 forest plan direction to restore pond cypress savannas within depressional wetlands and Carolina bays.

As a result of implementing alternatives 2 and 3, there would likely be beneficial effects to species associated with pond cypress savannas and depressional wetlands. Beneficial effects would likely be greater in alternative 2 than 3 given the larger acreage in depressional wetlands and Carolina Bays that would be maintained and restored using prescribed fire within Management Area 1 in alternative 2. The ecological sustainability of pond cypress savannas and depressional wetlands would likely be good in both the next 10 and 50 years in alternatives 2 and 3, and greatest in alternative 2 due to the higher amount of depressional wetland and Carolina bay ecosystems that will be maintained and restored with prescribed fire in alternative 3.

3.3.3.6 Upland Pine Woodland Associates

Threats to species of conservation in this species group include dense canopies, plant poaching, lack of frequent prescribed fire (1- to 3-year burning regime), and lack of growing-season fire. Crested fringed orchid and Bachman's sparrow are Regional forester sensitive species.

The North American Butterfly Association documented 38 monarchs on the Francis Marion in 2015, and the Carolina Butterfly Society document 41 monarchs in 2005, 19 in 2007 and 2011, 20 in 2010, and 5 in 2015 (reports available upon request). Populations and trends of forest birds in Southern forests from 1992-2004 show a decreasing trend in habitat usage by Bachman's sparrow from 42 point counts. The Amphibian and Reptile Conservancy (2016) documented 1 dwarf siren, 12 diamondback rattlesnakes, and 7 Southern hognose snakes.

This species group is associated with ecosystem key characteristics for upland pine woodlands, including dominant longleaf forest types, open woodland canopies, and frequent prescribed fire with a growing-season component (Appendix E). Based on the longleaf assessment conducted in 2010, 29 percent of the upland longleaf ecosystem extent was in the "maintain" condition class. Unpaved road densities, paved road densities, and off-road vehicle densities (all connectivity stressors) were ranked fair. Percent of the ecosystem in the "maintain" condition class, and percent of the ecosystem burned during the growing season were ranked poor.

Potential habitat acreage for species in this group is shown below for fire-adapted management areas within each alternative (Management Area 1 in alternatives 2 and 3 and Management Area 26 for alternative 1).

Table 3-35. Estimated ecosystem acreage used by upland pine woodland associates

Ecosystem	Alternative 1 (acres)	Alternative 2 (acres)	Alternative 3 (acres)
Upland longleaf pine woodland	38,228	33,407	23,596

Table 3-36. Species of conservation concern associated with upland pine ecosystems

Species Group	Latin Name	Common Name	Number of Documented Occurrences*
Bird	*Aimophila aestivalis*	Bachman's sparrow	42 point counts
Insect	*Amblyscirtes alternata*	Dusky roadside skipper	1
Insect	*Danaus plexippus*	Monarch butterfly	38
Vascular Plant	*Pteroglossapsis ecristata*	Crestless plume orchid	14
Reptile	*Crotalus adamanteus*	Eastern diamondback rattlesnake	20+
Reptile	*Heterodon simus*	Southern hognose snake	7

Alternative 1

Direct and Indirect Effects. Upland longleaf-associated ecosystems would continue to be maintained and restored in Management Area 26 using frequent prescribed fire. Direct and indirect effects from management activities, including but not limited to timber harvesting, prescribed burning, and trail and road construction, could have direct impacts on individuals from this species group. The current condition of upland longleaf pine ecosystems was ranked poor, based on poor indicator values for connectivity stressors (unpaved road density), percent of the

ecosystem extent in “maintain” condition class, and percent of the ecosystem burned during the growing season (Appendix E). Indirectly, the composition, structure, and function of associated habitats are not likely to be maintained and restored as needed at 10- or 50-year intervals. Indirectly, non-native invasive species, including feral hogs, would likely increase in alternative 1.

As a result of implementing alternative 1, the sustainability of species in the upland pine woodland group was estimated as likely to be poor in the next 10 years as well as the next 50 years, given alternative 1 (1996 forest plan direction). In alternative 1, the key characteristics related to fire regime, non-native invasive species, old growth, structural diversity, and vegetation condition for upland pine ecosystems all were rank poor to fair in terms of ecological sustainability across the landscape.

Alternatives 2 and 3

Direct and Indirect Effects. All known locations for species in this group would occur in the fire-adapted ecosystems of Management Area 1 or would be given priorities through rare community consideration. Direct effects from management activities, such as timber harvesting, prescribed burning and associated fireline construction, and trail and road construction could impact individuals, but would not likely impact populations due to standards and guidelines associated with at-risk species. Based on OBJ-MUB-6 (Comprehensive Roads Planning and Maintenance), priorities for road closures would include improving connectivity of ecosystems or reducing impacts to resources. Indirectly, desired conditions for DC-SCC-3 (Pine Upland/Wetland Ecotones Associates), and landscape-level burning within Management 1 will benefit the species habitat.

Within both alternatives 2 and 3, habitats and species in this group would be maintained and restored on a 1- to 3-year prescribed fire regime, including growing-season burns every third burn. Adaptive monitoring and management of these habitats would occur to ensure that desired conditions for upland pine woodlands would continue to be maintained and restored, and sustainable populations would continue to occur across the landscape. The direct and indirect effects of this alternative would be an improvement in the vegetation composition, structure, function and connectivity of upland pine woodland species. The ecological sustainability of the habitat is predicted as fair at both 10- and 50-year intervals in alternatives 2 and 3, given the likelihood of connectivity stressors.

As a result of implementing alternatives 2 and 3, there are likely to be beneficial effects to species associated with upland pine woodlands, compared to alternative 1. Beneficial effects are likely to be greater in alternative 2 than 3, given the larger quantity of upland ecosystems maintained and restored in alternative 2. The ecological sustainability of species in this group was predicted to be highest in alternative 2, improving from poor to fair during the next 10 to 50 years, and remain lower at fair in alternative 3, due to the lower relative amount of both upland pine woodlands that will be maintained and restored with prescribed fire in alternative 3, and likelihood of connectivity stressors.

Cumulative Effects. Management strategies in alternatives 2 and 3 are designed to improve our collaboration with partners to collect inventory and monitoring information, which documents locations, trends, habitat condition, threats, and management responses over the life of the forest plan. No cumulative effects beside what has been described for other fire-adapted ecosystems are anticipated.

3.3.3.7 Calcareous Mesic Slope Associates

Threats to species in this group include reforestation practices that favor pine, prescribed burning which is too frequent, non-native invasive species and fragmentation due to roads. Only three birds orchid was identified as a sensitive species in the 1996 revised forest plan.

The 1996 revised forest plan contained an objective to identify and maintain “calcareous mesic forests, and several examples of mesic slope forests are influenced by marl or calcareous geology.” These are addressed as natural areas in the 1996 forest plan and as rare communities in alternatives 2 and 3. High-quality examples have been documented on gentle slopes near the Santee River and Echaw Creek, along the Echaw Creek drainage to the confluence with the Santee River and in the Huger Creek drainage subbasin – Huger Creek, Nicholson Creek, Turkey Creek and Fox Gully Branch, mostly west of Highway 41 (Everett 2012; McMillan et al. 2001; Porcher 1995).

The species in this group can be linked to the desired conditions and key characteristics associated with oak forests and mesic hardwood forests. Potential habitat for species in this group is estimated to occur on 4,235 acres on the Francis Marion National Forest (based on ecological mapping of mesic slope hardwood forests, Appendix E). Key characteristics for unpaved road density and percent burned at desired return interval were ranked poor due to prescribed burning regimes that were too frequent.

Table 3-37. Estimated ecosystem acreage used by calcareous mesic hardwood associates, all alternatives

Ecosystem	National Forest Acreage
Forestwide - Mesic Slope Forests	4,235 acres

Table 3-38. Species of conservation concern associated with Calcareous Mesic Forests

Species Group	Latin Name	Common Name	Number of Documented Occurrences*
Vascular Plant	*Asplenium resiliens*	Black-stem spleenwort	1
Vascular Plant	*Carex basiantha*	Widow sedge	5
Vascular Plant	*Carex granularis*	Meadow sedge	3
Vascular Plant	*Carya myristiciformis*	Nutmeg hickory	8
Vascular Plant	*Tridens chapmanii*	Chapman’s redtop	1
Vascular Plant	*Listera australis*	Southern twayblade	9
Vascular Plant	*Matelea flavidula*	Yellow spinypod	1
Vascular Plant	*Triphora trianthophora*	Three birds orchid	5

Alternative 1

Direct and Indirect Effects. Management activities, including but not limited to timber harvesting, prescribed burning, and trail and road construction, could have direct impacts on species in this group, particularly if associated sites were managed for pine. Those species occurring in identified high calcium mesic communities would be maintained on the landscape, though they may not be restored. Indirectly, non-native invasive species, including feral hogs, would likely increase in alternative 1.

As a result of implementing this alternative 1, the ecosystems associated with calcareous mesic forests are likely to be fair to poor in terms of ecological sustainability. In alternative 1, key characteristics related to non-native invasive species, old growth forests, and vegetation composition integrity are ranked poor to fair.

Alternatives 2 and 3

Direct and Indirect Effects. Under alternatives 2 and 3, direct impacts to vascular plants in this species group could occur as a result of loblolly pine thinnings, prescribed burning, and non-native invasive species control. Direct impacts are likely to be minimized through standards and guidelines associated with at-risk species populations. At the coarse filter scale, hardwood forests would be maintained, improved and restored on appropriate sites wherever they occur. Rare communities would be a priority for maintenance and restoration including habitats for this species group. The direct and indirect effects of this alternative would be an improvement in the vegetation composition, structure, function and connectivity of hardwood forests on ecologically appropriate sites across the landscape.

As a result of implementing both alternatives 2 and 3, there likely would be beneficial effects to wet marl hardwood and calcareous mesic slope associates. The habitat acreage being maintained and restored in this hardwood species groups would result in good sustainability in alternatives 2 and 3 in both the 10- and 50-year intervals. Alternatives 2 and 3 would provide desired conditions for maintaining and restoring 100 percent of the total extent of hardwood ecosystems on appropriate ecological sites on the forest.

Cumulative Effects. There would be no additional cumulative effects beyond what is identified.

3.3.3.8 Rivers and Streams Associates

The species in this group (see Table 3-39) inhabit large river and stream habitat including species that migrate from salt and brackish waters into freshwater habitats. In rivers, the group is sensitive to in-stream flow modifications which include channelization, dredging, dams, road crossings and culverts. In many cases, hydrologic modification impedes or completely prevents natural migration and dispersal strategies. In other cases, hydrologic alteration may change water temperature regimes and water quality variables such as point and non-point source pollution. Other more subtle impacts of hydrologic alteration include unnatural fluctuations in hydro period that may impede reproduction or other phases in the life history of associated species.

Performance measures for hydrologic function, water quality, non-native species, water temperature and coarse wood serve as indicators for this species group (see Table 3-40). Both are at sustainable levels and are expected to remain sustainable in the future as long as guidelines established are followed. Plan components include desired conditions for floodplain forests and watershed health, objectives to maintain mature closed canopy forests in riparian areas and guidelines for soil and water.

In streams, these species are dependent on quantities of coarse woody debris and low levels of pollution, hydrologic modifications, and road crossings located in the stream or riparian area. Coarse woody debris plays a vital role in the life history of these species and their prey. Coarse woody debris is measured as a byproduct of a mature riparian area enclosing the stream. A sustainable amount of debris will enter the stream if the surrounding riparian area contains a mature, closed canopy forest with little or no unnatural disturbance. Trees and other woody debris should not be removed from streams unless it is for safety or transportation needs. If removed for transportation requirements, only those trees in the area adjacent to the road or causing direct

impacts to roads, trails or bridges should be removed. Plan components include desired conditions for floodplain forests and watershed health, objectives to maintain mature closed canopy forests in riparian areas and guidelines for soil and water.

Changes in aquatic communities will be used to assess forest management activities on the aquatic ecosystem. Fish populations are monitored on a rotational basis across the national forest in warm water stream habitats. Species composition and abundance reflect changes that may occur in stream populations. In addition, the aquatic insect community will be used as a monitoring tool to determine management activity effects on stream systems. Warm water pond habitats are monitored on an annual basis for the purpose of managing a recreational fishery for the public (for additional information on aquatic ecosystems see the Francis Marion National Forest Plan Assessment 2015).

Table 3-39. Rivers and streams associates

Species Group	Latin Name	Common Name	Designation	Group Weight
Fish	*Acipenser brevirostrum*	Shortnose sturgeon	Federally endangered	Equal
Fish	*Acipenser oxyrinchus*	Atlantic sturgeon	Federally endangered	Equal
Fish	*Anguilla rostrata*	American eel	Petitioned for listing	Equal
Reptile	*Clemmys guttata*	Spotted turtle	Petitioned for listing	Equal
Mammal	*Trichechus manatus*	West Indian Manatee	Federally endangered	Equal

Table 3-40. Key characteristics for predicting effects to rivers and streams associates

Key Characteristic	Indicator
Potential for Coarse Woody Debris Abundance	Percent Riparian Forested
Hydrologic Function	Major Hydroelectric Dam Proximity/Influence
Hydrologic Function	Riparian Road Density
Hydrologic Function	Road Crossing Rating
Hydrologic Function	Severity of Hydrologic Control Structures
Non-Native Invasive Species	Presence/Absence of Non-Native Invasive Species in the Watershed
Water Quality	Sediment Risk Rating
Water Quality: Toxics	Point Source Rating
Water Quality: Toxins	Non-Point Source Rating
Water Temperature Regime	Riparian Land Use Rating

All Alternatives

Direct, Indirect and Cumulative Effects. Algorithms in the ecological sustainability evaluation tool were developed taking into account all weights, rankings and scores associated with the streams and rivers associates group to derive composite current scores and estimated scores by alternative for the 10-year and 50-year intervals. These composite scores were calculated at both the unit level and aggregately across the forests. A forestwide species group by alternative summary of these scores is presented in Figure 3-34.

Hydrologic alterations within subject watersheds occur both on privately owned adjacent lands and national forest land. Other than man-made impoundments and stream crossings, National Forest System lands should not contribute negative impacts to hydrologic regimes. In some cases, the national forests may actually restore hydrologic regimes, particularly through stream enhancement and restoration projects. Stream crossings may increase sediment loads and modify hydraulic processes as well as serve as an impediment to species migration and dispersal. The creation and retention of manmade impoundments can also disrupt flow regimes as well as migration patterns and dispersal of some riverine aquatic species.

Road and trail density is an important aspect of these data that is unlikely to change or improve over time. Many roads that cross National Forest System lands are administered under the jurisdiction of local, State and other Federal entities and are therefore, outside of the control of the national forests. Roads and trails administered by the Francis Marion National Forest are in most cases considered essential to public access. While some National Forest System roads and trails may be gated and rehabilitated if considered unessential to the public good, the overall road and trail density scores among all alternatives would change little due to the statistical weight of roads outside the Francis Marion's jurisdiction. While road densities would be a concern in some instances, in many cases road and trail scores are already in the good or very good range, which is expected to continue to contribute to ecological sustainability on National Forest System lands.

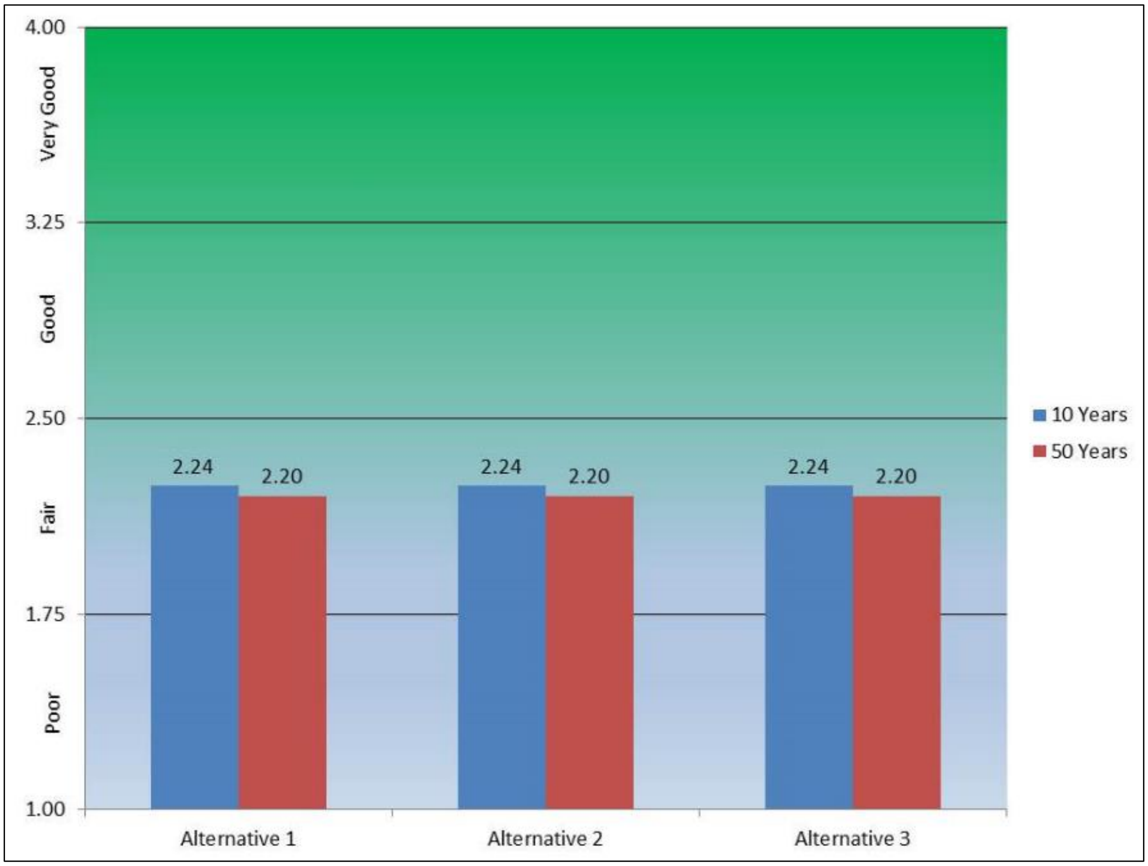


Figure 3-34. Aquatic streams and rivers associates; species association current (watershed-wide) and predictive status based on National Forest System land management and activities

The resulting scores of the analysis described above, which are measured watershed-wide regardless of ownership profiles, result in a fair rating for current status and all alternatives. While neighboring landowners may contribute varying and unpredictable levels of risk to watershed health, the national forests would continue to maintain a positive contribution to aquatic sustainability. As a result, watershed health should remain relatively stable, at least to the extent that the Forest Service can control based on ownership profiles. Dam densities, channelization, ditching, dredging, and stream crossings, a large majority of which are on neighboring privately owned lands, play a major role in elevating risk levels to hydrological integrity. In many watersheds, depending on ownership and land-use profiles, the Francis Marion may be a primary contributor to coarse woody debris associates due to riparian forest management practices and guidelines.

3.3.3.9 Terrestrial Species Groups Not Covered by Ecological System Group Sustainability Plan Components (Fine Filter Analysis)

Wildlife Species Sensitive to Road Mortality

Species in this group listed in Table 3-41 are sensitive to excessive human disturbance such as trampling, harassment, vehicular mortality, and direct mortality. Reptile species are especially sensitive to being harmed, harassed, and killed by humans. This interaction with humans can have long-term negative effects on population sizes and sustainability.

Table 3-41. Species of conservation concern sensitive to road mortality

Species Group	Latin Name	Common Name
Reptile	*Clemmys guttata*	Spotted Turtle
Reptile	*Crotalus adamanteus*	Eastern Diamondback Rattlesnake
Reptile	*Heterodon simus*	Southern Hognose Snake
Amphibian	*Lithobates capito*	Gopher Frog

The Carolina gopher frog and spotted turtle, are especially sensitive to harm due to off-road vehicles, heavy equipment, horses, and human traffic (see Table 3-42). Some species are collected commercially and used for a variety of purposes including but not limited to food, medicinal uses, decorative, gardening and landscaping uses, and the pet trade.

Table 3-42. Key characteristics ranked moderate to very high for predicting effects to species sensitive to road mortality

Key Characteristic	Indicator
Connectivity	Off-highway Vehicle Trail Density. Legal and illegal recreational vehicle trail density and associated fragmentation/connectivity expressed in road miles per square mile of this ecosystem or habitat type.
Connectivity	Unpaved Open Road Density. Unpaved, open public road density and associated fragmentation/connectivity expressed in road miles per square mile of this ecosystem or habitat type.

Alternative 1

Direct and Indirect Effects. The impacts of roads and the need to minimize road impacts on flora and fauna would continue to not be specifically addressed in the 1996 forest plan. However, alternative 1 would continue the following standards and guidelines related to roads and trails:

1. FW-127: Close all new roads constructed solely to remove timber.
2. FW-101: Avoid construction (roads, trails, recreational sites, etc.) in floodplains and wetlands whenever there is a practical alternative.
3. FW-88: Off-highway vehicle (OHV) use is restricted to designated OHV trails and if street legal, opened roads.
4. FW-8: Avoid constructing additional plowed firelines. Use existing plowed lines and other barriers such as roads, streams and trails when possible. Where plowed firelines are needed, every effort will be made to reuse the same location for each successive burn.
5. FW-131 (R8–VM): Where practical, native flowering species are established, maintained and enhanced on intermittent service roads when they are closed and on cut-and-fill slopes of all roads.
6. FW-153: Site prepare, fertilize and seed, as needed, intermittent roads, primary skid trails and log decks following timber sale and related activities (to provide wildlife plant cover).
7. FW-155: Emphasize closing roads in areas that will provide a contiguous block of land 250 acres or greater, 1/2 mile from an open road.

The following are identified as research needs in the 1996 forest plan related to roads and trails:

1. Determine the effects of past and current maintenance of drainage modification systems (including roads constructed with inadequate cross drainage) and identify the potential costs and benefits associated with restoration of hydrologic function.
2. Determine the effects of off-road vehicle trails or roads on wetland ecosystems. Identify Best Management Practices to use when crossing wetland ecosystems with these trails.

Very few items in the 1996 forest plan would address the impacts of roads on flora and fauna. However, the forest did begin analyzing the impacts of roads to forest resources beginning around 2010 and has identified some opportunities for minimizing road impacts. More analysis would be needed to gain a better understanding of road impacts to species and their habitats. Considering what is included in the 1996 forest plan to address impacts to species in this group, the negative biological and ecological impacts of roads on the Francis Marion would not be addressed under this alternative.

Although there are still data needs, road impacts to this group would be anticipated to increase under alternative 1. As such, alternative 1 would be expected to directly and indirectly negatively affect species in this group. The ecological sustainability ranking for this group would be expected to remain poor under alternative 1.

As a result of implementing alternative 1, the sustainability of species in this group would likely be poor during the next 10 to 50 years. Desired conditions and objectives would not address restoration or mitigation needs for species in this group.

Alternatives 2 and 3

Direct and Indirect Effects. With the exception of the spotted turtle, all known species in this group occur within and are dependent upon fire-adapted ecosystems. Opportunities to minimize road effects to species in this group would be included under alternatives 2 and 3 as plan components. Ecosystem desired conditions, DC-SCC-2 (Wildlife Species Sensitive to Road Use Associates), and OBJ-MUB-6 (Comprehensive Roads Planning and Maintenance, would strive to improve ecosystem connectivity). As such, the direct and indirect effects of alternatives 1 and 2 are expected to result in decreased road impacts when compared to alternative 1. Unfortunately, due to the anticipated rate of human population growth in the tri-county area of Berkeley, Charleston and Dorchester Counties during the next 10 to 50 years, road impacts to species in this group would only be expected to continue to get worse. As such, the ecological sustainability of this species group is likely to remain poor during the next 10 to 50 years due the anticipated increase in roads and vehicular traffic.

Cumulative Effects. Management that contributes to the viability of species in this group would likely be increasingly difficult in the future especially with the anticipated urban growth that is expected in the tri-county area of Berkeley, Charleston and Dorchester Counties during the next 10 to 50 years. This is primarily because the increased urbanization, coupled with decreased prescribed burning, is expected to lead to increases in road densities and associated traffic, non-native invasive species, fire exclusion and suppression, and use of alternative silvicultural practices (such as mastication, grazing, and pesticide application).

Because alternatives 2 and 3 actually would address road impacts to species in this group, these alternatives would be expected to result in beneficial effects for species in this group, especially with regards to Forest Service roads. Unfortunately, due to the projected increase in urbanization in the tri-county area of Berkeley, Charleston and Dorchester during the next 10 to 50 years, the sustainability of species in this group would likely be poor during the next 10 to 50 years under all alternatives. Cumulatively, negative effects are expected under all alternatives, just less severe under alternatives 2 and 3.

Wildlife Snag and Large Diameter Hollow Tree Associates

Many species depend on dead and dying trees and large diameter hollow trees. In terms of bats, bat species typically live in mature riparian areas in the forests and forage in open areas. They use bridges, cisterns, culverts, old abandoned houses, leaf litter, snags and branches, bark, and cavities of live trees as roosts. They are insectivores and require some proximity to water.

Table 3-43. Species of conservation concern grouped as wildlife snag and large diameter hollow tree associates

Species Group	Latin Name	Common Name
Mammal	*Corynorhinus rafinesquii*	Rafinesque's big-eared bat
Mammal	*Myotis austroriparius*	Southeastern myotis

Table 3-44. Key characteristics ranked very high for predicting effects to wildlife snag and large diameter hollow tree associates

Key Characteristic	Indicator
Terrestrial Habitat Snag, Bat Roost, Woody Debris, Stump Retention	Snag Retention. Number of snags (dead pine and hardwood trees) per acre forestwide.

Unfortunately, habitat data is extremely limited for forest-roosting bats in the Southeast (Miller et al. 2003). This is especially true on the Francis Marion, where only a few bat studies have been conducted in the past 75 or more years. Most U.S. studies have primarily occurred in older-aged forests with little to no active forest management. However, in South Carolina, Menzell et al. (2001) examined the foraging habitat of male Rafinesque's big-eared bats in Aiken County. This study was conducted on a 1,057-hectare property owned and managed by the National Audubon Society known as the Silver Bluff Plantation. Based on the individuals studied, Menzell et al. (2001) observed that *Corynorhinus rafinesquii* had biphasic activity patterns, with most foraging activity occurring during the first 4 hours after sunset and 2 hours before sunrise. Mean home range size of the animals that Menzell et al. (2001) studied was 93.1 hectares. Although there were numerous large contiguous tracts of mature bottomland hardwoods in the Menzell et al. study area, most foraging activity occurred in young pine stands. Only 9 percent of foraging areas were in bottomland hardwoods (Menzell et al. 2001). Menzell et al. (2001) found male *Corynorhinus rafinesquii* in approximately 90 percent of the abandoned structures that they surveyed, indicating that manmade structures such as abandoned buildings can be extremely important for species in this group. On the Francis Marion, this species has been observed under Forest Service bridges.

Forestwide desired conditions, as well as desired conditions for each ecological system, serve as ecological system diversity plan components for this group of species. Objectives to restore or maintain mature and old-growth forest help to sustain these species as well. Although ecosystem plan components should supply ample amounts of suitable habitat, this group has additional needs. In riparian areas, it is assumed that if the surrounding riparian area contains mature to old-growth closed-canopy forest with little or no unnatural disturbance, a sustainable amount of bat roost and hibernacula should be present. If retention and recruitment guidelines and other guidelines pertinent to creation of snags are implemented on the Francis Marion and there is sufficient mature and old-growth forest (within good or very good rating criteria), then it can be assumed that adequate snags are being provided to sustain dependent species.

Although ecosystem plan components should supply ample amounts of suitable habitat for snag and large-diameter hollow tree associates, there are additional needs for this group. It is necessary to retain snags and cavity/hollow trees for potential roosting by bats and other snag-dependent species. Pine snags play a critical role in providing prey for species such as the red-cockaded woodpecker and can also minimize kleptoparasitism of red-cockaded woodpecker cavities by other woodpecker species such as the red-headed woodpecker and red-bellied woodpecker. Snags are also important for providing refugia for many other animal species including insects, small mammals, amphibians and reptiles. Plan provisions to retain this habitat element help to insure sustainability of these species. In addition, human disturbance can interfere with bat roosting behavior and removal of existing artificial habitat can limit reproductive and foraging activity for bats. Bridges, cisterns and culverts should be checked for presence of bats before removal or modification of structure and alternative habitat should be provided when necessary. The key factors for sustainability of this group are recruitment of new snags and hollow trees and the retention of existing trees. Both of these can be measured through implementation monitoring

using guidelines. Artificial cavity installation and roost or den structures may be necessary for some species in this group. Where suitable roosting and nesting habitat doesn't exist, artificial bat and bird houses can be used to improve habitat conditions.

Alternative 1

Direct and Indirect Effects. The 1996 forest plan contains the following guideline with regards to snags: "FW-151 During TSI, WSI, and site preparation, at least 2 standing dead snags (greater than 12 inches) are retained per acre. Give priority to the largest snags available and to hardwood species; however, pine snags may be substituted if appropriate hardwoods are not available. Appropriate treatments are used to create snags where natural snags are lacking." Data is lacking for the number and density of snags on the Francis Marion, as this has never been measured. However, snags would continue to be created by a combination of biotic and abiotic events on the national forest under this alternative. As such, alternative 1 would be expected to continue to directly and indirectly benefit species in this group by providing snags and habitat components.

Although alternative 1 would continue to directly and indirectly provide habitat for species in this group, the ecological sustainability ranking for this group would be expected to decline under alternative 1 during the next 10 to 50 years due to forces that the forest is unable to control (such as increased urban growth within and adjacent to the national forest boundary and white-nose syndrome). Although alternative 1 would continue to directly and indirectly provide habitat for species in this group, the ecological sustainability ranking for this group would be expected to decline during the next 10 to 50 years due to negative cumulative effects outside of the Forest Service's control. As such, the ecological sustainability ranking for this group would be expected to decline during the next 10 to 50 years under alternative 1.

Alternatives 2 and 3

Direct and Indirect Effects. Based on DC-SCC-9 (Wildlife Snag and Large Diameter Hollow Tree) and G31 (Stumps, standing snags, and den trees should be retained during vegetation management activities and forest plan strategies related to old growth conditions), under alternatives 2 and 3, plan components are designed to create and maintain snags and hollow trees at a higher level than alternative 1. As such, the direct and indirect effects for species in this group would be more beneficial than those under alternative 1.

Although alternatives 2 and 3 would continue to directly and indirectly provide habitat for species in this group, the ecological sustainability ranking for this group would be expected to decline during the next 10 to 50 years due to forces that are beyond the Forest Service's control (such as increased urban grown within and adjacent to the national forest boundary and white-nose syndrome). However, this decline would likely be less pronounced than under alternative 1; this is especially true for alternative 2. Alternative 2 would likely produce the greatest amount of beneficial effects for this species group and the highest ecological sustainability ranking during the next 10 to 50 years.

Cumulative Effects. As mentioned for alternative 1, the increased urbanization and population growth of the tri-county area would be anticipated to result in negative cumulative effects for species in this group. This is primarily because increased urbanization, coupled with decreased prescribed burning, would be expected to lead to increases in road densities and associated traffic, non-native invasive species, fire exclusion and suppression, and use of insecticides in and around the national forest. Additionally, bats in the U.S. are being plagued by the white-nose syndrome. Although there is some uncertainty associated with the effects resulting from the disease, white-nose syndrome is only anticipated to lead to increased cumulative effects.

Although alternatives 2 and 3 would provide substantially greater habitat for species in this group, the ecological sustainability ranking for this group is expected to decline during the next 10 to 50 years due to cumulative effects outside of the Forest Service's control. Cumulatively, negative effects would be expected under all alternatives, just less severe under alternatives 2 and 3. This is especially true for alternative 2.

Wildlife Stump and Root Mound Associates

Coarse woody debris, root mounds and stump holes provide critical refugia for species of conservation concern in Table 3-45.

Table 3-45. Species of conservation concern, stump and root mound associates

Taxa	Latin Name	Common Name
Amphibian	*Lithobates capito*	Gopher frog
Reptile	*Crotalus adamanteus*	Eastern diamondback rattlesnake

Where frequent fire would occur, coarse woody debris, root mounds, and stump holes would provide essential escape cover for slow-moving wildlife species. Numerous other wildlife species use these microhabitats as well, including virtually all native snake species, various small mammal species and even turtles such as the Eastern box turtle and spotted turtle. Retention of downed wood, stumps, stump holes and root mounds is essential for this group of species. Objectives to restore or maintain mature and old-growth forest would help to sustain these species as well.

Table 3-46. Key characteristics ranked very high for predicting effects to wildlife stump and root mound associates

Key Characteristic	Indicator
Underground Access	Root Mounds and Stump Holes. Density of root mounds and mature stumps/stump holes with sufficient surface access and underground cavities to provide seasonally critical refugia to herpetofauna, their predators and prey. Number of stumps/stump holes per acre.

Alternative 1

Direct and Indirect Effects. Coarse woody debris, root mounds and stump holes are not addressed in the 1996 forest plan. The 1996 forest plan also doesn't have any plan components that would limit activities that directly decrease this habitat component (such as stumping operations and site preparation). Species in this group would not benefit under this alternative; potentially destructive activities such as stumping would continue to be allowed. As such, alternative 1 would be expected to continue to directly and indirectly negatively impact species in this group.

In implementing alternative 1, the ecological sustainability rankings for this group would likely be poor during the next 10 to 50 years. Plan components in alternative 1 would not address restoration and mitigation needs for species in this group.

Alternatives 2 and 3

Direct and Indirect Effects. Under alternatives 2 and 3, habitats and species in this group would be maintained and restored under a 1- to 3-year fire return interval; including growing-season burns every third burn. Although ecosystem plan components should supply ample amounts of

suitable habitat, this group has additional needs that would be provided within plan components in alternatives 2 and 3, such as DC-SCC-1 (Wildlife Stump and Root Mound Associates) and G31 (Stumps, standing snags, and den trees should be retained during vegetation management activities). Exceptions may be made where necessary to control insects or disease outbreaks or to provide public and employee safety.

In addition to explicitly protecting and providing habitat for species in this group, alternatives 2 and 3 also would provide opportunities to minimize road effects. As such, the direct and indirect effects of alternatives 1 and 2 are expected to significantly improve and maintain habitat for species in this group. Although human population growth is expected to dramatically increase during the next 10 to 50 years, alternatives 2 and 3 would provide for greater maintenance, protection and creation of habitat components for species in this group. As such, the ecological sustainability for this species group would be expected to improve during the next 10 to 50 years under alternatives 2 and 3.

Although there are data gaps for this species group, alternatives 2 and 3 would be anticipated to greatly improve habitat for species in this group, which should lead to improved ecological sustainability rankings during the next 10 to 50 years. Only beneficial effects would be anticipated for alternatives 2 and 3, with alternative 2 resulting in the greatest benefits for these species.

Due to the fact that alternatives 2 and 3 would actually address habitat components for this group and identify mitigation measures, these alternatives would be expected to result in beneficial effects for species in this group.

Cumulative Effects. Increased urbanization and population growth are anticipated to negatively impact species in this group. This is primarily because the increased urbanization is expected to lead to increase road densities and associated traffic, non-native invasive species, and fire exclusion and suppression.

Cumulatively, negative effects would be expected under all alternatives, just less severe under alternatives 2 and 3. Although urbanization is expected to increase in the tri-county area of Berkeley, Charleston and Dorchester Counties during the next 10 to 50 years, the overall sustainability of species in this group would be likely to improve during the next 10 to 50 years under alternatives 2 and 3, but decline under alternative 1.

Forest Opening Associates

Plant and animal species depend on openings in the forest created by biotic and abiotic forces (such as wind throw and fire mortality; see Table 3-47). Ecosystem plan components should supply ample amounts of suitable habitat for forest opening associates. Objectives to restore or maintain mature and old-growth forest, along with maintenance of existing permanent wildlife openings would help sustain these species as well. Key attributes and indicators associated with this group include the number, size, structure and distribution of wildlife openings (see Table 3-48 and Table 3-49).

Table 3-47. Species of conservation concern grouped as Forest Opening Associates

Species Group	Latin Name	Common Name
Mammal	*Corynorhinus rafinesquii*	Rafinesque’s big-eared bat
Mammal	*Myotis austroriparius*	Southeastern myotis

Table 3-48. Key characteristics ranked high for predicting effects to forest opening associates

Key Characteristic	Indicator
Early Successional Openings	Number of permanent openings per analysis unit between .25 and 2 acres in size, no canopy (for bat foraging) and early successional vegetation including a mixture of herbaceous (for Northern bobwhite quail) and shrubs (for Swainson's warbler).

The numbers of known permanent wildlife openings within the Cane Gully, Hellhole, Macedonia, French Santee and Wando Analysis Areas were used to assess the current conditions across the national forest (see Table 3-49). Desired conditions would include 30-100 openings (plus or minus 10 percent) within each of the aforementioned analysis areas on the Francis Marion. The indicators used to determine ecological sustainability rankings consisted of the number of permanent openings per analysis area that were between 0.25 and 2 acres in size, had no canopy (for bat foraging) and had early successional vegetation including a mixture of herbaceous (for quail) and shrubs (for Swainson's warbler).

Alternative 1

Direct and Indirect Effects. The 1996 forest plan contains the following objective that provides habitat for species in this group: "Maintain 5,000 to 10,000 acres in early successional habitat (0- to 3-year age class, permanent openings, wildlife openings, road rights-of-way, utility rights-of-way) in the short and long term." The 1996 forest plan also recognizes 441 acres of wildlife openings in Management Area 26, 133 acres in Management Area 27 and 54 acres in Management Area 29. The 1996 forest plan has a standard stating that new wildlife openings would not be constructed within Management Area 29. As was previously mentioned, the numbers of known permanent wildlife openings within the Cane Gully, Hellhole, Macedonia, French Santee and Wando Analysis Areas were used to assess the current conditions across the national forest. Desired conditions would include 30-100 openings (plus or minus 10 percent) within each of the aforementioned analysis areas on the Francis Marion.

Table 3-49. Key attributes indicators, indicator weights and current indicator ratings for forest opening associates

Element	Key Attribute	Indicator Name	Indicator Description	Poor Criteria	Fair Critiera	Good Criteria	Very Good Criteria	Current Indicator Value	Current Indicator Rating	Indicator Weight
Forest Opening Associates	Early Successional Openings	Cane Gully: Number, Size, Structure and Distribution of Openings	Number of permanent openings per analysis unit between .25 and 2 acres in size, no canopy (for bat foraging) and early succesional vegetation including a mixture of herbaceous (for quail) and shrubs (for Swainson's Warbler). This indicator is measure by a	30-100 openings +/- >25%	30-100 openings +/- 11-25%	30-100 openings +/- 10%	30-100 openings	13	**Poor**	Very High
Forest Opening Associates	Early Successional Openings	French Santee: Number, Size, Structure and Distribution of Openings	Number of permanent openings per analysis unit between .25 and 2 acres in size, no canopy (for bat foraging) and early succesional vegetation including a mixture of herbaceous (for quail) and shrubs (for Swainson's Warbler).	30-100 openings +/- >25%	30-100 openings +/- 11-25%	30-100 openings +/- 10%	30-100 openings	161	**Poor**	Very High
Forest Opening Associates	Early Successional Openings	Hellhole: Number, Size, Structure and Distribution of Openings	Number of permanent openings per analysis unit between .25 and 2 acres in size, no canopy (for bat foraging) and early succesional vegetation including a mixture of herbaceous (for quail) and shrubs (for Swainson's Warbler).	30-100 openings +/- >25%	30-100 openings +/- 11-25%	30-100 openings +/- 10%	30-100 openings	47	**Very Good**	Very High
Forest Opening Associates	Early Successional Openings	Macedonia: Number, Size, Structure and Distribution of Openings	Number of permanent openings per analysis unit between .25 and 2 acres in size, no canopy (for bat foraging) and early succesional vegetation including a mixture of herbaceous (for quail) and shrubs (for Swainson's Warbler).	30-100 openings +/- >25%	30-100 openings +/- 11-25%	30-100 openings +/- 10%	30-100 openings	33	**Very Good**	Very High
Forest Opening Associates	Early Successional Openings	Wando: Number, Size, Structure and Distribution of Openings	Number of permanent openings per analysis unit between .25 and 2 acres in size, no canopy (for bat foraging) and early succesional vegetation including a mixture of herbaceous (for quail) and shrubs (for Swainson's Warbler).	30-100 openings +/- >25%	30-100 openings +/- 11-25%	30-100 openings +/- 10%	30-100 openings	31	**Very Good**	Very High

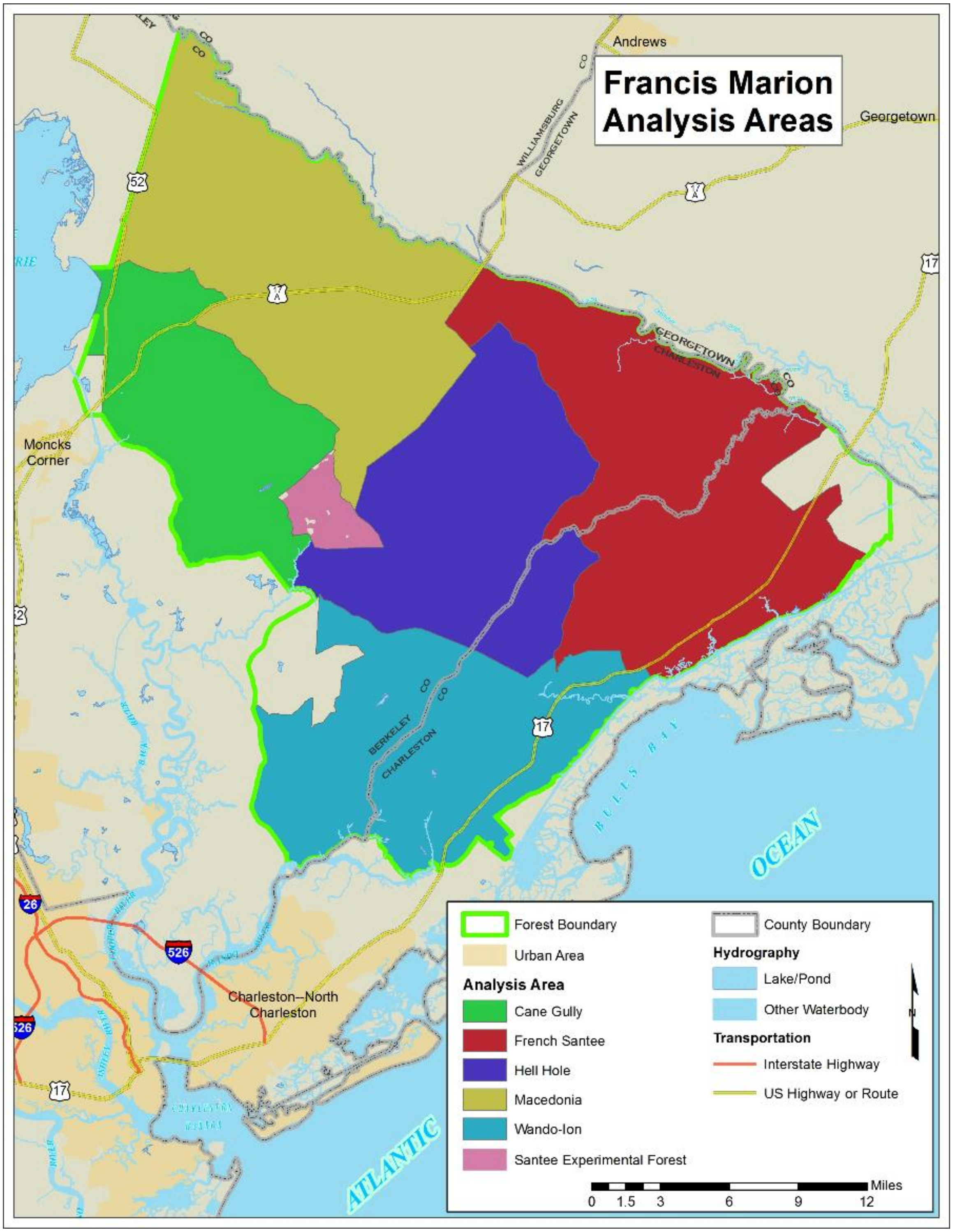


Figure 3-35. Analysis areas used to analyze current conditions for forest opening associates

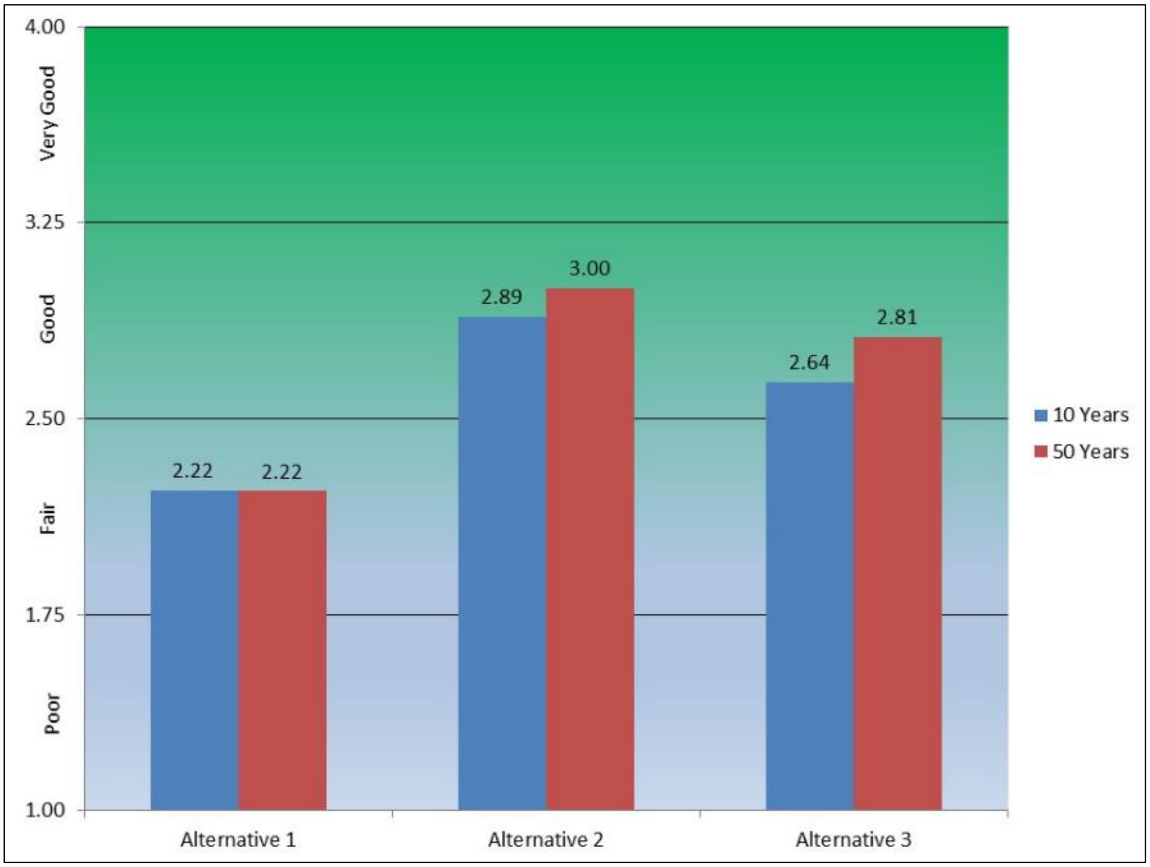


Figure 3-36. Estimated ecological sustainability rankings for forest opening associates under the three alternatives for 10 and 50 years

Based on the current conditions, the ecological ranking for this group would be expected to remain fair during the next 10 to 50 years under alternative 1 (see Figure 3-36). Alternative 1 would be expected to continue to directly and indirectly benefit species in this group by providing forest opening components via biotic and abiotic forces, but to a lesser extent than alternatives 2 and 3.

