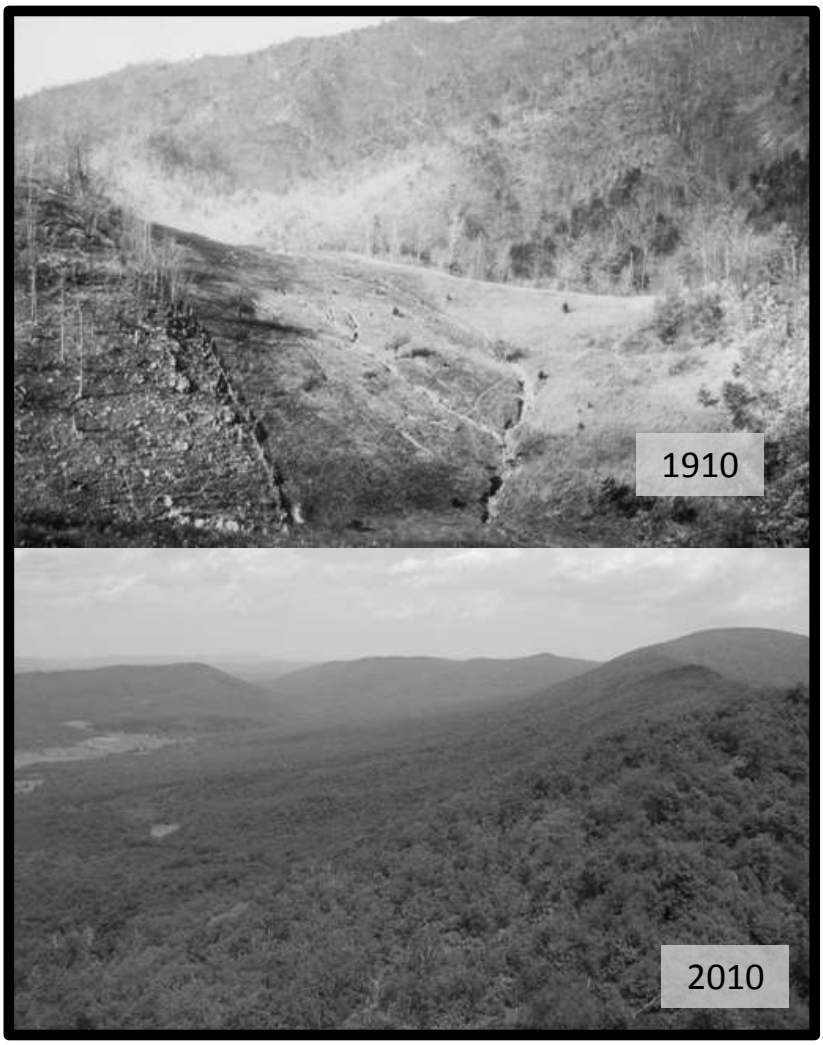
U.S. Department of Agriculture
Forest Service
Southern Region

Draft Environmental Impact Statement

for the Revised Land and Resource Management Plan

George Washington National Forest



R8-MB 137B

April 2011

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Draft Environmental Impact Statement for the George Washington National Forest
Draft Revised Land and Resource Management Plan

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Hampshire, Hardy, Monroe and Pendleton Counties in West Virginia.

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ABSTRACT

The Forest Service proposes to revise the 1993 Land and Resource Management Plan (Draft Forest Plan) for the George Washington National Forest. The proposal updates the management direction for the Forest's 1.1 million acres of land in Virginia and West Virginia by describing desired conditions, goals, objectives, suitable uses, standards and monitoring requirements. In accordance with the National Environmental Policy Act of 1969, the Forest has prepared a Draft Environmental Impact Statement (DEIS) for the Draft Forest Plan. The DEIS provides the purpose and need for Plan revision, presents issues addressed, describes management alternatives considered to respond to those issues, and analyzes the potential environmental effects of the alternatives. The Draft Environmental Impact Statement describes seven alternatives including a "no action" alternative which would continue managing the land and resources of the Forest under the 1993 Forest Plan as amended. The Forest Service has identified Alternative G as the Agency's Preferred Alternative. This summary document provides a brief overview of the Draft Forest Plan and the accompanying DEIS.

COMMENTS

Comment period ends 90 days after the Notice of Availability is published in the Federal Register

It is important that reviewers provide their comments at such times and in such a way that they are useful to the Agency's preparation of the EIS. Therefore, comments should be provided prior to the close of the comment period and should clearly articulate the reviewer's concerns and contentions. The submission of timely and specific comments can affect a reviewer's ability to participate in subsequent administrative review or judicial review.

Comments received in response to this solicitation, including names and addresses of those who comment, will be part of the public record for this proposed action. Comments submitted anonymously will be accepted and considered; however, anonymous comments will not provide the respondent with standing to participate in subsequent administrative review or judicial review.

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CHAPTER 1 PURPOSE AND NEED

INTRODUCTION

The purpose of this proposed action is to revise the George Washington Land and Resource Management Plan (Forest Plan). The revised Forest Plan guides all natural resource management activities on the George Washington National Forest to meet the objective of Federal law, regulations, and policy. The proposed action also affects a wide range of socioeconomic factors, as they relate to natural resources. The existing Forest Plan for the George Washington National Forest was approved January 21, 1993. There have been ten amendments to the existing Forest Plan. Revision of the Forest Plan is now needed to satisfy regulation requirements and to address new information about the forest and its uses.

The George Washington and Jefferson National Forests were administratively combined in 1995. However, each National Forest continues to have its own Forest Plan. The Forest Plan applies to the George Washington National Forest for a total of 1,065,000 acres.

This Draft Environmental Impact Statement (DEIS) describes the analysis of several alternatives for revising the Forest Plan for the George Washington National Forest and discloses the environmental effects of these alternatives. The DEIS is guided by the implementing regulations of the National Environmental Policy Act (NEPA) of 1969 found in the Council of Environmental Quality Regulations, Title 40, CFR, Part 1500. The companion document to this DEIS is the Draft Forest Plan - a detailed presentation of the preferred alternative. The preferred alternative is Alternative G.

Notification of initiation of the plan revision process for the George Washington National Forest was provided in the Federal Register on February 15, 2007 [72 FR 7390]. The plan revision was initiated under the planning procedures contained in the 2005 Forest Service planning rule (36 CFR 219 (2005)) and one series of public meetings was held. On March 30, 2007, the federal district court for the Northern District of California enjoined the Forest Service from implementing the 2005 planning rule and the revision of the GWNF Forest Plan under the 36 CFR 219 (2005) rule was suspended in response to the injunction. On April 21, 2008 the Forest Service adopted the 2008 Planning Rule that allowed resumption of the revision process if it conformed to the new planning rule (36 CFR 219.14(b) (3) (ii), 2008). Notification of adjustment for resuming the land management plan revision process under the 2008 Planning Rule for the GWNF was provided in the Federal Register on June 24, 2008 [73 FR 35632]. A series of five topical public meetings were held between July 2008 and February 2009. On June 30, 2009, the 2008 Planning Rule was enjoined by the United States District Court for the Northern District of California (Citizens for Better Forestry v. United States Department of Agriculture, No. C 08-1927 CW (N.D. Cal. June 30, 2009)) and the revision of the GWNF Forest Plan was again suspended. The Department has determined that the 2000 Planning Rule is now back in effect. The 2000 Rule's transition provisions (36 CFR 219.35), amended in 2002 and 2003 and clarified by interpretative rules issued in 2001 and 2004, and reissued on December 18, 2009 [74 FR 67059-67075] allow use of the provisions of the National Forest System land and resource management planning rule in effect prior to the effective date of the 2000 Rule (November 9, 2000), commonly called the 1982 planning regulations, to amend or revise plans. The GWNF has elected to use the provisions of the 1982 planning regulations. On March 10, 2010 a Notice of Intent to prepare an environmental impact statement and revised land management plan using the provisions of the 1982 National Forest System land and resource management planning regulations for the George Washington National Forest was published in the Federal Register [75 FR 11107].

The information gathered from public collaboration efforts and most of the analysis conducted prior to the court's injunction in June 2009 remained useful for completing the plan revision using the provisions of the 1982 planning regulations. The GWNF concluded that the following material developed during the plan revision before the 2010 Notice of Intent was appropriate for continued use:

- The inventory and evaluation of potential wilderness areas published on August 21, 2008 was consistent with the 1982 planning regulations, and was brought forward into this plan revision process.

- A Comprehensive Evaluation Report (CER) was developed under the 2005 and 2008 rule provisions, and it was available for public comment. This analysis was updated with additional information to meet the requirements of the Analysis of the Management Situation (AMS) provisions of the 1982 rule. The information from this analysis was used to help identify the need for change and the preliminary proposed actions that were identified in the 2010 Notice of Intent. Comments received during the scoping process were used to further update the need for change analysis.
- Information on the life history, threats, habitat needs and population trends for a number of terrestrial and aquatic species contained in the forest planning records for the ecosystem and species diversity assessments were used as a reference in the planning process as appropriate to meet the requirements of the 1982 planning regulations. This was scientific information and was not affected by the change of planning rule. Public comments previously submitted in writing, or recorded at past public meetings, related to the revision of the GW Forest Plan since 2007 were used to help identify issues and concerns and to help develop alternatives to address these issues and concerns.

FOREST PROFILE

The George Washington National Forest extends for about 140 miles along the Appalachian and Blue Ridge Mountains of northwestern Virginia and adjacent West Virginia. The George Washington National Forest comprises lands located in Virginia (approximately 960,282 acres) and West Virginia (approximately 105,099 acres) and is close to a population of about 9 million people. The Forest contains the Lee, North River, Warm Springs, James River and Pedlar Ranger Districts. See Figures 1 and 2.

The National Forest is located in the Northern Blue Ridge and the Northern Appalachian Ridges and Valleys (Major Land Resource Areas of the U.S.), providing habitat for a wide variety of species including at least 70 amphibian and reptiles, 180 species of birds, 60 species of mammals, and 100 species of freshwater fishes and mussels. Eight of the plants and animals species found on the Forest are listed by the US Fish and Wildlife Service as threatened or endangered. The Forest affords excellent opportunities for wildlife viewing, as well as hunting and fishing.

The George Washington National Forest is a part of the Appalachian Hardwood Forest which is located within the Eastern Deciduous Forest Province. There are over 60 tree species represented on the National Forest. Hardwood-dominated forest types comprise over 75 percent of the acreage. There is much variation in the vegetation and many natural changes are taking place as forest succession progresses.

The George Washington and Jefferson National Forests together have an average of 44 wildfires each year, with the average size approximating 55 acres. Seventy-five percent of the wildfires are human-caused. Research indicates that fire played a major role in establishing and maintaining the plant communities of the Appalachian Mountains. Major insect pests include the gypsy moth, southern pine beetle, and hemlock woolly adelgid. Major disease problems include oak decline, dogwood anthracnose, and shoestring root rot.

The Forest is located within two major river basins -- the James and the Potomac Rivers and is entirely within the Chesapeake Bay watershed. The Forest contains 1,171 miles of perennial streams, of which over 700 miles support a cold water fishery. At least 30 communities use water from the Forest for all or part of their water supplies.