Alternatives 2 and 3

Direct and Indirect Effects. Under alternatives 2 and 3, plan components would be designed to create and maintain habitat for this group to a much greater extent than alternative 1. As such, the direct and indirect effects for species in this group would be more beneficial than those provided under alternative 1.

Alternatives 2 and 3 would continue to directly and indirectly provide habitat for species in this group. The ecological sustainability ranking for this group would be expected to remain at the good level during the next 10 to 50 years, which is primarily related to the increased amount of ecological restoration expected to occur under alternatives 2 and 3. However, due to the decreased acreage of Management Area 1, along with the increased wilderness areas, alternative 3 would be expected to produce somewhat less beneficial effects than alternative 2 (see Figure 3-36).

Because alternatives 2 and 3 would provide substantially greater habitat than alternative 1, the ecological sustainability ranking for this group would be expected to remain good during the next 10 to 50 years.

Cumulative Effects. Additionally, bats in the U.S. are being plagued by the white-nose syndrome. Although there is some uncertainty associated with the effects resulting from the disease, white-nose syndrome is only anticipated to lead to increased cumulative effects. However, all things being considered, anticipated negative cumulative effects should be offset by habitat management practices on the national forest.

The potential negative cumulative effects would be expected to prevent this group from achieving good ecological sustainability rankings. Cumulatively, negative effects would be expected under all alternatives, just less severe under alternatives 2 and 3.

3.3.4 Forest Health and Protection

This section of the document focuses on old growth, native insects and diseases, and non-native invasive species. Healthy forests have the physical and biotic resources to support functioning ecological systems that support a diversity of native plants and animals. Native ecosystems are resistant or resilient to dramatic change caused by abiotic and biotic stressors (like urban development or climate change) and mortality agents (like the southern pine beetle). Through an adaptive management approach, priorities for management activities may shift to respond to changing conditions such as expansion of non-native invasive species, southern pine beetle outbreaks, disease infestations, or storm events.

3.3.4.1 Affected Environment: Old Growth

In June, 1997 the Southern Region of the Forest Service completed a report entitled “Guidance for Conserving and Restoring Old Growth Forest Communities on National Forests in the Southern Region” (USDA-FS 1997). The old growth report contains direction for promoting development of a network of small, medium and large-sized patches of native old growth communities in conjunction with forest plan revision. The report includes desired conditions for a diversity of old growth community or ecosystem types throughout the Southern Region, given the best information available at that time. On the Francis Marion National Forest, the planning team used these ecosystem groups to provide the framework for eight old growth ecosystems on the national forest (including associated composition, structure and disturbance regimes) as a better and more consistent reflection of the local diversity. Direction to maintain and restore ecosystem groups in alternatives 2 and 3 will promote conditions compatible with old growth characteristics in the future. A crosswalk of old growth community types from the 1997 Region 8 Old Growth Guidance and Forest Plan Ecosystems is listed below (Table 3-50).

Old growth remnants appear to be both biologically and socially significant on the Francis Marion. Forests with large trees create a special place for people who come to the national forest to view nature and escape urbanization. Old growth forests contribute ecologically to landscape structural diversity. Old growth longleaf forests provide habitat for a variety of animal species, namely red-cockaded woodpecker, which requires old living pine trees for cavity excavation and foraging. Walker (1999) cites 22 birds and frosted flatwoods salamander as other animal species more typical of intact longleaf old growth forests. Twenty wildlife species were identified as old-growth associates through the forest ecological sustainability evaluation process. Old growth desired conditions vary with ecosystem type and are consistent with the desired conditions for forest plan ecosystems, providing habitat for a diversity of plant and wildlife species.

Given the land use history of southern forests, very little true old growth is thought to exist today, though few inventories have been conducted. Most of the available data is based on dominant tree ages within stands. Pond cypress trees in the Florida Bay Pond Cypress Savanna were recently aged at more than 400 years (Gaddy 2014), and pond cypress along the Santee River in the Guilliard Lake Research Natural Area at 1,200 years old. Forest vegetation stand data queried as part of a possible old growth inventory suggested that only 10,046 acres of stands (3.9% of forested acres) were dominated by trees older than 110 years old in 2013, and the majority (4,230 acres) was in swamp hardwoods (see Table 3-50).

Table 3-50. Crosswalk showing the relationship between old growth community types (2007) and ecosystems in the revised forest plan, and the minimum age of dominant trees to qualify as possible old growth (2007)*

Old Growth Community Type (2007)	Forest Plan Ecosystems (2016)	Minimum Age of Dominant Trees for use in possible Old Growth (2007)
River Floodplain Forest (Type 13); Eastern Riverfront Forest (Type 28); Cypress-Tupelo Swamp Forest (Type 14)	Broad Forested Swamps and Large River Floodplains	100 years; 200 years (Bald Cypress)
Cypress-Tupelo Swamp Forest (Type 14)	Depressional Wetlands and Carolina Bays	120 years (Pond Cypress)
Not Addressed	Maritime Forests and Salt Marsh	NA
Hardwood Wetland Forests (Type 10)	Narrow Forested Swamps and Blackwater Stream Floodplain	120
Coastal Plain Upland Mesic Hardwood Forest (Type 6)	Oak Forests and Mesic Hardwood Forests	120
Not Addressed	Pocosins	
Dry and Xeric Oak Forest, Woodland, Savanna (Type 22); Xeric Pine and Pine-Oak Forest and Woodland (Type 24); Upland Longleaf Woodland and Savanna (Type 26)	Upland Longleaf Pine Woodlands	110 (Longleaf)
Southern Wet Pine Forest, Woodland, and Savanna (Type 29)	Wet Pine Savannas and Flatwoods	110 (Longleaf)

***Based on half-life (typical mortality) of dominant tree species**

Desired conditions for old growth vary by ecosystem type, are consistent with the desired conditions for native ecosystems in the revised forest plan, and are also described in the 1997 R8 Old Growth Guidance. Old growth in mesic hardwood forests includes large trees, accumulations of large-sized dead standing and fallen trees, canopy gaps and multiple canopy layers, and wide variation in tree size and spacing (USDA Forest Service 1997). Characteristics specific to old growth longleaf forests and woodlands include open, low density park-like stands of flat-topped and contorted longleaf pine tree crowns, multiple tree size classes, a species-rich herbaceous layer dominated by grasses and forbs, multiple size classes of trees and naturally frequent fire regimes (Walker 1999). The minimum age for longleaf pine old growth ranges from 150 to 200 years (USDA Forest Service 1997), although Walker (1999) notes that old growth characteristics can be observed in stands as young as 100 years of age.

The Vision for Old Growth in the Revised Forest Plan (Chapter 2)

Old growth communities provide reference conditions for a diversity of ecosystems and plant and animal communities across the landscape. Old-growth conditions in reference maintenance conditions for ecosystems occur as large (greater than 2,500 acres), medium (100-2,499 acres), and small-sized areas (less than 100 acres) across the landscape.

While desired conditions vary with ecosystem, the desired conditions within Management Area 1 are old growth compatible and provide old growth conditions, but typically include the following:

- Old-growth conditions are represented for each ecosystem and occur across the landscape;
- Old trees (more than 100 years old);
- Large trees for the species or site;
- Hollow trees and snags;
- Variation in tree size and spacing within stands; and
- A low incidence of non-native invasive species.

Possible Old Growth. To determine possible old growth and trends compared to what was identified in the 1996 final environmental impact statement (based on age criteria alone), the planning team developed an inventory of possible old growth, considering stand ages both 100 years or older and 110 years and older as of 2013. The data for this analysis is typically based on even-aged stand data, and ages sampled from the dominant age class, in the agency's forest vegetation and timber database, FSVEG. The team first queried all stands on the Francis Marion meeting a minimum age criteria of 110 years or older (age year less than or equal to 1903), which is the minimum half-life for the predominant longleaf communities based on the 1997 guidance report. The team also looked at stands meeting the lower age criteria of 100 years (age year less than or equal to 1913) and compared it to what was identified in the 1996 analysis (USDA Forest Service 1996a). Between assessment and release of the draft revised forest plan, the team again looked at stands with age year less than or equal to 1915 and intersected these with the ecosystem layer to determine total ecosystem extent close to meeting age criteria for old growth. Results are shown in Table 3-51 and Table 3-52.

Table 3-51. Possible old growth (2013) by forest type group (age year 1903 or earlier and by age year 1913 or earlier) compared to 1996 forest plan environmental impact statement, Francis Marion National Forest (based on dominant stand ages in FSVEG)

Forest Type Group	1996 FEIS Suitable Lands >100 years	1996 FEIS Unsuitable Lands	2013 ≥110 years	2013 ≥ 100 years
Loblolly Pine and mixtures with hardwood	0	3,201	343	2,898
Longleaf Pine and mixtures	527	3,141	795	3,583
Sweetbay-swamp tupelo-red maple	0	276	1,286	5,030
Upland Hardwood	53	56	248	939
Bottomland Hardwood	897	1,816	3,144	6,557
Swamp Hardwood	2,933	12,334	4,230	13,276
Brush[1]	7,353	7,286		
Mixed Hardwood and Pine	101	1,761		
TOTAL	11,864	29,871	10,046	32,283

1. Brush is a term used in the 1996 FEIS prior to the development of an old growth strategy for the Southern Region in 2007, which was based on the best available science at that time.

Table 3-52. Extent of stands containing possible old growth characteristics (acres by age year less than or equal to 1915) by forest plan ecosystem (obtained through an intersection of Forest FSVEG data with ecosystems)

Forest Plan Ecosystem	Percent of Ecosystem Group Extent
Broad Forested Swamps and Large River Floodplains	26
Depressional Wetlands and Carolina Bays	13
Maritime Forests and Salt Marsh	4
Narrow Forested Swamps and Blackwater Stream Floodplain	15
Oak Forests and Mesic Hardwood Forests	19
Pocosins	0.9
Upland Longleaf Pine Woodlands	6
Wet Pine Savannas and Flatwoods	6

Future Old Growth. In determining the forest plan strategy for achieving old growth conditions in the future, the planning team considered the lands that were already in old growth compatible prescriptions, and identified those as follows:

1. Stands determined to be unsuitable for timber production (including wilderness, riparian management zones, select special and designated areas); the unsuitable land base was estimated in 1996 and developed for 2016 forest plan;
2. Rare communities (alternatives 2 and 3), or botanical areas (alternative 1);
3. Pine stands on upland longleaf and wet pine savanna sites occurring within red-cockaded woodpecker 0.5-mile foraging partitions within Management Area 1 (estimated to be managed on a 120-year rotation based on the red-cockaded woodpecker recovery standard (p. 200, Red-cockaded Woodpecker Recovery Plan, Second Revision), or Management Area 26 in alternative 1;

Table 3-53 displays the percentage of each ecosystem group in these future old growth-compatible allocations based on the criteria above, based on compatibility of revised forest plan for ecosystem maintenance and restoration and old growth conditions.

Table 3-53. The percentage of each forest ecosystem (rounded) in future old growth-compatible allocations by alternative (obtained through a query of FS VEG data intersected with ecosystems, based on strategy listed above)

Ecosystem Group	ALT. 1	ALT. 2	ALT. 3
Upland Longleaf and Loblolly Pine Woodlands and Forests	51	53	37
Wet Pine Savannas and Flatwoods	25	51	38
Depressional Wetlands and Carolina Bays	41	19	13
Pocosins	59	52	42
Narrow Forested Swamps and Blackwater Stream Floodplain Forests	31	22	16
Oak Forests and Mesic Hardwood Forests	26	18	20
Maritime Forests and Salt Marsh	76	78	79
Broad Forested Swamps and Large River Floodplain Forests	54	39	47

The following objective and management strategy for old growth is included in chapter 3 of the revised forest plan:

> **OBJ-ECO-1. Old Growth Conditions**
>
> Over the next 10 years, contribute to a network of small (between 1 and 99 acres) and medium (between 100 and 2,499 acres) – sized areas providing future old growth conditions during project or activity planning.
>
> ***Management Strategy:*** Old growth reference conditions for longleaf pine ecosystems are maintained or restored within 0.5 mile foraging partitions for the endangered red-cockaded woodpecker in Management Area 1 (53% of the total ecosystem extent), wilderness and riparian management zones and other unsuitable lands and rare communities.

The following standard for old growth is included in chapter 4 of the revised forest plan:

> **S37.** Maintain stands meeting criteria for old growth during project planning using the criteria in the Region 8 Old Growth Guidance. Consider the contribution of old growth communities to the future network of small and medium-sized areas of old growth conditions including the full diversity of ecosystems across the landscape.

3.3.4.2 Environmental Consequences: Old Growth

Alternative 1

Direct and Indirect Effects. Old growth conditions would be promoted on lands unsuitable for timber production, which account for 11.5 percent of forested acres, the majority of which occur as broad forested swamps and large river floodplains. Provisions in the 1996 forest plan do not consider old growth community composition, structure, connectivity and prescribed fire management needs for longleaf ecosystems above and beyond needs for the red-cockaded woodpecker. Indirectly, non-native invasive species infestations would be likely to impact old growth characteristics in all ecosystem groups. Longleaf ecosystems would be less likely to have the composition and structure typical of typical old growth communities, which would affect their value in providing diversity across the landscape. The forest would continue to age and there would be a predominance of older forests.

Alternatives 2 and 3

Direct and Indirect Effects. Desired conditions and standards associated with old growth and with ecosystem restoration and maintenance in alternatives 2 and 3 would ensure that a network of old growth communities and old growth conditions would occur across the landscape, including characteristic fire regimes. These conditions would be most likely to occur within fire-adapted ecosystems in Management Area 1 and within all ecosystems in both management areas. Upland pine and wet pine savanna ecosystems occurring within ½-mile red-cockaded woodpecker foraging partitions within Management Area 1 (over 50 percent of their extent) would be managed to maintain or restore old growth characteristics, including consideration of composition, structure, function and connectivity. Through S37, stands meeting age criteria for old growth would be maintained using the age criteria in the Region 8 Old Growth Guidance.

The majority of longleaf pine dominated stands identified in the possible old growth inventory would be maintained in future old growth through Management Area 1 direction. In alternative 2, all but 83 acres of the longleaf-dominated stands over 100 years would be maintained and restored as future old growth, whereas in alternative 3, approximately 808 acres of longleaf-dominated stands would not occur in the fire-adapted restoration prescription. Direct and indirect effects could impact these older stands as a result of harvesting or conversion to loblolly pine or lack of prescribed fire management. Both alternatives 2 and 3 would directly and indirectly benefit development of future old growth conditions and characteristics by improving the composition, structure, and connectivity of all ecosystem types. Benefits to fire-adapted ecosystems would be less in alternative 3, where 808 acres of longleaf dominated stands on the possible old growth inventory, and less of the forest, would be maintained with characteristic natural fire regimes.

Cumulative Effects. The availability of old growth conditions on private lands is likely to decline in the future, as population centers and the demand on older forests for timber products continue to grow. This trend suggests that national forests will fill a large role in creating and maintaining these areas in the future. The urban-interface between the Francis Marion and Charleston will continue to expand and challenge our prescribed burning activities in the future, particularly in and around state highways.

The cumulative effects of the revised Francis Marion National Forest Plan is a benefit to the old growth resource, and will result in an increase in abundant older forests, including hardwood swamps through wilderness, riparian, and eligible wild and scenic river settings, and older longleaf pine ecosystems, which are required by the federally endangered red-cockaded woodpecker. All alternatives provide for a diversity of old growth communities and ecosystems, particularly in management areas where natural fire regimes are implemented. Alternatives 2 and 3 strengthen consideration of ecological capability and ecosystem composition, structure, connectivity, and function, as well as drivers and stressors in our management, and will ensure a network of small and medium patches of old growth across the landscape.

3.3.4.3 Native Insects and Diseases

Insect damage and plant disease are natural disturbances that are part of a healthy, functioning ecosystem, as are certain amounts of fire and wind damage. At times, the Forest Service uses vegetation management activities, such as timber harvest, fire, manual and chemical treatments to promote forest health (see sections 3.4.1 “Forest Products and Timber Harvesting” and 3.4.2 “Community Wildfire Protection Planning”). This section examines the most serious threats to forest health and those that require the most active prevention, suppression or monitoring efforts, as well as strategies in each of the three alternatives for achieving healthy forests.

Each alternative uses a combination of vegetation management practices to restore and maintain resilient native ecosystems, including prescribed burning. Though the extent and location of these activities differs with each alternative, the emphases in each one is to:

1. Apply frequent prescribed fire in designated portions of the national forest;
2. Convert loblolly pine stands to longleaf pine forests on appropriate sites;
3. Maintain moderate stand densities; and
4. Control several non-native invasive species.

These actions are expected to improve not only native species diversity but also the resilience of ecological communities to stressors such as disease and insect outbreaks, extreme weather disturbances associated with climate change and others. In addition to resilience, a variety of age classes, including old growth, are needed for ecological sustainability.

Numerous native insects and diseases may be found on the Francis Marion National Forest. The one likely to have the most harmful effect is a native pest—the Southern pine beetle.

Southern Pine Beetle

Southern pine beetle (*Dendroctonus frontalis*) infestations have occurred cyclically throughout recorded history in the South. Outbreaks move from low levels of infestation to high levels over several years. Cycles may be localized or regional and depend upon weather, other stress factors and the interrelationship between southern pine beetle populations and its predators.

Factors that determine southern pine beetle hazard include:

1. The proportion of susceptible host trees such as southern yellow pine species (the more host trees, the higher the risk);
2. Radial growth of those trees over the past 5 years (slower growth brings higher risk); and
3. Density of host trees (higher densities equal higher risk).

Because individual tree radial growth data to estimate susceptibility is unavailable, the planning team used age as a proxy for radial growth. For the purpose of this analysis, stands equal to or older than 60 years old are considered to be of a higher susceptibility to southern pine beetle.

Currently, approximately 63 percent of the Francis Marion is in pine-dominated forest types. Of this acreage, approximately 26 percent are 61 years of age or older. Natural enemies, such as diseases, parasites, predators and weather help maintain southern pine beetle populations and bring cyclic outbreaks under control.

Alternatives 1, 2 and 3

Direct and Indirect Effects. When southern pine beetle outbreaks occur, direct suppression would need to be implemented using integrated pest management strategies. Integrated pest management may be achieved through rapid salvage and use of infested trees, piling and burning infested materials, chemical control in high value resources, and cut-and-leave methods.

Thinning is the preferred practice for reducing a forest stand’s southern pine beetle susceptibility. Maintaining pine stands below a threshold of about 100 square feet per acre of basal area (USDA Forest Service 1985) decreases the frequency and severity of southern pine beetle infestations, reduces intraspecific competition and provides trees with enhanced ability to ward off southern pine beetle attacks via increased resin flow. Reducing stand density through thinning also disrupts

southern pine beetle pheromone communication by increasing the amount of air flow within the stand (Ayres et al. 2009).

Restoring longleaf pine and other native ecosystems can reduce the impacts of southern pine beetle infestations on the Francis Marion. In the event that climate change brings more periods of drought, longleaf pine is more drought tolerant and less susceptible to attack by southern pine beetle than loblolly pine.

Table 3-54. Acres in pine-dominated ecological systems regenerated and thinned and at risk from southern pine beetle effects at the end of the first decade by alternative

Activity in Susceptible Types	Alternative 1 (acres)	Alternative 2 (acres)	Alternative 3 (acres)
Pine Acres Regenerated by Harvest	6,911	28,257	23,631
Pine Acres Thinned by Harvest	48,647	17,864	27,506
Total Acres Mature (60+) Pine	48,226	46,292	43,450

Each alternative emphasizes maintaining moderate densities in pine stands. Alternative 1 would thin more acres in the first decade. However, a significant portion of these thins would be reducing moderate stand densities to relatively low densities to provide better habitat for red-cockaded woodpecker. Alternatives 2 and 3 would convert more acreage from loblolly pine types to longleaf pine types, which are generally at much lower risk of southern pine beetle attack. Acres of mature pine are very similar across the three alternatives.

Cumulative Effects. When considering actions on private and other agency lands within or directly adjacent to the Francis Marion, cumulative effects regarding southern pine beetle hazard are somewhat mixed. Management actions on privately held lands vary quite a bit depending upon the objectives and beliefs of individual landowners. Forested lands held for timber investment are likely to be intensively managed and southern pine beetle outbreaks aggressively fought using timber harvest. However, many acres of privately held lands would remain unmanaged and likely increase the probability of southern pine beetle outbreaks regardless of the responsible official’s decision. Each alternative would help decrease southern pine beetle outbreaks on the Francis Marion National Forest, thus decreasing southern pine beetle spread from the national forest to adjacent lands.

3.3.4.4 Affected Environment: Non-native Invasive Species

Non-native invasive species pose a long-term risk to the health of the America’s forests. In the absence of natural predators, non-native invasive species can increase across the landscape with little opposition beyond limited control and reclamation measures. 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). Non-native invasive species are believed to be the second greatest cause of species endangerment and decline worldwide with habitat destruction being the first.

Trends. Insect damage and plant disease are natural disturbances that are part of a healthy, functioning ecosystem, as are fire and wind damage. However, both native and non-native insects and diseases have caused above-normal mortality rates on forested lands in the United States. High mortality rates can accelerate the development of high fuel-loading in fire-dependent forests, effectively removing important ecosystem elements and reducing private property values.

The non-native insects and diseases of most concern include the emerald ash borer, sudden oak death, redbay ambrosia beetle (associated with laurel wilt disease), Asian longhorned beetle and sirex woodwasp. The highest profile non-native animals found on the Francis Marion National Forest are feral hogs. Feral hogs disrupt plant life, devastate ecosystems, and have been known to decimate hardwood seedling plantings.

Aside from the potential economic loss from timber volume, many wildlife and fish species are dependent on the ecosystems affected by these invasive animals, insects and diseases.

Non-native Diseases

Diseases of most concern for the purposes of this analysis include laurel wilt and sudden oak death. The effects of the three alternatives on non-native diseases would be similar.

Laurel Wilt

Laurel wilt is a deadly disease of redbay (*Persea borbonia*) and other tree species in the laurel family (Lauraceae). The disease is caused by a fungus (*Raffaelea lauricola*) that is introduced into host trees by a non-native insect, the redbay ambrosia beetle (*Xyleborus glabratus*). The fungus plugs the water-conducting cells of an affected tree and causes it to wilt. Laurel wilt has caused widespread and severe levels of redbay mortality on the Francis Marion and in the southeastern coastal plain.

Direct, Indirect and Cumulative Effects. Laurel wilt is now well established in the Francis Marion as well as the southeastern Atlantic Coastal Plain; eradication of the vector and pathogen on the Francis Marion or in this region is not feasible. Continued dramatic reductions in redbay populations are anticipated not only on the Francis Marion, but also across the southeastern Atlantic Coastal Plain, although survival of redbay regeneration in the aftermath of laurel wilt epidemics suggests that redbay will not go extinct (Agricultural Research Service 2009).

The ecological impacts of drastic reductions in redbay populations are not well researched or have not yet been reported in the scientific literature. Potential ecological impacts on host species other than redbay are even less certain at this time. Other native forest species such as sassafras (*Sassafras albidum*) and the endangered pondberry (*Lindera melissifolia*) are also susceptible hosts of the disease, but the impact (both realized and potential) on these species is less certain. Due to this uncertainty, the impacts of management activities in the three alternatives are expected to be similar.

There are not any identifiable cumulative activities on private or other public lands that would combine with Francis Marion management activities to alter the impacts of redbay ambrosia beetle and associated laurel wilt.

Sudden Oak Death

Sudden oak death (*Phytophthora ramorum*) was first reported in 1995 in central coastal California. Since then, tens of thousands of tanoaks (*Lithocarpus densiflorus*), coast live oaks (*Quercus agrifolia*) and California black oaks (*Quercus kelloggii*) have been killed by this newly identified fungus, *Phytophthora ramorum* which causes a bleeding canker on the stem. The pathogen could also infect southeastern species including some from both the red and white oak groups and others such as the southern magnolia (*Magnolia grandiflora*), southern red oak (*Q. falcata*), pin oak (*Q. palustris*), Northern red oak (*Q. rubra*), white oak (*Q. alba*), cherrybark oak (*Q. pagoda*), chestnut oak (*Q. prinus*), laurel oak (*Q. laurifolia*), live oak (*Q. virginiana*), water oak (*Q. nigra*) and willow oak (*Q. phellos*).

Widespread susceptibility of many eastern forest and landscape trees and shrubs makes establishment of sudden oak death in South Carolina or other southeastern states a very real possibility. The susceptibility of many popular horticultural plants such as camellias, rhododendrons (including azaleas), and viburnums has already led to the pathogen being spread to some eastern states such as Georgia, Florida, the Carolinas and Mississippi. In these locations, *P. ramorum* was usually detected in potted plants, soil and water in or adjacent to a nursery that had unknowingly obtained infected stock. So far, the pathogen is not yet established in natural forests in South Carolina or elsewhere in the eastern United States.

Direct, Indirect and Cumulative Effects. Since there is no known cure for oaks infected with *P. ramorum*, control measures focus on regulation (quarantines), detection and education. Federal and State entities monitor nurseries throughout the country for new cases of sudden oak death. When new infestations are discovered, extensive eradication and quarantines should be enacted.

As there are few management actions or treatments identified to reduce susceptibility to or risk of sudden oak death, it is difficult to display differences in effects between the alternatives. At this time the most effective activities in combating sudden oak death on the Francis Marion involve continued detection, cooperating with enforcement of quarantines (administered by the Animal and Plant Health Inspection Service) and perhaps restrictions on the importation of firewood and certain ornamentals. These activities would continue under all alternatives.

In the event that an infestation is discovered on the national forest, removing the infested trees is the only tactic that would prevent further spread. It is expected that all alternatives would use this approach. Therefore, the direct and indirect effects of all three alternatives are the same.

Similar to the discussion above, there is a concern about the potential impact of this fungus in our ecosystems. Fortunately, this species has not yet been found on the Francis Marion. There are no identifiable cumulative actions or activities that would combine with activities on the Francis Marion National Forest to alter the impacts of *P. ramorum*.

Non-native Insects

Insects of most concern for the purposes of this analysis include Asian longhorned beetle, emerald ash borer, gypsy moth, and sirex woodwasp. The effects of the alternatives on non-native insects would be similar for each alternative.

Asian Longhorned Beetle

The Asian longhorned beetle (*Anoplophora glabripennis*) has been discovered attacking trees in the United States—tunneling by beetle larvae girdles tree stems and branches. Repeated attacks lead to dieback of the tree crown and, eventually, death of the tree. Asian longhorned beetle probably traveled to the United States inside solid wood packing material from China.

Since its first discovery in Brooklyn, NY in 1996, the beetle has been detected in four other states (Illinois in 1998; New Jersey in 2002; Massachusetts in 2008; and Ohio in 2011), as well as in Toronto and Vaughan, Ontario, Canada. Alert workers have reported the beetle in warehouses in other parts of the United States where the insects were destroyed before they could escape to start new infestations.

This beetle is a serious pest in China. In the U.S., the beetle prefers maple species (*Acer spp*.). Other preferred hosts are birches, buckeye, elms, and willows. Occasional to rare hosts include

ashes, European mountain ash, London planetree, mimosa and poplars. A complete list of host trees in the United States has not been determined.

Direct, Indirect and Cumulative Effects. Since Asian longhorned beetle has not yet been found in South Carolina, control measures focus on regulation (quarantines), detection, eradication and education. Federal and State entities are monitoring areas throughout the country for new cases of Asian longhorned beetle. When new infestations are discovered, extensive eradication and quarantines should be enacted. Currently, the only effective means to eliminate this pest is to remove infested trees and destroy them by chipping or burning. Early detection of infestations and rapid treatment response are crucial to successful eradication of the beetle.

Fortunately, this species has not yet been found on the Francis Marion. If it were, the Forest Service would be expected to take all of the measures outlined above regardless of the selected alternative. Therefore, the direct and indirect effects of all three alternatives would be the same.

There are no identifiable cumulative activities that would combine with the Francis Marion National Forest to alter the impacts of the Asian longhorned beetle.

Emerald Ash Borer

This non-native boring insect was first identified in the United States in 2002. Initial infestations were located in Michigan and Ontario, Canada. The insect has rapidly spread south and east and now occurs as far south as North Carolina, Tennessee and Georgia. It has not yet been detected in South Carolina. The emerald ash borer feeds on the cambium of ash trees as larvae. It is the destruction of the cambial layer that disrupts the transport of water and nutrients up the tree and causes mortality. A single generation of larvae occurs in any given season, with the larvae overwintering in the sapwood of the tree. Beetles emerge in May or early June to mate and start a new cycle. At this time, only ash trees are believe to be susceptible to this species of borer. Infested trees decline over a few years and may die after 3 to 4 years of heavy infestation.

Ash is rarely a dominant tree in the Francis Marion National Forest; but ash species are found there. While this insect pest is not likely to cause widespread severe mortality at the stand or landscape level because the host tree is not a dominant species in the forest, it could lead to severe decline and impact ash species across the national forest.

Direct, Indirect, and Cumulative Effects. Since there are no known occurrences of emerald ash borer, control measures focus on regulation (quarantines), detection and education. Federal and State entities are continuing to monitor detection throughout the country for new cases of emerald ash borer. When new infestations are discovered, extensive eradication and quarantines should be enacted.

As there are few management actions or treatments identified that can prevent emerald ash borer susceptibility or risk, the effects do not differ between the three alternatives. Quarantines are administered by the Animal and Plant Health Inspection Service and may include restrictions on the importation of firewood. These activities would continue under all alternatives. In the event that an infestation is discovered on the forests, removing the infested trees is about the only tactic that would prevent further spread. It is expected that all alternatives would use this approach.

There are no identifiable cumulative activities on nearby property that would combine with the Francis Marion National Forest to alter the impacts of the emerald ash borer.

Gypsy Moth

The European gypsy moth (*Lymantria dispar*) is a major defoliator of deciduous hardwood forests. It was first introduced from Europe into Massachusetts in 1869; because the favored host, oak, is widespread in the eastern deciduous forests, it thrived and continues to expand its range west and south each year. It is established throughout the Northeast; the infested area extends from New England south into Virginia and one county in North Carolina and west into Ohio and all of Michigan. As the infested area expands, the frequency of accidental introductions of gypsy moth on the Southern Appalachian national forests will increase, which may lead to the use of insecticides for their elimination or eradication. The continued implementation of the Gypsy Moth Slow the Spread Project will probably delay the permanent establishment of gypsy moth on the Sumter National Forest. However, the Slow the Spread Project will not stop its spread.

Gypsy moth larvae feed on more than 500 species of trees, shrubs and vines, including the following:

1. Favored hosts: oak, apple, birch, basswood, witch hazel and willow;
2. Moderately favored hosts: maple, hickory, beech, black cherry, elm and sassafras; and
3. Least favored hosts: ash, yellow poplar, American sycamore, hemlock, pine, black gum, and black locust.

Late instar larvae can feed upon tree species that younger larvae avoid, such as hemlock, maple and pine. Feeding on less favored host plants usually occurs when high density larval populations defoliate the favored tree species and move to adjacent, less favored species of trees to finish their feeding and development.

Defoliation by the gypsy moth may reduce tree vigor and growth of shoots and stem; cause dieback of the crown; trigger a failure of hard mast production; and sufficiently weaken a tree such that it is attacked and killed by wood boring insects and root decay fungi. Hardwoods in a vigorous condition often can tolerate a year or two of defoliation before canopy dieback becomes pronounced. However, hardwoods that are stressed by drought, oak decline or some other factor tolerate defoliation less well. The damage caused by gypsy moth feeding in spring is harmful because trees must draw upon reserve carbohydrates and nutrients to produce a second canopy of leaves following defoliation (a process referred to as refoliation). Generally, a tree refoliates when approximately 60 percent of its canopy is consumed. Production of a new set of leaves following defoliation restores the photosynthetic capability of a tree’s canopy; however, the refoliation process draws upon nutrient reserves that would normally be used for shoot growth and foliage production the following spring. The refoliated canopy is not able to fully replace the nutrients and stored reserves mobilized by the tree during refoliation, leaving the tree in a weaker condition the following spring. As a result, trees exposed to repeated defoliation and refoliation are weaker and more susceptible to attack by wood-boring insects and root-decay fungi.

Once established, gypsy moth population densities fluctuate widely from year to year resulting in episodes of dramatic and severe defoliation followed by periods of relative innocuousness. At low densities, the gypsy moth is regulated, but not eliminated, by natural enemies such as parasitic insects and predaceous vertebrates, particularly small mammals. As populations increase beyond the control of these natural enemies, the gypsy moth is regulated by different mortality factors, primarily diseases and starvation. Of these two factors, diseases caused by the nucleopolyhedrosis virus and the gypsy moth fungus (*E. maimaiga*) lead to the collapse of outbreak populations of gypsy moth. At the forest stand level, the period between outbreaks may range from 2 to 5 years; the actual outbreak period may range from 1 to 3 years. On a regionwide basis, gypsy moth

populations develop to outbreak levels across wide areas of the northeast, mid-Atlantic and Great Lake states for a period of years and then drop to very low levels for several years. Factors regulating these regional outbreaks and collapses of gypsy moth populations are not well understood.

Direct, Indirect and Cumulative Effects. Gypsy moth is not expected to spread to the Francis Marion National Forest within the planning period. Therefore, management actions in any of the alternatives are not expect to affect the risk of a gypsy moth outbreak spread.

There are no identifiable cumulative activities that would combine with Francis Marion National Forest activities to alter the impacts of gypsy moth.

Sirex Woodwasp

Sirex woodwasp (*Sirex noctilio*) has been the most common species of exotic woodwasp detected at United States ports-of-entry associated with solid wood packing materials. It has been found in Michigan, New York, Vermont, Connecticut, Pennsylvania and Ohio. The sirex woodwasp is considered a secondary pest of trees in its native range of Europe and Asia. Where it has been introduced it is considered a major pest. Females carry a fungus, *Amylostereum areolatum*, they deposit in trees when laying their eggs. This fungus and the mucus injected by the wasp rapidly weaken and kill host trees; the developing larvae feed on the fungus. This pest is attracted to stressed trees that are often used to make solid wood packing material. Since the life cycle can take a year or more, the insect is transported easily in pallets or other solid wood-packing material and not readily detected at a port.

Since sirex woodwasp has not yet been found in South Carolina, control measures focus on regulation (quarantines), detection, eradication and education. Federal and State entities are monitoring areas throughout the country for new cases. When new infestations are discovered, extensive eradication and quarantines should be enacted. Sirex woodwasp has been successfully managed using biological control agents. The key agent is a parasitic nematode, *Deladenus siricidicola*, which infects sirex woodwasp larvae and ultimately sterilizes the adult females. These infected females emerge and lay infertile eggs that are filled with nematodes, which sustain and spread the nematode population. In addition to the nematode, hymenopteran parasitoids have also been introduced into sirex woodwasp populations in the Southern Hemisphere, most of which are native to North America. Early detection and rapid treatment are crucial to successful eradication of this insect.

Direct, Indirect and Cumulative Effects. Fortunately, this species has not yet been found on the Francis Marion National Forest. In the event that an infestation is discovered on the national forest, control by use of biological agents and silvicultural practices would be implemented. The Francis Marion would be expected to take the same approach regardless of the selected alternative. Therefore, the direct and indirect effects of all three alternatives would be the same.

There are no identifiable cumulative actions or activities that would combine with the Francis Marion National Forest to alter the impacts of the sirex woodwasp.

3.3.4.5 Affected Environment: Non-native Invasive Plant Species

A multitude of non-native invasive plants threaten the integrity of native ecosystems and forest health on the Francis Marion. Although not addressed in the 1996 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 the following:

1. To prevent the introduction of invasive species;
2. To detect and respond rapidly to control new invaders;
3. To monitor;
4. To provide for restoration of native species and habitat conditions in invaded ecosystems;
5. To promote public education on invasive species; and
6. To avoid 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 since 1996. 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 South Carolina Comprehensive Wildlife Strategy (2011) includes as a high priority conservation action preventing the spread of existing invasive and non-native species, and eliminating them, where possible. The Forest Service issued new invasive species management directives (Forest Service Manual 2900) effective December 5, 2011, which sets 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 new chapter replaced Forest Service Manual 2080 (noxious weed management).

Non-native invasive plant species surveys were incorporated into project plant surveys on the Francis Marion beginning in 2002. To date, more than 35,000 acres have been surveyed for rare species and non-native invasive plants (GIS data 2013). Acres treated are estimated at 2,500 in 2014. Table 3-55 displays non-native invasive plant species that have been confirmed on the Francis Marion from 2002-2014, included the infested area (obtained by multiplying the total area times the percent of the area infested by the non-native invasive plant at the time it was documented). Cogongrass, a Federal and State noxious weed, occurs at three locations on the Francis Marion and continues to be a priority for the South Carolina cogongrass Task Force and the Forest Service. Of the terrestrial and riparian non-native invasive plant species known or likely to occur on the Francis Marion, only cogongrass, common reed, and alligator weed are regulated as State or Federal noxious weed species (https://plants.usda.gov/java/noxComposite) or aquatic nuisance species (http://www.dnr.sc.gov/water/envaff/aquatic/index.html).

Cogongrass surveys have been conducted in conjunction with the task force throughout South Carolina since it was discovered on the Forest in 2007. Japanese climbing fern, which has the potential to disrupt fire regimes, is the most common non-native invasive plant species on the forest (68 percent or 1,888 of 2,769 records in longleaf ecosystems). Chinese tallow is a primary threat at the forest's borders with Cape Romaine National Wildlife Refuge. The Forest works with the South Carolina Exotic Pest Plant Council to maintain state lists of early detection and rapid response (EDDR) species and more common non-native invasive plant species posing the most threat to natural areas in the state (https://www.se-eppc.org/southcarolina/). Invasive plant species

are expected to increase with changes in climate (SCDNR, 2013; Wear and Greis, 2012) and will increasingly threaten ecological integrity and forest health on the Francis Marion National Forest in the future.

Table 3-55. Infested area (rounded to 1 acre) of non-native invasive plants documented on the Francis Marion National Forest as of September 2014

Latin name	Common name	Infested Area (acres)
Ailanthus altissima	tree of heaven	<1
Albizia julibrissin	silktree	2
Alternanthera philoxeroides	alligatorweed	<1
Arundo donax	giant reed	<1
Arthraxon hispidus	small carpgrass	8
Elaeagnus pungens	thorny olive	<1
Elaeagnus umbellata	autumn olive	<1
Imperata cylindrica	cogongrass	<1
Lagerstroemia indica	crapemyrtle	<1
Lepidium bidentatum	Kunana pepperwort	<1
Lespedeza bicolor	shrub lespedeza	<1
Lespedeza cuneata	sericea lespedeza	110
Lemna	duckweed	<1
Ligustrum lucidum	glossy privet	<1
Ligustrum sinense	Chinese privet	39
Lolium arundinaceum	Tall fescue	61
Lonicera japonica	Japanese honeysuckle	60
Ludwigia peploides	floating primrose-willow	<1
Lygodium japonicum	Japanese climbing fern	473
Mahonia bealei	Beale's barberry	<1
Melia azedarach	Chinaberrytree	32
Miscanthus sinensis	Chinese silvergrass	<1
Microstegium vimineum	Nepalese browntop	29
Paspalum notatum	bahiagrass	<1
Phragmites australis	Common reed	<1
Phyllostachys aurea	golden bamboo	<1
Pueraria montana	kudzu	<1
Pyrus calleryana	Callery pear	<1
Pyracantha koidzumii	Formosa firethorn	<1
Rosa multiflora	multiflora rose	<1
Sesbania punicea	rattlebox	<1
Triadica sebifera	Chinese tallow	19
Wisteria sinensis	Chinese wisteria	7
TOTAL		**841**

The following is applicable revised forest plan language in regard to non-native invasive species:

Chapter 2- Vision

The desired condition for all ecosystems is that the occurrence of non-native invasive species is low.

DC-THR-1. Non-Native Invasive Species Management

Non-native invasive species are reduced on the landscape. Populations of non-native invasive species, such as feral hogs, are reduced through partnerships with appropriate state, local and private organizations. Through collaboration with partners on education, timely treatment and control, equipment cleaning and early detection and rapid response, the spread and introduction of non-native invasive species is minimized. Proactive management activities and monitoring reduce the number of non-native species and improve the integrity of ecosystems and forest health. Guidance from the regional noxious and invasive strategy is incorporated into project planning and implementation.

In partnership with the U.S. Department of Agriculture Animal and Plant Health Inspection Service, Clemson University Department of Plant Industry, South Carolina Cogongrass (See Figure 2-24) and Wild Hog Task Forces, the South Carolina Department of Natural Resources Aquatic Nuisance Species Program, and the South Carolina Exotic Pest Plant Council, the forest will reduce resource damage due to non-native invasive species through a combination of education, research, and management, not only on national forest lands but with cooperating landowners. Educational materials are provided to the publics which encourage the use of weed-free feed for horses, boat cleaning at landings, and the use of local firewood (cut within 50 miles of where it will be burned). The Forest Service works with state and industry partners on the development of weed-free certifications for soil, gravel, mulch and feed to reduce the introduction of non-native invasive species on national forest lands.

Design Criteria (Chapter 4)

S34. Require equipment cleaning practices on equipment, using equipment cleaning clauses in contracts, permits and agreements, when moving equipment from areas infested with non-native invasive plants (FSM 2903).

S36. Use plant materials that contain genetically appropriate native plant species when maintaining and restoring vegetation. Use of non-native plants is allowed only when in compliance with Forest Service native plant policy (FSM 2070).

G39. Non-native invasive plants on existing sites should be removed or treated before they become widespread within recreation sites.

G40. Encourage the use of weed-free materials (including but not limited to gravel, mulch, seeds, plant materials) to limit the accidental introduction and spread of non-native invasive plant species (including but not limited to gravel, mulch, seeds, plant materials)(FSM 2900). If certified weed-free materials become available in SC, then the use of those certified weed-free materials would be required for use on national forest lands.

G41. Commercially-purchased seed mixes should be tested by a certified seed laboratory for purity, viability, and noxious weed seed.

3.3.4.6 Environmental Consequences: Non-native Invasive Plant Species

Alternative 1

Direct and Indirect Effects. Under alternative 1, there is no forest plan direction, desired conditions, or standards 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.

Non-native invasive plant species would have the greatest impacts on forest health and ecosystem sustainability in alternative 1. Ecological integrity is predicted to be poor (more than 5 percent infestation) or fair (1-5 percent infestation) for all of our ecosystem groups in the 50-year interval.

Alternatives 2 and 3

Direct and Indirect Effects. Under alternatives 2 and 3, ecosystems would be maintained with no or low levels of non-native invasive species (less than 1 percent infestation), including plants, particularly within fire-adapted ecosystems in Management Area 1, which includes high priority ecosystem and species groups for at-risk species. Within these areas, frequencies of prevention, early detection and rapid response, and integrated control efforts would be highest; non-native plant populations would be treated to ensure they do not proliferate and dominate stands. As part of prevention, roads not needed for administrative access would be closed and revegetated with native plant species. Non-native invasive species such as tall fescue, bahiagrass and sericea lespedeza would not be used to vegetate or revegetate roads or rights-of-way (road and utility) on the national forest. 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. Native perennial or annual plant species would be used, preferably from local ecotypes 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.

Cumulative Effects. 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.

In alternatives 2 and 3, ecological integrity and forest health are predicted to be good (less than 1 percent infested) for most of forest ecosystems at both 10- and 50-year intervals. An exception is the Santee River large river floodplain ecosystem, which is predicted to be maintained at fair (1 to 5 percent) in the next 10 years, and then go to poor (more than 5 percent) in the next 50 years.

Rates of Japanese climbing fern infestation in the Santee River floodplain are currently more than 1 percent; they are anticipated to be relatively high in both alternatives in the future due to their relatively low accessibility, low management priority, and as habitat for at-risk species.

Non-native invasive plant species would have fewer impacts on forest health and ecosystem sustainability in alternatives 2 and 3. Ecological integrity is predicted to be maintained at good or very good for all of ecosystems groups in the 10- to 50-year intervals, with the exception of the Santee River floodplain ecosystem, which is predicted to be at fair or even poor levels of infestation in the future.

3.3.4.7 Affected Environment: Non-native Fauna

Feral Hogs

In terms of non-native invasive animal species, the wild pig (*Sus scrofa*) is currently the most widespread and destructive species on the Francis Marion. The pig family (Suidae) is not indigenous to North America so the wild pig has the potential to significantly impact ecosystems on the national forest. Local feral hog populations have proliferated and expanded their range across the Francis Marion. Feral hogs have the potential to damage ecosystems as they create wallows and root for food, compete with native species, and transmit diseases.

Foraging by wild pigs may reduce oak regeneration because the animals will feed on acorn crops. These pigs also damage longleaf pine regeneration when they root up seedlings to feed on their roots and grubs. They can also compete with and prey upon native wildlife species. Habitat damage in sensitive areas may have a negative impact on endangered and sensitive species and their habitat, as well as game species, such as turkeys and deer. Feral hogs may also destroy the nests, eggs, and offspring of ground nesting birds and can impact other animals directly or indirectly.

Wild pigs are highly mobile and freely move across land ownership boundaries. Attempts to reduce wild pig impacts to National Forest System land and water must be considered within the context of what occurs on adjacent land. Coordination of control efforts across boundaries is imperative. Reducing or eliminating impacts of wild non-native pigs can be both challenging and expensive. It is difficult to remove all members of a population. Even if all pigs were to be removed, the potential for wild pigs repopulating the area remains. Hunting and trapping these animals remains the most viable method of control. The Francis Marion National Forest will cooperate with Federal, State and private entities in order to proactively control the species across the Francis Marion National Forest.

During 2011, a total of 118 wild pigs were controlled on the Francis Marion by South Carolina Department of Natural Resources employees. They were primarily trapped in the Waterhorn Hunt Unit; some were also trapped in the Santee and Wambaw Hunt Units. Since 2009, Department of Natural Resources employees have trapped approximately 100 to 125 pigs annually. Trapping efforts that started in 2009 were the first targeted control efforts (other than special pig hunts) that the Francis Marion has implemented in the past 30 or more years. Since 2009, the National Wild Turkey Federation has purchased six corral-style pig traps for the Forest Service. Plans are currently underway to increase control efforts on the Francis Marion; increased funding should be available through stewardship and Knutson-Vandenberg sources. The use of dogs and aerial gunning appear to be two of the most efficient methods for controlling the wild pig. During a 3-week time period in 2015, dog contractors controlled over 34 pigs on the national forest.

Direct, Indirect and Cumulative Effects. Even though the wild pig was not even mentioned in the 1996 forest plan, control activities are expected to continue and even increase under all alternatives. In the event that a landscape-wide control method is feasible, control would be implemented. The Francis Marion would be expected to take this approach, regardless of the selected alternative. Therefore, the direct and indirect effects of all three alternatives would be the same. There are no identifiable cumulative actions or activities that would combine with forest management activities to alter the impacts of wild pigs.

Nine-banded Armadillo

Another non-native species of animal that is rapidly expanding across the Southeast and Midwest is the nine-banded armadillo (*Dasypus novemcinctus*). Nine-banded armadillos are only native to the southwestern United States. This species has been confirmed in the nearby town of Moncks Corner (Mark Danaher personal road kill observation, 2012) and is a common occurrence in Dorchester County, especially between the towns of Summerville and Walterboro. Armadillos can be destructive in natural habitats as they forage for food. They also carry diseases such as St. Louis encephalitis, leptospires, arboviruses, and leprosy.

Armadillos typically rest in a deep burrow during the day, and are primarily active during the night and early morning. Armadillo burrows are usually located under brush piles, stumps, root mounds, rock piles, and dense brush. Burrows are typically about 7-8 inches (18-20 centimeters) in diameter and can be up to 15 feet (4.5 meters) long. Armadillos often have several burrows throughout their territory, but use only one to raise their young. Armadillo burrows can provide underground refugia for native animal species, especially reptile and amphibians that require underground microhabitat for refugia (such as Carolina gopher frog and frosted flatwoods salamander). Personal observations have shown that armadillo burrows can be used by slow moving species such as the eastern box turtle and eastern diamondback rattlesnake, and may offer protective cover from fire and predators.

Armadillos primarily feed on beetles, caterpillars, snails, centipedes and other insects and invertebrates. Plants, eggs and small vertebrates likely constitute less than 10 percent of their diet (NatureServe 2013; Figg 1993). Although the nine-banded armadillo is a non-native invasive species, the presence of the species on the Francis Marion during the next 15 to 20 years is not expected to be severe enough to warrant specific control activities.

Direct, Indirect and Cumulative Effects. Armadillos move freely across land ownership boundaries, so it is not a question of if the nine-banded armadillo will show up on the Francis Marion, but a question of when. Effects from armadillos are uncertain, but are expected to be similar for each of the three alternatives and minor during the next 15 to 20 years. For all alternatives, activities to address the armadillo and other non-native invasive species will be addressed at the project level if necessary.

There are no identifiable cumulative activities on lands bordering the Francis Marion that would combine with Francis Marion management actions to alter the impacts of the armadillo.

3.3.4.8 Affected Environment: Non-Native Invasive Aquatic Species

Introductions of non-native aquatic species have had a significant impact on native aquatic fauna in the Coastal Plain Ecoregion. The species currently on the Francis Marion range from fish to snails and are listed in Table 3-56.

Table 3-56. Occurrence of non-native aquatic species on the Francis Marion National Forest

Scientific Name	Common Name	Occurrence
Cyprinus carpio	Common carp	Large rivers
Pylodictis olivaris	flathead catfish	Large rivers
Ictalurus furcatus	blue catfish	Large rivers
Corbicula fluminea	Asian clam	Three sites
Viviparus georgianus	banded mysterysnail	One site
Viviparus purpureus	olive mysterysnail	Potential – upstream of forest
Bellamya/Cipangopaludina japonica	Japanese mysterysnail	Potential – upstream of forest
Procambarus clarkii	red swamp crayfish	Potential
Aedes albopictus	Asian tiger mosquito	widespread
Pomacea insularum	Island applesnail	Potential
Pterois volitans	red lionfish	Potential

Common carp, flathead catfish, and blue catfish are established in several drainages. Flathead catfish are known to prey on bullheads, darters, shad, suckers, and sunfish. Declines in native species have been observed after the introductions of flathead catfish. Common carp occur in every South Carolina drainage and are considered a pest, but their impact on native fauna is not well known. Common carp disrupt aquatic habitats by rooting around in the substrate, which uproots aquatic plants and increases turbidity and siltation. They also have been shown to prey on the eggs of other fish species (www.dnr.sc.gov/cwcs/pdf/habitat/CoastalPlainAquatics.pdf). Grass carp are used as biological control agents for nuisance aquatic vegetation in South Carolina. South Carolina Department of Natural Resources regulates and tests this species as they are brought in by growers from other states; only triploid grass carp are permitted. This insures that they are sterile and cannot reproduce if escapement occurs (South Carolina Aquatic Invasive Species Management Plan, 2008). No reproducing populations of grass carp occur on the Francis Marion, but sterile grass carp have been stocked in the past to control aquatic vegetation in recreational fishing ponds.

The Asian clam has been introduced and has widely spread throughout the United States, including South Carolina. The effects of the Asian clam on native species are not particularly well understood. Three invasive snail species (*Viviparus georgianus*, *V. purpureus* and *Bellamya/Cipangopaludina japonica*) are present in Lake Marion and Lake Moultrie just west of the national forest; however, their impact on native fauna is not known (SCDNR Coastal 2015). The island applesnail has been found in the South Carolina coastal plain, but not yet reported from the Francis Marion. Potential impacts of introduced populations of the island applesnail are broad reaching and can even have human health implications. Because they eat such a wide range of aquatic plants, they are a potential threat to South Carolina aquatic ecosystems. Infestations can be very dense and cover large areas, causing harm to the aquatic environment by destroying native plant species and drastically affecting the food web through their ability to kill or out-compete native snail species (SCDNR Snail 2015).

The red swamp crayfish has been introduced to South Carolina and has been observed at several locations in the southeastern plains and coastal plain, but it is unclear how widespread it is in the state. The lack of survey work since its introduction and the difficulty distinguishing the red swamp crayfish from a native crayfish (eastern red swamp crayfish) have made it particularly difficult to determine the extent of its introduced range (SCDNR Coastal 2015). It is possible that

the red swamp crayfish occurs on the Francis Marion National Forest; it would be expected to occur in the types of habitat where the eastern red swamp crayfish has been collected. The two are very closely related species and have similar habitat requirements. The red swamp crayfish has been introduced as an aquaculture species within the range of eastern red swamp crayfish in South Carolina, but little is known about the distribution of escaped the red swamp crayfish populations in South Carolina (Jones and Eversole 2011).

The Asian tiger mosquito now occurs statewide. This species is a competent vector of many viruses including dengue fever, eastern equine encephalitis, potentially St. Louis and La Crosse encephalitis, as well as dog heartworm. The life cycle of this species is closely associated with human habitat and it breeds in containers of standing water. It is a very aggressive daytime biter with peaks generally occurring during early morning and late afternoon. It feeds on a number of hosts, including man, as well as domestic and wild animals. Its generalized feeding behavior contributes to its vector potential (SCDNR 2008.).

The Forest Service's "Southern Region Aquatic Nuisance Species Strategy, Aquatic Animals" (Leftwich 2013) provides guidance for managing nuisance species and supports the South Carolina Aquatic Invasive Species Management Plan 2008. State agencies are recognized as the lead agency in controlling the establishment of aquatic nuisance species and managing established aquatic nuisance species both on and off the Francis Marion National Forest.

Aquatic Nuisance Species and Climate Change. Increased temperatures, changes in rainfall and other environmental factors affected by climate shifts or change can create ideal conditions for proliferation of invasive plant and animal species, including parasites and pathogens. An increase in the number and diversity of native and non-indigenous invasive plant and animal species has been documented in South Carolina's terrestrial, freshwater, and marine habitats. Some of these species may have been released accidently, but others are likely migrating northward from more tropical climates as a result of warming temperatures. Regardless of the manner in which they have become established, these species already are impacting native animals and their habitats. As climate changes, an increasing number of exotic species likely will migrate to South Carolina. Habitats can be destroyed as resources are overused. Invasive and non-indigenous species have the potential to outcompete native species for food and other resources.

Tilapia is a warmwater, non-indigenous group of fish that are stocked extensively under permit in the state to control algae in private ponds. With few notable thermal refuges excluded, tilapia will die from cold stress in a typical South Carolina winter when water temperatures drop below 50 degrees Fahrenheit (10 degrees Celsius). Historically, south coastal South Carolina water temperatures routinely drop to 45 to 50 degrees Fahrenheit (7 to 10 degrees Celsius) during the winter. Tilapia could overwinter in the state if waters were to become warmer. Tilapia currently overwinters in Florida and has become an invasive species and a major management problem. If tilapia were to routinely overwinter in South Carolina it would result in direct competition with native and existing species for space, food, habitat and spawning areas, which could drastically alter natural fish communities. The destruction that non-indigenous peacock bass (*Cichla* spp.) can cause to native fish communities is well documented. In Florida, these fish currently are widespread, but are very temperature dependent and do not typically survive in waters cooler than 60 degrees Fahrenheit (16 degrees Celsius). Given current South Carolina winter low temperatures, tilapia is much more of an eminent threat than peacock bass. However, if winter temperatures increase, peacock bass could become a threat in South Carolina. Other invasive fish that are common in Florida and could become established in South Carolina include various cichlids, pleco (*Hypostomus plecostomus*), Asian swamp eel (*Monopterus albus*), walking catfish

(*Clarias batrachus*), various piranha and oscar (*Astronotus ocellatus*). All of these fish could, like tilapia, compete with native species for habitat, food and spawning resources (SCDNR Climate Change 2015).

3.3.4.9 Environmental Consequences: Non-native Invasive Aquatic Species

Alternative 1

Direct and Indirect Effects. Under this alternative, there is no forest plan direction, desired conditions or standards to help ensure the prevention, early detection and rapid response, control and management, nor rehabilitation and restoration of ecosystems degraded by non-native invasive aquatic species. Therefore, non-native invasive aquatic species likely would continue to negatively impact the Francis Marion's aquatic ecological systems.

Alternative 2 and 3

Direct and Indirect Effects. Under these alternatives, there is management direction, desired conditions and guidelines to help ensure the prevention, early detection and rapid response, control and management, rehabilitation and restoration of ecosystems degraded by non-native invasive aquatic species. Therefore, non-native invasive aquatic species would have much fewer impacts on the Francis Marion's aquatic ecological systems in alternatives 2 and 3.

Cumulative Effects. As noted previously, the majority of non-native invasive aquatic species are unregulated on all but Federal lands. Given this fact, as well as the demand for some species for sport, climate change predictions and the high costs of control, invasive species will increasingly threaten the composition and function of aquatic ecological systems on the landscape in the future, both in the 10-year, and to much greater extent, in the 50-year interval.

3.4 Economic and Social Environment

3.4.1 Forest Products and Timber Harvesting

3.4.1.1 Affected Environment

Forestry is first in South Carolina among manufacturing industries in jobs (90,624) and payroll ($4.1 billion) according to the South Carolina Forestry Commission, Forest Management Facts. By 2015, the state desires to increase forestry's economic impact from $17.4 billion to $20 billion and increase job numbers by about 12,000.

A sustainable supply of wood products is one of the uses provided by the Francis Marion National Forest. The Francis Marion's role in the timber supply and demand picture, while small in the context of regional and state markets is nevertheless important to the local timber industry. Though the forest products industry has been through a continuing trend of consolidation, a strong, competitive market still exists. Strong local demand has been reflected by the fact that the Francis Marion has been able to sell all the live timber sales it has offered for many years. This held true even through the severe recent recession and depressed construction market.

Timber harvest is a valuable ecological and fuels management tool. In addition to the continuing economic value it produces, timber harvest serves valuable functions in helping to achieve desired conditions, maintaining or restoring key ecosystem characteristics, improving forest resistance and resilience to pests and reducing the risk of wildfire. Some examples of this are:

1. Moderating tree densities to help create desired habitat for the endangered red-cockaded woodpecker;
2. Removing species and individual trees that are less desired to move forests toward desired species composition and structure;
3. Reducing tree densities in pine stands to make them less susceptible to Southern pine beetle;
4. Reducing tree densities in pine stands to make them less susceptible to damage from wildfire and to present less risk of wildfire spread than dense un-thinned conditions;
5. Serving as a tool to help restore longleaf pine;
6. Serving as a tool to help restore pine savannas;
7. Creating new young forest stands to provide diverse habitats, a flow of habitats over time and resilience to wind events and pest outbreaks;
8. Capturing carbon sequestered by the forest and increasing the carbon sequestered by the forest as an effect of creating young rapidly growing stands; and
9. Removing fuel that has accrued as tree biomass.

Trends. Following are three key trends noted in the Francis Marion National Forest Plan Assessment:

1. According to forest inventory and analysis (FIA) data there has been a large increase in timber inventory since the 1996 forest plan was signed. Comparing recent harvest levels for the Francis Marion to both forest inventory and analysis growth estimates and to the sustained yield limit estimate indicates that harvest levels are easily sustainable.
2. Data in the 2010 Resources Planning Act Assessment indicate that long-term timber demand is expected to remain steady or increase.
3. Francis Marion National Forest data show that the age class distribution has shifted with time. Defined as forest stands 0-10 years of age, the amount of early successional, young aged forest is quite low, comprising only about 0.1 percent of the national forest.

Land Suitable for Timber Production and Product Yields. For each alternative, Table 3-57 below displays the acreage suitable for timber production, sustained yield limit and estimated projected wood sale quantity. As conversion of loblolly pine to longleaf pine is completed, projected wood sale quantity would decline in the 5th decade.

Table 3-57. Acres suitable for timber production and estimated 10-year timber volumes sold for the different plan alternatives

Alternative	Alternative 1	Alternative 2	Alternative 3
Land Classified as Suitable for Timber Production (acres)	184,343	193,483	176,875
Percent of Land Ownership Classified as Suitable for Timber Production (%)	71%	75%	68%
Sustained Yield Limit (MMCF)			113.8
Projected Wood Sale Quantity, 1st decade (MMCF)	98.6	98.6	100.4
Projected Wood Sale Quantity, 5th decade (MMCF)	87.7	96.2	97.3

Note: MMCF = Million cubic feet.

Environmental Consequences: Forest Products and Timber Harvesting

All Alternatives

Direct and Indirect Effects. As shown in Table 3-57, most of the land base on the Francis Marion National Forest is considered suitable for timber production under each alternative. Offsetting features makes the yields of the different alternatives similar to each other. Compared to alternative 2, alternative 1 would have almost 10,000 acres fewer lands suitable for timber production. However, it keeps flatwoods in loblolly pine forest types, which are more productive than the longleaf pine in alternative 2.

Alternative 3 would have almost 17,000 fewer acres of land suitable for timber production than alternative 2. Almost all of this change in alternative 3 would be due to larger allocations to wilderness. Alternative 3 also would have around 20,000 acres less allocated to Management Area 1, meaning a larger allocation to Management Area 2. This would increase the portion of pine lands that are:

1. Managed for loblolly pine instead of longleaf pine; and
2. Have less extended rotations than Management Area 1.

These two factors would increase productivity with the result that the estimated yields for alternative 1 would be very similar to alternative 2 and even slightly higher.

Projected timber volumes are somewhat lower for each alternative in the 5th decade compared to the 1st decade. In alternatives 2 and 3, the intent is to convert very large acreages of loblolly pine to longleaf pine in the first decade. This tends to create a large spike in harvest the first decade, and a drop in the following several decades.

The age class distribution resulting from Hurricane Hugo also contributes to this same tendency. The acreage in age 20- to 30-year-old forest is quite large, resulting in a large pulse of acres needing thinning immediately, but in which less thinning will be needed by the 5th decade. This effect is most pronounced for alternative 1. In that alternative, age 20- to 30-year-old loblolly pine stands in flatwoods and wet pine savannas would not be converted to longleaf pine, but would remain as loblolly pine and grow to age 70 to 80 by the 5th decade, not yet of age for regeneration, nor as much in need of thinning.

Sustainability and Long-Term Productivity: The alternatives considered in detail, including the preferred alternative, would incorporate the concept of sustained yield of resource outputs while maintaining the productivity of all resources. The specific direction and mitigation measures included in the forestwide management standards and guidelines ensure that long-term productivity would not be impaired by the application of short-term management practices. Planned timber sale program quantities would not exceed the sustained yield limit of the forest. As stated above, forest inventory analysis data indicate that proposed harvest levels are very sustainable. While this data has sizeable error terms, it shows that over the last few years the Francis Marion National Forest has grown approximately 18 million cubic feet (MMCF) per year. Figure 3-37 shows the current age class distribution of the Francis Marion National Forest.

When the 1996 forest plan was written, the Francis Marion had an overabundance of very young forest due to Hurricane Hugo. That event is 25 years in the past and young forest habitats are now scarce. Diverse age classes make forests more resilient to disturbance events, insects and pathogens; and provide a sustained flow of habitats over time. While there are younger age trees in the understory of many fire maintained stands, the age of main stand canopies remains as

shown in Figure 3-37. The acreage of stands aged 0-10 is 0.1 percent of the national forest. The acreage of stands aged 0-20 is approximately 2 percent of the national forest. Longer term, it is expected that longleaf pine stands in Management Area 1 in both upland longleaf pine ecosystems and wet pine savanna and flatwoods ecosystems would likely be managed as uneven-aged. For the next several decades, however, these forests would probably remain relatively even-aged.

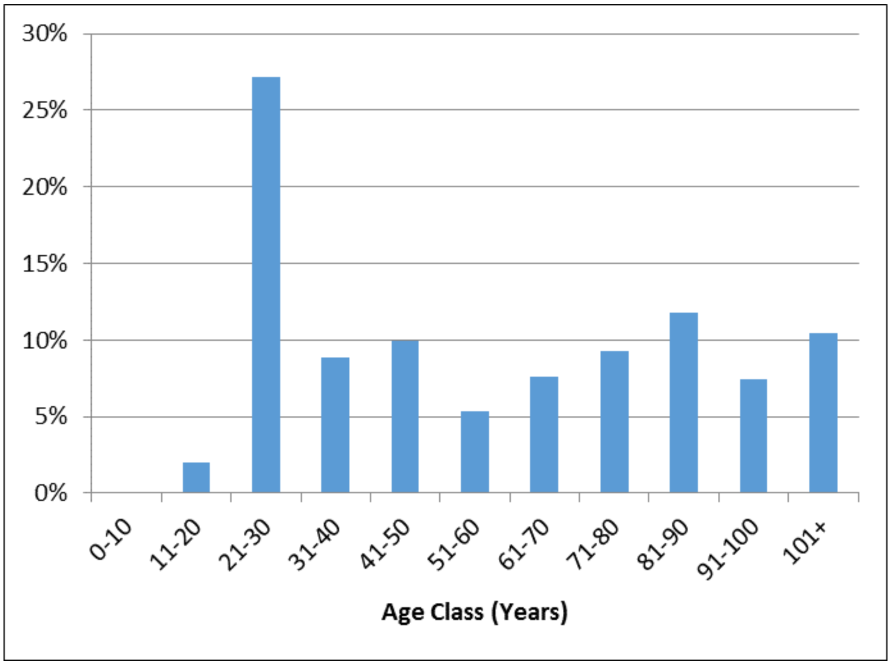


Figure 3-37. Age class distribution of trees on the Francis Marion National Forest as of September 2014

Figure 3-38. Projected age classes for each alternative, end of first decade

Figure 3-38 displays the projected age class distribution at the end of the first decade for each of the 3 alternatives. Comparing Figure 3-37 and Figure 3-38 shows several things.

1. Alternatives 2 and 3, especially alternative 2, would put far more acres than alternative 1 into the 0-10 year age class due to large acreages planned for restoration of longleaf pine in these two alternatives.
2. Alternatives 2 and 3, especially alternative 2, would reduce the large post-Hurricane Hugo age class from 27 percent to 22 percent and 24 percent respectively. This is because alternatives 2 and 3 would convert large acreages of age 20- to 50-year-old stands from loblolly pine to longleaf pine forest types.
3. The 101 years plus age class should have a large increase under each of the three alternatives as age 91- to 100-year-old forest moves into this next age class. This increase is just under double, increasing from approximately 10 percent to 18 percent.

The age class distribution changes significantly after five decades, as shown in Figure 3-39 below.

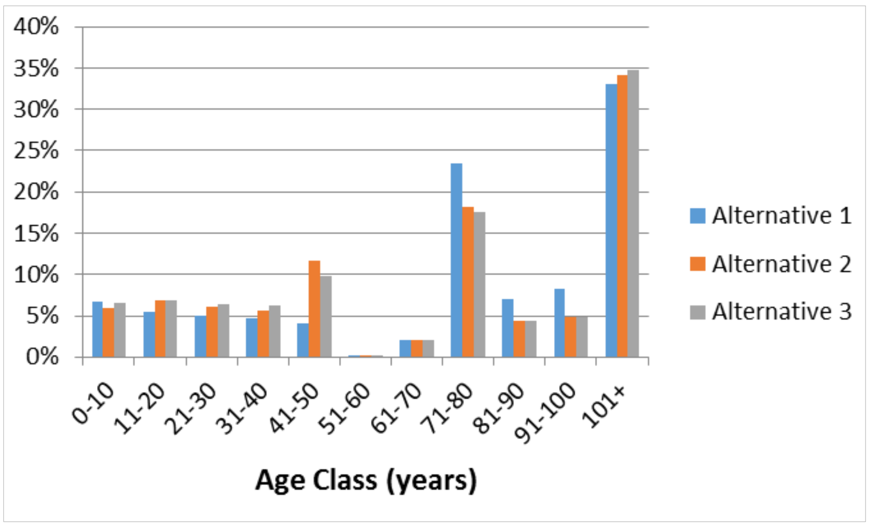


Figure 3-39. Projected age classes for each alternative, end of fifth decade

After five decades, forest over 100 years of age increases dramatically to 33-35 percent of the Francis Marion National Forest. The majority of these oldest ages, over 55 percent of the total, are in lands not suitable for timber production, and about half of this amount is in cypress-tupelo types. On lands suitable for timber production, longleaf pine maintained by frequent fire is carried to ages of at least 120 years and cypress-tupelo types are generally carried to ages beyond that. The Hurricane Hugo pulse of the 71-80 year age class remains prominent, as does the trough in ages 51-70.

There are differences, however, in the alternatives. Alternatives 2 and 3 have far fewer acres in the 71-80, 81-90 and 91-100 age classes. That is due to the emphasis that those alternatives place on converting young loblolly pine stands to longleaf pine back in the first decade. Alternatives 2 and 3 also have far more acres in the 41-50 years age class for the same reason.

Alternative 3 has fewer acres in the 41-50 age class after five decades than alternative 2 because large additions to wilderness in alternative 3 reduce the acres suitable for timber production and

therefore the acres available to regenerate to new age classes. Alternative 3's additional acreage in wilderness also accounts for the slightly higher percentage of forest age 101 or older.

Methods of Harvest and Site Preparation: The Francis Marion Forest Plan would not select or prescribe silvicultural systems to be used. Those are project-level decisions. However, probable methods of timber harvest are provided in Table 3-58.

Table 3-58. Estimated acres of harvest methods and site preparation for first decade

Practice	Alternative 1	Alternative 2	Alternative 3
Regeneration Harvest (even- or 2-aged)	8,826	28,257	23,631
Uneven-aged Management	0	94	86
Commercial Thinning	49,998	17,864	27,506
Site Preparation, Herbicide	4,457	22,757	19,797
Site Preparation, Mechanical	937	4,562	3,964

Compared to alternative 1, regeneration harvest would be much higher in alternatives 2 and 3 because of large longleaf pine restoration efforts. Likewise, estimated regeneration harvest would be about 4,600 acres more in alternative 2 than alternative 3 because alternative 2 would have more acres allocated to Management Area 1. Estimated site preparation follows the acres of regeneration harvest. Adverse effects of herbicide application would likely be minimal because threatened or endangered species would be avoided, buffer zones would be in place near streams, desired herbaceous species tend to recover quickly, applications may be banded if necessary, and applications typically only take place during stand establishment. Thinning quantities would be much lower in alternatives 2 and 3 because large acreages that would otherwise be thinned (ages 20-50 loblolly pine) would instead be regenerated to longleaf pine. Thinned acres also would be limited in alternatives 2 and 3 to stay within the sustainable yield and still accomplish the desired conversions from loblolly pine to longleaf pine.

Anticipated Changes in Longleaf Pine Acreage Due to Restoration. Restoration of the longleaf pine forest and its associated ecological systems would be one of the highest priorities of the revised plan. The acres of forest in regeneration (0-10 years) and mature condition (age 61 years and over) would be important for evaluating ecological conditions of each system. For longleaf pine, the acres in regeneration all would be the result of conversion from loblolly pine.

Table 3-59. Anticipated longleaf pine forest age structure after first decade

	Acres of Longleaf Pine	Acres age 0-10	Acres of Mature Forest
Existing:	49,581	4	19,270
Alternative 1	53,974	4,526	23,113
Alternative 2	75,816	26,237	23,191
Alternative 3	65,805	18,002	21,444

Alternatives 2 and 3 would restore far more acres to longleaf pine in the first decade than alternative 1. Restoration would also be more operationally realistic in alternatives 2 and 3 because the longleaf pine restoration emphasis in Management Area 1 would align far better with areas that can operationally be burned under prescription than Management Area 26 in alternative 1. This would probably be the single most important difference in alternative 1 compared to alternatives 2 and 3.

Alternative 2 would restore significantly more acres to longleaf pine than alternative 3 because that alternative would have approximately 20,000 more acres in Management Area 1.

Alternative 3 would have fewer acres of mature longleaf pine forest than the other 2 alternatives. The reason is that it would allocate less land to Management Area 1 and therefore more land to Management Area 2, which would not manage for longleaf pine forest because prescribed fire would unlikely be applied with the frequency needed to maintain longleaf pine systems.

Cumulative effects. National forest lands comprise about 4.6 percent of the land in South Carolina and 6 percent of the timber inventory. Although the Francis Marion's role in the overall supply and demand picture is relatively small, it is important to loggers and mills in the area. Even through the recent recession and depressed construction market, the forest has been able to sell all the live timber sales it has offered. These sales are especially important during depressed markets since little privately owned timber is offered during such times. In regard to forest products any difference in cumulative effects between the three alternatives would be small.

3.4.2 Community Wildfire Protection Planning

Note: For more information on fire management, see section 3.2.3 "Air Quality" and section 3.3.1 "Ecosystems."

3.4.2.1 Affected Environment: Community Wildfire Protection Planning

No other ecosystem driver across the U.S., and specifically the Southeast, has had a more profound and influencing role on the ecological processes of plant and animal diversity than wildland fire. Furthermore, some 95 percent of the Francis Marion National Forest, shrubland and grassland ecosystems of the Southeast Coastal Plain have been shaped by the occurrence of fire (Frost 1993). The current health of southern ecosystems can be attributed to the role of fire, the presence or lack thereof, and the implementation of policies and/or practices throughout the past several hundred years.

Throughout the past several hundred years, agriculture, urban growth, wildland fire suppression and smoke management constraints have completely altered these natural fire cycles and fire exclusion has created a dangerous trend of larger, faster and more destructive wildfires (Duncan and Mitchell 2009). The effects of these aforementioned fire-spread inhibitors have been dramatic in terms of large-scale fuel accumulations and changing structure and composition of many ecological systems in South Carolina (Fairchilds and Trettin 2006).

A large and rapidly expanding wildland-urban interface, driven by swiftly expanding population growth and urbanization, has added new complexities to both wildland fire suppression and prescribed fire operations. Within the Francis Marion National Forest boundary, approximately 38 percent of the land is privately owned; which contributes to the wildland-urban interface. The South is projected to experience the largest decline in forest area by 2060, losing about 17 million acres in one population growth scenario (Bowker et al. 2012). Total population growth within eight counties that encompass and surround the Francis Marion increased by 60 percent from

1980 to 2010. Berkeley County alone observed a significant doubling of housing units between 1980 (31,771 units) and 2010 (65,367 units).[3] See Figure 3-19 on page 142 for a graphic showing population growth from 1970 through 2005 with 2030 projected.

Uncharacteristic fire behavior in ecological systems excluded from fire can threaten the life and safety of both the public and wildland firefighters while also leading to direct loss of community infrastructure such as communication, transportation, energy and water supplies. Due to limited resources for treatments and elevated values adjacent to these ecological systems, treatments have historically been accomplished almost exclusively in systems where implementation risk and consequence is mitigated by distance of human presence. Fire is a natural ecological process, but unlike others (hurricanes, floods, or tornadoes) people have the capability to use fire as a tool and, as recent history has shown, to suppress the natural processes of fire. By doing so, people have most certainly changed the landscape and effects of fire once present. The consequences of all our management decisions must be considered, and suppression versus the use of planned and unplanned wildland fire must be weighed to adequately manage the ecosystems entrusted to land managers.

To help protect people and their property from potential catastrophic wildfire, the National Fire Plan (http://Forestsandrangelands.gov) directs funding to projects designed to reduce the fire risks to communities. A fundamental step in achieving this goal was the identification of communities that are at high risk of damage from wildfire. These high-risk communities identified within the wildland-urban interface were published in the Federal Register in 2001 (Federal Register 66:3). At the request of Congress, the Federal Register notice only listed those communities neighboring Federal lands. The August 2001 Federal Register lists 12 communities at risk that are within the Francis Marion proclaimed boundary (Germantown, Tibwin, McClellanville, Awendaw, Wando, Honey Hill, Germantown, Shulerville, Huger, Cordesville, Bethera, Jamestown, and St Stephen). The Healthy Forest Restoration Act (2003) further supports the creation of fire-adapted human communities by calling for preparation of community wildfire protection plans. Community wildfire protection plans assist communities in defining the wildland-urban interface, establishing priorities for hazardous fuels reduction work, addressing structural ignitability, and promoting landscape cooperation focused on minimizing wildfire threats. Currently, there is one community wildfire protection plan that covers more than 144,431 acres on Federal, State, county, and private lands in and around the Francis Marion. Of this, approximately 66,504 acres is on National Forest System lands. This community wildfire protection plan is for Awendaw-McClellanville Consolidated Fire District and the surrounding communities within the applicable resource integration zones.

Additional areas on the Francis Marion meet the national definition of wildland-urban interface and would greatly benefit from the establishment of community wildfire protection plans. For the plan revision, wildland-urban interface is defined in the Forest Plan Assessment.

The concept of fire regimes help categorize the multi-faceted role of fire while also characterizing and describing expected severity. Knowledge of fire regimes is increasingly recognized as a critical basis for ecosystem management. "Fire regime" refers to the nature of fire occurring over long periods and the prominent immediate effects of fire that generally characterize an ecosystem (Brown 2002). "Fire regime group" is a classification system used to describe fire severity within separate ecosystem types (Table 3-60).

[3] https://www.berkeleycountysc.gov/drupal/zoning

Table 3-60. Fire regime group in terms of fire regime and severity type

Fire Regime Group	Fire Regime	Fire Severity Type	Severity Description
I	0-35 years	Low/Mixed	Generally low-severity fires replacing less than 25 percent of the dominant overstory vegetation; can include mixed-severity fires that replace up to 75 percent of the overstory
II	0-35 years	Replacement	High-severity fires replacing greater than 75% of the dominant overstory vegetation
III	35-200 years	Low/Mixed	Generally mixed-severity; can also include low severity fires
IV	35-200 years	Replacement	High-severity fires
V	200+ years	Replacement/ Any	Generally replacement severity; can include any severity type in this frequency range

A fire regime condition class (FRCC) uses three classes to describe how much fire regimes have changed or "departed" from the natural range of variation. There is low departure (FRCC 1), moderate departure (FRCC 2) and high departure (FRCC 3). This departure results from changes to one or more of the following ecological components:

1. Vegetation characteristics, including species composition, structural stage, and canopy cover; and
2. Spatial fire regime characteristics, including fire frequency and severity (Hann and Bunnell 2001; Schmidt and others 2002; Hardy and others 2001; Hann and others 2004).

There are no wildland vegetation and fuel conditions or wildland fire situations that do not fit within one of the three fire regime condition classes.

The three fire regime condition classes are defined in the Interagency Fire Regime Condition Class Guidebook as follows:

1. Fire Regime Condition Class 1: Fire regimes are within the natural or historical range and risk of losing key ecosystem components is low. Vegetation attributes (composition and structure) are intact and functioning.
2. Fire Regime Condition Class 2: Fire regimes have been moderately altered. Risk of losing key ecosystem components is moderate. Fire frequencies may have departed by one or more fire intervals (either increased or decreased). This may result in moderate changes in fire and vegetation attributes.
3. Fire Regime Condition Class 3: Fire regimes have been substantially altered. Risk of losing key ecosystem components is high. Fire frequencies may have departed by multiple fire intervals. This may result in dramatic changes in fire size, fire intensity and severity, and landscape patterns. Vegetation attributes have been substantially altered.

Fire regime condition class is useful for monitoring and assessing current conditions of wildland ecosystems, as well as providing a good understanding of potential hazards and risks across the landscape.

Table 3-61 describes the fire regime condition class of all wildland vegetation on the Francis Marion National Forest.

Table 3-61. Fire regime condition classes (FRCC) of all wildland vegetation on the Francis Marion in acres

FRCC 1	FRCC 2	FRCC 3
140,338	59,143	55,879

Table 3-62. Total annual prescribed burn acreage by year

	Dormant Acres		Growing Season Acres		Dormant Acres	Growing Season Acres
Year	Longleaf	Total All Veg Types	Longleaf	Total All Veg Types	Longleaf Total	All Veg Types
1997[1]	no data	14,141	no data	4,960	no data	19,101
1998[1]	no data	20,396	no data	13,038	no data	33,434
1999[1]	no data	19,210	no data	9,286	no data	28,496
2000[1]	no data	18,987	no data	11,077	no data	30,064
2001[1]	no data	22,269	no data	13,017	no data	35,286
2002[1]	no data	18,668	no data	4,568	no data	23,236
2003[1]	no data	18,114	no data	22,580	no data	40,694
2004[1]	no data	23,588	no data	8,010	no data	31,598
2005[1]	no data	24351	no data	12,100	no data	36,451
2006	7,140	19,521	5,029	11,409	12,169	30,930
2007	8,546	24,008	2,688	10,501	11,234	34,509
2008	9,859	25,539	4,426	13,710	14,286	39,249
2009	9,908	28,985	2,560	5,894	12,468	34,879
2010	10,865	25,933	2,130	7,572	12,996	33,505
2011	5,360	17,304	4,980	14,136	10,341	31,440
2012	7,586	21,380	1,813	8,964	9,399	30,344

1. Dormant/growing season acreage breakdown not available.

Due to a successful history of prescribed fire in the core of the Francis Marion, significant portions of the national forest are in fire regime condition classes 1 and 2. The prescribed fire strategy on the Francis Marion currently is to maintain ecosystems with frequent prescribed burning rotations. Continuing to follow this strategy would allow managers to maintain condition class 1 areas and move condition class 2 areas into condition class 1. Increasing the current core area of burning would also result in moving additional condition class 2 areas into condition class 1 while beginning to further move condition class 3 areas into condition class 2.

3.4.2.2 Environmental Consequences: Community Wildfire Protection Planning

Alternative 1

Direct and Indirect Effects. Alternative 1 would not address the hazards and risks associated with the wildland-urban interface, nor would it follow the National Cohesive Wildland Fire Management Policy and associated guidance in creating fire-adapted human communities. More

than a decade of prescribed burning following Hurricane Hugo has significantly reduced fuel loadings and moved fire regime condition classes closer to historic levels within core areas of the national forest. However, in spite of this and coinciding are complexities and challenges land managers face when attempting to reintroduce fire to fire-dependent and once fire-adapted systems: growing and expanding human communities; fragmented lands intermixed with highways, infrastructure and utility corridors; potentially volatile fuels; and smoke management issues all elevate risk. The Forest Service acknowledges that those most intensive wildland-urban interface areas are simultaneously the areas of greatest threat to our communities and those of greatest value from (and highest priority for) treatment. Desired treatment is any mechanical, biological, or fire treatment (or combinations of each) that reduces future (0 to 10 years) fire intensity and severity.

Alternative 1 carries and creates the greatest risk. By not treating the build-up of hazardous fuels within fire dependent ecosystems in the wildland-urban interface these systems will continue to display uncharacteristic fire intensity and fire severity characteristics. These uncharacteristic fire intensities are more difficult to react to and suppress and are more unpredictable.

Alternative 1 would significantly decrease opportunities to work with neighboring partners and land managers in the treatment of hazardous fuels through community wildfire protection plan implementation across Federal, State, and private boundaries.

Alternative 1 would present the least opportunity for implementing treatments because it constrains using unplanned wildfires to meet resource objectives and includes a general lack of emphasis on alternative treatments within the wildland-urban interface. Alternative 1 would explicitly prohibit wildfires to meet resource objectives.

Alternative 2 - Proposed Action

Direct and Indirect Effects. Alternative 2 would provide the greatest opportunity to reduce the threat and risks associated with wildland fire. Alternative 2 would provide the greatest opportunity for treatment by explicitly stating desired conditions and the need to mimic fire using alternative treatments within the wildland-urban interface. Where alternative 1 is silent on hazardous fuels reduction and possible treatment activities, alternative 2 details the broad array of tools managers could use to assist in creating fire-adapted human communities.

Alternatives to landscape level prescribed burning include:

1. Prescribed burning in smaller burn blocks. In Management Area 1, fire compartments could be thousands of acres; in Management Area 2, these fire compartments could be hundreds of acres.
2. Mechanical methods to reduce fuel loading. Some methods could include mastication or chipping the midstory, or roller drum chopping after a regeneration harvest.
3. Herbicide use. Herbicides could be used to reduce fuel buildup in the understory.
4. Grazing. Cattle, goats, llamas, or donkeys could be used to control vegetation and reduce fuel loading, except within riparian management zones.

Alternative 2 would provide increased opportunities for Federal, State and private partners to work together while creating fire-adapted human communities. By working with partners and homeowners to reduce hazardous fuels, the likelihood that a wildfire burning in adjoining vegetation would ignite homes or other structures can be mitigated. Using existing programs,

such as community wildfire protection plans and FireWise education would be effective tools to encourage homeowners and local governments to create fire-resistant neighborhoods and communities.

Alternative 2 also incorporates Federal Wildland Fire Management Policy,[4] which states, "The role of wildland fire as an essential ecological process and natural change agent will be incorporated into the planning process." Alternative 2, at a minimum, would offer managers the ability to concurrently manage naturally occurring wildland fire for one or more objectives. Alternative 2 would carry increased risk; however, when using a decision support process to guide and document wildfire management decisions, the process would provide situational assessment, analyze hazards and risk, define implementation actions and document decisions and rationale for those decisions.

The 1996 forest plan defines the need to implement prescribed fire across the landscape of the Francis Marion for several desired effects. Alternative 2 would further define this need while also increasing the area burned and the return interval frequency in the growing season.

Alternative 2 would see increased impacts of smoke production and associated impacts from planned ignitions upon human populations. However, smoke output from maintenance prescribed burning releases less particulate matter due to less available fuel (frequent fire rotations continually remove understory fuel accumulations). Also, without maintaining hazardous fuel buildup, once ignited and burned under wildfire, these fuels would produce levels of emissions far exceeding those output under planned ignition events. By not treating the build-up of hazardous fuels within fire-dependent ecosystems in the wildland-urban interface, these systems would continue to display uncharacteristic fire intensity and fire severity characteristics. These uncharacteristic fire intensities would be more difficult to react to, suppress, and predict.

Alternative 3

Direct and Indirect Effects. Alternative 3 would reduce landscape-level prescribed burning in smoke-sensitive areas, thus minimizing and even negating smoke to some receptors. However, this short-term tradeoff would have profound consequences to long-term human health and safety. Without regularly treating hazardous fuel buildup, once ignited and burned by wildfire, these fuels would produce levels of particulate matter and emissions far exceeding those output under most planned ignition events. As more acres are restored to fire regime condition class 1 in ecological communities adapted to low-intensity periodic fire, a grass- and forb-dominated understory would prevail over a larger part of the landscape. In this condition, surface fuels are the primary component contributing to fire behavior. There would not be as much of a woody live and dead fuels component to contribute to either flaming or smoldering fire behavior.

In prescribed fires and wildfires, the grassy component would burn more easily, faster and produce fewer smoke emissions (both in concentration and duration) as compared to current fuel conditions. Fire intensity would be less and there would be less likelihood (risk) of stand-replacement burns. Suppression efforts would be less costly while providing a higher degree of safety to both the public and firefighters. By not treating the build-up of hazardous fuels within fire-dependent ecosystems, these systems would be more conducive to wildfires with uncharacteristic intensity and severity characteristics. These uncharacteristic fire intensities would be more difficult to react to, suppress and predict. Prescribed fire would also decrease the risk of wildfires burning onto adjacent lands.

[4] http://www.fs.fed.us/fire/management/policy.html

The additional recommended wilderness areas in alternative 3 present further constraints to prescribed fire and alternative treatment activities due to increased coordination needs, logistical complexity (access), potential reduction in fire management tools (chainsaws, engines, bulldozers, aviation resources) and the need to mitigate activities and motor vehicle use to maintain wilderness character. Several existing roads and firelines are located within the proposed wilderness; new firelines would have to be constructed to implement prescribed fire.

Alternatives 1, 2 and 3

Cumulative Effects. As more acres are restored to fire regime condition class 1 in ecological communities adapted to low-intensity periodic fire, a grass- and forb-dominated understory would prevail over a larger part of the landscape. In this condition, surface fuels are the primary component contributing to fire behavior. There would not be as much of a woody live and dead fuels component to contribute to either flaming or smoldering fire behavior. In prescribed fires and wildfires, the grassy component would burn more readily, faster and produce fewer smoke emissions (both in concentration and duration) as compared to fire regime condition classes 2 and 3. Fire intensity would be less and there would be less likelihood (risk) of stand-replacement burns. Suppression efforts would be less costly while providing a higher degree of safety to both the public and firefighters.

Table 3-63 and Figure 3-40 display current and projected fire regime condition class conditions across the Francis Marion. These illustrations are used to show shifts of fire regime condition classes between alternatives. The substantial increase in fire regime condition class 3 acres on the Francis Marion over the next 10 years in alternative 3 would be due to a decreased prescribed fire program, specifically in Management Area 2.

Table 3-63. Current and projected fire regime condition class (FRCC) conditions across the Francis Marion National Forest

FRCC	Alternative 1 Acres	Alternative 2 Acres	Alternative 3 Acres
1	280,674	300,874	244,358
2	118,285	108,185	88,031
3	111,759	101,659	178,121

Note: Fire regime condition class is calculated using Region 8 guidance as applied to existing vegetation types.

Alternative 1 is current fire regime condition class breakdown across the Francis Marion.

Alternative 2 is current with slight reduction from 2 and 3 to 2 and 1 using proposed plan objective of converting fire regime condition class (approximately 20,000 acres).

Alternative 3 is current with a projected rise from 1 to 3 due to lack of fire treatment in Management Area 2 over the next 10 years.

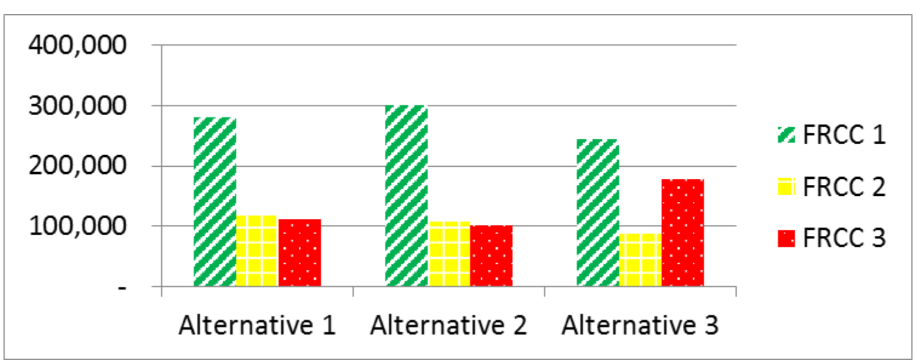


Figure 3-40. Current and projected fire regime condition class conditions across the Francis Marion National Forest

The effects of prescribed fires are usually short-lived and cumulative impacts are generally ascribed to impacts to soil and potential for smoke accumulation. Prescribed fire can have short-term negative effects on air quality. These effects may be mitigated by burning at certain times of the year, at certain fuel moisture thresholds and under meteorological conditions that promote smoke dispersion. This information is provided in the burn plan prepared for each prescribed fire. A smoke management plan is required for each burn plan. The impacts of prescribed fire on soils and air would be expected to stay within established limits for all alternatives.

3.4.3 Infrastructure

3.4.3.1 Affected Environment: Roads

A total of 576 miles of National Forest System roads, in addition to Federal highways, and state and county roads lie within the proclaimed national forest boundary. The road system within the planning area provides access to public lands and private inholdings. The majority of the access is provided for national forest administration, public recreation, wildlife management, and forest product extraction.

Public National Forest System roads are those open for the general public to use. Administrative roads are for Forest Service personnel, contractors, and permittees and, therefore, likely have much less use and are not maintained as well as public system roads. Roads used exclusively for regular administrative access to recreation are an exception. Annual motor vehicle use maps produced by the Francis Marion show which roads are open to public travel; all other roads are used for administrative purposes only or unauthorized and under consideration for obliteration. Private roads are roads that provide access to private property. Private roads are administered as easements or special use permits and are considered in the lands special use analysis. The motor vehicle use map would not be changed immediately following a decision on the forest plan, regardless of which alternative is selected. Differences among alternatives are based on limitations and desired conditions in the alternatives that would guide future site-specific decisions about roads and access.

Forest roads are designated according to maintenance levels and provide constant use by the motorized public or intermittent use for administrative purposes (gated). See Table 3-64 below. Gated roads (Level 1) are closed to motorized access except for more than one trip annually. Level 2 roads may be gated but available for administrative trips. Maintenance levels 3-5 are open for constant use unless temporarily gated to secure the area for administrative purposes, public safety or health, or to protect resources.