The Forest transportation network has nearly 1,823 miles of National Forest System Roads which range from paved highways to non-surfaced roads designed for high clearance vehicles. Many of these roads are available for pleasure driving, the removal of forest products, bicycling and scenic viewing. Interstate 81 and other U.S. and State highways also cross or adjoin the National Forest. The National Forest is also traversed by the Blue Ridge Parkway.

Developed recreation opportunities are offered at about 60 sites on the Forest. The Forest has approximately 1,100 miles of non-motorized trails. The Forest also has six designated Wildernesses, totaling approximately 43,000 acres and one designated National Scenic Area.

There are three individual ATV trail systems offering a total of about 65 miles of motorized trails. The George Washington National Forest encompasses approximately 48 percent of the public hunting lands located in Virginia (the combined George Washington and Jefferson National Forests comprise about 80 percent). Hunting is among the most popular recreation activities on the Forests. The Forests provide the majority of the black bear and ruffed grouse habitat in Virginia.

The George Washington National Forest has very limited energy resource development at the current time. Only about 12,000 acres of the Forest is currently leased under federal oil and gas leasing procedures. Mineral rights on about 16 percent of the Forest are privately owned.

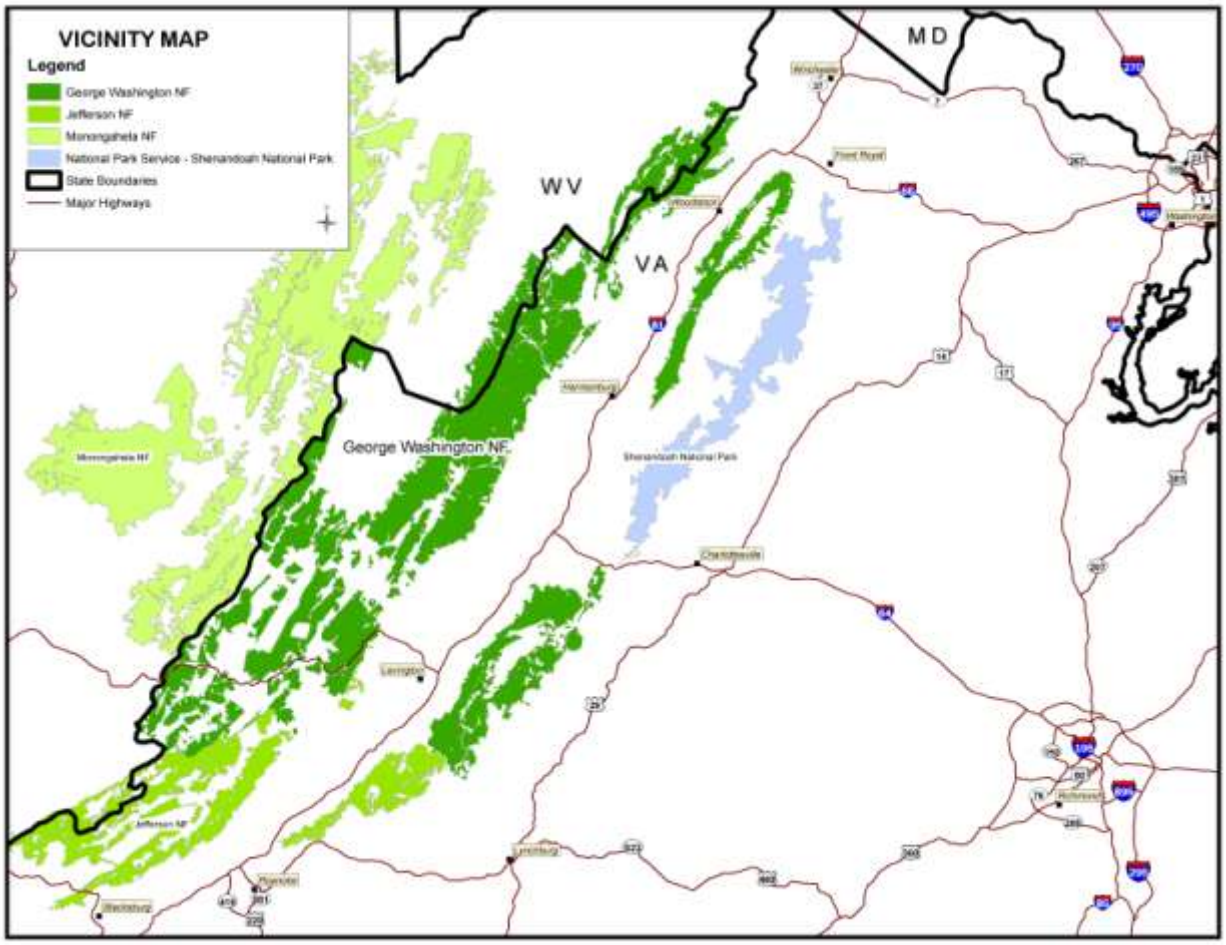

Figure 1. Vicinity Map

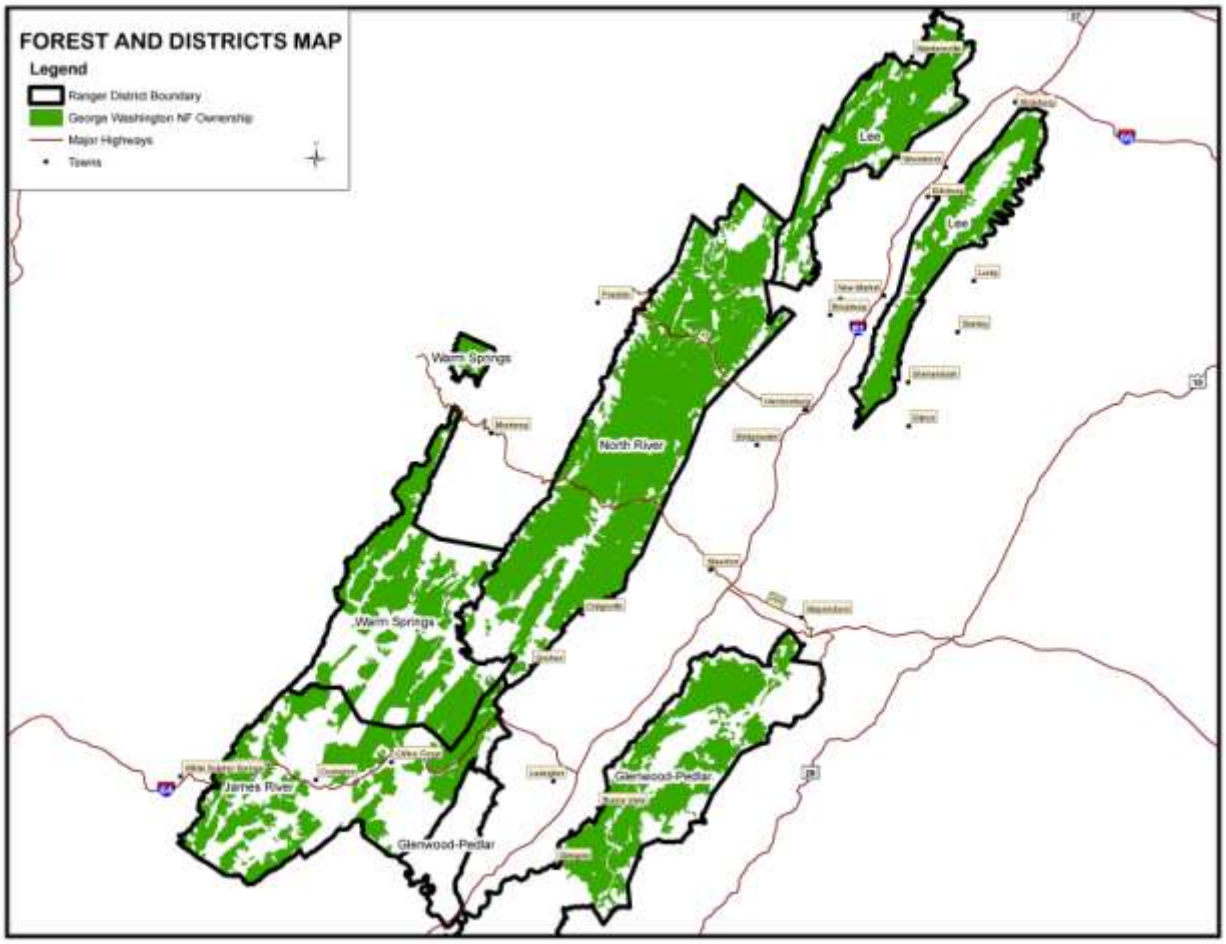

Figure 2.Ranger Districts on the George Washington National Forest

PROPOSED ACTION

The proposed action is to revise the 1993 Land and Resource Management Plan for the George Washington National Forest. The proposed action includes the determination of the National Forest System lands that will be administratively available for oil and gas leasing, as well as the associated stipulations. The Forest Service considers the leasing availability decision to be separate from planning decisions, but it is closely linked to planning decisions. Therefore, the leasing availability decision is also evaluated within this Draft Environmental Impact Statement.

PURPOSE AND NEED

The regulations implementing the National Forest Management Act of 1976 (NFMA) instruct the Regional Forester to make periodic revisions to forest plans and to provide the basis for any revision. The following section describes the need to change the 1993 Forest Plan and presents the basis for the proposed changes within the context of the regulatory requirements. The instructions to revise forest plans, the basis for revision,

are found in Code of Federal Regulations 36 CFR 219.10(g), using the 1982 planning regulations as allowed in the 2000 Planning Rule.
The purpose for revising the Forest Plan is to provide a revised Plan that will:

- Guide resource management activities on the Forest for the next 10 to 15 years;
- Address changed conditions and direction since the 1993 Plan was prepared;
- Assure the production and protection of high quality water for National Forest resources and downstream water users;
- Maintain or restore long-term ecosystem health and integrity;
- Contribute to the economic and social needs of people, cultures and communities;
- Meet the objectives and requirements of federal laws, regulations, and policies;
- Provide consistent direction at the Forest level that will assist managers in making project decisions at a local level in the context of broader ecological and social considerations.

The need for this proposed action is to meet the intent of 36 CFR 219.10(g) that land management plans are ordinarily revised on a 10 to 15 year cycle. The existing Forest Plan for the George Washington National Forest (GWNF) was approved on January 21, 1993. Since then, changes have occurred in resource conditions, environmental stresses and threats, societal demands, and our current state of scientific knowledge.

The following have been identified as items to be evaluated as needs for change from the current Plan. Changes are needed in management direction for maintaining or restoring healthy, resilient forest ecosystems due to the recognition that: vegetation conditions (structure, composition, and function) for some ecosystems have declined (e.g. oak regeneration, fire dependent pine regeneration); forest conditions indicate a substantial departure from natural fire regimes; stresses and threats from insects, diseases, and non-native invasive plant and animal species are increasing; and potential effects from climate change are uncertain. By restoring and maintaining the key characteristics, conditions, and functionality of native ecological systems, the GWNF should also provide for the needs of the diverse plant and animal species on the forest. The issue of vegetation management (where, how much, what type) is closely related to this topic because it is one of the tools by which the desired conditions and objectives for ecological health and sustainability can be accomplished.