Table 3-64. Miles of national forest system roads by maintenance level

Maintenance Level	Miles	Percentage
1	141.5	24.6
2	82.0	14.2
3	295.0	51.3
4	55.8	9.7
5	1.3	0.2
Total	**575.6**	**100**

3.4.3.2 Environmental Consequences: Roads

Guidance for the transportation system in the 1996 forest plan is limited to the management of roads within Forest Service jurisdiction. Forest management activities significantly affecting the transportation system are road construction, reconstruction, maintenance and decommissioning. In all alternatives, major roads necessary for through traffic would remain open. Most road closures would be on dead-end roads unless necessary to ensure public safety and mitigate resource damage. Specific roads designated for closure would not be identified at the plan level.

Road construction and reconstruction is related in almost all cases to timber harvest needs and providing adequate access in newly acquired parcels. Road maintenance is determined based on the maintenance level assigned to all national forest roads. Road decommissioning will be determined on a case-by-case basis considering long-term need for current system roads and the need to obliterate illegal travelways within the national forest.

Changes to the forest road system were evaluated based on management guidance (desired conditions, guidelines, standards, objectives, and management approaches) and geographic delineations (recommended wilderness, semi-primitive non-motorized designation, and management areas) in each alternative that would influence future motorized access on the national forest. Impacts from roads vary according to use, location, road maintenance level and other factors. This analysis looks at management designations and direction that would affect the forest road system and makes the assumption that across the Francis Marion, reduced miles of National Forest System roads would generally equate to decreased motorized access and ecological impacts from roads and increased opportunity for more primitive recreation.

The ecological consequences of closing, decommissioning, and naturalizing roads generally result in increased wildlife habitat connectivity, reduced dumping, reduced sedimentation and impacts to plants and archaeological sites, decreased vandalism and theft of archaeological sites, and less noise disturbance to wildlife. The exact magnitude and location of these effects, however, is difficult to assess at the plan scale because the effectiveness of achieving these effects is largely dependent on site-specific situations and design features. In general though, fewer roads equates to an overall trend of a decrease in these effects. It is also assumed that roads for administrative use only would have lower use and correspondingly fewer impacts to ecological resources than roads that are open to the public. Among the alternatives, alternative 3 would provide the greatest amount of recommended wilderness and management areas that decrease future opportunities for public motorized access.

Alternative 1 would provide the greatest number of miles of National Forest System roads open to motorized travel, but it would not consider any new wilderness or management areas. Alternative 2 would provide a mix between public access and recommended semi-primitive motorized closures, which decreases the motorized travel on the forest but not to the extent of alternative 3, which would include additional wilderness designation.

Alternative 1

No additional areas are recommended for wilderness in the 1996 forest plan. In alternative 1, four existing wilderness areas would be maintained, totaling more than 13,000 acres. Two inventoried roadless areas (Hellhole Extension and Wambaw Extension) would be maintained. No road closures would be needed to implement this alternative.

This would keep the current road system in place only evaluating needs for additional access for timber and new land acquisitions. It is expected that the maintenance level of all forest system roads would be evaluated to reduce the maintenance of the overall current road system.

Alternative 2

This alternative would increase opportunities for remoteness by emphasizing a semi-primitive, motorized desired condition on national forest land adjacent to three existing wilderness areas. Four existing wilderness and two inventoried roadless areas would be maintained. The semi-primitive motorized areas would emphasize a remote experience totaling more than 11,000 acres, but would not restrict mechanical activities. Over time, road closures would improve wilderness character in the three nearby wildernesses through a lower open road density in the semi-primitive, motorized areas. Roads that would need to be gated would be used for administrative access. Road closures would require site-specific environmental analysis and decisions.

This additional emphasis on semi-primitive motorized condition would reduce the current road mileage by 18 miles (eight miles of Maintenance Level 1; four miles of Maintenance Level 2; and 3 miles of Maintenance Level 3). It is likely that additional road miles would be closed based on biological needs and to protect human health and safety and resources.

Alternative 3

Four existing wildernesses would be expanded with four additions of recommended wilderness totaling more than 16,000 acres (including two inventoried roadless areas). Over time, road closures would improve wilderness character and lower road density. Two inventoried roadless areas would be included within the new wilderness recommendations. Roads that would be closed and obliterated would require a site-specific environmental analysis and decision.

This designation would decrease the current mileage of forest roads by 42 (17 miles Maintenance Level 1; nine miles Maintenance Level 2; 16 miles Maintenance Level 4. It is likely that additional road miles would be closed based on biological needs and to protect human health/safety and resources.

With any of the above road mileage activities, motorized vehicle use would eliminate motorized access while encouraging foot travel to areas within the wilderness boundaries.

Cumulative Effects

Based on projected population growth in the Berkeley and Charleston Counties (Figure 3-19 on page 142), it is anticipated that Forest Service roads will receive increasing use as new homes and businesses are constructed within the administrative boundary. In some instances, Forest Service roads are not designed for the increased public use, but they provide important connections to state roads that support school bus traffic and emergency services. As these impacts occur, Forest Service employees would work with State and county officials to address these concerns on a site-specific basis.

3.4.3.3 Buildings and Structure: Affected Environment

Sixty-eight Forest Service buildings and structures (both administrative and recreation) support administrative and recreation programs across the Francis Marion.

A Facility Master Plan would be developed to guide the acquisition, continued use, maintenance, improvements and disposal of Forest Service facilities on the Francis Marion. The plan would propose an overall reduction in facilities through consolidation and decommissioning.

3.4.3.4 Buildings and Structure: Environmental Consequences

The probable activities under all alternatives would have little effect on the current status of facilities since most activities are allowed under the current plan. Evaluations for decommissioning existing facilities and new facility construction are not addressed at the forest-plan level.

3.4.4 Energy and Minerals

3.4.4.1 Affected Environment: Energy and Minerals

Federal Mineral Materials

Maintaining public access and implementing forest plan projects including restoration of natural landscapes requires the use of mineral materials, such as aggregate, road base and surfacing material, sand, rip rap, fill, and other earthen construction materials. The Forest Service needs a continuing supply of mineral materials because road surfacing wears out or is rutted into the subgrade, or floods wash away roads, ditches, and other facilities. The Francis Marion National Forest has used mineral materials sources from borrow pits on the national forest and from pits and quarries on non-Federal lands. The Francis Marion’s mineral materials can also be in demand from public works projects, rural development, personal use sale, or commercial sale. Urbanization and rural development in areas around the Francis Marion are increasing demands for mineral materials. Additionally, any low-elevation urban or urbanizing coast is going to have enormous eventual demands for fill or raised-pad material under conditions of rising sea levels.

Limestone. There is a high potential for limestone in the northern part of the Francis Marion (see Figure 3-41). In northwestern and northeastern Berkeley County and in southwestern Georgetown County, limestone is mined for crushed stone aggregate. The Santee Formation has high enough quality limestone that mining is occurring on private lands near the northern edge of the Francis Marion. Currently Martin Marietta is mining limestone near Jamestown. The company is producing products for road base and agricultural fertilization, which are considered salable mineral products.

In the past, the Francis Marion has received proposals for mining limestone. Each proposal was turned down for various reasons. Since the agency could only give a five-year minerals material contract, and the area of interest contains a variety of rare or at-risk species, the inquirers have not pursued it further. While the Gulliard Lake Scenic Area has limestone, it is protected from mining as a Francis Marion-designated scenic area.

Sand. The Francis Marion National Forest has high potential for sand resources throughout the national forest. In areas outside the Francis Marion, sand from former beach and terrace deposits above sea level is often mined for fill material (upland borrow sites). These deposits are often covered with pine forest (often referred to as “pine-barrens”) since the soil is too poor for other agricultural uses. Examples of these areas are the ridges the Bethera and Cordesville communities sit upon.

The Francis Marion has several borrow pits that have been used to supply mineral materials for Forest Service projects. After use, some borrow pits become ponds. The Francis Marion has not received any requests to develop sand dredging operations from riverbeds. On larger rivers, the State owns the riverbed and the South Carolina Department of Health and Environmental Control (SCDHEC) processes the sand dredging permit, typically with a public notice and comment period. On smaller rivers, where the riverbed may be on national forest land, the Forest Service

would need to determine, based on an environmental analysis process, whether to issue a mineral material contract through competitive sale.

Federal Leasable Minerals

Congress passed laws providing for the exploration and development of energy and mineral resources on Federal lands administered by multiple-use agencies, which include the Forest Service and Bureau of Land Management (BLM). Under Federal leasing laws applicable to all Federal lands, Federal leasable minerals include oil and gas, geothermal resources, coal, phosphate, and a few other minerals. However, on the Francis Marion National Forest and other eastern national forests with acquired land status, the minerals (such as gold, silver, and copper) that would be locatable minerals on western national forests are classified as leasable hardrock minerals. The BLM is the Federal agency with legal authority to lease minerals (43 CFR 3000). Forest Service consent is required before the BLM can issue a lease on the Francis Marion National Forest.

There is no known potential for Federal leasable energy resources or for metallic minerals on the Francis Marion. There is potential for phosphate in the southwest part of the national forest (Figure 3-41). While phosphate was never mined on the Francis Marion, it was mined in the Charleston and Beaufort areas. Also, while most of the sand and limestone on the Francis Marion are mineral materials managed by the Forest Service, it is possible that some sand or limestone deposit may have distinct and special characteristics and value that would make it a leasable mineral managed by the BLM. Currently there are no BLM authorized operations or leases on the Francis Marion National Forest.

Outstanding or Reserved Mineral Rights

There is only one small area on the Francis Marion National Forest with outstanding or reserved mineral rights. The Francis Marion has no current operations or issues with outstanding or reserved mineral rights.

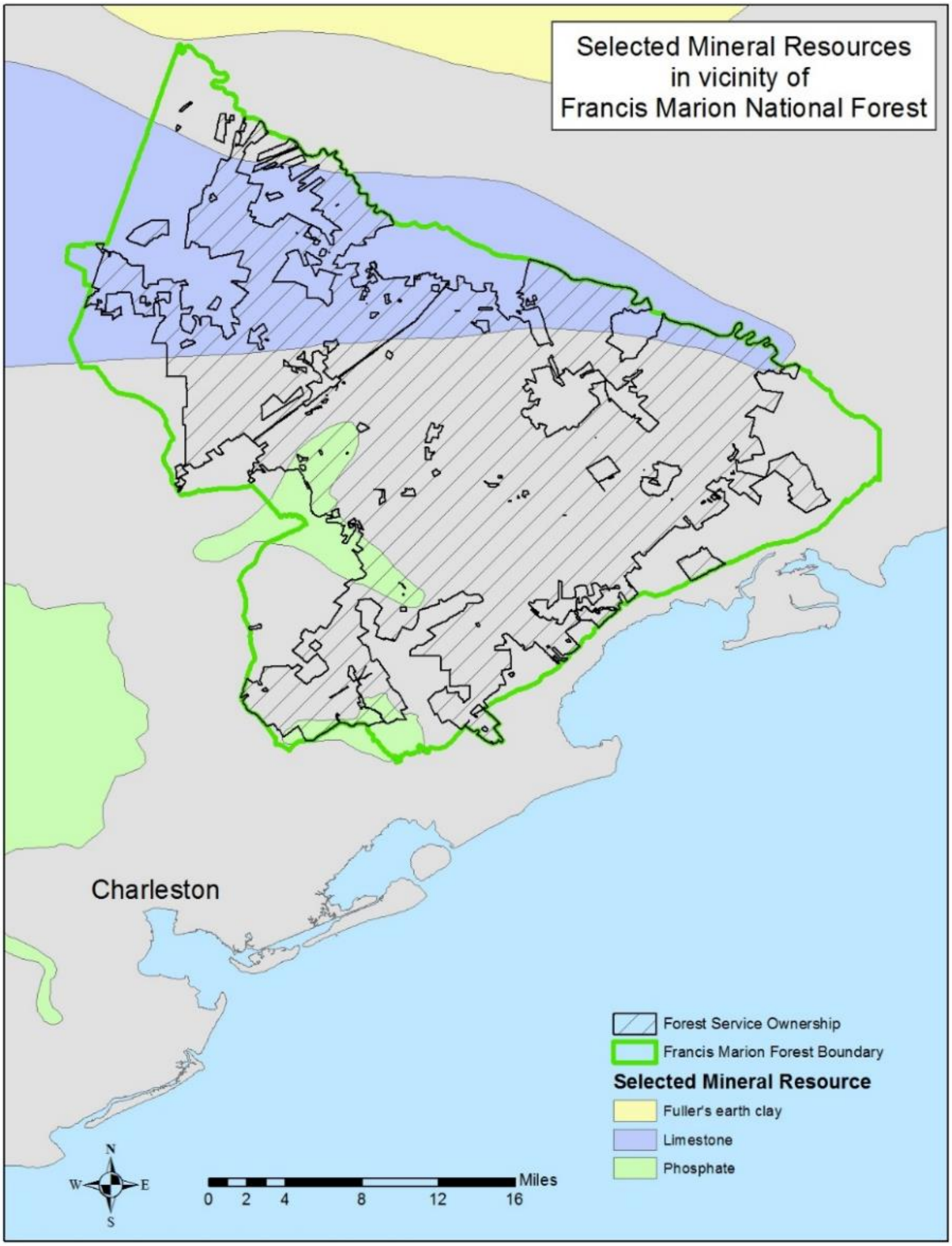


Figure 3-41. Mineral resources on the Francis Marion National Forest

Note: Mineral resources data from (Maybin 1997, South Carolina Geological Survey). Limestone and phosphate resources are in specific areas while sand resources are found throughout the Francis Marion National Forest.

3.4.4.2 Environmental Consequences: Energy and Minerals

All Alternatives

The 2012 Planning Rule requires that “The plan must include plan components, including standards or guidelines, for integrated resource management to provide for ecosystem services and multiple uses in the plan area” (36 CFR 219.10a). Supplying energy and minerals is not only part of multiple use but also ecosystem services. The Rule defines “ecosystem services” as benefits people obtain from ecosystems, including “Provisioning services, such as clean air and fresh water, energy, fuel, forage, fiber, and minerals; . . . ” (36 CFR 219.19). Thus, this section assesses the effects of the alternatives on access to and development of energy and mineral resources. The effects of energy and mineral resource development on other resources is assessed in those resource sections of this environmental impact statement.

To provide context, it is expected that the relatively low level of use of mineral materials from borrow pits on the Francis Marion National Forest will likely continue over the life of the revised plan as it has during the existing forest plan. Also, it is expected that the lack of BLM authorizations for leasable minerals on the Francis Marion will likely continue over the life of the revised plan as it has during the existing forest plan. Thus, the amount of ground disturbance associated with mineral materials and leasable minerals under all alternatives is expected to be on the same order of magnitude as existing ground disturbance from mineral activities on the Francis Marion.

Alternative 1

Existing laws withdraw some lands such as wilderness from mining activities. Plan designations and standards and guidelines protect red-cockaded woodpecker foraging clusters and other sensitive resources. The existing plan and existing laws and regulations (such as the Endangered Species Act) prohibit or severely restrict access to and development of energy and mineral resources in many areas in direct and indirect ways. The 1996 forest plan has limited direction on where it is suitable to mine limestone on the Francis Marion.

Alternatives 2 and 3

Plan designations, standards and guidelines, and adherence to Federal and State laws and policy would prohibit or severely restrict access to and development of energy and mineral resources in more areas and to a greater degree than alternative 1. Suitability determinations outline areas on the Francis Marion that are suitable or not suitable for mineral material development. Under alternative 3, more of the national forest would be wilderness, and thus, alternative 3 would have the most adverse effect on access to and development of energy and mineral resources.

3.4.5 Special Uses

3.4.5.1 Affected Environment: Special Uses

Approximately 108 special uses have been issued on the Francis Marion including rights-of-way (permits and easements), recreation events, outfitting and guiding, utilities (telephone, cable, fiber optic), community playgrounds, drainage ditches, churches, and cemeteries. Grazing permits ceased in 1970 and former agriculture permits were allowed to expire without renewal.

Special use authorizations on the Francis Marion continue to be an important and demanding program as a result of population growth. High population growth in the Lowcountry has resulted

in infrastructure demands, new easements, including widened and improved roadways and widened and new utility corridors, and communications facilities.

While research is not often considered to be a major use of Federal lands, the Francis Marion issues a number of special use permits for research purposes. Research on flora, fauna, water quality, seismic activity, weather, and soil conditions are common requests. Requests are being considered to restore ecosystems to their former conditions by working with local governments and private entities through mitigation banking. The forest also commonly allows communities, industry and other entities to use public lands for infrastructure, including power lines, rights-of-way, telecommunications, and other facilities. Special-use requests for developments such as electricity, fiber optic communications, and telephone services have increased over the past 20 years. With the changes in technology, this trend would increase need and demand for more of these types of developments and the services they provide. 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. Renewable energy resources such as wind and solar are resulting in new corridors being needed beyond the connections between existing traditional energy generator locations.

Procedures for the review and response times for special use applications and requests are now set by policy and regulations outside the forest plan and would apply regardless of the alternative selected.

3.4.5.2 Environmental Consequences: Special Uses

Encouraging maximum use of existing utility corridors and communication sites is common direction to all alternatives. As a result, new developments would be minimized across the landscape. All alternatives include this use as part of the desired landscape character in the appropriate management areas.

The probable activities under all alternatives would have little effect on the current special uses program, since most of the activities are allowed under the current plan. The most significant effect would be the minimum uses that would be allowed on lands in alternative 3 with the designation of additional wilderness acreage on the Francis Marion. This would specifically be addressed; no utilities, rights-of-way or specific recreation activities would be allowed in wilderness.

Alternative 1

Specific special use direction on processing and administration has seen changes in policy and regulation since the 1996 plan. Some direction and terminology in alternative 1 may no longer be consistent with current regulations and screening criteria. Current regulations and direction would need to be followed to provide a legally defensible special use permitting process.

Utility corridor maximizes the use of existing corridors. Corridors are considered in areas of the national forest where resource concerns are minimized. As a result, the location of new corridors on the Francis Marion would be limited.

Overall, continuing the 1996 plan would provide direction on suitable places for special use permits and a goal for special uses meeting the needs of communities and the public. It would encourage working to approve uses that meet the needs of expanding communities, while minimizing impacts to other resource values

Alternative 2

Alternative 2, like alternative 1, would retain much of the special uses direction from the 1996 plan and would include direction allowing uses when they are compatible with other resource objectives. However, stronger objectives would result in more restrictions on future utility corridors and other larger scale uses, limiting them mostly to existing corridors. Expectations of structures within roadway corridors, including potential wildlife crossings and other roadway facilities, would address the conflict between the valuable resources along major roadway corridors and the need for facilities associated with roads and reducing barriers to wildlife. New and expanded corridors and other special uses that include larger acreages would be limited under the stronger direction in alternative 2.

Alternative 2 would include more specific direction and desired conditions that describe where special uses can be compatible with other resources than the 1996 plan. Special uses screening criteria and application processes in the regulations would address some specific direction that is included in the previous plan and, therefore, does not need to be included in alternative 2. Use requests would still be considered, but may be more restricted under this alternative; however, it would allow other resource conditions and objectives to be better achieved. Guidance on infrastructure, utilities and roads, and scenery values in alternative 2 would be more specific than the 1996 plan. Additional direction for corridors would be similar to the 1996 plan by placing needed facilities in places that reduce ground disturbance and visual effects to multiple resources, while recognizing public needs and demands for reliable energy and communication services, as well as transportation and other infrastructure associated with growing populations and communities. Use requests that affect smaller areas could be allowed in less visible places that could meet scenery objectives.

Alternative 2 would rely on a broad public need being demonstrated to avoid communication and utility facilities becoming too frequent, dominating forest landscapes and degrading scenery, and impacting other resources from the additional ground disturbance.

Research permit direction would indicate when those activities are appropriate on National Forest System lands and have national forest values. This would not only address the Francis Marion being more supportive of research activities, but also clearly indicate that the agency would be more supportive of research that relates to the Forest Service mission and would not affect recreation opportunities or impact vegetation structure, composition and management objectives in the long term. Such guidance would clearly articulate and narrow the types of research the Francis Marion would consider permitting and support research projects that benefit the agency as well as the sponsoring research organization while reducing environmental impacts from permitted research activities. Climate change and the potential increases in fire and tree mortality may increase the needs of utility companies (in particular those with aerial lines) to invest more in removing hazards or in repairs to facilities. This may also result in more open areas adjacent to these corridors and the need to treat the adjacent edges to reduce the linear look and soften the corridor.

Alternative 3

The effects of alternative 3 would be similar to alternative 2. Additional recommended semi-primitive, non-motorized use could restrict management of existing authorized uses and could limit new uses. Alternative 2 would cover areas adjacent to roads and utility corridors and would limit any potential expansion of these corridors and some maintenance activities that may prove difficult for permit holders in these specific areas.

Cumulative Effects Common to All Alternatives

Ongoing population increases also would likely result in demand for new transportation systems both on and off the national forest, mostly in road corridors. Potential changes to the transportation system can be anticipated through both current and anticipated studies and plans. These improvements would impact scenery resources, and would have the potential for addressing wildlife connectivity through the construction of wildlife crossings as improvements are constructed. Other travel corridor improvements would also be expected during the life of the plan. These construction activities would have the potential to promote further introduction of invasive weeds along corridors and changes in scenery and recreation opportunities.

Inholdings and residential developments within and adjacent to the Francis Marion may also affect National Forest System lands. When inholdings of private property have gone through a lot-split process instead of a subdivision, access to individual parcels has not been provided for. This has resulted and would continue to result in additional road access requests and the potential for multiple access points and permits on the Francis Marion. Subdivision developments may result in higher standard road access corridors to meet local government requirements. These higher standard access roads would have the potential to move the area away from the desired landscape character for scenery, and impact wildlife habitat and recreation experiences.

Population growth in South Carolina continues to place pressure on utility providers to ensure reliable services. This growth results in continued requests for uses that allow for redundancy or alternative feeds (wireless and other communications services, water pipelines, electricity grids, power substations, and gas pipeline circuits), as well as additional storage facilities like water tanks. Locations for new uses would be limited because of the desire to maintain high or moderate scenic integrity objectives in most of the national forest. Population growth and popularity of the Lowcountry by tourists would also increase pressures for recreation in a forest setting provided by the Francis Marion.

As stated in the “Land Use and Ownership section,” cumulative effects of population growth and other entities’ future plans would likely move the Francis Marion away from desired conditions for some resources, depending on the location and scale of development. Infrastructure development on lands of other ownership within the national forest in many cases would result in connections being required on the national forest.

Identifying specific existing utility corridors for expansion would allow for new infrastructure to address new demands, but may not be in needed locations, depending on the sources of power, water or gas supplies. Continued growth would also likely result in the need for additional transportation corridors and other community infrastructure that are not currently known.

3.4.6 Land Use and Ownership

3.4.6.1 Affected Environment: Land Use and Ownership

Approximately 259,537 acres of the Francis Marion are located in Berkeley and Charleston Counties. The lands program area includes several different activities: land adjustment (exchanges, acquisitions, and conveyances), boundary management, and other activities that are primarily real estate type activities. Special uses activities include authorizations to use National Forest System lands for non-Federal type uses, as described in the previous section.

Actions and plans of local communities and their growth and development influence the Francis Marion through land adjustment cases, boundary management concerns, utility needs and

development, and residential impacts. These communities are also partners in acquiring and maintaining open space and providing needed services to residents and forest users.

The Forest Service may acquire lands through exchange, purchase, donation or condemnation. Land exchange and land purchase have been, and would continue to be, the means by which the Francis Marion acquires key wildland resources and open space areas. Most of the Federal lands exchanged are within or near existing communities and the majority of land conveyed to the Francis Marion, as a result, is located in more remote areas.

Procedures for processing cases and public participation is determined by set policies, rules and regulations outside the forest plan and would apply regardless of the alternative selected.

3.4.6.2 Environmental Consequences: Land Use and Ownership

Criteria for land adjustment cases are very similar among all alternatives even though the wording is different. Potential results of the criteria would likely be the same. Public concern about being involved early in land exchange projects and continued support for community needs would be addressed in all alternatives. As a result, the public would be informed of land exchanges early enough to meaningfully contribute to the outcome for the benefit of the community. This would increase trust in the Forest Service’s lands program. Due to budgetary and capacity constraints, limitations of the plan and community influences, the Francis Marion would likely continue to increase in acreage but probably at a small rate throughout the life of the plan.

Under each alternative, the Francis Marion would continue to pursue additional acres to add to and consolidate the existing footprint of the national forest. Lands would be evaluated for disposal and acquisition based on criteria developed in the Francis Marion’s Land Ownership Adjustment Strategy. Emphasis would continue to concentrate on lands with valuable recreation, wildlife habitat, or other natural resource attributes. Acreages such as those found in wilderness or other designated sites would not be considered for conveyance.

Alternative 1

The 2005 Land Ownership Adjustment Strategy identifies specific criteria and tracts to acquire, some of which have been acquired. However, the map has not been modified to keep up with adjustments. Other acquisition parcels are not listed and, therefore, may not be perceived as high priority. Parcels of importance would change throughout the life of the plan as resource values are discovered (cultural and archaeological resources) and identified, interested parties come forward, or additional species are listed or conditions change.

Land and Water Conservation Fund priority direction is contained in policy and ranking criteria and this wording is no longer needed in the plan. The criteria of lands to acquire would continue to be effective for determining potential purchase cases instead of a list of priority properties. Because this direction is redundant with Forest Service policy, it does not contribute to effects.

The existing plan states specific boundary and landline direction, but timeframes do not reflect current limitations in budget and capacity and the flexibility of the forest to determine priority work. As a result, this direction would remain unachievable.

Alternative 2

This alternative includes guidelines that would likely result in similar land adjustment opportunities identified in the 2005 Land Ownership Adjustment Strategy, including conveying inholdings that do not possess characteristics that would further the Forest Service mission and

increasing the ability to acquire lands of other ownership containing habitat for threatened, endangered, or sensitive species and consolidate Federal ownership.

Working collaboratively with local governments and communities early in the land exchange process per the associated management approach may result in land exchanges being developed that meet community and national forest needs, and parties agreeing to potential tradeoffs of open space values for other resource benefits.

Alternative 2 would continue to allow for conveyance of lands to meet community and public needs and would add loss of wildland character to the list of lands that could be conveyed. This could provide incentives for non-Federal neighbors to protect those values to reduce the potential for land exchange or sale. This alternative would also add forestwide emphasis to management approaches for collaboration with private landowners and local governments to protect forest values from adjacent development impacts. This could result in less habitat fragmentation and greater watershed health to forest resources from adjacent non-federal uses by developing buffers on private lands. Characteristics of lands to acquire would be stated in the guidelines and priorities would be set using the ranking system in the Forest Service Handbook.

Boundary survey and encroachments would not be specifically mentioned in alternative 2, but would still be part of a lands program and would be addressed according to policy and regulation and should not change current management.

Overall, alternative 2 would not be substantially different from the 1996 plan. However, adjustment guidelines and desired conditions would reflect more succinctly the criteria of lands desired for Federal acquisition and those appropriate for conveyance. Values would be included to address local concerns about land exchanges that result in conveyance of National Forest System lands. Loss of wildland character as a conveyance characteristic would be a good communication tool with adjacent non-Federal owners who can work to protect those values, perhaps reducing encroachment cases. This would allow communities to identify important open space, but also to take some responsibility for preserving wildland and resource values. If land adjustment actions are consistent with the guidelines, key resource-value properties would be acquired and would result in meeting the desired condition of a mostly contiguous land base that provides for biologically diverse public lands.

Alternative 3

This alternative is similar to alternative 2 except there would additional congressionally designated wilderness. These acres would be permanently removed from consideration for conveyance.

Cumulative Effects Common to All Alternatives

The cumulative environmental consequences are spatially bounded by an area larger than the Francis Marion National Forest’s proclaimed boundary, generally the area immediately adjacent to the national forest. Continued population growth in the communities within and surrounding the Francis Marion, as well as the state of South Carolina, influence landownership adjustment cases, boundary issues, and the demand for special uses. This analysis of cumulative effects considers foreseeable activities over the next 10 to 15 years.

Continued population growth in surrounding communities and in the Southeast are expected and would add to the demand for additional lands for development purposes, especially infrastructure. Communities that have not planned for additional infrastructure needs would likely request

special use authorizations or acquisition of National Forest System lands for infrastructure. As private properties (especially inholdings) change from rural or undeveloped land to subdivisions or higher density uses, encroachment onto National Forest System land becomes more frequent, resulting in resource impacts and boundary survey needs. As communities grow and infill occurs, undeveloped lands and their open space values are converted to residential or commercial uses. This growth would likely result in continued pressures to maintain National Forest System lands for their open space values. This may also trigger the need to acquire rights-of-way in places where informal public access is lost to development.

Cumulatively, continued growth in communities as shown in the census numbers and the resulting demands for acquisition of National Forest System land tend to move the national forest away from desired conditions of natural open space adjacent to communities. As further development occurs, residential encroachments onto the national forest are expected to occur more frequently and degrade wildland character and other resource values. Working with other governmental partners on zoning, ordinances, and plans could continue to reduce potential impacts to forest resources.

All communities adjacent to Francis Marion recognize the open space and recreational values the national forest provides and have developed goals and objectives in their plans to preserve these characteristics. Entities like The Nature Conservancy can assist in acquiring key parcels that would help retain water resources and habitat for desired conditions for fish and other wildlife species. There would continue to be tradeoffs of resource values on the Francis Marion as a result of expanding communities and their needs. There would also continue to be tension between the desire to retain National Forest System land near communities and the need to provide land for infrastructure for community expansion. Collaboration with communities and considering their desire for open space may result in localized exchanges. However, all alternatives acknowledge community needs and identify locations where land adjustments are appropriate and minimize impacts to other resources. These cumulative effects would be consistent among all alternatives.

3.4.7 Outdoor Recreation

3.4.7.1 Affected Environment: Outdoor Recreation

The Francis Marion is truly the backyard for many local residents. In fact, about 70 percent of outdoor recreation visits are made by people who live within 50 miles of the national forests in South Carolina. The Francis Marion offers a diversity of terrain and ecosystems for its visitors to explore. The numerous plant and animal communities and a rich cultural history add value to the visitors' experience. Mild winters permit year-round recreation. Fragmented ownership can make typical Forest Service management practices challenging in some places. While the presence of many neighbors allows them easy access to the national forest and creates a good environment for community partnerships, the structures and activities of nearby dwellings, roads and other development can disrupt a sense of remoteness and naturalness for forest visitors.

The Forest Service's Southern Forest Futures Project identifies and projects the driving changes for forests in the southern United States over the next 50 years. A finding is given: "Increasing populations would increase the demand for forest recreation while the availability of land to meet these needs is forecasted to decline." Places for nature-based recreation managed by Federal and State governments will probably remain constant. Open land area outside the national forests is expected to decline with conversions from forests and farmlands to cities and suburbs. And the amount of public land acres will not significantly increase. Also noted in the Southern Forest Futures Project, "The density of use of general forest area [on National Forest System land] is

expected to rise by 22 to 55 percent as participants substitute national forests for private forest and rangelands that have been reduced by urban development." While Federal acreage changes little over time, population changes greatly.

The recreation opportunity spectrum provides a framework for administrators to manage and users to enjoy a variety of recreation environments. The recreation opportunity spectrum is a management objective and provides a way of describing and providing a variety of recreation opportunities (USDA Forest Service 1982).

The recreation opportunity spectrum provides a framework for stratifying and defining classes of outdoor recreation environments, activities and experience opportunities. The settings, activities and opportunities for obtaining experiences have been arranged along a spectrum divided into six classes. Each class is defined in terms of its combination of activity, setting, and experience opportunities. Opportunities for experience along the spectrum represent a range from a very high probability of solitude, self-reliance, challenge and risk (primitive) to a very social experience where self-reliance, challenge and risk are relatively unimportant (rural or urban; USDA Forest Service 1986). Table 3-65 shows the acres and percent of the Francis Marion in each recreation opportunity spectrum class.

The forest plan sets the desired recreation opportunity spectrum class; it is used to determine if projects are compatible with forest recreation goals. At the project level, the desired recreation opportunity spectrum setting is used to determine if a project is moving toward or away from the desired class. In many cases, changes to the transportation system can have the biggest impact on recreation opportunity spectrum. For example, decommissioning a road may increase remoteness and nonmotorized opportunities, while building a new road to provide access would increase opportunities in a more developed setting. The nature and type of facilities provided in an area also impact the recreation setting. Additional campgrounds could increase the development level and can change the recreation opportunity spectrum setting. The more facilities that provide for comfort of the visitor, the more this is true. All projects that involve an active stage of construction or landscape alteration would have short-term impacts on the recreation setting, but unless those impacts would be evident over the long term, they would not require a plan amendment. For example, putting in a new toilet would increase the presence of human activities in the short term, but may provide for a larger area with less evidence of human activities in the long term.

Table 3-65. Inventoried recreation opportunity spectrum classes on the Francis Marion

Inventoried ROS Class	Acres	Percent of Forest
Primitive (P)	0	0%
Semi-Primitive, Non-Motorized (SPNM)	9,410	3%
Semi-Primitive, Motorized (SPM)	6,876	2%
Roaded Natural (RN)	242,859	94%
Rural (R)	290	>1%
Total	259,435	100%

In 2014, the Forest Service re-inventoried recreation settings on the Francis Marion and assessed what recreation opportunity spectrum class best represented these conditions. The inventory found that most of the national forest (more than 94 percent) is in a condition consistent with roaded natural settings. A much smaller percentage (about 5 percent) provides remote settings.

Primitive is the most remote, undeveloped recreation setting. Primitive settings are generally unmodified, natural environments located at least 3 miles from any open road and are 5,000 acres in size or larger. Interaction between users is very low and motorized use within this area is not permitted. The area is managed so that it is essentially free of evidence of on-site controls and restrictions. There are no lands on the Francis Marion National Forest that meet the inventory requirements for the primitive recreation opportunity spectrum setting due to proximity to roads or motorized trails. In the past, wilderness areas were identified as primitive but during the re-inventory, the proximity to roads and the size of some of the wildernesses precluded the areas from being included in primitive.

Semi-primitive non-motorized areas are dominated by a natural or natural-appearing environment. Interaction between visitors is low; evidence of other users may exist. They are managed to achieve a sense of remoteness, although semi-primitive non-motorized areas can be as small as 2,500 acres and only a half-mile or greater from any open road. These areas are managed to minimize the presence of on-site controls and restrictions. These settings accommodate dispersed, non-motorized recreation. On the Francis Marion, three of the wildernesses meet these settings.

Semi-primitive motorized areas are natural or natural appearing. Interaction between visitors is low, but there often is evidence of other users. Motorized use is permitted. Semi-primitive motorized accounts for 2 percent of settings on the national forest. They either buffer semi-primitive non-motorized areas or stand alone as tracts of 1,500 acres or larger with a lower road density (less than 1.5 miles of road per 1,000 acres). There is a very small proportion of the Francis Marion in semi-primitive motorized. One wilderness, Wambaw Creek, allows motorized boats on the creek and meets the setting of semi-primitive motorized.

Roaded natural settings are natural appearing with moderate evidence of sights and sounds of humans. Interaction between visitors may be low to moderate, but evidence of other users is prevalent. Conventional motorized access is accommodated. Roaded natural areas are located within 0.5 mile of a road and usually provide higher levels of development such as campgrounds, picnic areas, and river access points. The majority of the Francis Marion is inventoried as roaded natural.

Rural settings are substantially modified natural environments. Sights and sounds of other humans are readily evident and interaction between users may be moderate to high. Facilities for concentrated motorized use and parking are provided. Rural settings represent the most highly modified natural settings on the Francis Marion and include only highly developed recreation sites. They are so small that they are represented with a point, rather than a polygon on maps. Only highly developed complexes on the Francis Marion, including Buckhall and the Sewee Visitor and Environmental Education Center, meet the characteristic of rural setting.

Desired recreation opportunity spectrum is determined in the forest plan and used at the project level to demonstrate whether a proposed project moves the area away from or toward its desired condition for recreation setting. This process begins with an inventory of the recreation setting on the site. The recreation specialist then determines which recreation opportunity spectrum class best fits the existing conditions and whether these conditions fit the desired recreation opportunity spectrum setting. If they are different, then the specialist would determine based on the outcomes of the project if the setting would be moving toward the desired class. If not, they may recommend mitigations or a plan amendment to update the desired recreation opportunity spectrum class. Movement toward desired recreation opportunity spectrum class from existing conditions is not automatic but occurs on a project-by-project basis over time.

For instance, some routes are in areas where the desired recreation opportunity setting specifies a non-motorized experience (such as semi-primitive non-motorized). If there are roads that were designated in travel management in recreation opportunity spectrum classes that are non-motorized, these roads would not automatically be closed or decommissioned when the plan decision is made. Instead, they would require separate site-specific analysis to determine how much they detract from the recreation setting and the tradeoffs of closing them versus the needs of other desired conditions and resources would be weighed appropriately.

3.4.7.2 Environmental Consequences: Outdoor Recreation

Alternative 1

Alternative 1 would continue current ROS designations in the forest plan (Table 3-66). Four wilderness areas would remain classified as primitive, more than 13,000 acres in the current plan. The wildernesses would remain within 3 miles of an open road, making their primitive opportunities not optimal. The majority of the recreation opportunity settings would remain roaded natural or rural, more than 87 percent of the forest. More than 21,000 acres of the forest would remain in semi-primitive motorized setting in Management Area 29 (swamps and swampy flats) with an emphasis on linkages between wilderness and more remote opportunities. These settings would continue to provide opportunities for visitors to see and enjoy the forest. There would be limited opportunities for remote settings aside from the wilderness.

Wambaw Creek Wilderness would continue to allow for motorized boating on the creek, which is allowed by certain provisions in that wilderness's establishment. The visitors that have enjoyed the ability to hunt water fowl or fish with small electric boats within the wilderness would continue to do these activities. The majority of visitors in Wambaw Creek Wilderness enjoy the wilderness experience in boats. However, some people may not prefer to participate in wilderness activities where there is motorized boat use.

Table 3-66. Recreation opportunity spectrum class on the Francis Marion under each alternative

Recreation Opportunity Spectrum Class[1]	Alt. 1	Percent of Forest	Alt. 2	Percent of Forest	Alt. 3	Percent of Forest
Primitive	13,807	6%	0	0%	0	0%
Semi-primitive non-motorized	0	0%	13,671	5%	34,365	13%
Semi-primitive motorized	21,139	8%	11,198	4%	0	0%
Roaded natural	126,756	51%	234,208	90%	224,691	86%
Rural	81,201	32%	290	<1%	290	<1%
Excluded (Experimental Forest or unique areas)	8,830	3%	0	0	0	0

1. The acres of recreation opportunity spectrum class reflect what the land allocation direction of the plan is, not necessarily the inventoried acres. The re-inventory of forest lands in 2014 had more refined information than the previous plan.

Alternative 2

Alternative 2 would create a change in recreation opportunity spectrum settings by increasing the amount of remote semi-primitive motorized settings surrounding the three existing wildernesses. The areas surrounding Hellhole Bay Wilderness, Little Wambaw Swamp Wilderness and Wambaw Swamp Wilderness would be managed for semi-primitive motorized setting.

Alternative 2 would better manage the effects of roads on recreation and the natural setting in these areas by having more of the national forest in the semi-primitive motorized class (Table 3-66). The effect of this allocation would be to preserve the more semi-primitive setting in these areas. The increase in semi-primitive motorized would not be expected to negatively impact the agency’s ability to use machinery and prescribed treatments to meet its ecological restoration goals. Effects in this increase in semi-primitive motorized would be positive for those visitors seeking a more remote experience and less positive for those visitors who prefer a more developed experience with more access on roads. This alternative would also provide a more primitive hunting opportunity in the areas adjacent to wilderness. Road closure often reduces wildlife poaching and litter, as well as access by motorized vehicles. Closing roads increases the satisfaction of visitors who prefer solitude and fewer disturbances (such as dust and noise) by motorized vehicles. Visitors who prefer to access national forest by motorized vehicle would be less satisfied.

The four wilderness areas would be classified as semi-primitive non-motorized over 13,000 acres or 5 percent of the forest. Semi-primitive non-motorized describes the actual experience within the wilderness, as they are often bounded by roads. The majority of the recreation opportunity spectrum settings are roaded natural or rural, more than 88 percent of the national forest. This would be similar to the amount of more developed settings (roaded natural and rural) in alternative 1. These settings would continue to provide opportunities for visitors to see and enjoy the forest with easy access by vehicle.

Wambaw Creek Wilderness would continue to allow motorized boating on the creek, which is allowed by certain provisions in that wilderness’s establishment. The visitors that have enjoyed the ability to hunt water fowl or fish with small electric boats within the wilderness would continue to do these activities. The majority of visitors in Wambaw Creek Wilderness enjoy the wilderness experience in boats. However, some people may not prefer to participate in wilderness activities where there is motorized boat use.

Alternative 3

Alternative 3 would create the greatest change by recommending additional acreage to four wilderness areas (Table 3-66). The associated recommended road closures and recreation opportunity spectrum settings increase the more remote semi-primitive non-motorized settings surrounding existing wildernesses, from 5 percent of the Francis Marion to 13 percent. Effects of this change in settings would be positive for those visitors seeking a more remote experience and less positive for those visitors who prefer a more developed experience. This would also provide a more primitive hunting opportunity. Road closure decreases access by motorized vehicles. Closing roads increases the satisfaction of visitors who prefer solitude and fewer disturbances (such as dust and noise) by motorized vehicles. Changes in travel routes and motorized game retrieval would still be decided for each site specific area through the travel management process. Road closure often reduces wildlife poaching and litter. Fewer roads would be needed under alternative 3 due to an increase in wilderness area acres.

Cumulative Effects

A discussion on cumulative effects of the alternatives presented in this document examines how social and land use trends on public and private lands in the area together influence the management of National Forest lands. As overall demand for outdoor recreation opportunities, and the settings that provide them, is increasing and it is increasing at a rate at least equal to population growth.

Trends on private lands are relevant to Forest Service lands. 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 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).

Therefore, a general trend on private lands surrounding the Francis Marion National Forest is the gradual loss of preferred settings for nature based recreation as well the potential to access private lands. Private lands are not expected to increase the supply for the settings preferred by outdoor recreationists for their activities. As a result, public lands will face most of increasing recreation demand. For those alternatives that emphasize some increase in more remote settings, there will be a better opportunity to maintain scarce remote settings over time.

Regardless of the alternative selected, recreation demand is increasing and effects will occur. Effects, such as user conflict and resource impacts, will simply show up sooner in alternatives that do not emphasize recreation opportunities. User controls will be needed, in varying degrees, to protect the health of the natural systems and to maintain an acceptable recreation experience. 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 recreation demand. This is particularly important for high maintenance and operational cost facilities or trail systems such as off-highway vehicle areas where on-going maintenance and on-the-ground personnel are needed.

3.4.8 National Wild and Scenic Rivers

3.4.8.1 Affected Environment: National Wild and Scenic Rivers

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 possess one or more outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values. Designation preserves rivers in free-flowing condition, protects water quality and protects their immediate environments 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 Forest Service is required to consider and evaluate rivers on lands they manage for potential designation while preparing their broader land and resource management plans under section 5(d)(1) of the Act.

Rivers and stream corridors accommodate a lot of different uses such as picnicking, fishing, day hiking and walking for pleasure, primitive camping, boating (canoeing, kayaking, rafting, tubing), swimming, and nature study.

Demand for river designation is expressed primarily through public comment and responses to agency proposals. The degree to which the public input favors designation indicates the demand for a wide range of uses, activities, and resource qualities associated with river management. Although demand is closely related to the current population and the projected growth of the local

area, designation would likely produce increased levels of recreation use in designated and potential corridors.

Designated Rivers on the Francis Marion National Forest. The Francis Marion National Forest does not have any designated wild and scenic rivers.

Non-Eligible and Eligible Rivers. In previous planning efforts, rivers on the Francis Marion National Forest were considered for wild and scenic river eligibility. Several rivers were studied and only the Santee River was found eligible. During the current planning effort, another more comprehensive inventory was done. This inventory included rivers identified on the National Rivers Inventory, the South Carolina Statewide River Assessment (South Carolina Water Resources Commission 1988) and through public involvement. Eleven streams or rivers on the Francis Marion were reviewed for potential eligibility. Of the 11, 5 were found to be eligible based on their outstandingly remarkable values. Rivers/streams must possess at least one outstandingly remarkable value to be considered eligible. These streams were classified according to section 2 of the Wild and Scenic Rivers Act. The following rivers, creeks and streams were studied but found ineligible.

- Wando River
- Hampton Creek
- Dutart Creek or other river right feeder tributaries
- Chicken Creek
- Guerin Creek
- Huger Creek and feeder tributaries

Table 3-67 shows the rivers that were studied and found eligible.

Table 3-67. Rivers studied for National Wild and Scenic River System and found eligible

River	Miles	Outstandingly Remarkable Value(s)	Preliminary Classification
Awendaw	12.50	Recreation	Recreational
Echaw Creek	3.90	Ecological, scenic and recreation	Wild
Lower Santee Segment I	60.50	Ecological and Cultural	Scenic
Wadboo Creek Segment I	1.88	Ecological, scenic and recreation	Recreational
Wadboo Creek Segment II	12.96	Ecological, scenic and recreation	Wild
Wambaw Creek Segment I	1.95	Ecological, scenic, recreation and cultural	Scenic
Wambaw Creek Segment II	12.09	Ecological, scenic, recreation and cultural	Wild

3.4.8.2 Environmental Consequences: National Wild and Scenic Rivers

The identification of a river for study through the forest planning process does not trigger any protection under the Act until designation by Congress. Importantly, identifying rivers as eligible, or eligible and suitable, does not create any new agency authority; rather, it focuses the management actions within the discretion of the Forest Service on protecting identified river

values. For eligible rivers, the preliminary (inventoried) classification is to be maintained absent a suitability determination. The recommended classification is to be maintained throughout the duration of the forest plan. Protection of rivers and streams through the forest planning process helps to assure high-quality, free-flowing rivers and streams, as well as river-related recreation opportunities.

Management emphasis for the eligible rivers and their corridors is focused on protection and enhancement of the values for which they were established, without limiting other uses that do not substantially interfere with public use and enjoyment of those values. The establishment outstandingly remarkable values for the rivers on the Francis Marion National Forest include scenic, recreational, geological, fish and wildlife, historical, cultural or other values including ecological.