Specific items include:

- Better definition of desired conditions and objectives to maintain the resilience and function of identified ecological systems and determine the desired structure and composition of those ecosystems
- Management direction to provide habitat for maintaining species viability and diversity across the forest
- Evaluation of new or expanded existing Special Biological Areas to protect and restore rare communities and species
- Recognition of the role of fire as an essential ecological process
- Incorporation of the use of wildfires for achieving ecological objectives
- Incorporation of management direction for controlling, treating or eradicating non-native invasive plant and animal species
- Updating the Management Indicator Species (MIS) list
- Updating the direction for management of old growth to meet guidance for the Southern Region.
- Incorporating adaptive management strategies for addressing climate change.

The 2001 Roadless Area Conservation Rule used the roadless inventory from the 1993 GWNF Forest Plan to identify the inventoried roadless areas covered by the Rule. These Inventoried Roadless Areas, updated to reflect subsequent designations of Wilderness and a National Scenic Area, now include 24 areas for a total of about 242,000 acres. The 2001 Roadless Area Conservation Rule is in litigation. In 2008, an inventory of Potential Wilderness Areas was completed that identified 37 areas (totaling about 370,000 acres) that meet the definition of wilderness in section 2(c) of the 1964 Wilderness Act. This inventory included almost all of the remaining 2001 Inventoried Roadless Areas. A draft evaluation that is based on the capability (degree to which each area contains the basic natural characteristics that make it suitable for wilderness designation), the availability (value of and need for the wilderness resource compared to the value of and need of each area for other resources) and the need (degree that the area contributes to the local and national distribution of wilderness) for additional wilderness has been conducted for each of these areas.

Changes are needed in management direction for some of the tangible and non-tangible goods and services offered by various forest resources. The issue of road and trail access is most closely related to this topic.

Specific items include:

- Identifying the importance of maintaining the high quality of water for drinking water and for aquatic life.
- Evaluating the riparian corridor distance definition and updating the standards for riparian area protection to incorporate the best available science
- Strengthening the management direction for groundwater and karst areas
- Re-evaluating the oil and gas leasing availability designations
- Identifying uses suitable for specific areas of the forest (e.g. timber production, road construction, wind energy development, prescribed fire)
- Determine the allowable sale quantity of timber
- Evaluating road access needs

FOREST PLAN DECISIONS

National Forest System resource allocation and management decisions are made in two stages. The first stage is the Forest Plan, which allocates lands and resources to various uses or conditions by establishing management areas and management prescriptions for the land and resources within the plan area. The second stage is approval of project decisions.

Forest plans do not compel the agency to undertake any site-specific projects; rather, they establish overall goals and objectives (or desired resource conditions) that the individual national forest will strive to meet. Forest plans also establish limitations on what actions may be authorized, and what conditions must be met, during project decision making.

The primary decisions made in a Forest Plan include:

- Forest multiple-use goals and objectives that include a description of the desired condition of the forest and an identification of the quantities of goods and services that are expected to be produced or provided [36 CFR 219.11(b)].

- Establishment of multiple-use prescriptions for each management area, including proposed and probable management practices [36 CFR 219.11(c)].

- Establishment of management requirements, including associated standards and guidelines that would

apply to implementation of the Forest Plan [36 CFR 219.11(c), 219.13 to 219.27].

- Descriptions of lands suitable or not suitable for specific resource activities, including timber production [(16 USC 1604(k) and 36 CFR 219.14)].
- Establishment of the Allowable Sale Quantity (ASQ) of timber to ensure a sustained yield of wood products in perpetuity [16 USC 1611 and 36 CFR 219.16].
- Identification of lands as preliminary administrative recommendations for inclusion in the National Wilderness Preservation System [36 CFR 219.17; FSH 1909.12, Chapter 73.11].
- Identification of Research Natural Areas (RNA's), which are examples of important forest, shrubland, grassland, alpine, aquatic, and geologic types that have special or unique characteristics of scientific interest and importance and that are needed to complete the national network of RNA's [36 CFR 219.25].
- Identification of river segments that are suitable for inclusion in the National Wild and Scenic Rivers System [PL 90-542; 36 CFR 219.2(a)].

The monitoring and evaluation requirements needed to ensure that Forest Plan direction is carried out and to determine how well outputs and effects were predicted [36 CFR 219.11(d)].

The authorization of site-specific activities within a plan area occurs through project decision making, which is the implementation stage of forest planning. Project decision making must comply with NEPA procedures and must be consistent with the Forest Plan.

THE RESPONSIBLE OFFICIAL

The Regional Forester is the responsible official for the analysis and decisions in this Forest Plan revision. Conducting analysis, developing alternatives, and preparing the DEIS were done at the local Forest level under the direction of the Forest Supervisor for the George Washington and Jefferson National Forests.

SUPPORTING ENVIRONMENTAL ANALYSES

The following documents contain environmental analyses that are not repeated in this EIS, but provide supporting documentation for some of the Forest Plan decisions.

- Final Environmental Impact Statement for *Gypsy Moth Management in the United States: a Cooperative* Approach (Washington, DC: USDA Forest Service and APHIS, 5 volumes. November, 1995)
- Final Environmental Impact Statement for the *Suppression of the Southern Pine Beetle* (Atlanta, Georgia: USDA Forest Service, Southern Region, April 1987)
- Final Environmental Impact Statement for *Vegetation Management in the Appalachian Mountains* (Atlanta, Georgia: USDA Forest Service, July 1989)
- Environmental Assessment for *Management of the Federally Endangered Indiana Bat* (Roanoke, VA: USDA Forest Service, George Washington and Jefferson National Forest, March 1998)
- *Conservation Assessment For The Cow Knob Salamander 1994*

PLANNING PROCESS

Forest planning occurs within the overall framework provided by implementing the regulations of NFMA and

NEPA. National, regional, and forest planning form an integrated three-level process. This process requires a continuous flow of information and management direction among three Forest Service administrative levels.