Most impacts to all rivers come from upland activities outside the river corridor. However forest management would be subordinate to the river's outstandingly remarkable values. Vegetation management, road construction and construction or removal of recreation facilities could cause erosion along the river, sedimentation from soil runoff, visual intrusions or noise from nearby activities. Fire management within the corridor, prescribed fire and fire suppression actions may result in smoke impacts, noise from aircraft, chainsaws and engines, or visual effects from charred vegetation. Search and rescue operations may cause some impact from the use of equipment in the river corridor but these are predicted to be minimal. Increased public interest and use may result in development of additional trailheads and trails and access points to the river to accommodate additional public interest and use of the river. However, increased recreation use due to designation may also result in more river-related activities (such as boating and fishing) and cause localized increases in soil compaction and erosion of streambanks and the need for limited public access.

River sections classified as scenic or recreational are managed with a wider variety of activities allowed within the river corridor. However, forest management would be subordinate to the river's outstandingly remarkable values. Sights and sounds of man's activities would be more apparent. Management activities that have the greatest potential of affecting rivers and their potential suitability for wild and scenic designation are road construction, vegetation management, insect and disease control, special use utility rights-of-way, and mineral extraction. Other management activities that also can affect the river resources to a lesser degree are threatened and endangered species habitat management, range management, recreation and administrative site facility construction, and wildlife and fisheries management. Classification as wild would therefore be expected to have a smaller range of effects from activities within the river corridor (such as no new roads, no new rights-of-way, or wildlife openings).

Non-eligible Rivers: Rivers determined to be not eligible may be managed on the Francis Marion National Forest under a variety of management areas, geographic zones, and special designations. These prescriptions will allow a wide variety of activities within the river corridor. Management activities may include road construction, vegetation management, insect and disease control, special use utility rights-of-way and mineral extraction. Other management activities that also can affect the river resources to a lesser degree are threatened and endangered species habitat management, recreation and administrative site facility construction and wildlife and fisheries management.

All Alternatives

Direct and Indirect Effects. Under all alternatives, the five eligible wild and scenic rivers would have their eligibility maintained in accordance with Forest Service Manual and Handbook direction until they are evaluated for their suitability and either designated or released. This means that they would be maintained in their free-flowing condition and their identified outstandingly remarkable values would be retained. Table 3-68 shows the miles of each classification for eligible rivers and that none of the miles would change with any alternative.

Table 3-68. Miles of eligible rivers by preliminary classification by alternative

River Classification	All Alternatives
Wild	28.95
Scenic	62.45
Recreational	14.38

Cumulative Effects

Trends on private lands are relevant to national forest lands. 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 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.

Therefore, a general trend on private lands surrounding the Francis Marion National Forest is the gradual loss of preferred settings for nature-based recreation as well as the potential to access private lands. Private lands are not expected to increase the supply for the settings preferred by outdoor recreationists for their activities. As a result, public lands will face most of the increasing recreation demand.

Some resources are more sensitive to conversion of private lands from natural settings to more developed settings, including eligible wild and scenic rivers. Over time as relatively undeveloped river corridor becomes more developed, the ability to manage the rivers for their outstandingly remarkable values on the non-forest land becomes more difficult.

3.4.9 Wilderness and Inventoried Roadless Areas

3.4.9.1 Affected Environment: Wilderness and Inventoried Roadless Areas

Wilderness

Congressionally designated wilderness areas are protected by the Wilderness Act (P.L. 88-577 (16 U.S. C. 1131-1136)) and valued for their ecological, historical, scientific, and experiential resources. Also, wilderness is valued for preserving representative natural ecosystems and local landscapes. The very existence of wilderness is valued by the American public as part of the natural heritage of the country.

The Francis Marion National Forest is home to four designated wilderness areas: Hellhole Bay (2,125 acres); Wambaw Swamp (4,815 acres); Little Wambaw Swamp (5,047 acres); and Wambaw Creek (1,825 acres) (Table 3-69). The combined acreage for all four wilderness areas is 13,812 acres. On the Francis Marion National Forest this represents about 5 percent of the total

forest acreage. Annual wilderness use for both the Francis Marion and Sumter National Forests is about 11,590 visits per year, or about one percent of total visitor use.

Table 3-69. Existing designated wilderness areas

Name	Acres
Hellhole Bay	2,125
Wambaw Swamp	4,815
Little Wambaw Swamp	5,047
Wambaw Creek	1,825

The existing wilderness areas should maintain the areas’ natural characteristics. Four qualities of wilderness help describe wilderness character,

1. Untrammeled. Wilderness is essentially unhindered and free from modern human control or manipulation.
2. Naturalness. Wilderness ecological systems are substantially free from the effects of modern civilization.
3. Undeveloped. Wilderness is essentially without permanent improvements or modern human occupation.
4. Outstanding opportunities for solitude or a primitive and unconfined type of recreation. Wilderness provides outstanding opportunities for people to experience solitude or primitive and unconfined recreation, including the values of inspiration and physical and mental challenge.

Inventoried Roadless Areas

Inventoried roadless areas are designated areas under the Roadless Area Conservation Rule (36 CFR Part 294). The Forest Service first inventoried these areas in 1972, as part of the Roadless Area Review and Evaluation phase I (RARE I). A second inventory was completed for RARE II in 1977 and then in the Roadless Area Conservation Rule in 2001.

The Francis Marion National Forest has two inventoried roadless areas: Hellhole Bay Extension (890 acres) and Little Wambaw Swamp Extension (530 acres) (see Table 3-70). Both were identified in the 1996 forest plan and then again in the 2001 Roadless Area Conservation Rule. On the Francis Marion, inventoried roadless areas are adjacent to existing wilderness.

Table 3-70. Inventoried roadless areas, approximate acreages

Roadless Area	Acres
Hellhole Bay Extension	890
Little Wambaw Swamp Extension	530

Areas that May be Suitable for Inclusion in the National Wilderness Preservation System

The first step in the evaluation of areas that may be suitable to include in the National Wilderness Preservation System is to identify and inventory all areas that satisfy the definition of wilderness. Direction can be found in section 2(c) of the 1964 Wilderness Act and Forest Service Handbook 1909.12, chapter 70 – Wilderness Evaluation.

The Forest Service must evaluate lands that meet the inventory criteria for areas that may be suitable during plan revision and, from the information gathered in that evaluation, consider alternatives for recommending wilderness. A new inventory was conducted as a part of the Francis Marion plan revision process. The inventory indicates that the Francis Marion National Forest has six areas that may be suitable for inclusion in the National Wilderness Preservation System, totaling approximately 31,188 acres. Recommended areas would be managed as wilderness study areas to maintain their wilderness character until they are designated by Congress and added to the National Wilderness Preservation System.

Table 3-71. Six areas on the Francis Marion that may be suitable for inclusion in the National Wilderness Preservation System

Areas That May be Suitable for Inclusion in the National Wilderness Preservation System	Acres
Wambaw Creek Addition Area	5,747
Little Wambaw Swamp Additional Area	6,859
Wambaw Swamp Additional Area	2,306
Hellhole Bay Additional Area	4,535
Area A	6,643
Area B	5,098
Total	**31,188**

The Francis Marion staff evaluated areas that may be suitable for inclusion in the National Wilderness Preservation System (see appendix D). Based on this information, the planning team considered alternatives with varying amounts of wilderness study area as well as potential increases in semi-primitive motorized settings (see Table 3-72). Some areas would be managed as wilderness study areas to maintain their wilderness character until they are designated by Congress and added to the National Wilderness Preservation System.

Under alternatives 1 and 2, no areas are recommended. Under alternative 3, all, or portions, of Hellhole Bay Extension, Little Wambaw Swamp Extension, Wambaw Swamp Extension, and Area B are recommended.

Table 3-72. Summary by alternative

Area	Alternative 1	Alternative 2	Alternative 3
Wilderness	13,812	13,812	13,812
Wilderness Study Area	0	0	16,881
Inventoried Roadless Area	1,420	1,420	0
Semi Primitive, Motorized	0	11,139[1]	0

[1] This acreage included the Inventoried Roadless Areas.

Note: GIS acres are approximate.

Table 3-73. Detailed recommendations by alternative

Existing Designated Area	Other Area Considered	Alternative 1	Alternative 2	Alternative 3
Wambaw Creek Wilderness		1,825	1,825	1,825
	Wilderness Study Area	0	0	5,747
	Semi-primitive, Motorized	0	0	0
Total Wilderness or Wilderness Study Area		1,825	1,825	7,572
Wambaw Swamp Wilderness		4,815	4,815	4,815
	Wilderness Study Area	0	0	1,745[1]
	Semi-primitive, Motorized	0	1,745[2]	0
Total Wilderness or Wilderness Study Area		4,815	4,815	6,560
Little Wambaw Swamp		5,047	5,047	5,047
Inventoried Roadless Area		530	530	0
	Wilderness Study Area	0	0	4,854[3]
	Semi-primitive Motorized	0	4,324	0
Total Wilderness or Wilderness Study Area		5,047	5,047	9,901
Hellhole Bay Wilderness		2,125	2,125	2,125
Inventoried Roadless Area		890	890	0
	Wilderness Study Area	0	0	4,535
	Semi-primitive Motorized	0	3,650	0
Total Wilderness or Wilderness Study Area		2,125	2,125	6,665
	Area A	0	0	0
	Area B	0	0	3,814[4]
Total Wilderness or Wilderness Study Area		0	0	3,814

1. Wilderness study area boundaries were refined, in some cases to improve manageability by reducing interface with private lands as well as open roads. Therefore acres will not match inventory acres exactly.
2. Semi-primitive motorized boundaries were refined to improve manageability by reducing interface with private lands as well as open roads. Therefore acres will not match inventory acres exactly.
3. Wilderness study area boundaries were refined to improve manageability by reducing interface with private lands as well as open roads. Therefore acres will not match inventory acres exactly.
4. Boundary of Area B were refined to improve manageability with interface of private lands, acres changed accordingly. Therefore acres will not match inventory acres exactly.

Note: GIS acres are approximate.

3.4.9.2 Environmental Consequences: Wilderness and Inventoried Roadless Areas

Wilderness has many positive effects. As stated previously, wilderness preserves natural systems and provides places of solitude for visitors. However, there are environmental effects within

wilderness from many sources. Four previously defined wilderness characteristics are considered for effects:

1. untrammeled;
2. naturalness;
3. undeveloped; and
4. outstanding opportunities for solitude or a primitive and unconfined type of recreation.

Recreational use can cause a localized negative impact in the four wilderness characteristics, especially the opportunity for solitude and naturalness. Some of these negative impacts, especially on naturalness, include soil compaction, vegetation loss, disturbance or replacement by non-native species such as noxious weeds on trails caused by recreation use; as well as deterioration of water quality from improper disposal of human waste and waste water; and loss of or threats to biological and ecological processes and biodiversity through human disturbance.

Other environmental effects that impact the integrity of the natural systems in wilderness include air pollution from outside sources, interruption of natural functioning ecosystems by fire suppression, and threats to native plant species from the spread of noxious weeds from sources outside wilderness.

All Alternatives

All alternatives carry forward the need for wilderness patrols, wilderness rehabilitation of any impacted sites, wilderness education, and wilderness-specific management plans. These effects are common to alternatives 1, 2 and 3.

There would be no negative effects to the roadless character of inventoried roadless areas on the Francis Marion from these alternatives. All of these areas have a recreation opportunity setting of semi-primitive motorized or semi-primitive non-motorized and would continue to implement the direction from the 2001 Roadless Area Conservation Rule on limiting road construction and tree cutting in these areas.

Alternative 1

Wilderness and Recommended Wilderness: Alternative 1 would not recommend any wilderness study areas on the Francis Marion. Some guidance for wilderness in alternative 1 would remain redundant with existing law, regulation, and policy. Alternative 1 includes little to no restoration activities that encourage improvement in wilderness character.

The 1996 forest plan does not restrict group size in the wilderness, which can decrease the opportunity for solitude and increase the opportunity for crowding in some places. Maintenance of trails and facilities would be done using hand tools only and access would be made using non-mechanized and non-motorized means. Wambaw Creek Wilderness would continue to be open to motorized boat use. Non-motorized boat use would continue for hunting and other non-consumptive uses.

Fire management may continue with appropriate wilderness protection measures. Fire suppression of all human-caused wildfires would minimize the potential effects on wilderness values; however, fires in these areas would likely become larger in size than they would under current management because of the restrictions on motorized equipment such as dozers. Under emergency situations, mechanized equipment and motorized transport, use of helicopters, air tankers and other aircraft may be approved by the Forest Supervisor or the Regional Forester.

These actions would impact wilderness character and visitor experiences and leave evidence of man, although rehabilitation could help to reduce those impacts afterward. Lightning-ignited fires, if allowed to burn, may benefit some the naturalness and untrammeled character of wilderness by opening up the forest, reducing fuel loading to acceptable levels and maintaining the vegetation. There would be a short-term negative impact to air quality, visual aesthetics and possibly water quality.

Management-ignited fires that mimic the role of natural fire can benefit fire-dependent ecosystems and the naturalness of the area as well as the untrammeled character. Occasionally, reducing hazardous fuels can have negative results in wilderness through changes in vegetation types, impacts to wilderness visitors and experiences, water quality and habitat within wilderness. At the same time, it can benefit wilderness by reducing fuel loadings to acceptable levels such that naturally ignited fires may be returned to the wilderness or wilderness study area. Fire prevention strategies applied in the wildland-urban interface area on private land can reduce the need for management-ignited fires.

Inventoried Roadless Areas: Alternative 1 would continue to allocate both inventoried roadless areas to Management Area 29, which emphasizes a smaller degree of human disturbance as well as a semi-primitive motorized experience. Management-ignited fire could be used to maintain fuel loadings and mechanized equipment and motorized vehicles could be used. Vegetation composition and structure may be manipulated resulting in a greater diversity of age lasses among forest types.

Opportunities for solitude and remoteness may decrease. Sights and sounds of man’s activities may be more obvious. Noise levels and soil erosion may increase. Air and water quality may decrease although water quality would meet State and Federal standards. There would be no negative effect to the roadless character of inventoried roadless areas on the Francis Marion from this alternative. The areas have a recreation opportunity setting of semi-primitive motorized and would continue to implement the direction from the 2001 Roadless Area Conservation Rule on limiting road construction and tree cutting in these areas.

Alternative 2

Wilderness and Wilderness Study Areas: Alternative 2 would not recommend any wilderness study areas. However, alternative 2 would increase the area of the semi-primitive motorized setting by more than 11,000 acres adjacent to three existing wilderness areas (Wambaw Swamp, Little Wambaw Swam, and Hellhole Bay). Wambaw Creek Addition was not included in alternative 2 as semi-primitive motorized due to the extensive road system (over 27 miles) in the area that would require closing.

In the areas proposed for the semi-primitive motorized setting, site-specific decisions would administratively close some roads in these areas. These road closures would increase the opportunity for solitude and remoteness as well as opportunity for primitive and unconfined recreation due to road closures and prohibiting motorized use. Non-motorized dispersed recreation activities such as hiking, horseback riding, camping, mountain bikes, fishing, and hunting would continue.

Use levels would decrease in areas where vehicular access was previously the main means of transport. Road closures would result in decreased access for some activities. The effects of this change would be positive for those visitors seeking a more remote experience and less positive for those visitors who prefer a more developed experience with more access on roads. This

alternative would also provide a more primitive hunting opportunity in the areas adjacent to hunting. Road closures often reduce wildlife poaching and litter. Closing roads would increase the satisfaction of visitors who prefer solitude and fewer disturbances (such as dust and noise) by motorized vehicles. Visitors who prefer to access to the national forest by motorized vehicle would be less satisfied

Inventoried Roadless Areas: Alternative 2 would allocate both inventoried roadless areas to a semi-primitive motorized special area. Management-ignited fire could be used to maintain fuel loadings; mechanized equipment and motorized vehicles could be used on existing roads. Ecosystems would be restored and vegetation composition and structure may be manipulated.

There would be no negative effect to the roadless character of inventoried roadless areas on the forest from these alternatives. All of these areas have a recreation opportunity setting of semi-primitive motorized and would continue to implement the direction from the 2001 Roadless Area Conservation Rule on limiting road construction and tree cutting in these areas.

Alternative 3

Wilderness and Wilderness Study Areas: Alternative 3 recommends 16,351 wilderness study area acres, see Table 3-71.

Designation of areas as wilderness study areas would preserve additional lands, which would be managed to allow natural processes to occur, provide for solitude and primitive recreation and minimize the impacts of man and his activities on the land. The highest priority for management would be to manage for wilderness character (untrammeled, naturalness, undeveloped and outstanding opportunities for solitude and a primitive and unconfined type of recreation). These areas would be managed much the same as designated wilderness until a final determination is made by Congress as to whether they would be added to the National Wilderness Preservation System.

Direct effects of managing wilderness study areas include maintaining soil, and hydrologic and atmospheric conditions prevailing within the areas. Roads would be closed, rehabilitated, or allowed to return to natural state. Water quality and air quality should remain high and the imprint of man's influence would not increase or would diminish over time. On some occasions there may be restoration of degraded resources in the wilderness study area (such as non-native invasive species eradication or control). However, visual and experiential contrasts between wilderness study areas and other national forest lands would increase.

Opportunities for solitude and remoteness would increase as would the opportunity for primitive and unconfined recreation due to road closures and prohibiting motorized use. Non-motorized dispersed recreation activities such as hiking, horseback riding, camping, fishing, and hunting would continue. The use levels of some activities would decrease in areas where vehicular access was the main means or transport. Additional acreage for wilderness study would allow wilderness user impacts to be dispersed across a larger area providing an increase in wilderness visitor satisfaction. However, road closures would result in decreased access for some activities. A decrease in opportunities for bicycling and other forms of recreation requiring motorized transport or mechanized equipment would result. Bicycle and motorized use, as well as some other vehicular dependent activities would be displaced to other areas.

After congressional designation of the areas as wilderness, maintenance of trails and infrastructure would be done using hand tools only and access would be made using non-

mechanized and non-motorized means. Wambaw Creek Wilderness would be closed to motorized boat use. Non-motorized boat use would continue for hunting and other non-consumptive uses.

Research indicates that visitation and economic benefits resulting from tourism would increase in the surrounding local communities from more wilderness. However, economic benefits associated with the management, harvesting, manufacturing and retail sale of timber products from the wilderness study areas would decrease since management activities would not be allowed in these areas. Opportunities to recover commercial minerals and mineral exploration and development would be hindered.

Little or no mineral development or its associated impacts would be expected under any alternative. Federal oil or gas leases or other Federal mineral leases are non-existent in the areas recommended for wilderness study. The potential for energy mineral and other leasable or common mineral development is estimated to be low. These areas would be administratively unavailable for Federal oil and gas and other Federal mineral leases, pending final congressional action and would not be available for commercial purposes. Administrative use of mineral materials would be allowed but use and impacts would be extremely low.

Educational opportunities for the scientific study of natural ecological processes would increase in alternative 3 with increased acres in wilderness or wilderness study area.

The naturalness, uniqueness and representative ecosystems of the designated areas would be maintained. Natural ecological processes would continue including plant succession. Larger blocks of undeveloped land and reduction in open road density in areas recommended for wilderness study area would favor area-sensitive and disturbance-sensitive species. Existing old fields, wildlife openings, and other habitat improvements for fish and wildlife would not be maintained in prescriptions areas recommended for wilderness study. These early successional habitat areas would succeed to forest. New permanent wildlife openings would not be created. These factors would reduce habitat for early successional species. Fish stocking in these areas would be restricted to reestablishment or maintenance of indigenous, threatened, endangered or native species. Species traditionally stocked before wilderness designation may be considered for stocking if species is likely to survive.

Fire management could continue with appropriate wilderness protection measures. Fire suppression of all human-caused wildfires would minimize the potential effects on wilderness values. After wilderness designation by Congress, in emergency situations, mechanized equipment and motorized transport, use of helicopters, air tankers and other aircraft may be approved by the Forest Supervisor or Regional Forester. These actions would impact wilderness character and visitor experiences and leave evidence of man, although rehabilitation could help to reduce those impacts afterward.

Lightning ignited fires, if allowed to burn, may benefit some types of recreation by opening up the forest, reducing fuel loading to acceptable levels, and maintaining fire-dependent vegetation. Negative impact to air quality, visual aesthetics, and possibly water quality would be short term.

In wilderness study areas, management-ignited fires that mimic the role of natural fire can benefit fire-dependent ecosystems and the naturalness of the area. Reducing hazardous fuels can have negative results in wilderness through changes in vegetation types, and impacts to visitors and experiences, water quality, and habitat, thus impacting the untrammeled wilderness character. It can however benefit wilderness by reducing fuel loadings to acceptable levels such that naturally ignited fires may be returned to the wilderness or wilderness study area. It also may benefit some

types of recreation by opening up the forest and maintaining fire-dependent vegetation. Fire prevention strategies applied in the urban interface area on private land can reduce the need for management-ignited fires.

In all wilderness study areas (prior to congressional designation), administrative motor vehicle use would be allowed to continue until:

1. Congress acts upon the agency’s recommendations;
2. The area is incorporated into the National Wilderness Preservation System; or
3. If motorized use does not compromise the area’s wilderness character.

Forest Service and permitted facilities would not be expanded, except in cases where they could be maintained in a manner appropriate to wilderness management within these areas. Hunting and scouting would be non-motorized in the wilderness study areas, resulting in reduced hunting access for mobility-impaired individuals. Mechanized uses such as mountain biking would continue until congressional designation. As a result, these areas would have interim management that would protect wilderness character over the long term, but may still allow for the sights and sounds of limited motorized and mechanized use. This would result in some visitors experiencing a setting that is consistent semi-primitive motorized recreation classes, depending on the timing of their visit.

Additional effects to wilderness study areas would be similar to those found in wilderness such as soil compaction; vegetation loss or disturbance; non-native species; crowding and loss of solitude; deterioration of water quality from improper disposal of human waste and waste water; and loss of or threats to biological or ecological processes and biodiversity through human disturbance.

Inventoried Roadless Areas. In alternative 3, both inventoried roadless areas would have a recreation opportunity spectrum setting of semi-primitive non-motorized because they would be recommended for wilderness designation. Inventoried roadless areas that are recommended for wilderness would meet the recommended wilderness plan guidance, which would manage the areas to retain their primitive and undeveloped character, while limiting motorized vehicle activity to administrative use until these areas were congressionally designated and added to the National Wilderness Preservation System. This would retain the roadless character of the areas.

Cumulative Effects

Trends on private lands are relevant to Forest Service lands. 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 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 (Wear and Greis 2012).

Therefore, a general trend on private lands surrounding the Francis Marion National Forest is the gradual loss of preferred settings for nature-based recreation as well the potential to access private lands. Private lands are not expected to increase the supply for the settings preferred by outdoor recreationists for their activities. As a result, public lands will face most of increasing recreation demand. For those alternatives which emphasize some increase in more remote settings, there will be a better opportunity to maintain scarce more remote settings over time.

3.4.10 Scenery

Scenery plays a major role in any visit to the Francis Marion National Forest. Many recreation activities like hunting, fishing or camping are dependent on the forest setting; all visitors benefit from the forest's high scenic quality. Most visitors to the Francis Marion are satisfied with the scenery as they recreate, according to National Visitor Use Monitoring Survey (2008). Development on neighboring lands generally negatively impacts the scenic resource by diminishing the natural scene. This impact will expand as surround communities grow. Understanding the value of national forest scenery to the local community is important as it affects real estate values and quality of life.

3.4.10.1 Affected Environment: Scenery

In addition to other natural resources, scenery must be cared for and managed for future generations. Scenic resources vary by location and by existing natural features such as vegetation, water features, landform, geology, and human-made elements. All forest visitors' activities are experienced in a scenic environment defined by the arrangement of the landscape's natural elements combined with components of the built environment. Scenery combines all the ecological features and human elements; the composition of these attributes is what gives a landscape its character or image.

Currently, the forest's scenic resources are managed using the visual management system that allocates visual quality objectives to National Forest System lands. Visual quality objectives are a combined measurement of the scenic quality of the landscape and the public's level of concern for that scenic quality.

Management of multiple resources has, to varying degrees, altered the natural landscape character over the short and long terms including, but not limited to:

1. Vegetation management;
2. Construction and maintenance of roads and trails;
3. Recreation sites;
4. Wildlife habitat enhancement; and
5. Fire management (e.g., suppression and prescribed burning).

The most visible portions of the Francis Marion are seen from roads, trails or waterways. The more scenic landscapes are generally associated with or occur adjacent to lakes, rivers and streams, the frequently burned and relatively open long leaf pine ecosystems, or highly developed recreation areas and trails. Views beyond the immediate foreground are influenced by terrain as well as vegetation type. The Francis Marion is a flat coastal plain, occasionally interspersed with private ownership. This flatter terrain has fewer vistas (occasional ones from Santee River bluffs) and open views along the intercostal waterway.

Of the seven land-use themes described in the Scenery Management System, the Francis Marion's landscapes can be grouped predominantly into three: natural evolving, natural appearing and rural-forested (Landscape Aesthetics, A Handbook for Scenery Management, Agricultural Handbook Number 701, p. 1-3). The vast majority of the national forest (approximately 259,000 acres) is characterized as natural appearing. Designated wilderness and recommended wilderness study areas are lands where ecological processes predominate are characteristically natural

evolving landscapes. Rural-forested is a smaller category where small communities intersperse ownership with the national forest.

Landscape character is a reflection of the physical, biological, and cultural attributes in the landscape, and the beliefs, values and attitudes that people assign to these attributes. The landscape character has its origins in and is informed by early settlement patterns and land uses that have taken place over the years. These early and continuing influences affect the attitude toward landscape uses today. It is the physical appearance and cultural context of a landscape that gives it an identity and a “sense of place” (see the process record for descriptions of the Francis Marion’s landscape character).

The Visual Management System determines the scenic resource management direction. From that system, visual quality objectives describe the degrees of alteration (including vegetation manipulation) that is acceptable on the landscape. Preservation is the least altered; maximum modification is the most altered (the Francis Marion National Forest did not have any acres of maximum modification in the 1995 forest plan). In 1995, the Scenery Management System replaced the Visual Management System. The scenic resource has been re-inventoried to comply with the new terminology and the newer system (see Landscape Aesthetics, A Handbook for Scenery Management, Agricultural Handbook Number 701). To see how the two systems relate, see the crosswalk between the older and the newer systems (). In the environmental consequences section below, the acres will be expressed and effects discussed, using the crosswalk in the newer system.

Table 3-74). In the environmental consequences section below, the acres will be expressed and effects discussed, using the crosswalk in the newer system.

Table 3-74. Crosswalk between visual quality objectives of the Visual Management System and scenic integrity objectives of the Scenery Management System

visual Quality Objectives	Scenic Integrity Objectives
Preservation (P)	Very High (VH)
Retention (R)	High (H)
Partial Retention (PR)	Moderate (M)
Modification or Maximum Modification (M)	Low (L) or Very Low (VL)

3.4.10.2 Environmental Consequences: Scenery

The scenic resource is affected by management activities that alter the appearance of what is seen in the landscape. Short-term scenic effects are usually considered in terms of degree of visual contrast with existing or adjacent conditions that result from management activity. The scenic landscape can be changed over the long term or cumulatively by the alteration of the visual character. Management activities that affect scenery can result in visual alterations inconsistent with the assigned scenic integrity objective, even with mitigation. Those that have the greatest potential of affecting scenery include the following:

1. Road construction;
2. Vegetation management;
3. Insect and disease control;
4. Special use utility rights-of-ways; and

5. Mineral extraction.

Other management activities that also can affect the scenic resource include:

1. Threatened and endangered species habitat management;
2. Prescribed burning;
3. Fire suppression;
4. Land exchange;
5. Old-growth forest management;
6. Recreation;
7. Administrative site facility construction; and
8. Wildlife management.

Table 3-75 displays scenic integrity objective allocations by alternative as follows.

Table 3-75. Scenic integrity objective acres by alternative

Scenic Integrity Objective	Alternative 1[1]	Alternative 2	Alternative 3
Very High	13,812	13,653	34,369
High	18,663	92,156	49,779
Moderate	101,076	57,563	60,807
Low	170,466	95,973	114,380
Not inventoried, excluded	6,076	0	0

1. Alternative 1 is based on the SIO prescribed by a crosswalk of the existing allocations and the prescriptions. GIS acres for all alternatives are approximate.

Effects of All Alternatives

In all alternatives there would be little to no change in the landscape character themes of natural appearing and natural evolving or rural-forested. Wilderness and recommended wilderness always have a high or very high scenic integrity objective. Alternatives 2 and 3 would have the highest acreage in scenic integrity objectives ranking very high, high, and moderate. Alternative 1 has the most acreage assigned to a low scenic integrity objective. Many of these impacts would be avoided by implementing mitigation measures.

Alternatives 2 and 3 would result in more protection and enhancement to the scenic resources than alternative 1, which has fewer acres assigned to the higher scenic integrity objectives.

Prescribed burning is proposed in all alternatives, in both dormant and growing seasons. Drifting smoke and blackened vegetation and charred tree trunks would be the main negative visual effect. Visual contrast from fireline construction would also be evident. The contrast levels and duration vary with fire intensity. Blackened vegetation usually lasts a short time, but charring of trees may be evident for many years. Frequent burning in fire-adapted ecosystems increases overall visual diversity, which results in an herbaceous understory with many native flowering species and, when repeated over time, produces stands with open understories allowing views farther into the landscape.

- Alternative 1 would have the least impacts to scenery from prescribed burning.

- Alternatives 2 and 3 would have the most impacts to scenery from prescribed burning.

Insect infections and diseases can cause strong, unattractive contrasts in the landscape. Management efforts to control insect infestations and diseases can minimize or reduce effects. However, control efforts that include removal of infected trees and buffer areas often appear as clearcutting to forest visitors. These impacts can occur in areas of high scenic value.

- Alternative 1 would have the most risk for scenery impacts from insects and disease.
- Alternative 2 would have the least risk for scenery impacts from insects and disease.
- Alternative 3 would have moderate risk to scenery.

Utility rights-of-way have high potential to affect the scenic resource for a longer duration. Rights-of-way contrast in form, line, color and texture when compared to the natural appearing landscape. There are no large differences in rights-of-way management between alternatives therefore the impacts of rights-of-way to scenery would be similar in all three alternatives.

Minerals management and development activities can involve major landform alteration, as well as form, line, color and texture contrasts, causing substantially adverse scenic impacts. Most lands would be suitable for minerals management in all alternatives. Therefore, the impacts from minerals management would be similar in all three alternatives.

Road construction, reconstruction, and maintenance, including rights-of-way maintenance, affect scenery. In addition, mowing frequency and timing alters the appearance of the landscape. Road construction introduces unnatural visual elements into the landscape and causes form, line, color and texture contrasts. Road management controls how much of the landscape is seen by having roads open or closed.

- Alternative 1 would have the most impacts from right-of-way maintenance and road construction and reconstruction.
- Alternative 2 would have moderate impacts.
- Alternative 3 would have the least impacts from right-of-way maintenance and road construction and reconstruction.

Vegetation management has the potential to alter the landscape and impact the scenic resource. Vegetation management practices can cause long-term effects on scenery by altering landscapes through species conversion, reduction in species diversity, manipulation of the prominent age class and alteration of opening size, location and frequency. The potential effects may be positive or negative, depending on their consistency with the desired future condition of the landscape.

Table 3-76. Vegetation management (acres) by alternative

	Alternative 1	Alternative 2	Alternative 3
Regeneration (even aged)	8,826	28,257	23,631
Thinning	49,998	17,864	27,506
Herbicide Use (for site preparation)	4,457	22,757	19,797
Mechanical Use (for site preparation)	937	4,562	3,964

Even-aged management may be the most impactful of the management applications listed in Table 3-76 because of the highest visual contrasts it creates by removing the most forest canopy

and creating openings. These openings would vary in their effects on scenery depending on size, shape, location and nearness to other openings. Openings that repeat the size and general character of surrounding natural openings and the landscape character would impact scenery the least.

- Alternative 1 would have the least impacts from even-aged management.
- Alternatives 2 and 3 would have the most impacts from even-aged management.

All impacts from timber harvest (thinning) would be short-term because of rapid vegetation growth. Therefore, the impacts of thinning on scenery would be minimal in all three alternatives.

Site preparation activities (herbicide and mechanical uses) affect scenery by exposing soil and killing other vegetation. These effects are generally short term. Site preparation usually improves the appearance of the harvest area by removing the unmerchantable trees and most of the broken stems. Stand improvement work can affect scenery by browning the vegetation which reduces visual variety through elimination of target species.

- Alternative 1 would have the least impacts from timber site preparation activities.
- Alternatives 2 and 3 would have the most impacts from site preparation activities.

Recreation facilities are also deviations from the natural landscape that can have long-term effects. However, Forest Service recreation facilities are designed to blend into the landscape without major visual disruption. Trail construction introduces some unnatural visual elements into the landscape and causes form, line, color and texture contrasts.

- Alternatives 1 and 3 would have the least impacts from recreation facility and trail construction activities.
- Alternative 2 would have the most impacts from recreation facility and trail construction activities.

Insect and diseases can kill large numbers of pine and hardwood trees during outbreaks. Insect and disease outbreaks can cause strong, unattractive contrasts in the landscape. Management efforts to control insect infestations and diseases can minimize or reduce effects. Control efforts that include removal of infected trees and buffer areas often appear as clear-cutting to forest visitors. These impacts can occur in areas of high scenic value.

- Alternative 1 would have a moderate amount of acres susceptible to insect and disease impacts.
- Alternative 2 would have the least acres susceptible to insect and disease impacts.
- Alternative 3 has the most acres susceptible to scenery impacts from insects and disease outbreaks.

Cumulative Effects

A discussion on cumulative effects of the alternatives presented in this document examines the how social and land use trends on public and private lands in the area together influence the management of national forest lands.

Trends on private lands are relevant to national forest lands, especially for scenic character and sense of place of the Lowcountry. 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 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. (Wear and Greis 2012). Scenic character over time will be changed as private lands move from undeveloped to more developed, especially in areas of the national forest that are not as consolidated.

Related to recreation, scenery, and sense of place is tourism and its importance to gateway communities and regional economies. Many communities are encouraging tourism, which centers on using the attractions of national forests to stimulate their local economy.

Finally, nature-based settings are key ingredients for enhancing a sense of place in the Lowcountry of South Carolina and its communities. Local communities identify with landscape features or have cultural practices related to natural settings. Also, traditional uses of the land by residents for hunting, fishing and gathering of natural forest products have transferred in part to national forest lands as private lands become unavailable. Some conflicts may exist or may arise between longtime residents and new development related to tourism and outdoor recreation.

3.4.11 Cultural Resources

3.4.11.1 Introduction

The prehistoric culture history of a region is usually presented as a chronological sequence of developmental or evolutionary stages. The earliest widely recognized period, the Paleoindian Period, began sometime around 12,000 years ago. Paleoindian (10,000-8000 BC) adaptations appear to have been characterized by focal large-game hunting economies, low population densities and large territorial ranges. The succeeding Archaic Period (8000-1000 BC) exhibits a gradual shift toward hunter-gatherer adaptations involving the exploitation of secondary resources (such as nuts, seeds, greens, fish, or shellfish). Territorial ranges appear to have contracted and population levels are thought to have increased during this period. The following Woodland Period (1000 BC to AD 1100) saw the development of horticulture and other intensive forms of subsistence technologies and provided the basis for semi-sedentary and sedentary village life. Population levels were greater than those of the Archaic Period and territorial ranges continued to contract. The final prehistoric period in the Southeast is known as the Mississippian Period (AD 1100-1500). Mississippian groups were characterized by sedentary village life, intensive corn agriculture, regional chiefdom societies and platform-mound ceremonialism. These cultures rapidly declined with the entry of the Spanish and other Europeans in the sixteenth and seventeenth centuries.

The British Crown began open competition with Spain to settle the Southeast in 1629. This land was initially referred to as Carolana. After the Restoration in 1660, a group of noblemen who eventually put a claim on King Charles II to grant them possession of the province of Carolina in 1663 (Edgar 1998). These were the Lord's Proprietors and they held rights to make war and peace, establish towns and ports, raise and maintain armies, collect taxes and duties, impose penalties and grant both pardons and grant "title of honors." It was not until 1669 that the Lord's Proprietors decided to take an active role in the colonization. One of the proprietors, Lord Ashley, took the lead in this endeavor and supplied three ships for 100 English men and women to

immigrate to Carolina. Because land was scarce, the colony quickly attracted settlers from the West Indies, particularly Barbados.

The settlement of Charles Town, named after the king, soon took shape. A steady influx of new settlers was drawn from a diverse European population. Included in the mix of settlers besides the English were, in order of popularity, Scots, Irish, Welsh, German, French, Dutch and Swedish. The early French settlers were Huguenots, who first immigrated in 1680 and were fleeing religious persecution. Many of the Huguenots settled locations north of present-day Charleston along the Santee and East Branch of the Cooper River and became successful rice planters. Planting, in fact, served as the impetus to move away from Charles Town and out into the countryside along the major rivers (Kovacik and Winberry 1987). Land was variably fertile and the first plots settled were the “Indian old fields” formerly cultivated by the native population.

Owing to its deep harbor, Charleston rapidly became a major port city in the Americas and an influential and wealthy mercantile class emerged. The early export economy was driven by Indian trade, in particular the deerskin industry (Kovacik and Winberry 1987). Approximately 64,000 skins were exported annually to England at the end of the seventeenth century (Edgar 1998). Other important industries at the end of the seventeenth century included naval stores (pine pitch, rosin, and turpentine), lumber, and livestock. Naval stores products were used in the shipbuilding industry, but export levels reached a premature ceiling due to England’s reluctance to buy the products. Nevertheless, by 1720 South Carolina had become the leading exporter of naval stores in the British Empire (Edgar 1998). By the 1740s, this industry was well in decline. However, the rice industry was so profitable that its labor force could not be sacrificed to produce tar and turpentine. The main market for pine and cedar planking and shingles was the West Indies. The lumber industry maintained viability throughout the Colonial period. Barreled beef and pork were also exported in great quantities to the West Indies (Kovacik and Winberry 1987).

The agricultural industry was slow to develop beyond subsistence farming. Sugar cane was unsuccessfully grown, as were a number of other tropical crops grown in the West Indies. Rice ultimately became the colony’s main cash crop. In the earliest years, it was only grown on dry sites; planters gradually developed techniques to grow it in freshwater upland swamps, which greatly increased production and profits. These early rice plantations were built on the backs and experience of West African slaves, who were quite proficient in clearing swamps, building dikes, and preparing rice seeds for planting.

Settlement outside Charleston continued throughout the eighteenth century. A section of the James Cook map of 1773 shows the extent of this migration into the area in and around the Francis Marion just prior to the Revolutionary War. The Cook map is the most detailed and accurate map of the period (Cumming 1958). Especially evident are the line of plantations between Georgetown Road and the coast in Christ Church Parish and the Huguenot residences along the lower Santee River. Dwellings ranged from impoverished shelters called “potato houses” to refined mansions (Edgar 1998). Potato houses were made of branches and dirt and were generally constructed to provide temporary shelter during the initial stages of settlement. The settlements depicted by Cook were likely more substantial. Rudimentary domestic structures consisted of the following: dirt-floored, single room log cabins; sturdier hewn-log cabins; and wood frame houses. Finer homes consisted of either wood frames or brick walls and mimicked English floor plan styles, particularly central halls with flanking rooms. Many of the planters throughout the backcountry also had finer residences in Charleston. Enslaved Africans were generally charged with constructing their own dwellings. Consequently, they generally followed

West African traditions (Ferguson 1992). These houses were small and made of wattle and daub or hand-made clay brick. Thatched roofs were steep to promote drainage.

The Lowcountry figured prominently in the Revolutionary War (Kovacik and Winberry 1987). The British attacked Charles Town in June 1776; they were met with stern resistance and forced to withdraw. Charles Town served as an important link in the continental supply system thereafter. Rice and indigo were exported to the French West Indies to finance supplies for the war. However, not everyone in the colony sympathized with the patriots. A large faction of Tories occupied the backcountry, but the British were not adept at mustering their support (Lambert 1987). In 1780, the city was captured. Resistance to the British occupation of the colony was primarily conducted as guerilla warfare during the occupation. One of the most famous partisan leaders was Francis Marion, who launched attacks against the British from his stronghold in the swamps around Charles Town. The British did not withdraw from the colony until 1782.

The colony sustained a great deal of destruction during the war. Plantations were destroyed and nearly 30,000 slaves vacated. This destruction actually stimulated the development of tidal rice cultivation in the Lowcountry (Edgar 1998). This technique required a much greater capital investment than traditional inland swamp fields due to the need for extensive dam and dyke systems. Tidal rice cultivation produced five to six times the rice per enslaved worker, a fact which quickly led to the transformation of the Lowcountry's agricultural landscape. Many of the inland swamp plantations were abandoned. By 1839 South Carolina produced three-quarters of the rice in the United States. Mills' 1820 map of Charleston District shows very little change in the forest area since the Cook map was drafted. However, it is interesting to note that the routes of the major roads used today were already established by the 1820s.

The first skirmish of the Civil War occurred in 1861 when Confederate gun batteries opened fire on Fort Sumter in Charleston Harbor. The tensions that had initially emerged during the formation of the Union over slavery ultimately led to the secession of the Southern States.

The Civil War ended the plantation system throughout the South. The agricultural economy of the Lowcountry declined and was replaced by small subsistence farms, phosphate mining, and timbering. The average farm size in South Carolina in 1880 was 143 acres, a fourfold reduction from the 1860 average (Kovacik and Winberry 1987). The Union supplied very little help to the freed slave population, which ultimately returned to farming through a new system of farm labor called tenancy. Settlements became widely scattered across the Lowcountry rather than being aggregated at plantation sites. Post-bellum agriculture was primarily focused on cotton and corn production. In the twentieth century, tobacco and soybeans also became important crops. All of these crops, with the exception of tobacco, were more productively grown in the upstate than in the Lowcountry.

Timbering activities shifted from the Great Lakes region to the South in the late nineteenth century (Hester 1997). Industrial timbering companies purchased large tracts of land, built mills and commenced lumbering vast timber stands in the Southern pine belt. By 1918, in spite of cooperation with government foresters, private timbering companies had nearly depleted mature stands of trees. The Clarke-McNary Act of 1924 allowed the Federal Government to acquire lands for timber production. In 1928, the National Forest Reservation Commission approved the purchase of two tracts in South Carolina—a 75,000-acre tract on the Sampit and Black Rivers and the Wambaw purchase unit corresponding to the modern area of the Francis Marion National Forest. Most of the Wambaw unit, which consisted of about 100,000 acres, was held by the North State, Atlantic Coast, Dorchester, and Tuxbury lumber companies. Purchase of the Wambaw unit finally occurred in 1933, resulting in the formation of Francis Marion National Forest. Most of

the original facilities and roads associated with the forest were built by the Civilian Conservation Corps in the 1930s.

3.4.11.2 Affected Environment: Cultural Resources

Known Historic and Cultural Resources that May be Affected by the Plan

Although the Charleston area has a long history of archaeological research, very little investigation occurred within the Francis Marion National Forest. It was not until the mid-1970s that the Forest Service began a systematic inventory of cultural resources in compliance with the National Historic Preservation Act. In 1981 the Francis Marion published a comprehensive overview of investigations conducted through 1980 (Anderson and Logan 1981). More recent cultural resource work on the forest expands our knowledge on the prehistory and history of the forest area (Cable 2012; Southerlin 2014).

All cultural resources are, to some degree, important. Site locations can help in understanding past human land uses over time. However, depending on their conditions and other factors, not all cultural resources are managed as significant historic properties. Site significance is usually defined in terms of eligibility for listing in the National Register of Historic Places. Historic contexts, similar to culture histories, are written to develop research questions or define characteristics used to evaluate their eligibility.

Intensive, systematic archaeological inventory of the Francis Marion now exceeds 110,000 acres or approximately 42 percent of National Forest System lands. As of 2014, more than 2,600 archaeological sites, four historic buildings, and two historic fire lookout towers are recorded on the Francis Marion National Forest. To date more than 60 sites are eligible for listing in the National Register while another 1,300 cultural resources remain unevaluated, but are managed as if they were eligible for listing. The remaining 940 cultural resources are ineligible for the National Register and are not actively managed by the Francis Marion. Only the Sewee Shell Ring is listed on the National Register of Historic Places.

Thousands of archaeological sites within the plan area have survived three centuries of extensive land modification. Agriculture was the primary source of wealth from the colonial period onward. The landscape was modified to accommodate the various cash crops; rice in the swamps and wetlands; various row crops in the dryer uplands. Livestock grazed in both the fields and forests.

The dawn of the twentieth century saw the introduction of intensive timber harvesting by large lumber companies throughout the plan area. The Forest Service acquired much of these former lumber company lands to form the core area that became the Francis Marion National Forest. Since the mid-1930s, the area was subject to decades of modern land management activities conducted by the Forest Service.

In the late 1990s, the national heritage resources program sought greater accountability and visibility (National Heritage Strategy 1999). The result was the creation of a national heritage database to track all activities, both legal compliance support to other resources and heritage resource program activities. Greater emphasis on plan level monitoring of archaeological sites and historic buildings improved efforts to track and document administrative and field procedures which provided information on sufficiency of Forest Service efforts to protect cultural resources. The heritage program developed new accomplishment measures as part of the national objective of a heritage program managed to standard. Together the new database and program measures increased forest accountability in cultural resource management.

Sea Level Rise and Cultural Resources

Global climate change and rising sea levels predicted in the coming decades will affect not only modern and future coastal human populations and infrastructure, and coastal and near-coastal natural ecosystems and land, but also the preserved archaeological remains of millennia of human activity and occupation in those regions. In the Francis Marion National Forest, which is bordered to the southeast by the Atlantic Ocean and to the northeast by the Santee River, a tidal river, the effects of sea level rise on archaeological sites and other cultural resources located in low-lying areas will be significant.

Currently the inventory of archaeological resources documented partially or entirely within the proclaimed boundary of the Francis Marion National Forest stands at more than 2,600. To evaluate the potential effects of rising sea levels on archaeological sites located in the Francis Marion, a high-resolution (5 foot [1.5 meter]) digital elevation map was used to identify low-lying areas (less than 5 meters above mean sea level) within the national forest. These areas were sub-classified into six elevation categories, including: land situated less than 0 meters above mean sea level (class 0); 1-meter increments defining elevation increases from 0 to 5 meters above mean sea level (classes 1 – 5). Land above 5 meters above mean sea level was grouped into a seventh category (class 6). Total land area contained within each of these seven categories in the Francis Marion National Forest is presented in Table 3-77. Land lying below 5 meters above mean sea level within the Francis Marion's proclaimed boundary represents approximately 22.1 percent of the total 168,627 hectares (1686.27 square kilometers).

Sites were grouped into elevation classes based on the amount of total site area within each elevation increment. Many sites extended across multiple adjacent elevation classes. Thus, because the effects of sea level rise on even a relatively small proportion of a site would impact the total integrity of that site, sites were considered to be in the lowest elevation category in which at least 10 percent of their total area was contained (Table 3-77).

The total number of sites identified at elevations less than 5 meters above mean sea level accounts for slightly less than one quarter (n = 589, 25.29 percent) of the archaeological resources recorded within the administrative boundaries of the Francis Marion National Forest (n = 2,329) (Table 3-77; Figure 3-42). Of the 589 sites recorded at elevations less than 5 meters above mean sea level, prehistoric sites account for 52.29 percent (n = 308). Historic sites (n = 145, 24.62 percent) and multicomponent sites (n = 111, 18.85 percent) below 5 meters above mean sea level made up the most of the remaining total. An additional 25 sites (4.24 percent) at elevations less than 5 meters above mean sea level were listed as "other" or had no temporal or cultural affiliation indicated.

Table 3-77. Total land area and archaeological sites by elevation class in Francis Marion National Forest

Elevation Class	1-meter Increments Above Mean Sea Level	Area (hectares)	Percent Total Land in National Forest Boundary	Number of Sites	Percent Sites by Elevation Class
0	< 0	458.86	0.27	18	0.77
1	0 to 1	3837.97	2.28	64	2.75
2	1 to 2	6632.58	3.93	95	4.08
3	2 to 3	6990.89	4.15	104	4.47
4	3 to 4	7947.78	4.71	142	6.10
5	4 to 5	11,403.98	6.76	166	7.13
6	> 5	131,355.19	77.90	1740	74.71
Total Below 5 Meters Above Mean Sea Level		**37,272.06**	**22.10**	**589**	**25.29**
Cumulative Totals		**168,627.25**		**2,329**	

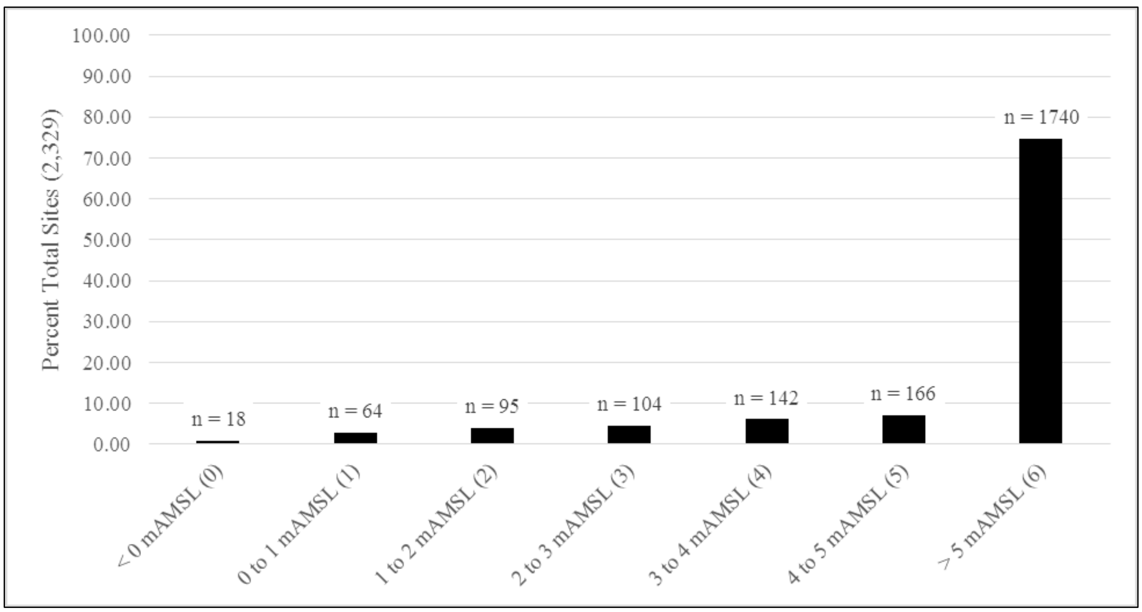


Figure 3-42. Total sites (n = 2,329) within Francis Marion National Forest proclamation boundary, grouped by elevation class (0 – 6)

Note: mAMSL = meters above mean sea level

Table 3-78. Archaeological sites by temporal affiliation, grouped by elevation class

Elevation Class	1-meter Increments Above Mean Sea Level	Prehistoric Sites	Historic Sites	Multi-component Sites	"Other" or No Data	Total Sites
0	< 0	4	7	4	3	18
1	0 to 1	35	16	9	4	64
2	1 to 2	61	17	13	4	95
3	2 to 3	58	23	22	1	104
4	3 to 4	66	43	27	6	142
5	4 to 5	84	39	36	7	166
6	> 5	918	488	229	105	1740
Total Below 5 Meters Above Mean Sea Level		**308**	**145**	**111**	**25**	**589**
Total Sites		**1226**	**633**	**340**	**130**	**2329**

These data suggest that a significant number of archaeological sites in the Francis Marion National Forest will potentially be affected by a rise in sea levels of 1 meter or more. However, count data alone do not provide a full appraisal of the potential severity of the effects of sea level rise on the Francis Marion's inventoried archaeological resources. A more complete picture emerges when data on total archaeological site area within each elevation class are included.

Area values were obtained from a polygon shapefile of archaeological resources within the Francis Marion National Forest. The total archaeological site area contained within the national forest's administrative boundaries was 1707.15 hectares[5]. Calculated area for sites located partially or entirely at or below 5 meters above mean sea level was 751.22 hectares, or approximately 44 percent. Contrasted with percentages from count data (23 percent for sites below 5 meters above mean sea level), these figures provide additional information about the nature of the sites situated below 5 meters above mean sea level, relative to the Francis Marion's total site inventory. Tabulation of site area data indicates that the largest amount of archaeological site area by elevation class below 5 meters above mean sea level occurs within 1 meter or less of modern sea level (235.34 hectares, 31.3 percent of total site area within the Francis Marion National Forest). Furthermore, within the 0 to 1 elevation class, the average area of sites was 1.54 hectares (Table 3-79). By contrast, average site area in any other elevation class was less than one-third of that value. In other words, these analyses suggest that, on average, larger sites are more common in lower-lying areas that will be first to experience the effects of sea level rise. If the total recorded area of an archaeological site can be considered as a coarse proxy for a site's potential significance, then these analyses suggest that some of the earliest negative effects of sea level rise, at less than 1 meter above mean sea level, will be experienced by many of the larger archaeological sites recorded in the Francis Marion National Forest.

[5] The full site polygon shapefile was clipped to include site area contained only within the Francis Marion administrative boundary. A number of sites polygons extend beyond the Francis Marion boundary, however, and several were situated entirely outside the boundary. The total area of all sites in the full site shapefile, including sites recorded partially or wholly within the Francis Marion National Forest, was 1998.7 ha.

Table 3-79. Total archaeological site area and average area of archaeological sites, grouped by elevation class, within Francis Marion National Forest boundary

Elevation Class	1-meter Increments Above Mean Sea Level	Total Area (ha)	Percent Total Area	Average Site Area (ha)
0	< 0	16.82	0.99	0.36
1	0 to 1	235.34	13.79	1.54
2	1 to 2	111.35	6.52	0.47
3	2 to 3	128.47	7.53	0.40
4	3 to 4	123.55	7.24	0.33
5	4 to 5	135.69	7.95	0.28
6	> 5	955.87	55.99	0.49
Total Area Below 5 Meters Above Mean Sea Level		**751.22**	**44.00**	
Total Site Area Within Francis Marion		**1707.15**		

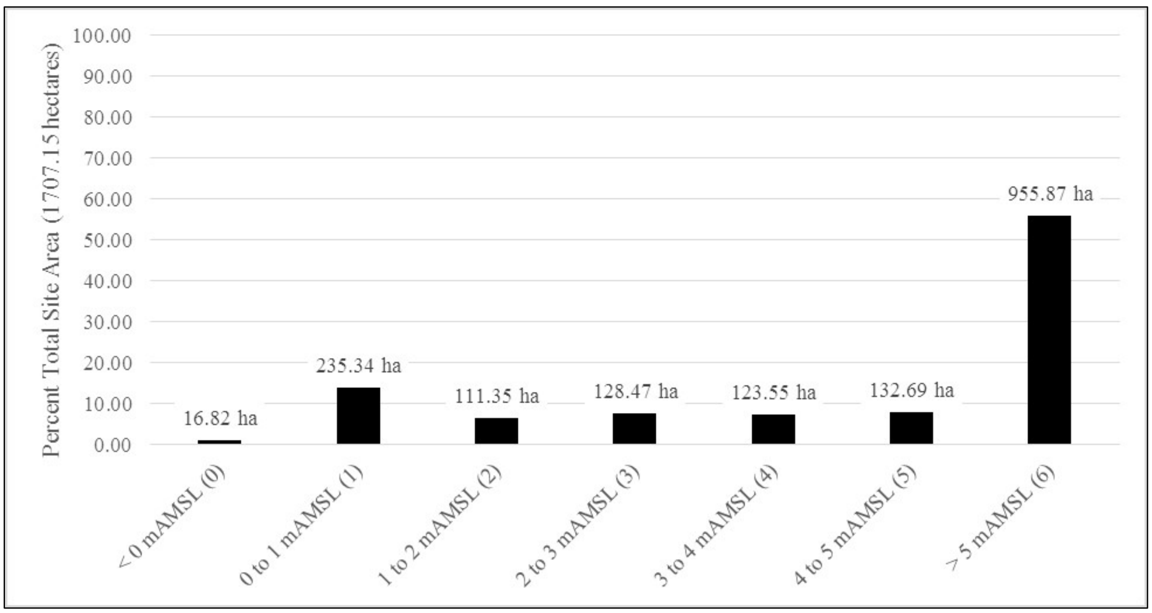


Figure 3-43. Percent total archaeological site area (1707.15 ha) in Francis Marion National Forest, grouped by elevation class (0 – 6)

Note: mAMSL = meters above mean sea level

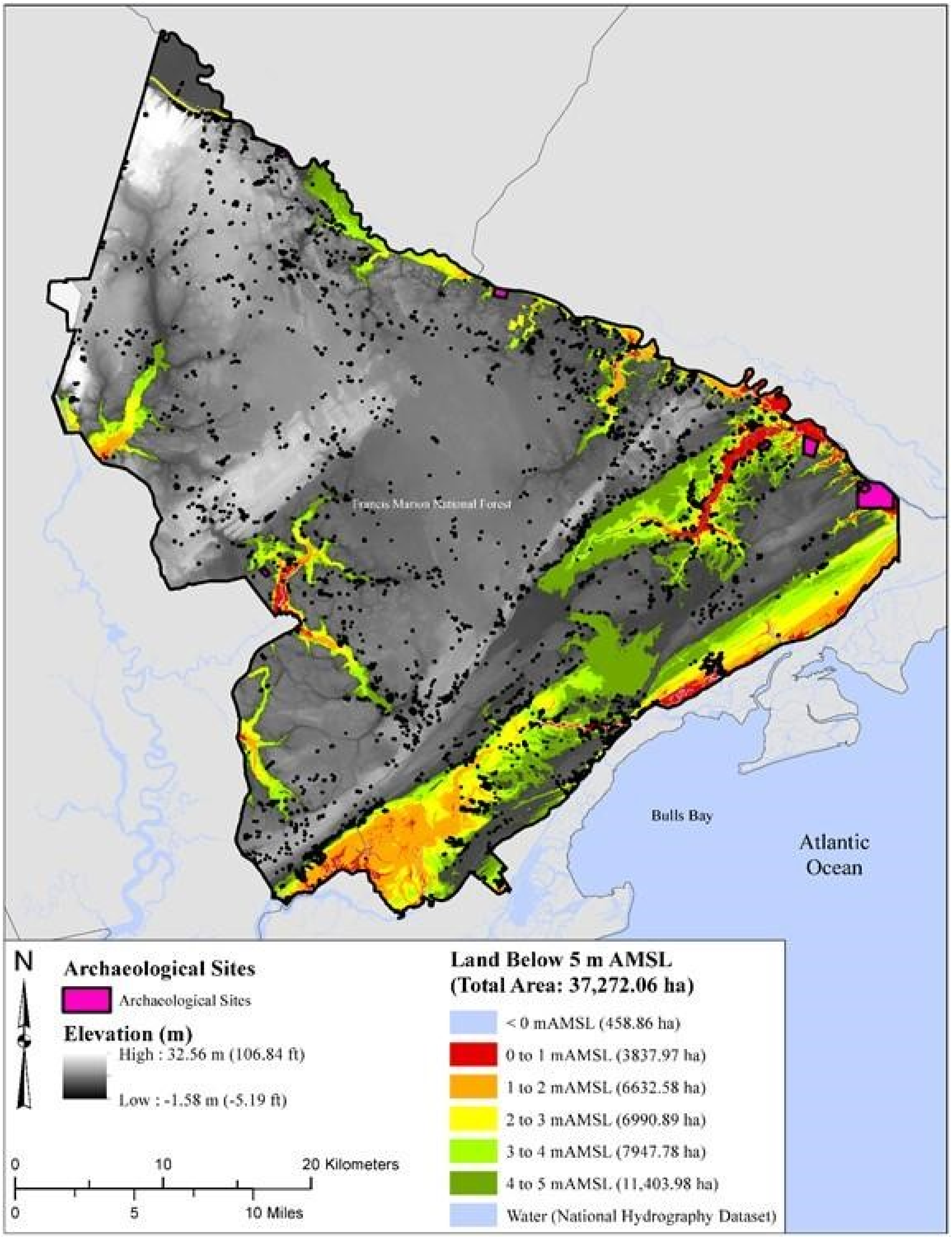


Figure 3-44. Archaeological sites by elevation on the Francis Marion

Note: mAMSL = meters above mean sea level

3.4.11.3 Environmental Consequences: Cultural Resources

Almost all land and resource management activities have the potential to affect cultural resources. Because most of the Francis Marion's cultural resources are archaeological sites, the greatest potential comes from activities associated with soil movement, mixing, or compaction. The plan proposes the ecological restoration of National Forest System lands and the reduction of hazardous fuels through a combination of prescribed fire, mechanical treatment of vegetation and grazing livestock. All of these management approaches include activities that involve some degree of soil disturbance.

Activities associated with the improvement of hydrologic function within several watersheds could impact historic embankments constructed for water impoundments and rice culture. These cultural landscape features are part of a vernacular, agricultural landscape exhibiting the combined works of nature and man and have been in place for more than two centuries.

Activities associated with dispersed recreation can affect cultural resources particularly trail construction associated with the expansion of existing trails. Such activities provide for greater public access which, in turn, can result in increased potential for vandalism of archaeological sites and historic buildings.

All Alternatives

Direct and Indirect Effects.

National Historic Districts: In alternatives 2 and 3, national historic districts are proposed, primarily in the Coastal Resource Integration Zone. Alternative 1 (1996 forest plan) protects cultural resources as well as provides opportunities for education and interpretation. The creation of multiple National Register of Historic Places districts in alternatives 2 and 3 affords greater recognition to the resources within them and emphasizes the desire to protect and enhance them.

Prescribed Fire: All three alternatives emphasize prescribed fire as an important management tool for ecosystem restoration and hazardous fuels reduction. Of particular concern are direct effects caused by activities associated with control and suppression using heavy equipment. The use of fire plows, dozer blades and disks can affect an archaeological site's integrity. Most archaeological sites on the forest lack combustible features and are not threatened by low- to moderate-intensity burning. However, both prescribed fire and wildfire can have indirect effect of making cultural resources more visible and thus susceptible to unauthorized and illegal collecting of artifacts.

The major difference between the three alternatives is the number of acres to be burned. Alternative 1 proposes the fewest acres while alternative 2 has the greatest number of acres followed by alternative 3. As the burn acres increases, the potential effects to cultural resources from the construction of control lines increases.

Mechanical Treatments: In addition to prescribed fire, all three alternatives propose mechanical treatments as a management tool for ecosystem restoration and hazardous fuels reduction. Again it is heavy equipment use that has the potential to affect cultural resources as well. Activities that have the potential to impact cultural resources include harvesting, skidding and yarding of timber. Access to harvest areas may require the construction or reconstruction of roads.

Again, the difference between the alternatives is the number of acres to be mechanically treated. Alternative 1 proposes the fewest acres while alternative 2 has the greatest number of acres

followed by alternative 3. As the number of mechanically treated acres increases, the potential effects to cultural resources from associated activities increases.

Herbicide Use: All three alternatives proposed to use herbicide treatments for site preparation and improvement of stand composition. While herbicides may be used to reduce hazardous fuels in alternatives 1 and 2. Alternative 3 proposes the greatest use of herbicides to reduce hazardous fuels. This treatment would have little or no potential to effect cultural resources.

Livestock Grazing: The Forest Service ended livestock grazing on the Francis Marion National Forest in the early 1950s. Until then, cattle and hogs were turned out to graze annually, a tradition that began as soon as people began settling the forest area in the late seventeenth and early eighteenth centuries.

Livestock are attracted to areas with high amounts of forage and access to water. While alternative 2 would allow the use of livestock grazing to reduce hazardous fuels, alternative 3 places a greater emphasis on the use of livestock as a method to reduce hazardous fuels. Pathways created by livestock and areas where they congregate would have the potential to affect cultural resources.

Restoration of Hydrologic Function: Alternative 1 (1996 forest plan) has very little direction on restoring hydrologic function. Alternatives 2 and 3 propose restoration of hydrologic function that would be focused primarily in the three priority watersheds: Guerin Creek, Headwaters of Wambaw Creek, and Turkey Creek. Activities associated with improving hydrologic function within forested wetlands, riparian areas, and streams could impact cultural resources, particularly cultural landscape features like historic embankments constructed for water impoundments and rice culture. Activities associated with restoration work are ground-disturbing and include plugging ditches, smoothing ruts, and installing or replacing culverts to improve water flow and aquatic passage. Similar to the ground-disturbing effects described above, alternatives 2 and 3 have the greatest potential to affect cultural resources.

Recreation: Increased public access and use of National Forest System lands would have the potential to affect cultural resources, particularly activities associated with off-highway vehicle use and camping. With greater public use comes the potential for vandalism of both archaeological sites and historic buildings and structures. On the other hand, wilderness designation carries with it restrictions on the use of mechanized equipment and motorized vehicles resulting in a lower risk of adverse effects to cultural resources.

Alternative 1 would reduce the potential adverse effects of recreation to cultural resources as it maintains four existing wilderness areas and two inventoried roadless areas but does not expand them. Developed recreation would be restricted as well; however, public access to these areas would still be possible. Pedestrian uses of these areas would be unlikely to adversely affect cultural resources.

Alternative 2 would reduce potential adverse effects to cultural resources as it maintains existing wilderness and inventoried roadless areas thus restricting management activities that involve ground-disturbing activities, such as timber harvesting. The addition of semi-primitive areas does not add any potential protection of cultural resources because mechanical management activities that are ground-disturbing would be allowed. Although developed recreation would be restricted, public access to these areas would still be possible. New trail construction to connect existing trails to improve connections within the forest trails system could affect cultural resources. Pedestrian uses of these areas are unlikely to adversely affect cultural resources.

Not only would alternative 3 maintain the four existing wilderness areas, but it would recommend additional wilderness areas and afford the greatest protection for cultural resources in the wilderness areas and the recommended wilderness the nature of management activities are restricted, particularly mechanical. Developed recreation would be restricted in the wilderness areas, as well as the recommended wilderness areas; however, public access to these areas would still be possible. Pedestrian uses of these areas would be unlikely to adversely affect cultural resources.

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. The cumulative effects are the same under all three alternatives.

Sea-level rise has the potential to impact cultural resources near the coast, particularly the Sewee Shell Mound. Climate change impacts, notably more intense storms and more hurricanes making land fall, would also have the potential to impact cultural resources near the coast. The cumulative effects of sea-level rise and climate change are the same under all three alternatives.

Partnerships created through the National Historic Districts proposed in alternatives 2 and 3 offer the greatest potential for interpretation and education of cultural resources. These national historic districts would highlight historic sites on the forest and increase opportunities for tourism over alternative 1.

3.4.12 Tribal Relations

Francis Marion National Forest personnel conducted formal face-to-face consultation with Catawba Indian Nation concerning the development of this forest plan revision. The Catawba Indian Nation is the only federally recognized tribe in South Carolina. The tribe has not identified any concerns about the forest plan direction being developed or the specific management activities that may be proposed to achieve forest plan direction.

It is important to consider the history of Indian people within the forest area. The Catawba Nation is the result of coalescence among a number of individual tribes living in South Carolina. By the end of the Yamassee War in 1718 the Catawba included remnants from as many as 30 other Indian tribes including surviving members of coastal tribes with direct association with the forest area. Others remained in the lower coastal plain and survived by forming small bands of Indian people and taking refuge in areas away from the colonial settlements in areas colonist did not find attractive for settlement. Many of those unfortunate individuals that did not migrate away from colonial settlements along the central South Carolina coast were enslaved and removed from the region. Some of these small bands were able to maintain their identity as Indian people through subsequent centuries and still exist as state recognized tribes in the region. But to date none have achieved federal recognition as sovereign tribes.

The subsequent isolation of tribal members and the distance from the forest resulted in the loss of traditional cultural ties to the forest area. There are no known Federal or State tribal members practicing traditional cultural activities on the Francis Marion and no sacred sites are known to exist on the national forest. Therefore, there would be no direct, indirect or cumulative effects on tribal relations across all three alternatives.

3.4.13 Recreational Fisheries Management

Presidential Executive Order 12962 provides the primary direction for managing national forest recreational fishing resources. In compliance with this mandate, forest management activities are implemented in a manner to provide quality recreational fishing opportunities to the public.

3.4.13.1 Affected Environment: Recreational Fisheries Management

The Francis Marion National Forest contains more than 15 manmade ponds totaling more than 41 acres of water. These impoundments range in size from 1 to 10 acres. The original purpose for the construction of many of these impoundments was for road building material. Others were constructed primarily for recreational purposes. These impoundments were stocked with largemouth bass (*Micropterus salmoides*), bluegill (*Lepomis macrochirus*), redear sunfish (*Lepomis microlophus*), channel catfish (*Ictalurus punctatus*) and grass carp (*Ctenyopharyngodon idella*), all of which now provide recreational fishing benefits. The Forest Service manages most of the Francis Marion's ponds that are larger than 1 acre for sustainable recreational fishing.

Recreational fishing is one of the most popular outdoor activities in the state. The South Carolina Department of Natural Resources is responsible for managing and improving the state's fisheries resources. The Forest Service cooperates with its efforts to improve the fisheries resources on national forest lands. National forest ponds are managed to support balanced, productive self-sustaining recreational fisheries that are capable of meeting current and projected demands. Target species associated with fishing include: largemouth bass (indicator species), bluegill, redear sunfish and channel catfish (*Ictalurus punctatus*). Maintenance and restoration efforts cooperate with all program areas to achieve the desired conditions.

The Francis Marion's strategy for maintaining and enhancing ponds emphasizes maintaining and improving water quality and healthy populations of desired species. Fisheries management is practiced on the Francis Marion to provide fishing opportunities to the public. Management practices include liming and fertilization, fish habitat improvement, aquatic weed control, angler access improvement, fish population management, and nuisance animal control.

Largemouth bass is the principal predator in most forest ponds. As the principal predator, the presence or absence of largemouth bass strongly influences the population structure of other fish species in a pond. For this reason, largemouth bass was selected as the indicator species to represent the effectiveness of Forest Service recreational fisheries management activities. The effects of recreational fisheries management (directly related to this species) is discussed below.

Liming: Many forest impoundments are slightly acidic with poor buffering capacity. Tannic acid from leaves and pine needles from the surrounding forested watershed is washed into the ponds, which results in limited productivity and fish growth. Good water quality is necessary to maintain a healthy fish population in ponds (SCDNR 2014). Fish in acidic water with low alkalinity are more likely to get sick, especially during times of stress such as spawning season or periods of rapid temperature change. Rapid pH fluctuations can cause stress, making fish more vulnerable to disease and hindering growth. Lime would enhance the water quality and productivity of these ponds.

Fertilization: Many fish and wildlife agencies in the South practice pond fertilization. The addition of some nutrients to ponds can yield positive results as long as the added nutrients are in the appropriate balance and amount. Fertilization enhances the productivity of the fish population and improves the quality of the fishing experience.

Ponds that receive heavy fishing pressure may be at risk of overharvest or poor fishing. Fertilization can increase the abundance of fish to compensate for heavy fishing (SCDNR 2014).

Spawning Habitat Improvement: Good spawning sites are limited in many national forest ponds because natural spawning areas have become covered with silt and muck over the years. Placement of spawning beds enhances the productivity of the fish population and improves the quality of the fishing experience. Where possible, structures can be added to increase spawning success and concentrate sport fish for angling.

The availability of suitable nesting substrate has been recognized as a major factor affecting reproductive success of bass, bluegill, and redear. Although they will use the best habitat available, these fish prefer gravel substrate for spawning material. Willis (2005) examined 75 random locations in a 330-acre lake in South Dakota where 15 bluegill spawning sites were identified. All the locations contained four types of substrates (muck, sand, gravel, rock). However, all 15 bluegill colony spawning sites were built on gravel substrate.

Fish Attractors: Natural fish cover is absent or inadequate in many national forest ponds because during their construction, the basins were cleared of trees and brush. Even standing trees that were left have decomposed over the years and become ineffective as fish cover. In addition, any trenches or habitat structures scattered through the bottoms have silted in over time, providing little or no irregular bottom features that attract fish.

The purpose of fish attractors is to provide a type of structure that otherwise does not or will not exist in sufficient quantity within the pond bed. Fish attractors are used on the forest to improve fish cover, which improves survivability.

Shoreline Deepening: Many of the Francis Marion's ponds contain areas of excessively shallow water (less than 3 feet deep). This is the outcome of years of natural silt deposition along the shoreline and upper ends of the ponds, resulting in limited access for both bank and boat anglers. It has also promoted excessive aquatic weed growth reducing the predator/prey interaction needed to maintain fish population balance.

Aquatic Weed Control: Many of the Francis Marion's ponds contain areas of excessive aquatic weed growth reducing the predator/prey interaction needed to maintain fish population balance. This excessive aquatic weed growth is the result of vast areas of shallow water less than 3 feet deep.

The right species of aquatic plants in the right quantities and at the right location are very beneficial to a pond environment. However, if they are the wrong species, too abundant or in the wrong location, they become noxious weeds that can be detrimental to the fisheries and recreational pond use.

Aquatic weeds present a constant challenge. They can greatly reduce a pond's carrying capacity by using the nutrients normally available to phytoplankton. They can restrict water flow and often interfere with fishing and recreational boating. Aquatic weeds also can contribute to the stunting of game fish through reduced predator/prey interaction. When aquatic weeds die, silting can be accelerated, while oxygen levels become reduced.

Angler Access Improvement: Fishing piers and boat ramps are provided at some locations on the Francis Marion. These structures enable the pond sport fish population to be managed for optimal

recreational benefits. Access to angling opportunities should increase with the installation of these structures. These structures also provide added structure for the aquatic species.

Fish Population Management: Fish populations in ponds are managed to produce enhanced recreational fishing opportunities. The Francis Marion is currently monitoring fish ratios and augmenting with correct fish as determined appropriate. Fish populations of the proper species mix, the correct ratios and the right sizes can provide a quality fishing experience. However, when the opposite occurs, a poor fishing experience is the result. A healthy pond has a balance between predator and prey populations. In ponds of at least one acre, largemouth bass and bluegill provide this balance better than any other species. Other species such as redear, sunfish, and channel catfish can add variety to the fishing opportunities.

Nuisance Animal Control: Beavers, muskrats, nutria, otters and alligators can be a nuisance or even cause damage. Burrowing and damming can cause dam failure or flood adjacent landowners. Angler access and fish habitat improvements can also be flooded. A family of otters can virtually eliminate catchable-size fish in a small pond. Alligators can present a safety concern in pond with swimming. Trapping and removal will be practiced to maintain nuisance animal populations at acceptable levels. The Animal and Plant Health Inspection Service does trap animals on the national forest.

The Francis Marion National Forest’s strategy for maintaining and enhancing ponds emphasizes maintaining and improving water quality and healthy populations of desired species. Fisheries management is practiced on the forest to provide public fishing opportunities. Management practices include liming and fertilization, fish habitat improvement, aquatic weed control, angler access improvement, fish population management and nuisance animal control.

3.4.13.2 Environmental Consequences: Recreational Fisheries Management

Public Recreational Fishing

Alternative 1

Direct, Indirect and Cumulative Effects. Ongoing fisheries management would continue to improve public recreational fishing opportunities under alternative 1 and would have the following direct and indirect effects:

1. Improved water quality (buffered pH and increased total alkalinity)
2. Increased productivity from fertilization
3. Improved spawning habitat
4. Improved fish cover
5. Improved and increased angler access
6. Reduced aquatic weed problems
7. Reduced nuisance animal problems
8. Balanced and healthy fish populations

The cumulative effects of these activities would be improved recreational fishing opportunities for the public. Angler catch rates would increase resulting in improved angler satisfaction. Suitable habitat for aquatic threatened and endangered species does not occur in the Francis Marion’s ponds or immediately downstream; therefore, threatened and endangered species habitat

should not be affected by proposed management actions. The proposed management activities do not contribute to other unconnected actions within the vicinity that would create unacceptable levels of cumulatively negative impacts.

Alternatives 2 and 3

Direct, Indirect and Cumulative Effects. Fisheries management would be conducted in alternatives 2 and 3 to improve public recreational fishing opportunities; it would have the following direct and indirect effects:

1. Improved water quality (buffered pH and increased total alkalinity)
2. Increased productivity from fertilization
3. Improved spawning habitat
4. Improved fish cover
5. Improved and increased angler access
6. Reduced aquatic weed problems
7. Reduced nuisance animal problems
8. Balanced and healthy fish populations

The cumulative effects of these activities would be improved recreational fishing opportunities for the public. Angler catch rates would increase resulting in improved angler satisfaction. Suitable habitat for aquatic threatened and endangered species does not occur in the Francis Marion's ponds or immediately downstream; therefore, it should not be affected by proposed management actions. The proposed management activities do not contribute to other unconnected actions within the vicinity that would create unacceptable levels of cumulatively negative impacts.

Effects of All Alternatives

Direct and Indirect Effects by Activity: There is no variation in recreation fisheries management by alternative, so these effects apply to all alternatives.

Liming: Liming is the addition of agricultural lime, primarily calcium carbonate ($CaCO_3$) to neutralize acidic waters and buffer them from rapid pH fluctuations. Generally, ponds in the Southeast are limed in conjunction with a fertilization program. Based on individual situations such as manpower, budgets, size of pond, and flushing rate, one type of lime may be more efficient than the other.

The direct effect of liming of ponds is increased total alkalinity of the water. The threshold of whether lime is needed is 20 parts per million or 20 milligrams per liter of total alkalinity. Less than 20 parts per million indicates a need for lime in conjunction with a fertilization program (Boyd 1990).

Agricultural lime is made of particles of differing size taking several months to dissolve and increase the total alkalinity to the desired level. Approximately 3 to 5 tons per acre every 3 to 5 years is needed to raise and maintain total alkalinity at the desired level. Liming rates above this will not do any harm; the lime will just last longer. Only the lime surface will react with the water and go into solution. Higher rates will give a thicker coat of lime causing the initial lime application to last longer. As freshwater enters the pond from water runoff over the un-limed

watershed, the concentration of lime will continue to react with the water. This allows a slow release of lime over a number of years. Generally, a 5-ton-per-acre lime rate will last approximately 10 exchanges of water volume. Coating the bottom of a pond with agricultural lime protects or buffers the nutrients in the water from being absorbed by ions in the bottom mud and allows them to be more readily available for phytoplankton. Phosphorus is a key element that mud absorbs from the water and is the most critical for good fish growth.

Another direct effect of lime is neutralizing acidic water. The ability of agricultural lime to neutralize acidic water is based on the relative neutralizing value. Relative neutralizing value is an expression of agricultural lime effectiveness based on the combined effect of the calcium carbonate equivalent and fineness of grind.

The first indirect effect from increase in total alkalinity is increased availability of phosphorus, which, in turn, leads to increased phytoplankton productivity, which, in turn leads to increased fish production and growth. The second indirect effect from increase in total alkalinity is increased availability of carbon dioxide, which, in turn, is used for photosynthesis by phytoplankton. The last indirect effect from increase in alkalinity is increased buffering capacity (resist rapid fluctuations in pH) of the water.

There are no anticipated cumulative effects on the environment from the use of lime within the pond it was applied or downstream. The retention time of lime is based on the flushing rate or amount of water flow through the pond.

Fertilization: Several types of fertilizer are used, and all can be effective if the pond total alkalinity is at the desired level. Fertilizers used are in liquid, granular, and powdered forms. Liquid fertilizers dissolve most readily, followed by powders, then granular types. The key ingredient in each of these types of fertilizer is phosphorus. Phosphorus is the element most needed for phytoplankton growth. Typical formulations for each type are:

- Liquid: 10-34-0 and 11-37-0[6]
- Powdered: 12-49-6 and 10-52-4
- Granular: 0-46-0 and 0-20-0

Based on individual situations such as manpower, budgets, size of pond, and flushing rate, one type of fertilizer may be more efficient to use than the other.

A direct effect of the addition of fertilizer to ponds is the stimulation of growth of microscopic plants, called phytoplankton. When phytoplankton bloom, it makes the water turn green.

One indirect effect from increased phytoplankton productivity is increased fish production and growth. Phytoplankton forms the base of the food chain, and small animals eat these small plants, which serve as food for bream (bluegill and redear), which in turn are eaten by bass. Proper fertilization significantly increases the total weight of fish produced in a pond, often by as much as 3 to 4 times. Phytoplankton blooms also shade the bottom which tends and discourage submersed aquatic weed growth.

The potential negative effect of fertilizer is that if used improperly a dense phytoplankton bloom can form. During periods of cloudy weather or after a heavy rain the phytoplankton bloom can

[6] The three-number sequence for fertilizer formulation reflects the percentages of nitrogen, phosphorous, and potassium respectively.

die causing an oxygen depletion which can lead to a fish kill. However, with the following protective measures and guidelines implemented, fertilization should have no negative effects:

Liquid fertilizer should be applied at a rate of 0.5 – 1 gallon per surface acre per application. Powdered fertilizer should be applied at a rate of 2 – 8 pounds per surface acre per application. Granulated fertilizer should be applied at a rate of 4 – 12 pounds per surface acre per application. Secchi disc visibilities should be maintained between 18 inches and 24 inches on non-swimming ponds, and between 24 and 30 inches on ponds with swimming.

Another negative effect of fertilization would be the potential of creating a blue-green algae bloom. This can effect human health as well as be harmful to other wildlife. This can be controlled by starting fertilization early in the spring and by switching to more nitrogen rich fertilizer later in the summer.

There are no anticipated cumulative effects on the environment from the use of fertilizer within the pond it was applied in or downstream. There are concerns of agricultural fertilizers on the eutrophication (nutrient loading) of stream communities. However, when compared to inputs of nutrients from large-scale agriculture, pond fertilization contributions are minimal.

Spawning Habitat Improvement: Ponds with poor spawning habitat can be enhanced by the placement of gravel. The mechanical action of fish fanning the beds, however, makes the gravel spread out laterally over time, causing it to become thin and ineffective. Therefore, gravel spawning beds should be constructed or boxed in. Spawning beds can vary in size, averaging 20 feet by 20 feet and approximately 12 inches deep. The actual size of each bed will depend on the amount of level ground available at each spawning bed site.

A direct effect of creating gravel spawning beds is that the gravel improves water circulation allowing more oxygen to get to the bottom of the egg mass, resulting in higher hatch results from each egg mass. In addition, Bain and Helfrich (1983) found that survival of bluegill larvae was directly correlated with the proportion of coarse substrate in the nest. Substrate with larger particles provided interstitial space that allowed bluegill larvae to escape predation.

Gravel spawning bed construction sometimes requires the use of mechanical equipment to level sloped areas and to deliver gravel to the site. This construction may involve some soil disturbance. Any soil erosion resulting from this activity would be temporary and would be minimized by the installation of erosion control measures such as temporary vegetation around the shoreline until the pond is flooded.

There are no anticipated cumulative effects on the environment from spawning habitat improvement within the pond or downstream.

Fish Attractors: One of the best ways to enhance the fishing experience is to provide cover or structures at strategic locations. Fish such as largemouth bass, bluegill, and redear sunfish are attracted to cover or shelter of all types (Managing Mississippi Ponds and Small Lakes 2011).

A variety of structures can serve as fish attractors such as submerged trees, rootwads, ledges and channels, rock piles, and artificial structures. The direct effect of fish attractors in ponds is that they provide adequate refuge cover for fish. Largemouth bass are ambush predators and prefer to hide in cover and ambush their prey. Types of structures and their functions include the following:

- Submerged trees and rootwads provide interstices for smaller fish to hide in and attachment sites for aquatic invertebrates. A major advantage to using submerged trees is

low cost. These structures are readily available around most of the Francis Marion's ponds. Species of trees used is important. Cedar and oak tend to last longer than pine. All submerged trees, however, will deteriorate with age, so fish use will decrease over time. The rate of deterioration is dependent upon the trees exposure to air. Those exposed periodically from fluctuating water levels will deteriorate more rapidly than those that are not.

- Ledges and channels provide irregular features in pond bottoms that are attractive to fish. Ledges and channels are not to be confused with the availability of deep water. While it is true that ledges and channels will, by their very definition, provide deeper water, it is the fact that this deeper water is immediately adjacent to significantly shallower water that makes ledges and channels such an important addition to fisheries habitat. Fish will tend to congregate around this structure at various depths at different times of the year. While it is expected that ledges and channels may slowly deteriorate with age due to sediment deposition, these structures are anticipated to last at least 20 years.
- Rockpiles provide irregular features in pond bottoms that are attractive to fish. They also provide interstices for aquatic invertebrates and smaller fish to hide in. Rockpiles are usually made of rip-rap, large boulders, or broken concrete/brick. These structures deteriorate very little if any, and should last indefinitely.
- Artificial structures provide interstices for smaller fish to hide in and provide attachment sites for aquatic invertebrates. A major advantage to using artificial structures is durability. These structures deteriorate very little if any, and should last indefinitely. Artificial structures vary in configuration and size and are constructed from some of the following materials: PVC pipe, rubber tires, plastic streamers, wooden pallets, and wooden stakes. Another advantage is that lures tend not to snag on them as much as submerged trees and brush. Disadvantages are that commercially produced structures can be expensive and prone to vandalism during exposure in ponds with fluctuating water levels.

The indirect effect of fish attractors is improved fishing opportunities. Fish are attracted to the structures by the presence of cover and food, and they are concentrated so that anglers can better harvest them. Additionally, ledges and channels at the right location can attract or lead fish toward adjacent shorelines, which will be convenient for bank anglers, potentially making for some great fishing opportunities. Boxrucker (1983), Cofer (1991) and Glenn (1983) reported increased angler catch rates of largemouth bass, crappie, bluegill, and channel catfish around fish attractors.

Fish attractor placement or construction sometimes requires use of heavy equipment when ponds have been drained. During this process, some soil may be disturbed. Any soil erosion resulting from this activity would be temporary and would be minimized by the installation of erosion control measures such as temporary vegetation around the shoreline until the pond is flooded.

There are no anticipated cumulative effects on the environment from fish attractors within the pond treated or downstream.

Shoreline Deepening: The purpose of shoreline deepening is to reduce the amount of shallow water. This process deepens the pond edge in selected places by taking the current shoreline that is silted and rebuilding it with sediment deposits from the pond bed. This not only rebuilds the shoreline but also deepens the water next to the shoreline so that the depth drops quickly to 3 feet.

This deepening process also includes the shallow flats located primarily in the upper end of ponds, where the excess soil is formed into islands.

The direct effect of shoreline deepening in ponds is the reduction of shallow water that contributes to aquatic weed growth. Aquatic weeds need sunlight to grow. In most waters, sunlight is filtered out by 3 feet of depth.

Shoreline deepening requires use of heavy equipment when ponds have been drained. During this process, some soil will be disturbed. Loose soil that is exposed along the shoreline, islands, and land access piers would be mulched and seeded to establish temporary vegetation to reduce erosion. The minimal soil erosion that does occur would be temporary and contained within the pond basin.

Section 404 of the Clean Water Act requires a permit from the U.S. Army Corps of Engineers before dredged or fill material may be discharged into the waters of the United States. Before the permit is issued, the U.S. Army Corps of Engineers ensures that the proposed project has taken steps to avoid wetland impacts, or minimize potential impacts on wetlands. This permit is an essential part of protecting wetlands.

The indirect effect of shoreline deepening is improved fishing opportunities. The reworked shoreline extends on average 10 to 20 feet farther out in the pond and the depth of water increases approximately 1 to 3 feet. In addition, land piers are constructed from the excess soil extending bank angler access farther out in the pond near deeper water and increasing the amount of shoreline habitat for aquatic, as well as terrestrial species that use shoreline habitat.

There are no anticipated cumulative effects on the environment from shoreline deepening within the pond deepened or downstream.

Aquatic Weed Control: There are four categories of aquatic weed control methods: chemical, mechanical, biological, and habitat manipulation. At the time when aquatic weed control is needed, the control method chosen will depend on type of plants, quantity of plants, area of coverage, control methods available, funding, work force, and managers choices. Aquatic weed control will be conducted where applicable.

The direct effect of aquatic weed control in ponds is the reduction of nuisance aquatic weeds. This is expected to cause no significant effects. The following discussion discloses the specific effect of each control method.

- **Chemical control** involves the use of aquatic herbicides that have met strict Environmental Protection Agency standards for use in an aquatic environment. Improper use of chemicals could result in serious environmental damage, fish kills, contaminated water supplies, and danger to human health. If chemical treatment is used, the shallow water conditions conducive to aquatic vegetation growth would remain and the vegetation would become a problem again in two or three years. Therefore, a consistent treatment with chemicals would be required to keep the nuisance aquatic weeds under control. Low dissolved oxygen levels can result from the natural decay of treated (killed) aquatic weeds. Fish kills may result if the dissolved oxygen level becomes too low. However, with the following protective measures and guidelines implemented, chemical control should have no negative effects.

  Herbicides will be applied according to guidelines, rates, and restrictions specified on the label. Rates and methods of application would be controlled to prevent non-target species

from exposures. Any herbicide used in swimming or fishing areas will be labeled for that use. A certified applicator will supervise application. Equipment and containers will be cleaned or disposed of according to label instructions. To avoid dissolved oxygen depletions, no more than half of the pond should be treated at one time.

- **Mechanical control** is the actual removal of aquatic weeds by tools or machines. Mechanical removal of aquatic weeds is a very short term treatment. Most methods of mechanical control fragment aquatic vegetation and may in fact increase the problem in the future, since many species of aquatic vegetation reproduce from small pieces of the vegetation. Mechanical control is usually slower and more costly than other methods of control. There may be some significant biological impacts. Plant fragments left in a water body may deplete dissolved oxygen if they die and decompose. Dissolved oxygen depletion in turn may cause a fish kill. If mechanical treatment is used, the shallow water conditions conducive to aquatic weed growth would remain and the weeds would become a problem again in 2 or 3 years.
- **Biological control** measures have potential for effective, economical, and permanent control of aquatic weeds. Biological controls are not intended to eliminate nuisance plant species but rather to reduce them to a non-nuisance density. Control is successful if the predator and nuisance plant reach a state of equilibrium. Grass carp (*Ctenopharyngodon idella*) is a non-native species of fish that consumes vegetation almost exclusively after they reach 10 inches in length. During warm weather, grass carp can consume 30 to 40 percent of their body weight in aquatic vegetation every day. When stocked at the proper rate, these fish can provide effective control of most types of submerged aquatic weeds. Compared to other methods of aquatic weed control, the grass carp is relatively inexpensive and may provide long-lasting effects. Grass carp do eventually reach a large enough size that they are no longer effective consuming vegetation at a large rate. When this happens new smaller grass carp can be stocked. Unlike the common carp (*Cyprinus carpio*) found in South Carolina waters, grass carp feed primarily on submersed vegetation and do not stir up bottom mud. The possibility of grass carp having an adverse environmental impact on native aquatic plant communities is contingent upon their reaching streams, spawning successfully and the young surviving in large enough numbers to bring about harmful changes. Reproduction, however, normally does not occur in ponds because these fish need flowing water to successfully spawn. When stocked at recommended rates, displacement of or interference with existing fish species should not occur. With the following protective measures and guidelines implemented, grass carp should have no negative effects: Only certified triploid (sterile or non-reproducing) grass carp from licensed distributors will be stocked into Francis Marion National Forest ponds. Grass carp should only be used at the specific recommendation and guidance of a fisheries biologist.
- **Habitat manipulation** limits plant growth by altering one or more of the physical or chemical factors critical to growth, such as, light, or physiological processes factors of the plant. Fertilization is an effective method of control for submersed aquatic weeds. Organic turbidity caused by increasing fertility increases phytoplankton and reduces visibility and water clarity which shades the submerged plants so they cannot photosynthesize. The effects of fertilization are discussed in the fertilization section. Water level manipulation is an effective method of control for rooted species of aquatic weeds. Drawdowns during the fall and winter can expose the aquatic weeds to drying winds and freezing temperatures thus reducing it to acceptable levels. A winter drawdown would have the least significant impact because: (1) fishing during this time of year

would be at a minimum; and (2) there would be greater predator-prey interaction in the pond because of concentration of fish. Flooding may reduce certain species of rooted aquatic vegetation if the water is raised and kept above the plants exposed leaf zone. If water level manipulation is used, the shallow water conditions conducive to aquatic weed growth would remain and the weeds would become a problem again in 2 or 3 years.

There are no anticipated cumulative effects on the environment from aquatic weed control within the pond treated or downstream.

Angler Access Improvement: Fishing piers and boat ramps may be provided. These structures enable the pond sport fish population to be managed for optimal recreational benefits. Access to angling opportunities should increase with the installation of these structures.

The direct effect of installing fishing piers and boat ramps in ponds is that they improve angler access. Fishing piers provide bank anglers with access to deeper water. Many wooden piers in recreation area ponds are constructed to allow use by physically challenged anglers. These fishing piers can also provide structure for aquatic species. Boat ramps are constructed to allow anglers to launch boats on trailers with minimal difficulty.

The construction of fishing piers and boat ramps sometimes requires use of heavy equipment when ponds have been drained. During this process, some soil may be disturbed. Any soil erosion resulting from this activity would be temporary and would be minimized by the installation of erosion control measures such as temporary vegetation around the shoreline until the pond is flooded.

There are no anticipated cumulative effects on the environment from angler access improvement within the pond receiving the improvements or downstream.