Planning actions required by the NFMA and used in this planning process are:

- Identification of issues, concerns, and opportunities;
- Development of planning criteria;
- Inventory of resources and data collection;
- Analysis of the Management Situation;
- Formulation of alternatives;
- Estimation of effects of alternatives;
- Evaluation of alternatives;
- Recommendation of preferred alternative;
- Approval and implementation;
- Monitoring and evaluation.

The results of these planning steps are described in this document. Refer to Appendix B *Analysis Process*, for more detail on the results of some of these steps.

SUMMARY OF SIGNIFICANT ISSUES

Public involvement is a key part of the planning process. Providing for public comment helps identify what people want from the national forests in the form of goods, services, and environmental conditions. Issues submitted by the public, as well as from within the Forest Service and other federal and state agencies, guided the need to change current management strategies.

Issues were used to formulate alternatives, prescribe mitigation measures, or analyze environmental effects among alternatives. A detailed account of the public involvement process is in Appendix A, "Summary of Public Involvement."

ACCESS

ISSUE STATEMENT: Forest management strategies may affect the balance between public and management needs for motorized access to Forest lands (for recreation, hunting, management activities, fire suppression) and protection of soil and water resources, wildlife populations and habitat, aesthetics, forest health, and desired vegetation conditions.

BACKGROUND: System roads are the primary means of motorized access to the national forest. However, they are also a source of concerns including the environmental effects of roads (on water quality, soil erosion, and habitat) and the social effects on remote settings. Some people would like to see the motorized access to the national forests increased, especially during hunting seasons for big game, for other recreational uses, or to meet forest management needs. Other people, however, feel that road construction should be limited and some existing roads decommissioned. Other comments were made that new roads should not be constructed for the purposes of logging or for OHV use. The amount of motorized access will need to be balanced with wildlife habitat needs, the need to provide both motorized and non-motorized recreational opportunities, the need to protect the soil and water resources, the need to have management access, and the financial capability of maintaining safe and environmentally secure roads.

WATERSHEDS, SOIL AND WATER QUALITY, RIPARIAN RESOURCES AND AQUATIC DIVERSITY

ISSUE STATEMENTS: Management activities may affect soil quality, water quality (surface and groundwater) and riparian resources, including drinking water watersheds and those watersheds with streams impaired due to activities off the Forest. Management activities may affect the maintenance and restoration of aquatic biodiversity and may affect species with potential viability concerns.

BACKGROUND: Providing favorable flows of water was the main objective of the Organic Administration Act that created the forest reserves and of the Weeks Law that allowed the purchase of lands for National Forests in the eastern U.S. Water continues to be one the most important resources produced on the Forest. A number of communities in Virginia and West Virginia obtain their drinking water from the National Forest, whether their water supply watershed is completely within the Forest boundary or their supply is a river that is downstream from the Forest. The Forest is also an important component of the Chesapeake Bay watershed. There are streams within and downstream of the Forest that have impaired water quality. Most of these impairments are due to acid deposition or to agriculture and none have been attributed to management activities on the Forest. Water quality and aquatic systems can be affected by acid deposition, roads, trails, past storm events, insects and disease, non-native invasive species and other disturbances. Streams on the forest provide habitat for a number of species at risk, including brook trout and the James spiny mussel. The projections for climate change in this area indicate an increase in temperature, which could affect aquatic species, especially trout populations. Climate change projections are more uncertain on whether precipitation will increase or decrease in the southeast over the next 30-100 years but droughts or extreme weather events each would have impacts to future water quantity and quality conditions. Climate change could also increase acid deposition effects on soil productivity. Currently, the biggest concerns for aquatic habitats on the Forest are sedimentation, future sources of large woody debris for self-maintaining diverse habitat components, canopy cover to maintain water temperature regimes, impacts from roads, and acid rain.

TERRESTRIAL BIOLOGICAL DIVERSITY

ISSUE STATEMENT: Forest Plan management strategies may affect the maintenance and restoration of the diverse mix of terrestrial plant and animal habitat conditions and may affect species with potential viability concerns.

BACKGROUND: Ecological communities provide the foundation for biological diversity. Ecosystems identified on the Forest include ecological communities that predominate on the landscape (e.g. Central Appalachian Dry Oak-Pine Forest); communities that are declining, rare, or unique (e.g. Caves and Karstlands); and communities that provide habitat for species with potential viability concerns (e.g. Special Biological Areas). For the GWNF, management of ecological communities primarily involves the use of timber harvest and fire to influence vegetation composition and structural diversity of habitats. Some comments were concerned about the current age class distribution on the forest being too skewed toward the mid- to late-successional habitats and that management is needed to provide a mosaic of habitats, especially early successional habitat, which is needed by many species. They cited bird and animal species in decline that require early successional habitat at some point in their life cycle. Others thought the focus on the GWNF should be on providing habitat for species requiring late successional habitat or large home ranges since these conditions are rarer on private lands. They stated that private lands can provide for early successional habitat needs and natural disturbances can create openings on the Forest. Some comments identified the importance of the oak-hickory community in the Central and Southern Appalachians for species diversity and are concerned about oak regeneration and the continuity of future hard mast production.

OLD GROWTH

ISSUE STATEMENT: Forest management strategies may affect the potential biological and social values associated with the abundance, distribution and management of existing and future old growth.