Fish Population Management: There are three means of fish population management: stocking, removal, and harvest restrictions. At the time when fish population management is needed, management method chosen will depend on current population assessment, funding, work force, and managers choices.

The direct effect of fish population management in ponds is the establishment and maintenance of the proper species balance and size structure.

- **Stocking** – Renovated ponds or newly constructed ponds are typically stocked with a combination of largemouth bass, bluegill, redear, and channel catfish. In addition, species such as threadfin shad and fathead minnows are sometimes stocked to provide additional forage for largemouth bass.

  Supplemental stocking involves replacing a segment of the fish population that is absent. In some instances, a species may experience poor recruitment of young fish into the population. This would require supplemental stocking to replace that missing year-class of fish.

- **Removal** – This involves removing part or all of the fish population in a pond to restore balance. In some instances a non-native invasive species or an undesirable species has become established and all the fish in the pond will need to be eradicated and the pond restocked with desirable species. Eradication of the entire population may also be needed when it has become unbalanced beyond recovery. Partial removal may be needed when a particular species has become overabundant thus impacting the rest of the fish population.

Electrofishing may be used for partial removal. This will require an electrofishing boat with crew that includes a boat operator. The pond would be periodically electrofished until the desired population balance and size structure is achieved. Shocker efficiency, depth of the target species within the pond, underwater visibility, and sheer numbers of the target species present will all play a role in removal success. It is unlikely that more than twenty percent of the target species population would be removed. Negative impacts to sportfish would be minimal; however, some sportfish would be lost. No downstream areas would be impacted.

- **Harvest Restrictions** – This involves the use creel and length limits for designated species of fish to maintain balanced fish populations and quality fishing. Forest Supervisor orders provide for flexible creel limits and closures based upon the management needs of each individual body of water.

Nuisance Animal Control: Beavers, muskrats, nutria, otters, and alligators can be a nuisance or even cause damage. Burrowing and damming activities can cause dam failure or flood adjacent landowners. Angler access and fish habitat improvements can also be flooded. A family of otters can practically eliminate catchable-size fish in a small pond. Alligators can present a safety concern in ponds with swimming. Trapping and removal will be practiced to maintain nuisance animal populations at acceptable levels.

There are no anticipated direct, indirect, or cumulative effects on the environment from nuisance animal control within the pond treated or downstream.

3.4.14 Huntable and Fishable Species

3.4.14.1 Affected Environment: Huntable and Fishable Species

Hunting and fishing are two of the most popular recreational activities pursued on the Francis Marion National Forest. Both activities play a vital role in social and economic sustainability. Hunting was the number one activity selected by respondents as the main purpose of their national forest visit during the 2008 Francis Marion and Sumter Visitor Use Report (page 20). Furthermore, the Francis Marion is documented by the South Carolina Department of Natural Resources as having high hunter use.

The National Forest Management Act requires that national forests “provide for diversity of plant and animal communities based on the suitability and capability of the specific land area . . .” The Francis Marion is within South Carolina’s Lowcountry and is a mix of swamps, bays and dry sand landscapes of longleaf and loblolly pine. This setting provides an abundance of diverse native vegetation that serves as food for many wildlife species. The Francis Marion fills a specific niche by providing older forest conditions and open grassy/forb habitat, both of which are less likely to occur on adjacent private forestland.

Much of the privately owned property surrounding the Francis Marion is rural with residential areas scattered amongst agriculture fields and production forestlands. Vegetation types on the national forest include soft and hard mast producing trees as oaks, hickories, cherries and persimmon, but other forage as grapes, berries, succulent stems and herbaceous plants are abundant for wildlife species. The forest also provides critical and essential habitat components such as snags, stumps, stumps, holes, dens, and downed wood which provide cover, nesting and/or denning opportunities for many wildlife species.

Information about fishable species can be found in the "Recreational Fisheries Management" section.

Wildlife Demand Species: Due to the diversity of habitats found on the Francis Marion, hunters are able to pursue game animals such as white-tailed deer (*Odocoileus virginianus*), wild turkey (*Meleagris gallopavo*), bobwhite quail (*Colinus virginianus*), waterfowl, and other small game species. All areas open to hunting on the Francis Marion are enrolled in the South Carolina Wildlife Management Area Program. The Francis Marion and Sumter National Forests are vital components of the Wildlife Management Area Program in South Carolina. Forest Service lands account for approximately 60 percent (629,906 acres) of the roughly 1.1 million acres enrolled in the program. The Francis Marion manages approximately 324 acres of waterfowl impoundments and green-tree reservoirs.

Effects to game species habitat are influenced by the amount of early successional habitat, availability of mast, and the impacts of human disturbance (primarily roads and motorized trails) on brood rearing habitat. South Carolina Department of Natural Resources and the Francis Marion will continue their cooperative relationship in the management of wildlife management areas providing a wide choice of habitats for game species in all three alternatives.

3.4.14.2 Environmental Consequences: Huntable and Fishable Species

Effects to Wildlife Demand Species

The **white-tailed deer** population on the Francis Marion has been recovered from its near extirpation at the turn of the century, primarily due to the increase in hunting, restoration of forest lands and the ability of the species to adapt to fragmented habitats. This species was traditionally hunted for its meat and hides by Native Americans, and later by European settlers, which led to its near extirpation in the Southeast. Today the white-tailed deer is the most heavily hunted game animal in the Southeast and on the Francis Marion. White-tailed deer are primarily browsers, feeding on leaves and twigs of a variety of plants, acorns (other seeds or hard mast), fruits (soft mast), and herbs. They prefer a mixture of young and older forests, old fields and croplands. Forest management practices such as prescribed burning and timber thinning treatments are essential to improving habitat for this species.

The **wild turkey** population on the Francis Marion is currently stable to increasing, which is a recovery from its near extirpation in the mid-1900s. This recovery is due to restoration efforts by South Carolina Department of Natural Resources and the National Wild Turkey Federation. These efforts were followed by an increase in hunting regulations and intense harvest monitoring. In addition, this success could be attributed to the presence of forested conditions and open woodland habitats on national forest lands and adjacent privately owned lands. This species has traditionally been hunted across the Southeast for its meat and feathers; today it is a very popular game species.

Turkeys prefer forests with openings, burned areas and savannas. These areas support low herbaceous or grassy ground cover and insects needed for brood-rearing. Even though acorns are a favorite, a wide array of insects, fruits, seeds, buds, grasses, green vegetation, other mast and small animals are consumed regularly. Growing season burns may negatively impact nesting activities of individuals, but would not likely offset the local population. Additionally, the numerous acres of improved habitat after a prescribed growing season burn greatly outweigh any loss. These birds would typically recover from such a disturbance by re-nesting shortly after an event. Forest management practices, such as prescribed burning and timber thinning treatments are essential to improving habitat for this species.

Bobwhite quail inhabits, and is very much dependent on, early successional and open woodland habitats. Early successional habitat was more prevalent on the landscape in the early to mid-1900s due to the abundance of agriculture. This habitat is found less often today. Furthermore, research has shown this species to be declining within its historical range and this is likely due to this lack of habitat. Today, quail are often hunted in open woodland situations, similar to that of the longleaf pine forest found historically across the Southeast and the Francis Marion. Traditionally this species was hunted for its meat and its feathers.

Two management actions that vary by alternative and would affect this species habitat are:

1. The creation of early successional habitat (0 to 10 year old forest); and
2. The amount of prescribed fire to maintain open woodlands.

Forest management practices such as prescribed burning and timber thinning treatments are essential to improving habitat for this species. Growing season burns may negatively impact nesting activities of individuals, but would not likely offset the local population. Additionally, the numerous acres of improved habitat after a prescribed growing season burn greatly outweigh any potential loss. Bobwhite quail would typically recover from such a disturbance by re-nesting shortly after an event.

The **waterfowl** population on the Francis Marion is somewhat stable, but the demand for these species seems to be increasing. Traditionally these species were hunted for their meat and feathers, but today it may be mostly for the recreational experience. Of the wildlife demand waterfowl species, the wood duck (*Aix sponsa*) is the primary hunted species. On occasion other waterfowl game species may pass through. Most waterfowl species are migratory, only spending a short period of time on the Francis Marion then moving on, but wood ducks nest and raise their young on the national forest. This species is not dependent on early successional habitats or open woodland habitats, but prefers bottomland hardwood swamps, wooded sloughs, marshes or forested riparian areas.

Other **small game** species which are demand species include, but are not limited to: eastern gray squirrel (*Sciurus carolinesis*), eastern cotton-tailed rabbit (*Sylvilagus floridanus*) and mourning dove (*Zenaida macroura*). Even though these species and other small game species are not pursued as heavily as white-tailed deer or wild turkey they do have a local hunting populous. While these species are unique and have some independent habitat requirements, they also have an increased ability to adapt to disturbance.

Alternative 1

Direct, Indirect Effects. Alternative 1 would likely have no direct effects; however, it would have indirect effects to all the wildlife demand species expect the waterfowl species since there would be minimal creation of early successional and oak mesic habitats. Furthermore, hunting opportunities would decrease as the Francis Marion and landscapes move further away from habitat types these species require.

Alternative 2

Direct, Indirect Effects. Alternative 2 would likely have no direct effects; however, it would have an indirect benefit since there would be an increase in early successional habitat and the restored oak mesic habitats for the wildlife demand species (except the waterfowl species). Additionally, it would likely increase opportunities for hunting experiences which are dependent on early successional and restored oak mesic habitats. Ecological restoration activities would

generally produce more early seral stage forest in the first decade. Table 3-80 displays the conditions by alternative that would improve hunting. Increases in hunting habitat would increase user satisfaction for visitors; therefore, effects on hunters would generally be positive.

Some specific areas on the Francis Marion would provide more remote experiences and increase areas with closed roads; this would affect some hunters more negatively by decreasing access to certain places. This would have positive effects on other hunters who prefer a more remote experience and less vehicular disturbance.

Table 3-80. Estimated total acres (total for 1st decade) of wildlife habitat by alternative

Type of Game Habitat	Alt 1	Alt 2	Alt 3
Upland Hardwood (Oak Forest and Mesic Hardwood Forest)	5,800	5,800	5,800
Wildlife Openings	665	665	565
Early Successional Forest Habitat	9,238	28,257	23,631

Note: Early successional forest habitat includes even age treatments.

Alternative 3

Direct, Indirect Effects. Alternative 3 would likely have no direct effects; it would have an indirect benefit to the wildlife demand species (except the waterfowl species) since early successional and restored oak mesic habitats would increase. Additionally, opportunities would increase for hunting experiences that are dependent on early successional and restored oak mesic habitats. Ecological restoration activities would generally produce more early seral stage forest in the first decade. Table 3-80 displays the conditions by alternative that would improve hunting. Increases in hunting habitat would increase user satisfaction for visitors; effects on hunters would generally be positive.

In alternative 3, more wilderness areas are recommended—more than 33,000 acres. These areas would be open to hunting, but access would be decreased as some roads and a few wildlife openings would be closed. This may affect some hunters more negatively by decreasing roaded access to certain places. This would have positive effects on other hunters who prefer a more remote experience and less vehicular disturbance.

Cumulative Effects

The current status of these wildlife demand species is good, but improved habitat would greatly benefit most of these species. Hunting decreases the satisfaction of some other users, especially some trail users, due to safety concerns. Effects may include a decrease in use on certain trails during the hunting season to avoid safety concerns. It is not expected that private landowners will restore or manage to maintain significant amounts of these desired habitats for the wildlife demand species. Decreases in populations of these species are expected on private lands due to the continued loss of forested habitats and increased development.

Effects to Visual Demand Species

Due to the diversity of habitats and the associated flora and fauna found on the Francis Marion, many observers travel to the forest to hike, drive through, take pictures, or simply observe. These individuals may visit to view wildlife (such as birds, frogs, or dragonflies) and plant species including wild flowers, pollinators, and orchids, as well as open woodland and savannas or mature southern pine forest habitats.

Alternative 1

Direct, Indirect Effects. Alternative 1 would likely have no direct effects; however, there would be indirect effects to many of the visual demand species since creation of early successional and oak mesic habitats would be minimal. This alternative would allow for the lower amount of treatments, thus resulting in fewer acres of improved habitats for a diversity of species. Furthermore, viewing opportunities would decrease as the Francis Marion matures and landscapes move further away from the diversity of early successional habitat types.

Alternative 2

Direct, Indirect Effects. Alternative 2 would likely have no direct effects; however, there would be an indirect benefit to the visual demand species since in early successional and the restored oak mesic habitats would increase. Also, opportunities for viewing experiences that are dependent on the diversity of habitats would likely increase. Increases in the viewing habitat would increase user satisfaction and effects on this user group would generally be positive.

Some specific areas on the Francis Marion would provide more remote experiences and areas with closed roads; this would affect some of this user group more negatively by decreasing the access to certain places. It would also positively affect others who prefer a more remote experience and less vehicular disturbance.

Alternative 3

Direct, Indirect Effects. Alternative 3 would likely have no direct effects; however, there would be an indirect benefit since the diversity of habitats would increase. Additionally, opportunities for viewing experiences that are dependent on diverse habitats would increase. More viewing habitat would increase user satisfaction and effects on this user group would generally be positive.

Alternative 3 would recommend more than 33,000 acres in wilderness that would be open to viewing. However, access would decrease as some roads and wildlife openings would be closed. This may affect some individual users more negatively by decreasing roaded access to certain places. However, it will positively affect others who prefer a more remote experience and less vehicular disturbance.

Cumulative Effects

The current status of these visual demand species is good, but improved habitat would be beneficial to most of these species. Hunting decreases the satisfaction of some other users, especially some trail users, due to safety concerns. Effects may include a decrease in use on certain trails during the hunting season to avoid safety concerns. It is not expected that private landowners will restore or manage to maintain significant amounts of diverse habitats for the visual demand species. Decreases in populations of these species are expected on private lands due to the continued loss of forested habitats and increased development.

3.4.15 Social Demographics

3.4.15.1 Affected Environment: Social Demographics

Located 140 miles east of the Forest Supervisor’s Office in Columbia and 40 miles north of Charleston, the Francis Marion National Forest includes the communities of Awendaw, Huger, Jamestown, and McClellanville. While few people live within the national forest boundaries, numerous nearby communities have longstanding social and economic ties to the natural and

cultural resources of the Francis Marion National Forest. Since neighboring communities may be affected by forest management decisions on the Francis Marion, it is important to examine existing socioeconomic conditions of a broader region in order to establish a baseline against which potential impacts can be measured. To more effectively examine the linkages between national forest lands and the local communities they serve, the geographic scope of this analysis has been expanded beyond Francis Marion National Forest boundaries to encompass a broader social and economic study area.

Communities within Berkeley, Charleston, Clarendon Dorchester, Georgetown, Horry, Orangeburg, and Williamsburg Counties were recognized as having the strongest social and economic ties to the Francis Marion National Forest. While visitors travel from far and wide, residents of these eight counties were identified as having stronger ties and are most likely to be affected by changes in forest management because of their reliance on forest resources to sustain the social, cultural, and economic well-being of their communities. To more accurately measure the economic contributions and potential impacts resulting from changes in budget expenditures associated with management actions on the national forest, the economic study was further extended to include Lexington, Richland, and Calhoun Counties that surround the Supervisors Office in the capital of Columbia, South Carolina. The following “Affected Environment” section provides an overview of trends and current conditions related to the social and economic environment within these study areas, including: population and demographic changes, potential environmental justice populations, and employment and income conditions. Additional affected environment information, relevant to the effects analysis, is provided in Appendix F. To ensure large-scale impacts are addressed without masking changes in smaller regions, this analysis uses a multidimensional approach to analyze trends at the state, aggregated study area, and individual county levels. In addition, existing conditions and effects are portrayed for the resource integration zones (Coastal, Wando, Wambaw, and Santee).

The Francis Marion National Forest is located within the Gullah-Geechee Cultural Heritage Corridor, a congressionally designated National Heritage Area created to preserve the unique African-based heritage and culture of slave-descendants along the Southern Atlantic Seaboard. Gullah communities within the proclaimed national forest boundary are small heir property[7] communities, which developed a unique culture that blends African traditions with the cultures they encountered before and after emancipation. These rural communities share a common history rooted in farming, fishing, and slavery, and have sustained strong ties to the people and lands associated with their ancestors. Because of their relative isolation and strong sense of community, Gullah communities have retained high levels of their African heritage emphasizing its importance for their community. Their ability to continue to live off the land and pass down the language, traditions, and way of life of their ancestors is essential to preserving the Gullah ethnic identify and unique sense of place within South Carolina’s Lowcountry.

Population and Demographics. This section highlights population and demographic trends in the area surrounding the Francis Marion National Forest. Population is an important consideration in managing natural resources. In particular, population structure (size, composition, density) and population dynamics (how the structure changes over time) are essential to describing the consequences of forest management on the social environment (Seesholtz et al. 2004).

[7] Heir property is land that is jointly owned by descendants of a deceased person whose estate was never handled in probate. These descendants (heirs) have the right to use the property, but they do not have clear or marketable title to the property since the estate issues have not been resolved.

Population Growth. Population growth can be an indicator of a region's desirability to live and work. As displayed in Table 3-81 and *Source:* U.S. Census Bureau 1990, 2000, 2010.

Table 3-82, the rapid population growth in South Carolina and the eight-county study area over the last 30 years suggests that this area is highly desirable to current and prospective residents. While the total U.S. population grew by 36 percent between 1980 and 2010, the state's population increased by 48 percent and total population within the study area increased by 60 percent (U.S. Census 2010).

Growth within the eight-county study area exceeded the state and national growth over the last 30 years, growing by 2 percent on annual average. While the population of the eight-county study area grew rapidly between 1980 and 2010, the rate of growth varied considerably between counties included in the study area. Over this 30-year period, population growth within the study area was highly concentrated in Berkeley, Dorchester, and Horry Counties, while the population of Williamsburg slowly declined. On average these counties grew by 3, 4, and 5 percent respectively while Williamsburg decreased by less than 1 percent annually (U.S. Census 2010).

Amenities (the natural, cultural, and social characteristics of an area) have played an increasing role in U.S. migration (see discussion of migration in Appendix F that augments population data above). Areas characterized as having high levels of natural amenities (unique land and water features, mild temperatures, scenic quality, and recreation opportunities of a geographic region) have been shown to experience greater population growth than areas with fewer natural amenities (Rudzitis and Johansen 1991; Johnson and Beale 1994; Johnson and Beale 1998; McGranahan 1999; Hunter et. al 2005; Frentz et. al 2004), and this growth occurs increasingly at the boundaries of public lands (Hansen et. al 1998; Radeloff et. al 2001). In recent years communities surrounding the Francis Marion, like those in Dorchester and Horry Counties, have become increasingly attractive to many Americans because of their proximity to open spaces and natural settings, which provide residents with easy access to recreational opportunities year round. As a steward of South Carolina's public lands, a portion of population growth in this region can be attributed to the scenic beauty and outdoor recreation supported by the Francis Marion National Forest.

Table 3-81. Current and historic population totals in the nation, the state and 8-county area

	1980	1990	2000	2010	Percent Change 80-10
United States	226,545,805	248,709,873	281,421,906	308,745,538	36%
South Carolina	3,121,820	3,486,703	4,012,012	4,625,364	48%
8 County Area	722,308	847,298	962,760	1,155,951	60%

Source: U.S. Census Bureau 1990, 2000, 2010.

Table 3-82. Current and historic population totals in South Carolina counties

County	1980	1990	2000	2010	Percent Change 80-10
Berkeley	94,727	128,776	142,651	177,843	88%
Charleston	276,974	295,039	309,969	350,209	26%
Clarendon	27,464	28,450	32,502	34,971	27%
Dorchester	58,761	83,060	96,413	136,555	132%
Georgetown	42,461	46,302	55,797	60,158	42%
Horry	101,419	144,053	196,629	269,291	166%
Orangeburg	82,276	84,803	91,582	92,501	12%
Williamsburg	38,226	36,815	37,217	34,423	-10%

Source: U.S. Census Bureau 1990, 2000, 2010.

Racial and Ethnic Composition. South Carolina’s population tends to be more racially diverse than the general U.S. population. While 74 percent of the country’s population identifies themselves as White, Whites only account for 67 percent of the state’s population. Historically African American populations in South Carolina have accounted for a large share of the state’s population. In 2010 roughly 28 percent of South Carolina residents identified themselves as Black or African American. While individual shares are small, Native Americans, Asians, Pacific Islanders, and individuals identifying with some other or multiple races account for nearly 5 percent of the state’s population (U.S. Census Bureau 2010).

Minority populations make up an even larger share of the population within the eight-county study area. While shares of Native Americans, Asians, Pacific Islanders, and individuals identifying with some other or multiple races only make up 5 percent of the region’s population, African Americans account for nearly 30 percent of the region’s population (U.S. Census Bureau 2010). As a shown by Figure 3-45, there is considerable variation in the racial composition of study area counties.

Figure 3-45 shows county, state, and national populations broken down into racial groups’ share of total population. Within the study area Horry County was the least racially diverse, with roughly 80 percent of the population identifying themselves as White alone; while Williamsburg was the most diverse with Whites accounting for only 32 percent of the population. The area surrounding the Francis Marion National Forest has a large African American population, with African Americans making up 50 percent or more of the population in Clarendon (50 percent), Orangeburg (63 percent) and Williamsburg (66 percent).

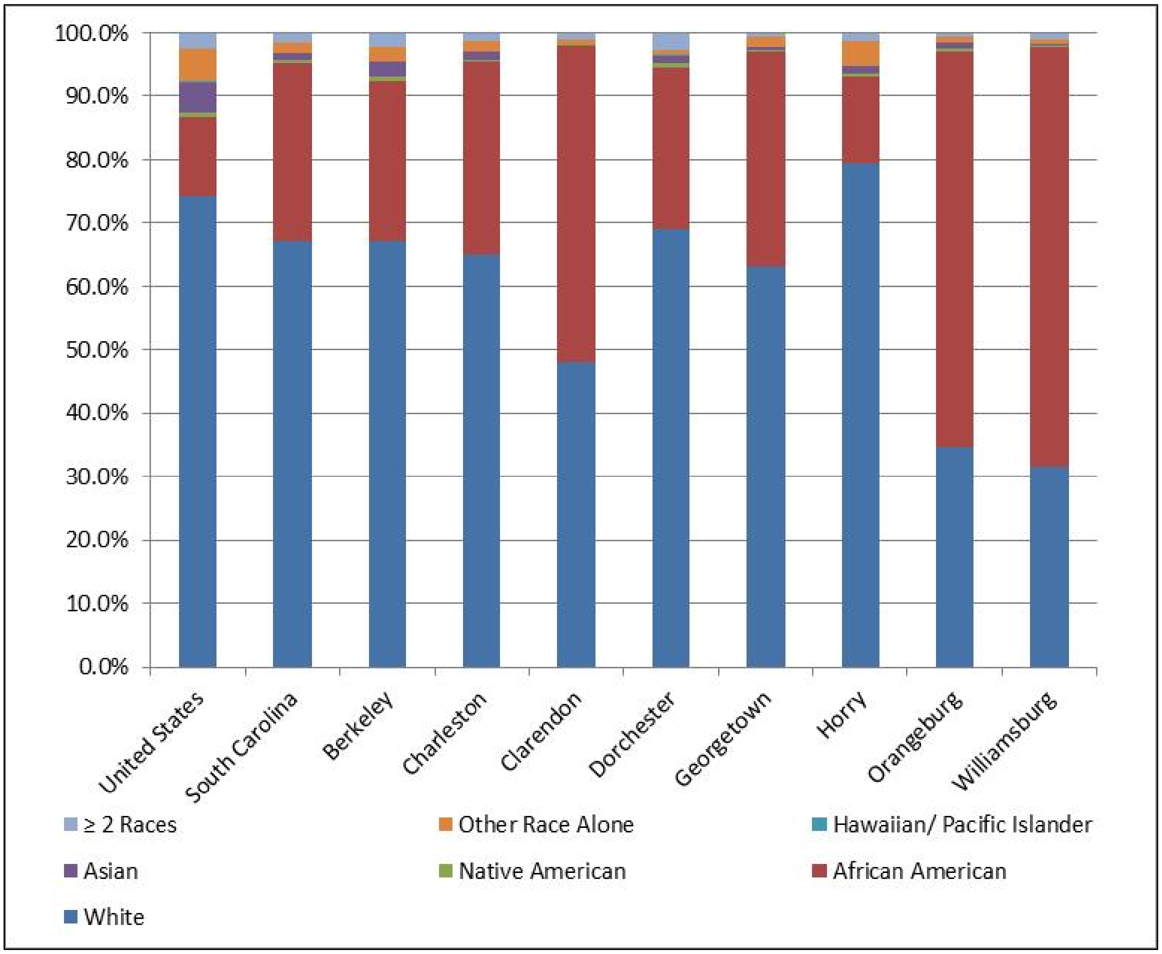


Figure 3-45. Racial composition, 2010
Source: U.S. Census Bureau, 2010: Table QT-P6

Many Americans identify with, and are proud of, the cultural heritage from which they descend. Although Americans may appear to look White, Black, Asian, or belonging to some other racial group, they often continue to speak the native language, and follow cultural traditions, from the regions where their families originated. In 2010, roughly 17 percent of Americans described their family ancestry as being Hispanic, Latin, or Spanish. While these cultures have a noticeable presence in the United States, only 5 percent of the state and study area's population reported being of Hispanic descent. Even though Hispanics accounted for a slightly greater share of the population in Berkeley (6 percent) and Horry (6 percent) Counties, Hispanic cultures are less predominate in this region of the country relative to the United States as a whole (U.S. Census Bureau 2010).

Employment and Income. The previous section discussed demographics and population trends in counties surrounding the Francis Marion National Forest relative to the state and nation. The following section will focus on economic conditions within the study area to further develop a baseline on which potential impacts can be measured against.

Employment and Specialization. The local economy examined in the analysis of the Francis Marion is diverse and supports employment in more than 300 industries. In general these industries are identified as being either services related or non-services related. Services-related

sectors include: utilities; wholesale trade; retail trade; transportation and warehousing information; finance and insurance; real estate and rental and leasing; professional, scientific, and technology; management of companies and enterprises; administrative and support services; educational services; health care and social assistance; arts, entertainment, and recreation; accommodation and food services; and other services. Non-services-related sectors consist of the following sectors: mining, construction, manufacturing, and agriculture, forestry, fishing, and hunting.

Total employment in the eight-county study area increased from 348,044 to 377,939 jobs between 1998 and 2010. 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. Study area jobs in service-related sectors paid on average 36 percent less than jobs in non-services-related fields (Bureau of Labor Statistics, 2012). Between 1998 and 2010 employment in non-services-related sectors declined by 28 percent while employment in services-related sectors increased by 18 percent. In 1998, services-related sectors supported 79 percent of regional employment, with services-related employment growing to 86 percent of total employment in the eight counties surrounding the Francis Marion by 2010 (Bureau of Labor Statistics 2012). 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 of the area's minority or underserved populations. In general, services-related sectors provide greater employment opportunities for women and minority racial groups than industries in the non-service sector.

Economic diversity generally promotes stability and offers greater employment opportunities. Highly specialized economies (those that depend on a few industries for the bulk of employment and income) are prone to cyclical fluctuations and offer more limited job opportunities. Assessing employment by sector helps identify industries which are important to the local economy surrounding the Francis Marion National Forest Figure 3-46 shows local employment in aggregated sectors as a share of total employment (IMPLAN 2012). In 2012 the Government (16 percent), retail trade (12 percent), and accommodation and food services (11 percent) sectors were the largest employers within the eight-county study area, accounting for 39 percent of total study area employment. A portion of employment in many industries can be directly or indirectly attributed to the Francis Marion National Forest but not all employment in Figure 3-47 is attributable; employment contributions provided by the Francis Marion are discussed below in the "Forest Users and Contributions to Social and Economic Sustainability" section.

The Interior Columbia Basin Ecosystem Management Project identified communities that were specialized with respect to employment. Employment specialization can be examined using the ratio of the percent employment in each industry in the region of interest (eight-county study area) to the percent of employment in that industry for a larger reference region (the state of South Carolina). For a given industry, when the percent employment in the analysis region is greater than in the reference region, local employment specialization exists in that industry (USDA Forest Service 1998). Applying this criterion to 2012 employment data for the Francis Marion National Forest study area reveals that the region is specialized with respect to the accommodations and food services (+2.9 percent), followed by the real estate & rental sector (+2.0 percent) and the arts, entertainment & recreation sector (+1.2 percent), retail trade (+0.7 percent), professional services (+0.2 percent), and transportation and warehousing (+0.4 percent).

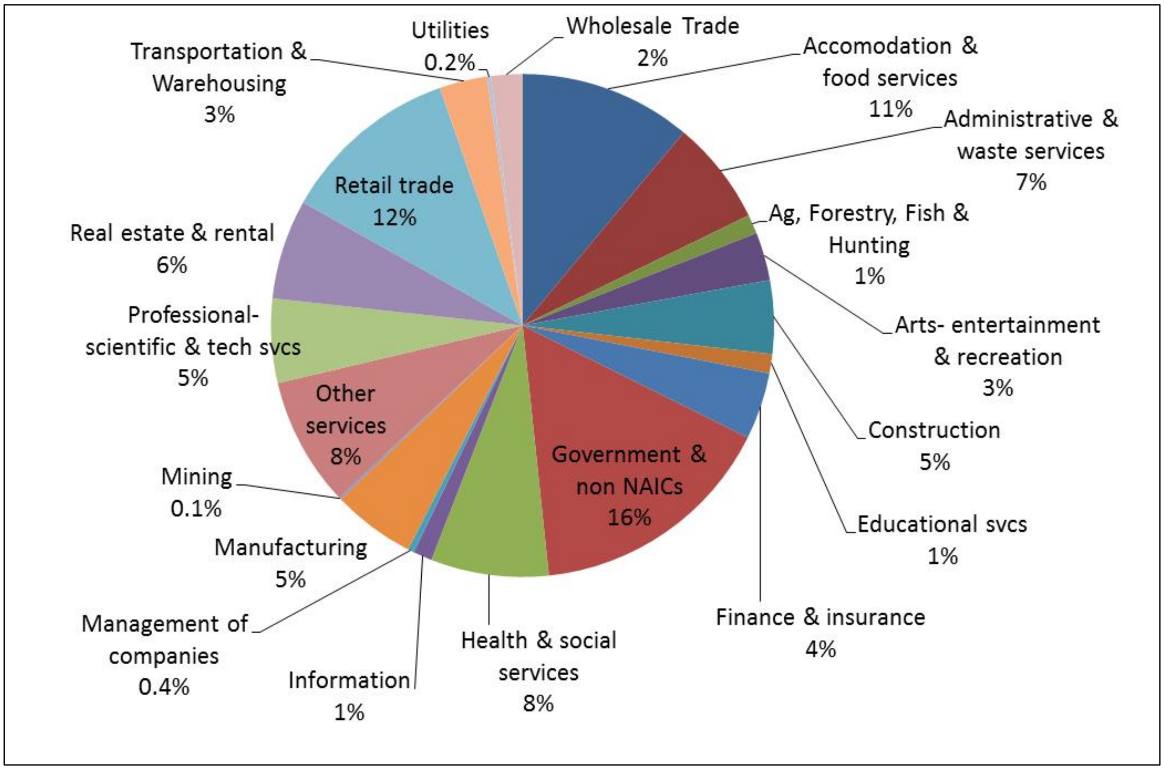


Figure 3-46. Employment by industry, 2012

Employment specialization is of particular interest when specialization occurs in sectors related to forest management. A portion of employment in the sectors shown in Figure 3-47 can be attributed to forest management, timber production[8] and recreation on the Francis Marion National Forest. The government sector includes all Federal, state and local employment, while a portion of employment in the accommodations and food services, arts, entertainment and recreation, retail trade, and passenger transportation sectors is specifically attributed to tourism and recreation (Marcouiller and Xia 2008). Relative to the state of South Carolina, the eight-county study area is not specialized in sectors related to forestry and is specialized in service-related sectors that support recreation and tourism. Specialization in the four recreation-related sectors highlights the importance of tourism and recreation to the local economy. While the Charleston area provides an abundance of recreational opportunities, the unique recreational experiences of the Francis Marion are attributed with attracting outdoor recreationists to the Charleston area. For a more detailed discussion of the Francis Marion's recreation-related employment contributions see the "Recreation" section included in "Forest Contributions."

[8] Sectors related to timber include: forestry and logging (IMPLAN sectors 15, 16, 19, 335), primary forest products manufacturing (IMPLAN sectors 31, 95, 96, 98, 105), and secondary forest products manufacturing (IMPLAN sectors (97, 99, 100, 102, 106, 107, 108, 109, 110, 111, 112, 295, 297, 301, 302) (BBER 2010).

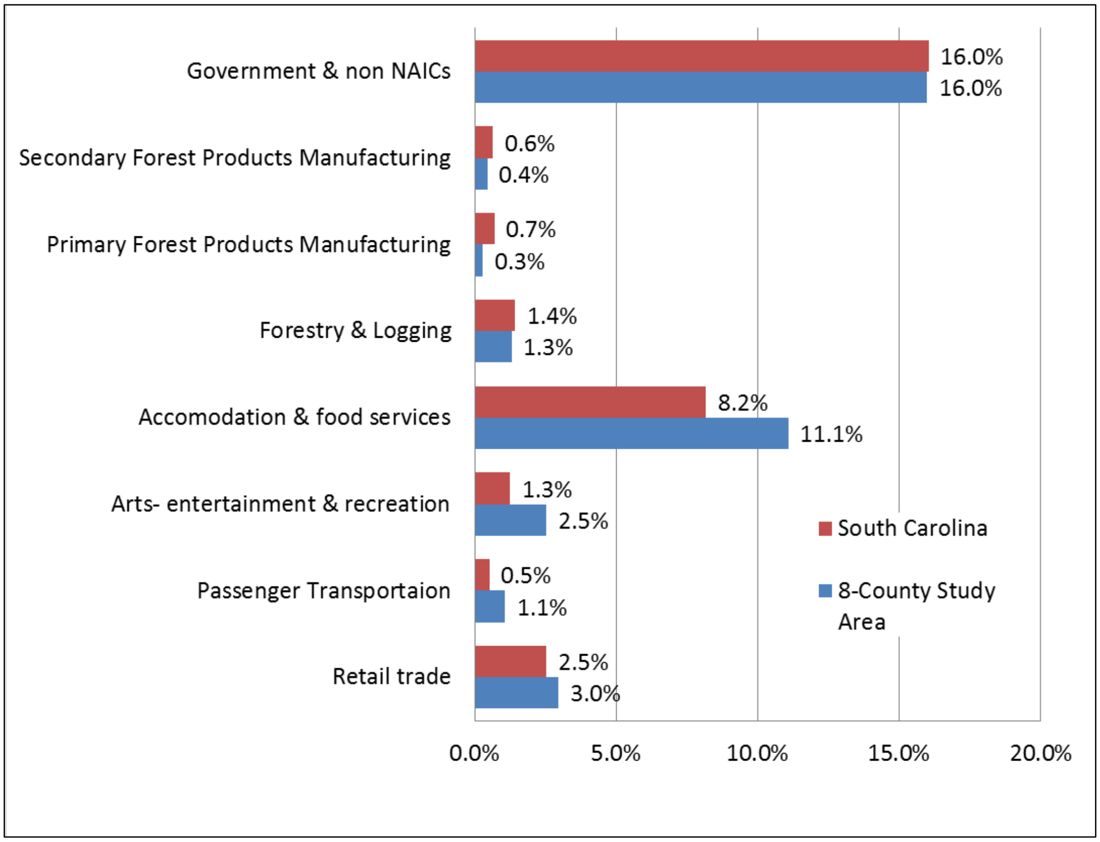


Figure 3-47. 2012 State and study area employment distribution for forest-related sectors
Source: IMPLAN 2012

Personal Income. Personal income is an indicator of the economic well-being of a county and provides a measure of all sources of income within the Francis Marion National Forest study 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 the poor economic conditions and relatively few economic opportunities available within a region. Total personal income in the study area exceeded $41.3 billion dollars in 2011, with Charleston County accounting for more than a third of the study area's total personal income. Personal income in the study area has grown much more rapidly than total personal income across the state. Between 2000 and 2011 total personal income in South Carolina grew by 18.6 percent while total personal income within the eight-county study area grew by 30.4 percent (adjusted for inflation and reported in 2011 dollars; Bureau of Economic Analysis, 2012a).

Per capita personal income measures average income per person in a region. Historically per capita personal income in South Carolina and much of the region surrounding the Francis Marion National Forest has been lower than that across the country. As shown by Table 3-83, per capita personal income across the state and country has steadily increased between 1990 and 2011. While per capita personal income at the state level grew at a slightly slower rate than that of the nation, per capita personal income across the study area occurred much more rapidly. On average per capita personal income rose by 32 percent across the study area between 1990 and 2011, with sluggish growth in Horry County (+9 percent) and very rapid growth in Georgetown County (+51 percent). Though personal income in the region has increased, average per capita personal income

within the study area remains below that of the state and the country (Bureau of Economic Analysis 2012b).

Table 3-83. Per capita income, 1990 and 2011 (adjusted for inflation and reported in 2011 dollars)

Area	1990	2011	Percent Change 1990-2011
United States	$33,309	$41,560	25%
South Carolina	$27,268	$33,388	22%
Berkeley	$24,402	$33,184	36%
Charleston	$30,400	$41,656	37%
Clarendon	$18,998	$24,431	29%
Dorchester	$27,251	$33,468	23%
Georgetown	$25,420	$38,403	51%
Horry	$26,698	$29,148	9%
Orangeburg	$22,663	$28,965	28%
Williamsburg	$18,630	$27,263	46%

Source: Bureau of Economic Analysis 2012

There are two major sources of personal income: (1) labor earnings or income earned through employment and (2) non-labor income. Labor earnings, or wages, were supported by a wide range of industrial sectors and represented 63 percent of the study area's total personal income in 2011. Although wages can fluctuate between counties and across industries, average annual wage in the Francis Marion National Forest study area remain well below those of the state and the nation. In 2011 the average annual wage in the eight-county study area was $34,716, ranging from $27,885 in Clarendon County to $43,744 in Berkeley County (Table 3-84). On average, study area jobs in services-related sectors paid 36 percent less than jobs in non-services-related fields.

Table 3-84. Average annual wages, 2011

	All Sectors	Services	Non-Services
United States	$49,049	$46,983	$57,397
South Carolina	$39,231	$35,731	$49,030
Berkeley	$43,744	$38,522	$59,027
Charleston	$42,354	$37,417	$58,982
Clarendon	$27,885	$22,930	$31,223
Dorchester	$33,109	$26,416	$53,621
Georgetown	$34,815	$27,604	$49,792
Horry	$29,089	$25,999	$38,162
Orangeburg	$33,419	$ 26,611	$39,793
Williamsburg	$33,316	$26,958	$40,369

Source: U.S. Bureau of Labor Statistics 2012.

While the local economy surrounding the Francis Marion National Forest supports a large share of lower paying service jobs, the unique natural and cultural amenities of the national forest may provide addition benefits which help offset these low wages. Living in close proximity to national forest lands provides residents with greater access to open spaces, wildlands, and a wide range of recreational opportunities. 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 Francis Marion National Forest. 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; Treyz et al. 1993; Mueser and Graves 1995; McGranahan 1999; Lewis et al. 2002). As a steward of coastal South Carolina's unique natural and cultural amenities, the Francis Marion increases the attractiveness of local communities and increases regional well-being.

Personal income also includes non-labor income that individuals receive from sources other than an employer. In general there are two categories of non-labor income, investment income (dividends, interest, and rent payments) and transfer payments from the government to individuals (retirement and disability insurance, medical payments, welfare assistance, unemployment, and veteran's benefits). Non-labor income's share of total personal income has grown drastically in recent years. In 1970 non-labor income accounted for nearly 18 percent of total personal income within the study area and the state of South Carolina. By 2011 non-labor income had grown to represent more than 37 percent of total personal income in these regions (Bureau of Economic Analysis 2012a).

Poverty. Poverty is an important indicator of both economic and social well-being. Individuals with low incomes are more vulnerable to a number of hardships which may negatively affect their health, cognitive development, emotional well-being, school achievement and promote socially unacceptable behavior (Williams 1984; Haan et. al 1986; Battistich et. al 1995; Farrington 1995; Chung 2004; Booth and Caan 2005; and Hopson and Lee 2011). Following the Office of Management and Budget's Directive 14, the Census Bureau uses a set of income thresholds that vary by family size and composition to detect who is poor. If the total income for a family or an individual falls below the relevant poverty threshold, then the household members are classified as being "below the poverty level."

Table 3-85. Poverty rates, 2011

	People Below Poverty	Families Below Poverty
United States	14%	10%
South Carolina	17%	13%
Berkeley	14%	11%
Charleston	17%	12%
Clarendon	21%	16%
Dorchester	12%	10%
Georgetown	21%	14%
Horry	17%	12%
Orangeburg	25%	20%
Williamsburg	33%	27%

Source: U.S. Census Bureau 2012.

Relative to the general U.S. population, South Carolina and the eight-county study area had a slightly larger share of residents and families living below the poverty line in 2011 (Table 3-85). Poverty rates were exceptionally high in Clarendon, Georgetown, Orangeburg, and Williamsburg counties, and exceeded rates at both the state and national level (U.S. Census Bureau 2012). In general, low income individuals tend to rely more heavily on natural resources and depend more directly on national forest lands for sustenance and home heating. Since these individuals will be more vulnerable to changes in the management of local resources, it is important for forest management to understand how these forest users may be affected by restricting forest uses.

Forest Users and Contributions to Social and Economic Sustainability. National forests are productive assets which contribute to sustaining the viability of national, regional, and local communities. Uses, products, services, and visitor opportunities supported by national forest lands produce a steady flow of benefits, which contribute to the robustness and sustainability of local communities. While robustness implies diversity, sustainability refers to the community's capacity to maintain a certain level of function within the social, ecological, and economic systems it encompasses. Sustainability is a complex idea focused around intergenerational equity. This concept relates to the maintenance and enhancement of resources in order to meet the needs of current and future generations.

Sustainability is difficult to measure since the concept lacks a universally agreed upon definition. The most widely accepted definition of sustainability was developed by the United Nation's Brundtland Commission and has since been incorporated into the 2012 Planning Rule, where sustainability is defined as the capability to meet the needs of the present generation without compromising the ability of future generations to meet their needs (36 CFR 219.19). The rule's objective states that plans are to guide management so that forests and grasslands 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. Consequently a framework for evaluating contributions to social and economic sustainability needs to incorporate contributions to beneficiaries of ecosystem services.

For the purposes of examining current social and economic contributions to sustainability, and environmental consequences under the alternatives, criterion 6 of the Montréal Process is used. Criterion 6 and its indicators can be useful for purposes of evaluating social and economic sustainability under the 2012 Planning Rule (Ng 2014; Ng and Miller 2014). Criterion 6 deals with the maintenance and enhancement of long-term multiple socio-economic benefits to meet the needs of societies (MPWG 2009). Indicators under criterion 6 are mostly discussed qualitatively for communities of interest and quantitatively in the Forest Economic Contributions section. Criterion 6 indicators are:

6.1 Production and consumption

- Volume of wood production
- Total and per capita consumption of wood production
- Non-wood forest product produced or collected
- Total and per capita consumption of non-wood forest produced or collected

6.2 Investment in the forest sector

- Investment and expenditure in forest-related research, extension and development, and education

6.3 Employment and community needs

- Employment in the forest sector
- Resilience of forest-dependent communities
- Area of forest used for subsistence purposes

6.4 Recreation and tourism

- Area of forest available and/or managed for public recreation and tourism
- Number of visits attributed to recreation and tourism

6.5 Cultural, social and spiritual needs and values

- Area of forest managed primarily to protect the range of cultural, social and spiritual needs and values
- The importance of forests to people

Montréal Process indicators are incorporated into the discussion below of communities of interest and in the section below on "Forest Economic Contributions" to establish a baseline for evaluation of environmental consequences under the alternatives.

Communities Interested in Francis Marion National Forest Management. The long-term viability of communities is dependent upon the social, cultural, and emotional attachments people form with places. Although communities are often thought of in terms of geographical boundaries, communities within the Francis Marion's eight-county study area can be described by their physical place and by their connections to the local landscape. This distinction is best characterized as the difference between communities of place (people who are bound together because of where they reside, work, visit or otherwise spend a continuous portion of their time) and communities of interest (people who share a common interest or passion, regardless of their location or degree of interaction) (Patterson et al. 2003). The geographically based community refers to physical or political boundaries and not to the relationships among people who reside within these boundaries. Brown and Duguid describe communities of interest as communities-of-communities (Brown and Duguid 1991); they provide unique opportunities to explore the linkages between people and public land that may transcend the geographically defined community. The distinction between place and interest is not mutually exclusive; in fact many communities share location and values, beliefs, and attitudes because community members choose to live near like-minded people.

Uses, products, services, and visitor opportunities supported by national forests produce a steady flow of benefits, or ecosystem services, which contribute to the sustainability of forest-dependent communities. While contributions to communities of place can be measured in terms of the economic activity forest resources support in the local economy (discussed in the "Forest Economic Contributions" section), the social and cultural links between the national forest and communities of interest often transcend the boundaries of a physical place. These communities of interest are also beneficiaries of many ecosystem services. People, or beneficiaries, derive well-being from the components of nature they enjoy, consume, or use (Boyd and Banzhaf 2007). Thus

communities of interest provide a means of examining connections between communities and ecosystem services that transcend geography. Communities of interest are described below as beneficiaries (in terms of the ecosystem goods and services that they benefit from) and other interests outside the scope of ecosystem services not captured in economic considerations discussed in the “Forest Economic Contributions section.”

While each community of interest may have a unique character and unique priorities related to natural resource use, the national forest contributes to the livelihood of these communities by facilitating shared values, beliefs, and attitudes associated with the forest’s resources. In this manner, the Francis Marion National Forest can be attributed with contributing to the long-term sustainability of several communities of interest. Social sustainability refers to the maintenance of vibrant communities through the network of relationships, traditions, culture, and activities that connect people to each other and to the land (36 CFR 219.19). Based on scoping, discussions with national forest staff, and other input received from the public, communities of interest associated with the Francis Marion National Forest were identified. These communities include:

- Cultural community of interest - protection and access to resources
- Educator, student and researcher community of interest
- Government, municipal and residential community of interest
- Non-use values community of interest (those who derive benefits from the existence and bequest values of resources, including wildlife, a diverse ecosystem, viewsheds, carbon sequestration and certain designated areas)
- Recreational community of interest - consumptive, including hunting, fishing and food pickers/gathers
- Recreational community of interest - non-consumptive, including art (writing, painting, photography) connecting with history and wildlife viewing
- Recreational community of interest - water (boaters, waders, swimmers and divers)
- Recreational community of interest - regional and local contributions and effects
- Timber and forest products community of interest - regional and local contributions and effects
- Subsistence community of interest

A description of each community of interest is provided in Appendix F. Relevant components of social and economic sustainability are also included for each group, consistent with definitions and requirements under the 2012 Planning Rule, applied within the Montréal Process framework described above.