BACKGROUND: Nearly all the lands that became the George Washington National Forest had been cut over at least once before becoming National Forest System lands. However, in many areas of the Forest, stands of trees have reached ages and structural conditions that qualify as “old growth” under the current definitions used in the Southern Region of the Forest Service. Old growth provides both biological and social values. Old

growth communities provide large den trees for wildlife species such as black bear, large snags for birds and cavity nesters, and large cover logs for other wildlife. Ecologically, old growth provides elements for biologic richness, gene conservation, and riparian area enhancement. Old growth areas provide for certain recreational experiences, research opportunities, and educational study. Other areas have associated historical, cultural, and spiritual values. Some may never visit an old growth site but will receive satisfaction from just knowing that it exists. On the other hand, old growth areas can be a source of large-diameter, high-value hardwoods, which are limited in supply and in high demand for such products as furniture and finish construction work. Others say that insect and disease risk can be relatively high in old growth stands and could (for some community types) threaten the retention of those stands as old growth. There is concern that fire exclusion could favor a buildup of fire-intolerant, but shade-tolerant, species that could eventually replace the original old growth type. Another view is that active management, including timber harvest and prescribed fire, could be used to accelerate the development of old growth attributes.

FOREST HEALTH

ISSUE STATEMENT: Forest Plan management strategies may affect the spread and control of non-native invasive species, forest pests, and pathogens, all of which have the potential to affect long-term sustainability, resiliency, and composition of forest ecosystems.

BACKGROUND: While the term "Forest Health" can have several meanings, it is used here to identify the effects of forest pest problems and non-native invasive species. It is a dynamic concept that considers the conditions of our forested ecosystems when subjected to insect and disease organisms and/or invasive species that may otherwise contribute to poor development. While not all non-native species are known to disrupt native ecosystems, of particular concern are those that are successful at invading and rapidly spreading through natural habitats. These include a wide variety of organisms such as the chestnut blight fungus, gypsy moth, hemlock woolly adelgid, didymo algae, and Ailanthus. In addition to these non-native pests, it also includes the native pine bark beetles. Invasive plants create a host of harmful environmental effects to native ecosystems including: displacement of native plants; degradation or elimination of habitat and forage for wildlife; extirpating rare species; impacting recreation; affecting fire frequency; altering soil properties; and decreasing native biodiversity. Invasive plants spread across landscapes, unimpeded by ownership boundaries. Control of existing populations, prevention of the spread of known pests, mitigation of existing problems, and prevention of the introduction of new pests are all components of this issue.

WIND ENERGY

ISSUES STATEMENT: Responding to opportunities to develop wind energy generation may result in effects on a wide variety of resources (including birds, bats, scenery, trail use, soils on ridgetops, water, noise, remote habitat, local communities/economies, and social values).

BACKGROUND: Wind energy is renewable and can reduce the use of fuels generating carbon gases and positively affect climate change. The USDA Forest Service and National Renewable Energy Laboratory (2005) identified 35,810 acres (primarily ridgetops) of the GWNF with a high potential for wind area development. The GWNF is in close proximity to growing population centers that would benefit from additional and clean energy production. However, there are concerns about the effects to water, birds, bats, views, visuals, aesthetics (height of towers), noise, carbon sequestration, and fragmentation of habitat. These concerns relate to both construction and operation of the wind turbines and the associated infrastructure development to support the turbines (roads, powerlines). Some people believe that this need for wind energy development can and should be met on private lands, or that the power would not be used to solve local needs. Other people believe that the National Forests should contribute to the development of renewable resources and green energy.

OIL AND GAS LEASING

ISSUE STATEMENT: Use of National Forest System lands to support energy needs through federal oil and gas leasing may affect forest resources and impact adjacent private lands.

BACKGROUND: Energy production has long been a component of National Forest System management and gas development provides energy to meet national needs. There are no active gas wells currently in production on the Forest and only about 12,000 acres are currently under lease for gas and oil. A particular type of gas

well operation is the development of gas deposits within the Marcellus shale formations, through horizontal drilling and use of hydrofracturing at numerous locations throughout the horizontal bore holes. Concerns about hydrofracturing include the quantity of water needed in the process, negative effects on water quality (ground and surface), wildlife, air quality, viewsheds, forest fragmentation, and ecotourism. Some public comments identified that developing Marcellus shale gas is okay when it is properly regulated and that National Forest System land should be available for leasing Marcellus shale so that people can maintain their standard of living and meet energy needs. Other comments stated that there must be an effects analysis for hydrofracturing or that there should be a moratorium on development until federal/state regulations are in place and an on-going EPA study is complete. Other comments are opposed to this development or want limitations on where it could be used.

FIRE

ISSUE STATEMENT: The management of fire to achieve goals related to protection of property, wildlife habitat, ecosystem diversity and fuels management may affect air quality, non-native invasive species, recreation, water quality, wildlife, and silviculture.

BACKGROUND: Fire is acknowledged as an important part of some ecosystems on the Forest. Aggressive control of wildfire (unplanned ignitions) throughout much of the twentieth century resulted in changes to these ecosystems. Management of wildfires and prescribed fire can serve to restore and maintain these ecosystems, while also protecting National Forest and adjacent lands from the negative effects of fire. Some people support the continued use, and advocate an increase in the use, of prescribed fire to restore ecosystems, create habitat, encourage oak regeneration and reduce fuels. Some comments support the proposed increase in use of prescribed fire, but caution that fire does not replace timber harvest as a management tool; rather it should be considered an additional option for timber management. Some comments identified concerns with the burning program including impacts on adjoining private land, carbon emissions, impacts on native vegetation, opening up habitat for non-native invasive plants, stream sedimentation, and air pollution. Some comments indicated support for using lightning ignited fires to achieve ecosystem restoration goals.

RECREATION

ISSUE STATEMENT: Forest management strategies should determine an appropriate mix of sustainable recreational opportunities (including trail access) that responds to increasing and changing demands and also provides for public health and safety and ecosystem protection (such as soil and water resources, nesting animals, riparian resources and spread of non-native invasive species).