Forest Economic Contributions. The Francis Marion National Forest is managed in accordance with the Multiple-Use Sustained-Yield Act of 1960 (16 U.S.C. 528–531) to sustain the multiple uses of its renewable resources while maintaining the long-term health and productivity of the land. The Francis Marion’s resources are managed for the long-term social and economic benefit of human communities. In addition to tangible and nontangible human benefits, multiple uses mandated under the Multiple-Use Sustained-Yield Act are often economic drivers in rural communities surrounding national forest lands. Economic contributions associated with managing forest resources are generally measured in terms of the jobs and income which they support in forest-related industries. In addition to employment and income contributions directly supported

by national forest expenditures and employment, the Francis Marion's resources directly contribute to economic activity in the local recreation and tourism and timber industries, which in turn, stimulate economic activity in supporting non-forest-related sectors. Employment and labor income generated in these seemingly unrelated sectors are known as the secondary, or indirect and induced effects of economic activity supported by the Francis Marion National Forest.

Descriptions of economic contributions to the study from recreation, timber and forest products, forest expenditures and employment, and payments to states and counties are provided in Appendix F. Relevant components of economic sustainability are also included for these national forest uses, consistent with definitions and requirements under the 2012 Planning Rule, applied within the Montréal Process framework described above.

3.4.15.2 Environmental Consequences: Social Demographics

The previous sections assessed social and economic conditions and trends to establish a baseline against which potential consequences could be measured. The following section will consider the potential consequences of alternative management scenarios on the social and economic environment.

Methodology. The following economic impact analysis quantifies changes in local employment and labor income levels as a result of alternative management strategies. These impacts were estimated using a customizable input-output model known as IMPLAN Professional Version 3.0 and the Forest Economic Analysis Spreadsheet Tool (FEAST), with 2012 data. This model provides a snapshot of the local economy, from 2012, and uses forest inputs (such as resource outputs and recreation visits) so that effects can be isolated.

In addition to economic impacts, management of the Francis Marion National Forest may also have social consequences not reflected in employment and labor income effects from IMPLAN and FEAST. Potential social impacts are discussed for communities of interest, as they relate to key ecosystem services, identified as part of the assessment process, input received from the public and internal discussions with national forest staff.

Effects also address how the alternatives may affect the social and economic sustainability of communities of interest and from national forest economic contributions. This method, using criterion 6 of the Montréal Process is discussed above in the "Affected Environment" section since current trends are presented as context for evaluation under the alternatives. Indicators under criterion 6 are mostly discussed qualitatively for communities of interest and quantitatively in the "Forest Economic Contributions" section.

Assumptions. The following list presents the basic assumptions related to the social and economic analysis of potential impacts resulting associated with management of the Francis Marion National Forest under the alternatives.

- The economic analysis assesses economic impacts (net changes to the region's economy attributable to the resource outputs projected under each alternative) and does not provide measures for social welfare which could be interpreted as economic benefits or costs.
- Regional economic impacts are estimated on the basis of the assumption of full implementation of each alternative. The actual changes in the economy would depend on individuals taking advantage of the resource-related opportunities that would be supported by each alternative. If market conditions or trends in resource use were not

conducive to developing opportunities, the impact on the economy would be different than estimated here.

- Resource specialists projected annual resource outputs based on the best available information and professional judgment. The purpose of the economic analysis is to compare the relative impacts of the alternatives and should not be viewed as absolute economic impacts.
- Salary and non-salary related expenditures associated with administering the Francis Marion are assumed to be allocated to different economic sectors based on spending profiles developed by the Forest Service. It is difficult to project future salary and non-salary forest expenditures since congressional appropriations vary each year. The Francis Marion's annual budget was assumed to remain constant under all alternatives since the Francis Marion exhausts its annual budget each year and changes in management are unlikely to effect the amount of funds the national forest receives to cover operating costs.
- This analysis does not address livestock grazing. The Francis Marion has not had an active range program since 1970, and there have not been any special use requests to use the Francis Marion for grazing or to designate allotments since 2005. Although prescribed grazing has been proposed as a tool to reduce hazardous fuels in non-riparian areas, lack of existing infrastructure and necessity for specialized browsers would prohibit this method from being cost effective.

Effects Common to all Alternatives

Implementation of all alternatives will comply with valid existing rights, Federal regulations, Forest Service policies, and other requirements. While implementing alternative management strategies on the Francis Marion has the potential to impact local businesses and industrial sectors, the contribution of the Francis Marion to the local economy, and the relative differences between the alternatives, would not be large enough to cause measurable changes to local economic diversity (the number of economic sectors) or economic dependency (which occurs when the local economy is dominated by a limited number of industries). Shifts in emphasis are likely to occur over the next 20 years; however, these changes would not result from actions implemented under this forest plan.

Population Growth and Density: As mentioned in the "Affected Environment" section, a portion of population growth in this region can be attributed to the scenic beauty and outdoor recreation supported by the Francis Marion National Forest. Communities surrounding the Francis Marion have become increasingly attractive as places to live because of their proximity to open spaces and natural settings, which provide residents with easy access to recreational opportunities year round. Under all the alternatives, these open spaces and natural settings would continue to support quality of life for area communities and a portion of population growth. For communities where rural to urban transition is feared, for Gullah-Geechee example, in the Wando, Wambaw, and Santee Resource Integration Zones, the Francis Marion National Forest will continue to act as a buffer to these changes. This buffering effect will foster continued social sustainability for cultural communities of interest, non-use values communities of interest and the consumptive recreation community of interest.

Forest Expenditures and Employment: Overall trends show that annual budgets for National Forests across the U.S. have been declining. Since congressional appropriations that support salary and non-salary forest expenditures have become increasingly variable, it is difficult to

forecast the Francis Marion's future fiscal capabilities with any certainty. Future salary and non-salary expenditures associated with administering these national forest lands are anticipated to continue to exhaust the Francis Marion's budget each year, and would be allocated between resource programs based on priorities identified through adaptive management.

Under all alternatives, field support for the Francis Marion National Forest would continue to come from the District Ranger's office in Huger, while additional financial and administrative support will be provided by the Forest Supervisor's Office in Columbia, South Carolina. Annual salary and non-salary expenditures associated with administering these lands will fluctuate based on amount of funds allocated to the Francis Marion by the Supervisor's Office, and are anticipated to be fully exhausted each year. Management actions implemented under the alternatives are not expected to have an effect on annual funding allocations to the national forest. Consequently, total national forest expenditures (including salary and non-salary expenses) will be constant across the alternatives.

If future expenditures remained relatively constant, national forest spending would support 148 jobs (direct, indirect and induced) and approximately $9.8 million in local labor income on annual average. These economic contributions would be distributed across the 11 counties (Berkeley, Calhoun, Charleston, Clarendon, Dorchester, Georgetown, Horry, Lexington, Orangeburg, Richland, and Williamsburg) that surround the Francis Marion National Forest and its Supervisor's Office (IMPLAN 2012). Fluctuations in future national forest spending may affect future economic contributions, but are unlikely to affect overall economic diversity or dependency of surrounding communities.

Payments to States and Counties: Although the future of receipt-sharing and per acre Federal land payment programs is uncertain, the Twenty Five Percent Fund Act of 1908 guarantees South Carolina a 7-year rolling average of receipts from the Francis Marion National Forest. A portion of which, will be returned to Berkeley and Charleston counties to fund local schools and roads. In addition to 25-percent payments, Berkeley and Charleston counties will receive Payment in Lieu of Taxes (PILT) payments through fiscal year 2015. No precise dollar figure can be given in advance for each year's PILT authorized level.

State and county payments associated with the Francis Marion National Forest would continue to help fund schools, roads, public services such as law enforcement and emergency services. The PILT program may or may not continue to be funded, and Congress could initiate new discretionary or non-discretionary Federal land payment programs over the next 20 years. State and county Federal land payments, in whatever form they take on, will continue to be essential to balancing tight local budgets. As these revenues are invested in the maintenance and improvement of local infrastructure and public services, they will contribute to the sustainability and health of local communities by supporting a portion of the valuable services these local governments provide. In addition, employment opportunities in both the public and private sectors would continue to be supported.

Cumulative Effects Common to All Alternatives

Population Growth and Density: Future population projections suggest that migration will likely play an increasing role in population changes as national, state, and county populations grow. As shown in Table 3-86 and Table 3-87, South Carolina and the eight-county study area are projected to grow faster than the general U.S. population. Projections indicate that Berkeley, Dorchester and Horry Counties will continue to experience high levels of population growth while Williamsburg County is expected to experience further population loss (South Carolina Budget

and Control Board 2013). These forecasts show that study area growth is anticipated to remain concentrated in communities which offer residents relatively easy access to recreation, open space, and wildlands provided by the Francis Marion National Forest.

These population projections reflect continued urban, suburban, and ex-urban development, enabling counties surrounding the Francis Marion to become more densely populated. Growth within these counties is unlikely to be distributed evenly among local communities and can cause some areas to become more urban while others become increasingly more decentralized. Though residents, community officials, and government agencies have been working together to mitigate the effects of continued urban growth in the region, the region surrounding the Francis Marion is anticipated to become increasingly more urban. Even assuming urban development would slow, the urban area surrounding the Charleston Metropolitan area is predicted to triple by 2030 (Allen and Lu 2003).

Table 3-86. Population projections in the nation, the state and the 8-county area, 2015–2030

Area	2015	2020	2025	2030	Growth Between 2010 and 2030
United States	321,363,000	333,896,000	346,407,000	358,471,000	16.1%
South Carolina	4,823,200	5,020,800	5,235,500	5,451,700	17.9%
8 County Area	1,218,500	1,280,800	1,344,500	1,408,400	21.8%

Source: U.S. Census Bureau 2012, South Carolina Budget and Control Board 2013.

Table 3-87. Population projections in South Carolina Counties, 2015–2030

County	2015	2020	2025	2030	Growth Between 2010 and 2030
Berkeley	187,800	197,700	208,400	219,100	23.2%
Charleston	360,600	370,900	383,800	396,700	13.3%
Clarendon	35,600	36,300	37,400	38,600	10.4%
Dorchester	152,000	167,400	178,800	190,200	39.3%
Georgetown	61,300	62,500	63,800	65,100	8.2%
Horry	294,600	319,900	345,800	371,700	38.0%
Orangeburg	92,800	93,000	93,500	94,100	1.7%
Williamsburg	33,800	33,100	33,000	32,900	-4.4%

Source: U.S. Census Bureau 2012, South Carolina Budget and Control Board 2013.

Growing populations and the encroachment of human development will place greater demand on forest resources and may affect the natural aesthetics, uses and values of multiple Francis Marion communities of interest presented above. Forest management can expect to be tasked with maintaining the quality of visitors' experiences while providing forest products and unique cultural and recreational experiences to a greater number of people. The pressure of native landscapes to adapt to these conflicting pressures threatens the forest's sense of place and the quality of life in communities surrounding the forest (Stedman 2003). For communities of interest across the planning area these pressures may have detrimental effects on quality of life that may be alleviated by presence of forest service land shielding communities from increased urbanization. For example, the southwest portion of the Francis Marion is near one of the most

rapidly urbanizing areas in South Carolina; Francis Marion National Forest land may buffer communities in the Wando Resource Integration Zone from this urbanization.

Alternative 1

Direct and Indirect Effects.

Cultural Community of Interest - Protection and Access to Resources: Traditional cultural practices would continue to be supported under existing management but would not be enhanced through targeted management, under the other alternatives, to reduce fuels and improve early successional habitats important in the provision of forest products (such as sweetgrass, mushrooms, or other products). As a result, this alternative would contribute less to important cultural practices that rely on these products; thereby contributing less to their resilience and social and economic sustainability as a forest-dependent community.

As mentioned above cultural practices depend on water from the Francis Marion National Forest. Continued cultural benefits would be provided under this alternative; however, cultural communities of interest would not benefit from direction targeted to improve hydrologic function included under the other alternatives. Direction under this alternative on threatened and endangered species would continue to protect species of cultural importance; however, additional at-risk species have been identified that were not included in the 1996 forest plan. Thus this alternative would not support the same levels of protection as provided by the other alternatives important for cultural communities of interest. The lack of additional direction to improve hydrologic function and additional threatened and endangered species would contribute less to cultural communities' quality of use and appreciation of these resources. In turn, the contribution to their resilience and sustainability would be less under this alternative than the other alternatives.

Areas designated for management play an important role in the social and economic sustainability of cultural communities of interest. Under this alternative, areas on the national forest are not currently managed to meet the specific needs of the Gullah-Geechee or other cultural communities of interest. Under the other alternatives, resource integration zones would be specifically managed to protect the range of cultural, social, and spiritual needs and values of these crossroad communities and would thus contribute more to social and economic sustainability.

Educator, Student and Researcher Community of Interest: Existing opportunities for this group of beneficiaries are dependent on wilderness opportunities to understand, communicate and educate. As a result these designated areas play an important role in the social sustainability of this community of interest. Opportunities and management of existing wilderness would continue to benefit this group (such as trail use within current wilderness); however, educators, students, and researchers would not benefit from the increased opportunities associated with additional acres being recommended for wilderness designation, as in alternative 3. As a result, this alternative would contribute less than alternative 3 to their social sustainability with fewer opportunities to understand, communicate, and educate.

Water resources are important for educators, students, and researchers. For example, these groups use the Hydrologic lab at Santee Experimental Forest and outfitter/guides use rivers and streams for environmental education. Continued benefits would be provided under this alternative; however, educators, student and researches would not benefit from direction targeted to improve hydrologic function under the other alternatives. Existing opportunities to understand,

communicate and educate would be supported by existing direction on threatened and endangered species; however, additional at-risk species have been identified that were not included in the 1996 forest plan. Thus, this alternative would not include the additional opportunities provided by additional species protection under the other alternatives. The lack of additional direction to improve hydrologic function and additional threatened and endangered species would contribute less to the quality of use and appreciation of these resources for this community of interest. In turn, the contribution to their resilience and sustainability would be less under this alternative than the other alternatives.

Government, Municipal and Residential Community of Interest: Direction under the 1996 forest plan, on protection of riparian areas and wetlands, would continue to protect infrastructure and property values important to local governments, municipalities and private land owners. However, these groups would not benefit from targeted direction, under the other alternatives, on restoration of hydrologic function.

Government, municipalities, and private landowners would continue to benefit from current management that controls the buildup of hazardous fuels adjacent to communities and infrastructure. However, these beneficiaries would not benefit from additional direction under the other alternatives addressing smoke effects with and other benefits from community wildfire protection planning. As a result this alternative would provide less of a sense of protection and quality of life for these beneficiaries than the other alternatives.

Non-Use Values Community of Interest: Management of existing wilderness would continue to benefit non-use values held by the non-use community of interest that derive benefits from the existence and bequest values of wilderness that people may not use but recognize value in their importance of forests. These beneficiaries would find satisfaction with not losing an available resource, but they would not accrue additional benefits from the additional acres being recommended for wilderness designation under alternative 3. As a result, this alternative would contribute less to the range of cultural, social and spiritual needs imbedded in non-use values held by this community. In this manner contributions to their well-being and sustainability would be less than alternative 3.

Existing protection of threatened and endangered species would support existing non-use values associated with threatened and endangered species; however, additional at-risk species have been identified that were not included in the 1996 forest plan. Thus this alternative would not support additional non-use values provided by species protection under the other alternatives.

Recreational Community of Interest: Continued consumptive and non-consumptive recreation benefits would be provided under this alternative given the benefit to scenery, resource integrity and associated recreation experiences supported by prescribed burning to restore longleaf pine on dry upland sites. However, the lack of targeted management, compared to the other alternatives, to reduce fuels and improve early successional habitats would not support increases in benefits to consumptive recreation uses, such as improvements in habitats important for foragers, pickers and hunters. As a result this alternative would contribute less to recreational uses that support community sustainability by contributing less to their range of cultural and social needs and values.

Direction under the 1996 forest plan, on protection of riparian areas and wetlands, would continue to protect water resources and expected experiences important for boating, recreational fishing, and commercial fishing resources. However, this community of interest would not benefit from direction, under the other alternatives, on restoration of hydrologic function. The lack of

additional direction to improve hydrologic function would contribute less to the quality of experience, use and appreciation of water resources on the Francis Marion National Forest. In turn, the contribution to their resilience and sustainability would be less under this alternative than the other alternatives.

Management of existing wilderness would continue to benefit non-consumptive recreation uses; specifically those that value opportunities for inspiration (such as writing, painting or photography), wildlife viewing, and connecting with history. These beneficiaries would not experience the increased benefits from the additional acres being recommended for wilderness designation under alternative 3. As a result, this alternative would contribute less to the range of cultural, social and spiritual needs of wilderness recreationists. In this manner contributions to their well-being and sustainability would be less than alternative 3.

Timber and Forest Products Community of Interest: Contributions important to local economies, businesses and people, from non-timber forest product resources, would continue to be supported under existing management but would not be enhanced through targeted management, under the other alternatives, to reduce fuels and improve early successional habitats important in the provision of forest products (such as sweetgrass, mushrooms, or other products). As a result, this alternative would contribute less to the local economy, businesses and people that rely on these products; thereby contributing less to their resilience and social and economic sustainability as a forest-dependent community.

Subsistence Community of Interest: Effects to subsistence users of the Francis Marion National Forest are covered under "Environmental Justice" section.

Recreation Related Economic Effects: Under this alternative, current management would continue to provide existing recreational opportunities, largely for dispersed use, including hunting and fishing and trail use, both motorized and non-motorized. With unanticipated changes to future population and unknown changes in recreation use patterns, recreation specialists estimated a range of visitation use based on population projections for the study area over the period from 2010 to 2030. Under this alternative, anticipated increases in recreation visits from just population change (no change in recreation management) are expected to be from 5 to 10 percent over current annual visits. As a result of these increases, an additional 6 to 12 jobs would be added to the study area economy, in addition to the 116 jobs currently supported (see Table 3-88 and Appendix F discussion). In addition, from $196,000 to $392,000 in labor income would also be added to the study area economy as a result of these increases, in addition to the $3.9 million currently supported (IMPLAN 2012).

Table 3-88. Employment and labor income effects from recreation

Jobs and Income	Alternative 1 minimum	Alternative 1 maximum	Alternative 2 minimum	Alternative 2 maximum	Alternative 3 minimum	Alternative 3 maximum
Jobs (full- and part-time)	6	12	12	23	6	12
Labor Income (2015 dollars)	$195,952	$391,903	$391,903	$783,806	$195,952	$391,903

As noted in the "Affected Environment" section, trends suggest that the economic base of nearby communities is shifting towards service businesses that rely, in part, on outdoor recreation. Under this alternative, the Francis Marion National Forest would continue to contribute to

economic sustainability, by supporting local and non-local recreation opportunities that contributes to the tourism industry. While these contributions are small relative to the size of recreation related industries within the 8-county study area (less than 1 percent) they are more important for smaller gateway communities and individual businesses. In this way recreation supported by the Francis Marion National Forest would continue to contribute towards sustainability and the resilience of forest-dependent communities.

Timber and Forest Products-related Economic Effects: Under this alternative current management would continue to provide timber and forest products to the study area economy. Projected wood sale quantity under this alternative is far greater than current yields given productivity increases anticipated within the sustained yield limit. As noted in the Forest "Products and Timber Harvesting" section, data indicate that proposed harvest levels are very sustainable and that over the last 2 years the Francis Marion National Forest has grown approximately 28 million cubic feet (MMCF) per year. As a result of this growth, projected wood sale quantity over the first decade would be 98.6 MMCF per year (Table 3-57 in the "Forest Products and Timber Harvesting" section). Harvest and processing of this material, in the 8-county study area, would add 333 jobs and $13.2 million in labor income in addition to the 57 local jobs and $2.5 million currently provided (see Table 3-89 and Appendix F for further discussion of current contributions to the timber industry) (IMPLAN 2012). This increase is due to anticipated increases over the life of the plan with maturation of trees established after Hurricane Hugo devastated the South Carolina coast in 1989. These trees have grown to a merchantable size and anticipated levels of harvest are expected to increase supporting large increases in employment supported by material from the Francis Marion National Forest.

Table 3-89. Employment and labor income effects from timber and forest products

Jobs and Income	Alternative 1	Alternative 2	Alternative 3
Jobs (full- and part-time)	333	323	339
Labor Income (2015 dollars)	$13,198	$13,096	$13,712

These may not be new jobs or income, but rather jobs and income that can be attributed to this plan. Existing capacity at existing wood product processing facilities would process much of this material. New jobs are created from two principal sources; local unemployment and in-migration. It is impossible to estimate the levels of in-migration or filled unemployment resulting in new income. Regardless, these jobs would contribute to forestry, logging, and primary and secondary wood processing sectors in the 8-county study area. While these contributions are small relative to the size of the manufacturing and agriculture sectors in the 8-county study area (less than 1 percent), they are more important for smaller communities and individual businesses. In this way the timber and wood product volume from the Francis Marion National Forest would continue to contribute towards sustainability and the resilience of forest-dependent communities under this alternative.

Cumulative Effects. Cumulative effects under this alternative are discussed under the section on "Cumulative Effects Common to All Alternatives."

Alternative 2

Direct and Indirect Effects.

Cultural Community of Interest - Protection and Access to Resources: Traditional cultural practices would be enhanced through targeted management of fire-adapted human communities

in resource integration zones. Management would focus on reducing fuels and improving early successional habitats that are desired. For example, early successional habitats important in the provision of forest products (such as sweetgrass, mushrooms, and other products) would continue to be made available and resource availability could improve with targeted management. As a result, this alternative would contribute more to important cultural practices that rely on these products; thereby contributing more to their resilience and social and economic sustainability as a forest-dependent community.

Under this alternative, cultural benefits would be enhanced from direction targeted to improve hydrologic function not included under alternative 1. This direction would improve the quality of cultural practices that depend on water and practiced on the Francis Marion National Forest. Direction under this alternative on threatened and endangered species would continue to protect species of cultural importance, included in the 1996 forest plan, and would provide management direction for additional at-risk species. Thus this alternative would support greater levels of protection than alternative 1. The additional direction to improve hydrologic function and additional direction for threatened and endangered species would contribute more to cultural communities' quality of use and appreciation of these resources. In turn, the contribution to their resilience and sustainability would be more under this alternative than the other alternatives.

Educator, Student and Researcher Community of Interest: Opportunities and management of existing wilderness would continue to benefit this group (such as trail use within current wilderness); however, educators, students, and researchers would not benefit from the increased opportunities associated with additional acres being recommended for wilderness designation under alternative 3. As a result, this alternative would contribute less to the social sustainability of this group than alternative 3.

Educators, students, and researchers would benefit from additional direction under this alternative, which is targeted to improve hydrologic function. In addition, opportunities to understand, communicate and educate would be further supported by additional direction on threatened and endangered species not identified in the 1996 forest plan. Thus, this alternative would support additional opportunities provided by additional species protection than alternative 1. The additional direction to improve hydrologic function and additional protection for threatened and endangered species would contribute more to the quality of use and appreciation of these resources for educators, students, and researchers. By protecting water resources and habitats, the Francis Marion National Forest contributes to sustaining communities' interests for current generations and providing opportunities to pass knowledge down to future generations. In turn, the contribution to their resilience and sustainability would be more under this alternative than alternative 1.

Government, Municipal and Residential Community of Interest: Under this alternative, targeted direction on restoration of hydrologic function would protect infrastructure and property values important to local governments, municipalities and private land owners. This direction would go beyond that provided under alternative 1 which focuses only on protection of riparian areas and wetlands, and not on restoration of hydrologic function. Threats on adjacent land (such as fire, insect and pest invasion) would be less under this alternative through targeted management of fire-adapted human communities in resource integration zones. Management would focus on reducing fuels and improving early successional habitats that are desired. As a result, this alternative would contribute more to the sense of security for this community of interest; thereby contributing more to their resilience and social and economic sustainability of local government, municipalities, and residents.

Under this alternative, the community of interest would experience improvements over alternative 1 in smoke management and treatment of fuels using alternative methods for maintaining fire-adapted human communities in resource integration zones. Improvements would be realized with alternative fuels reduction techniques (such as mechanical, chemical, and biological) with no additional smoke production (see “Fire Adapted Human Communities” section for further information. In addition, the combination of prescribed fire and non-smoke producing treatments, under this alternative, would reduce fuel loading in proximity to human communities, which could result in less severe wildfire and less associated smoke than alternative 3 (see section 3.2.3 “Air Quality”). As a result, this alternative would provide more of a sense of protection and quality of life for these beneficiaries than the other alternatives.

Non-Use Values Community of Interest: Effects to this community of interest would be the same as discussed under alternative 1.

Additional species protection, for threatened and endangered species identified but not included in the 1996 forest plan, would provide additional non-use value, over alternative 1, for these beneficiaries who derive benefits from the existence and bequest values of wildlife and a diverse ecosystem. As a result, this alternative would contribute more to the range of cultural, social and spiritual needs imbedded in non-use values held by this community. In this manner contributions to their well-being and sustainability would be more than alternative 1.

Recreational Community of Interest: Forest product resources, important for commodity based recreation (food pickers and gathers), would be enhanced through targeted management in resource integration zones to improve desired-early successional habitats. For example, berries, mushrooms, and animal habitats would continue to be made available and resource availability could improve with targeted management. As a result, this alternative would contribute more to recreational uses that support community sustainability by contributing more to their range of cultural and social needs and values.

Under this alternative, targeted direction on restoration of hydrologic function would protect water resources and expected experiences important for boating, recreational fishing and commercial fishing resources. This direction would go beyond that provided under alternative 1 which focuses only on protection of riparian areas and wetlands, and not on restoration of hydrologic function. The additional direction to improve hydrologic function would contribute more to the quality of experience, use and appreciation of water resources on the Francis Marion National Forest. In turn, the contribution to their resilience and sustainability would be more than under alternative 1.

Effects to the non-consumptive recreation community would be the same as described under alternative 1.

Timber and Forest Products Community of Interest: Non-timber forest product resources would be enhanced through targeted management of fire-adapted human communities in resource integration zones to reduce fuels and improve early successional habitats that are desired (such as sweetgrass, mushrooms, and other products). For example, material for basket weaving would continue to be made available and resource availability could improve with targeted management under this alternative. As a result, this alternative would contribute more to the local economy, businesses and people that rely on these products; thereby contributing more to their resilience and social and economic sustainability as a forest-dependent community.

Subsistence Community of Interest: Effects to subsistence users of the Francis Marion National Forest are covered under the "Environmental Justice" section.

Recreation-related Economic Effects: Under this alternative, management would focus on collaborative efforts and partnerships. Trails and dispersed recreation opportunities would increase with management in four distinct zones that help focus recreation opportunities. In addition, four rivers would be eligible for wild and scenic designation. As a result, anticipated increases in recreation visits are expected to be from 10 to 20 percent over current annual visits. As a result of these increases, an additional 12 to 23 jobs would be added to the study area economy, in addition to the 116 jobs currently supported (see Table 3-88 and Appendix F discussion). In addition, from $392,000 to $784,000 in labor income would also be added to the study area economy as a result of these increases, in addition to the $3.9 million currently supported (IMPLAN 2012).

As noted in the "Affected Environment" section, trends suggest that the economic base of nearby communities is shifting towards service businesses that rely, in part, on outdoor recreation. Under this alternative, the Francis Marion National Forest would continue to contribute to economic sustainability, by supporting local and non-local recreation opportunities that contributes to the tourism industry. While these contributions are small relative to the size of recreation related industries within the 8-county study area (less than 1 percent) they are more important for smaller gateway communities and individual businesses. In this way, the recreation supported by the Francis Marion would continue to contribute towards sustainability and the resilience of forest-dependent communities under this alternative.

Timber and Forest Products-related Economic Effects: Alternative 2 would have approximately 10,000 acres more than alternative 1 of lands suitable for timber production. However these additional acres are not as productive as under alternative 1. As noted under alternative 1, projected wood sale quantity under this alternative is far greater than current yields given productivity increases; over the last 2 years the Francis Marion National Forest has grown approximately 28 MMCF per year. As a result of this growth, projected wood sale quantity during the first decade would be slightly greater than alternative 1 at 98.6 MMCF per year (see Table 3-57 in the "Forest Products and Timber Harvesting" section). While overall yields would be greater than alternative 1 decreases are anticipated for harvest of material that would be processed as pulp and hardwood sawtimber. These decreases result in fewer anticipated jobs and labor income than alternative 1. Regardless of this decrease this alternative would result in an additional 324 jobs and $13.1 million in labor income in addition to the 57 local jobs and $2.5 million currently provided (see Table 3-89 and appendix aa for further discussion of current contributions to the timber industry) (IMPLAN 2012).

These may not be new jobs or income, but rather jobs and income that can be attributed to this plan. Existing capacity at existing wood product processing facilities would process much of this material. New jobs are created from two principal sources; local unemployment and in-migration. It is impossible to estimate the levels of in-migration or filled unemployment resulting in new income. Regardless, these jobs would contribute to forestry, logging and primary and secondary wood processing sectors in the 8-county study area. While these contributions are small relative to the size of the manufacturing and agriculture sectors in the 8-county study area (less than 1 percent), they are more important for smaller communities and individual businesses. In this way the timber and wood product volume from the Francis Marion National Forest would continue to contribute towards sustainability and the resilience of forest-dependent communities under this alternative.

Cumulative Effects. Cumulative effects under this alternative are discussed under the section on "Cumulative Effects Common to All Alternatives."

Alternative 3

Direct and Indirect Effects.

Cultural Community of Interest - Protection and Access to Resources: Effects to this would be the same as discussed under alternative 2.

Educator, Student and Researcher Community of Interest: Educators, students, and researchers would receive additional benefits from the increased opportunities associated with the acres being recommended for wilderness designation under this alternative. Additional protection for threatened and endangered species and hydrologic function under this alternative over alternative 1, would also increase opportunities to understand, communicate and educate. By managing additional areas suitable for wilderness designation and protecting habitats, the Francis Marion National Forest contributes to sustaining communities' interests for current generations and providing opportunities to pass knowledge down to future generations. As a result this alternative would contribute more to their social sustainability, than the other alternatives.

Government, Municipal and Residential Community of Interest: Benefits from improved hydrologic function and targeted management of fire-adapted human communities in resource integration zones would be the same as discussed under alternative 2.

Under alternative 3, less smoke from prescribed fire would be appreciated by adjacent government, municipal and residential communities. However, more smoke over longer periods of time, than alternative 2 could result from wildfires starts in untreated fuels (see section 3.2.3 "Air Quality"). As a result, this alternative would provide less of a sense of protection and quality of life for these beneficiaries than alternative 2.

Non-Use Values Community of Interest: Additional non-use value, over the other alternatives, would be experienced from additional acres recommended for wilderness designation in Hellhole Bay Extension, Little Wambaw Swamp Extension, and Wambaw Swamp Extension. As a result, this alternative would contribute more to the range of cultural, social and spiritual needs imbedded in non-use values held by this community. In this manner contributions to their well-being and sustainability would be more than alternative 2.

Benefits from additional species protection, for threatened and endangered species identified but not included in the 1996 forest plan, would be the same as discussed under alternative 2.

Recreational Community of Interest: Effects to recreation uses and boating opportunities, from targeted management in resource integration zones and improved hydrologic function, would be the same as discussed under alternative 2.

Non-consumptive recreationist would experience additional benefits, over the other alternatives, from additional acres being recommended for wilderness designation in Hellhole Bay Extension, Little Wambaw Swamp Extension, and Wambaw Swamp Extension. Wilderness recreationists would also experience additional benefits from the additional acres recommended for wilderness designation under alternative 3. As a result, this alternative would contribute more to the range of cultural, social and spiritual needs of wilderness recreationists. In this manner contributions to their well-being and sustainability would be more than alternative 2.

Timber and Forest Products Community of Interest: Effects to this community of interest from effects to non-timber forest product resources are discussed under alternative 2

Subsistence Community of Interest: Effects to subsistence users of the Francis Marion National Forest are covered under the “Environmental Justice” section.

Recreation-related Economic Effects: Under this alternative, additional acreage would be recommended for wilderness designation. There would be no increase in developed sites or land-based trails. Recreation opportunities would be managed in three distinct zones and four rivers would be eligible for wild and scenic designation, as under alternative 2. As a result, anticipated increases in recreation visits are expected to be from 5 to 10 percent over current annual visits. As a result of these increases, an additional 6 to 12 jobs would be added to the study area economy, in addition to the 116 jobs currently supported (see Table 3-88 and Appendix F discussion). From $196,000 to $392,000 in labor income would also be added to the study area economy as a result of these increases, which is in addition to the $3.9 million currently supported (IMPLAN 2012).

As noted in the “Affected Environment” section, trends suggest that the economic base of nearby communities is shifting towards service businesses that rely, in part, on outdoor recreation. Under this alternative, the Francis Marion National Forest would continue to contribute to economic sustainability, by supporting local and non-local recreation opportunities that contributes to the tourism industry. While these contributions are small relative to the size of recreation related industries within the 8-county study area (less than 1 percent), they are more important for smaller gateway communities and individual businesses. In this way the recreation supported by the Francis Marion would continue to contribute towards sustainability and the resilience of forest-dependent communities under this alternative.

Timber and Forest Products-related Economic Effects: Alternative 3 would have approximately 17,000 acres fewer lands suitable for timber production than alternative 2; mostly due to the additional acres being recommended for wilderness. However, there would be an increase in pine lands managed for loblolly pine, instead of longleaf pine, and an increase of lands allocated to Management Area 2 (with more frequent rotations) than under the other alternatives. As a result of this growth, projected wood sale quantity during the first decade would be greater than the other alternatives at 100.4 MMCF per year (Table 3-57 in the “Forest Products and Timber Harvesting” section). These increases result in an additional 340 jobs and $13.7 million in labor income in addition to the 57 local jobs and $2.5 million currently provided (see Table 3-89) (IMPLAN 2012).

These may not be new jobs or income, but rather jobs and income that can be attributed to this plan. Existing capacity at existing wood product processing facilities would process much of this material. New jobs are created from two principal sources; local unemployment and in-migration. It is impossible to estimate the levels of in-migration or filled unemployment resulting in new income. Regardless, these jobs would contribute to forestry, logging and primary and secondary wood processing sectors in the 8-county study area. While these contributions are small relative to the size of the manufacturing and agriculture sectors in the 8-county study area (less than 1 percent) they are more important for smaller communities and individual businesses. In this way the timber and wood product volume from the Francis Marion National Forest would continue to contribute towards sustainability and the resilience of forest-dependent communities under this alternative.

Cumulative Effects. Cumulative effects under this alternative are discussed under the section on “Cumulative Effects Common to All Alternatives.”

3.5 Other Effects

3.5.1 Environmental Justice

3.5.1.1 Affected Environment: Environmental Justice

Executive Order 12898 directs Federal agencies to focus attention on the human health and environmental conditions in minority and low-income communities. The purpose of the executive order is to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects on minority and low-income populations.

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. The goal of environmental justice is for Federal agencies to identify impacts that are disproportionately high and adverse with respect to minority or low-income populations and identify alternatives that will avoid or mitigate those impacts.

Census data presented in previous sections describing the demographics and economic conditions of communities surrounding the Francis Marion National Forest indicate that there is a concentration of minority and low-income populations within the planning area. These environmental justice populations are most prevalent outside of Charleston in the area known as the Cainhoy Peninsula. Located at the confluence of Charleston and Berkeley Counties, this area includes nearly two dozen small communities that create the contiguous communities of Cainhoy, Wando, and Huger. These are primarily “heirs’ property” communities where land, purchased by former slaves after emancipation, has been passed down from generation to generation without formal wills. In the absence of official documentation, these lands have remained in communal ownership outside the jurisdiction of any one entity for hundreds of years.

The area known as Cainhoy lies within the Gullah-Geechee Cultural Heritage Corridor, a congressionally designated National Heritage Area created to preserve the unique African-based heritage and culture of slave-descendants who continue to live along the Southern Atlantic Seaboard. Communities within this corridor share a common history rooted in farming, logging, and slavery, and take great pride in their culture, sense of place, and strong devotion toward family. Residents of Cainhoy are primarily African Americans who identify themselves as “Gullah” or “Geechee,” who continue to carry on the language, arts, crafts, religious beliefs, folklore, rituals, and food preferences of their African and African American ancestors. Although many historic Gullah communities have transitioned from agriculture and bartering to a more cash and services-based economy, many residents of these rural areas maintain strong ties to the land and rely on subsistence farming, fishing, hunting, bartering and small-scale marketing of subsistence and artisan products for a portion of their income.

During the scoping period for this analysis, environmental justice concerns were raised; including use of the national forest for traditional cultural practices and subsistence. The Francis Marion National Forest has provided local residents with food, water, and forest products used for home heating and construction; and enabled generations of local residents to scratch out meager incomes through subsistence farming, fishing, hunting, bartering and small-scale marketing of subsistence. For example, sweetgrass has special cultural and economic importance in coastal

South Carolina, where the local Gullah community uses this resource in a form of coiled basketry (Hart et al. 2004).

Residents of these crossroad communities maintain strong communal ties to the people and lands which make up South Carolina's Lowcountry. Although relative isolation has stifled modern economic development in the planning area's smaller communities; strong social, cultural, and economic ties to the natural environment have long sustained communities now thought to be economically suppressed. The natural abundance of the lands which make up the Francis Marion National Forest has provided local residents with food, water, and forest products used for home heating and construction; and enabled generations of local residents to scratch out meager incomes through subsistence farming, fishing, hunting, bartering and small-scale marketing of subsistence.

3.5.1.2 Environmental Consequences: Environmental Justice

Direct and Indirect Effects: As discussed in the "Affected Environment" section, environmental justice populations exist within the 8-county planning area. Populations most at risk of experiencing disproportionately high and adverse human health or environmental effects include low-income households and African Americans who identify ethnically as Gullah-Geechee. These populations are not mutually exclusive and have been identified as being dispersed throughout the planning area. Although census data for crossroad communities is unavailable, environmental justice populations are likely most concentrated in the small, unincorporated, crossroad communities scattered across the socioeconomic study area.

In addition to supporting subsistence lifestyles, these lands are directly attributed with helping to sustain the unique ethnic identity, cultural heritage, and African based traditions of the Gullah-Geechee people. Gullahs who continue to live within the socioeconomic study area gather sweetgrass to practice the ancient African art of basket making; farm the land settled by their emancipated ancestors; pay homage to their West African traditions by keeping alive folk traditions and beliefs; and continue to make a living fishing, shrimping and harvesting oysters using handmade nets in the same coastal waters as generations before them.

Under all the alternatives, continued management of the Francis Marion's ecosystems for ecological integrity and healthy, plant, fish and wildlife populations will contribute to the resilience of these forest-dependent communities. These contributions are a vital part of Gullah-Geechee community and will continue to contribute to their community sustainability.

The Francis Marion National Forest has developed a land ownership adjustment strategy that prioritizes exchanges and acquisitions of national forest lands. Lands that have lost their national forest character or are isolated tracts are a priority for conveyance. Lands that consolidate national forest and connect ecological systems are a priority for acquisition. Land acquisition near crossroad communities may buffer these changes and increase community resilience and sustainability under the alternatives. Land conveyance near crossroad communities may decrease community resilience and community sustainability under the alternatives. Future site-specific decisions need to examine each land tenure decisions relative to uses and lifestyles of area Environmental Justice communities.

Cumulative Effects: Lands and natural resources administered as the Francis Marion National Forest enable current generations to reconnect with the values, traditions, and lifestyles of their ancestors. Although the Gullah-Geechee are working hard to preserve and pass on the values, traditions, and lifestyles of their African ancestors, rapid coastal development and soaring coastal

property values will continue to threaten the unique sense of place of crossroad communities and push Gullah families off ancestral lands.

Specific effects of rapid costal development include the loss of habitat and ease of access, to areas where basket makers formerly collected sweetgrass. Fire suppression has reduced habitat available for collection (Hart et al. 2004). In addition, areas are now restricted from entry, on private property, or access is less available with rapid growth and development (Hart et al. 2004, Hurley et al. 2008). These trends place more importance on the value of habitat on the Francis Marion National Forest for Gullah communities. These effects will continue under all the alternatives.

3.5.2 Relationship of Short-Term Uses and Long-Term Productivity

The relationship between the short-term uses of the environment and the maintenance and enhancement of long-term productivity is complex. Short-term uses are generally those that occur irregularly on parts of the national forest, such as prescribed burning. Long term refers to a period greater than 10 years.

Productivity is the capability of the land to provide market and amenity outputs and values for future generations. Soil and water are the primary factors of productivity and represent the relationship between short-term uses and long-term productivity. The quality of life for future generations would be determined by the capability of the land to maintain its productivity. By law, the Forest Service must ensure that land allocations and permitted activities do not significantly impair the long-term productivity of the land.

The alternatives considered in detail, including the preferred alternative, incorporate the concept of sustained yield of resource outputs while maintaining the productivity of all resources. The specific direction and mitigation measures included in the forestwide management standards ensure that long-term productivity would not be impaired by the application of short-term management practices.

Each alternative was analyzed using an EXCEL spreadsheet model (see appendix B), to ensure that the minimum standards could be met. The alternative was changed if some aspect did not meet any of the minimum standards. Through this analysis, long-term productivity of the national forest's ecosystems is assured for all alternatives.

As stated earlier, the effects of short-term or long-term uses are extremely complex, and depend on management objectives and the resources that are emphasized. No alternative would be detrimental to the long-range productivity of the Francis Marion National Forest.

The effects of implementing the forest plan will be monitored at the forest level. Broad-scale monitoring will focus on changes in the environment that may affect resources on the Francis Marion National Forest. Evaluation of the monitoring data collected will determine if standards for long-term productivity are being met, or if management practices need to be adjusted. A monitoring plan is included in chapter 4 of the forest plan.

3.5.3 Irreversible and Irretrievable Commitment of Resources

Irreversible and irretrievable commitments of resources are normally not made at the programmatic level of a forest plan. Irreversible commitments are decisions affecting non-renewable resources such as soils, minerals, plant and animal species, and cultural resources. Such commitments of resources are considered irreversible because the resource has been

destroyed or removed, or the resource has deteriorated to the point that renewal can occur only over a long period of time or at a great expense. While a forest plan can indicate the potential for such commitments, the actual commitment to develop, use, or affect non-renewable resources is normally made at the project level.

Irretrievable commitments represent resource uses or production opportunities, which are foregone or cannot be realized during the planning period. These decisions are reversible, but the production opportunities foregone are irretrievable. An example of such commitments is the allocation of management prescriptions that do not allow timber harvests in areas containing suitable and accessible timber lands. For the period of time during which such allocations are made, the opportunity to produce timber from those areas is foregone, thus irretrievable.

Oil and gas leasing decisions are not made here due to the lack of industry interest and the low potential for oil and gas resources. If the circumstances change, then a leasing decision would be made at that time. Actual extraction of oil and gas would be considered an irreversible commitment, since oil and gas are non-renewable resources. Any site-specific decisions to actually permit this extraction will occur following receipt of an application for permit to drill.

3.5.4 Effects on Wetlands and Floodplains

No significant adverse impacts on wetlands or floodplains are anticipated. Wetlands values and functions would be protected in all alternatives through the implementation of the riparian management zones and by following the Forest Service's National Best Management Practices for Water Quality Management on National Forest System Lands and South Carolina's Best Management Practices for Forestry. Under the requirements of Executive Order 11990 and Clean Water Act, Section 404, wetland protection would be provided by ensuring that new construction of roads and other facilities would not have an adverse effect on sensitive aquatic habitat or wetland functions. In addition, wetland evaluations would be required before land exchanges or issuance of special-use permits in areas where conflicts with wetland ecosystems may occur.

Mitigation measures have been designed to conserve riparian areas and protect floodplains through the direction in the rivers and streams ecosystems. The direction of this ecosystem is embedded in all other ecosystem groups. Executive Order 11988 also requires site-specific analysis of floodplain values and functions for any project occurring within the 100-year floodplain zone, and prior to any land exchange involving these areas. Effects to wetlands are also discussed in section 3.2.4 "Climate Change," section 3.2.5 "Water Resources," section 3.3.1 "Ecological Systems," section 3.3.2 "Threatened and Endangered Species" and section 3.3.3 "Forest Health."

Protective measures for riparian areas include the delineation of riparian management zones on perennial and intermittent streams. Management activities within the riparian management zone must comply with the previously mentioned national and state best management practices and other state water quality regulations. Floodplains would be managed by locating critical facilities outside of floodplains or by using structural mitigation measures. Further protections are provided in forestwide standards for management of ephemeral stream zones.

3.5.5 Unavailable or Incomplete Information

The Francis Marion National Forest has used the best available scientific information and state-of-the-art analytical tools to evaluate management activities and to estimate their environmental effects. However, gaps will always exist in our knowledge. The Council on Environmental Quality regulations discuss the process for evaluating incomplete and unavailable information (40

CFR 1502.22 (a) and (b)). Incomplete or unavailable information is noted in this chapter for each resource, where applicable.

Forest plan monitoring is designed to evaluate assumptions and predicted effects. Should new information become available, the need to change management direction or amend the forest plan would be considered. Any amendments to the forest plan would require additional analysis and public involvement.

Chapter 4. List of Preparers and Distribution

4.1 Preparers

The following individuals contributed to this final environmental impact statement.

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Robin Mackie	Forest Ecologist/Botanist
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4.2 Mailing List for the Draft Environmental Impact Statement

Francis Marion's mailing list is as follows.

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Sarah Sawyer, Refuge Manger

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4.3 Francis Marion Plan Revision Email List Used for the Draft Environmental Impact Statement

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4.5 Mailing List for the Final Environmental Impact Statement

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Jim Cubie

Keith Bustraan
County Administrator, Charleston

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James Alton Cannon Jr.
Sheriff, Charleston County

Dr. Jean Everett
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4.6 Francis Marion Plan Revision Email List Used for the Final Environmental Impact Statement

The Francis Marion plan revision email list (as of July 7, 2016) is as follows.

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Franklin, Bob
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Prater, Ben; Defenders of Wildlife

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Richardson, Sharon; Audubon Society, executive director

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Zurawski, Carol; Bureau of Land Management

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Adams, T. 1996. Implementation monitoring of forestry best management practices for site preparation in South Carolina. South Carolina Forestry Commission, Columbia, SC. 24 p.

Adams, T.; Hook, D. 1993. Implementation and effectiveness monitoring of forestry best management practices on harvested sites in South Carolina. South Carolina Forestry Commission, Columbia. 32 p.

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