BACKGROUND: The Forest is within a day's drive for a large population of people in the eastern U.S. Local and regional visitors use the forest for a variety of recreational opportunities, from primitive hiking and camping to developed recreation sites and motorized travel. Developed recreation is not a significant issue. Demand for long-distance trails for special recreation events, such as long-distance mountain bicycling, equestrian endurance rides and runner marathons, has increased in recent years. The demand is greatest among the equestrian and mountain biking communities. There is more demand than supply for motorized trail opportunities as opportunities for such use is very limited on private land. Some comments stated that off-highway and all-terrain vehicle use is not appropriate at all on the Forest due to the noise, potential environmental damage, and the need could be met commercially on private lands.

WILDERNESS/ROADLESS

ISSUE STATEMENT: Forest management strategies may affect the balance between the desires for permanent protection of remote areas and the desires for management flexibility and ability to respond to changes in ecological, social and economic conditions when identifying areas to be recommended for Wilderness and determining how potential wilderness areas and other remote areas should be managed.

BACKGROUND: Management of remote areas on the Forest continues to be one of the most prominent issues raised in comments. Remote areas include existing Wilderness, the Inventoried Roadless Areas identified in the 1993 GW Forest Plan Revision (and incorporated into the 2001 Roadless Area Conservation Rule), and the Potential Wilderness Areas (identified as areas meeting the definition of wilderness that need to be evaluated in the current revision process). Public rationale for additional wilderness includes: ecological values of

remote, intact areas; recreational values; proximity of large masses of people to the Forest; protection of watersheds through permanent protection; carbon sequestration; ability for latitudinal range adjustments for species due to climate change; future scientific reference; and a need to bring the amount of wilderness on the Forest more in line with amounts on other National Forests. Public rationale opposing wilderness includes: lack of balance of forest age classes (many species are threatened without early successional habitat); limitations on recreation use by those less physically fit; limitations on group size for recreation events; limitations on special use events; prohibiting all motorized and mountain bike access; restrictions on treatment of invasive species; limitations on meeting energy resource demands; limitations on emergency access; firefighting restrictions; and limiting options as conditions or future demands change.

The GWNF has 23 Inventoried Roadless Areas (IRAs) with a total of 242,278 acres. As part of the revision process, the Forest has identified 37 areas as Potential Wilderness Areas (PWAs) with a total of 372,631 acres. The PWA inventory includes all of the IRAs, with the exception of Southern Massanutten and The Friars. For the remote areas in the PWA inventory that are not identified for Recommended Wilderness Study by Congress, some people would like to see them managed according to the direction in the 2001 Roadless Area Conservation Rule (RACR) and others would like to see them actively managed for wildlife habitat and timber production.

TIMBER HARVEST

ISSUE STATEMENT: Forest Plan management strategies may affect: a) the amount and distribution of land suitable for the sustainable harvest of timber products; b) the amount of timber offered by the Forest; c) the role of timber harvest in benefitting local economies and other multiple use objectives; and d) the methods used to harvest the timber. If the Forest responds to needs for biomass for energy production, whole tree harvesting may affect nutrient cycling, wildlife habitat, and soil productivity and stability. Timber harvest may have effects on other resources.

BACKGROUND: Timber harvest is one of the tools used to manage vegetation on the Forest to create a diversity of habitat conditions. It also produces wood products that benefit local economies. The ecological, social, and economic effects of the timber management program on the GWNF, both positive and negative, are of great importance to many. Some people strongly state that the forest should reduce the acres suitable for harvest, reduce the Allowable Sale Quantity (ASQ), and decrease the commercial timber program due to adverse impacts to: water quality, competition with private lands, air quality, scenery, ecological habitats such as large areas of intact forest (fragmentation), and a wide variety of other ecological/environmental resources. Some indicate that commercial timber harvest on the Forest is not economically viable and competes with privately held timber, that demand for timber can be met on private land, or that the level of the timber sale program should be based on reasonable budget expectations. Other people strongly support an expanded timber program because of the positive impacts on: balancing age classes and reducing acres of an aging forest, maintaining species composition, wildlife habitat, responding to an increased demand for wood products (including biomass), reduction of hazardous fuels, and benefits to local economies. Therefore, there should be an increase in suitable acres and Allowable Sale Quantity.

The potential use of forest wood and fiber as biomass for energy production raises concerns on the effects on carbon sequestration and on the removal of too much organic material which could increase soil erosion and/or remove too many nutrients from the site, particularly in low site index areas or areas affected by acid deposition. Some people believe that the Forest should contribute to this green energy demand while meeting other resource needs (fuels reduction and wildlife habitat), that this will produce green jobs and wood products, and that it is better to burn the trees for fuel rather than burning them as part of prescribed burns. Other people don't believe that biomass fuels are a green source of energy, don't believe that energy should take precedence over forest health, or believe that biomass will compete with pulpwood and drive up prices.

ECONOMICS AND LOCAL COMMUNITY

ISSUE STATEMENT: Management activities may affect the economic role of the Forest, particularly the role it plays in the economy of local communities, including the production of ecosystem services and commodity outputs. Increasing population and development near the Forest may influence access to the National Forest and management activities such as special use requests, fire management, and responses to additional

recreation demands.

BACKGROUND: Some outputs from management activities can be readily valued such as timber, firewood, and recreation fees. Ecosystem services are the suite of goods and services from the Forest that are vital to human health and livelihood and are traditionally viewed as free benefits to society, or "public goods" - wildlife habitat and diversity, watershed services, carbon storage, and scenic landscapes, for example. These outputs and services can all be important to many of the rural communities in and around the National Forest. Several categories of activities identified as important to local communities include tourism (family-based nature activities, recreation events, aggressive trail experiences like all-terrain vehicle trails, equestrian and mountain bike use, wilderness, new trails), habitat management that increases diversity for wildlife viewing and game populations for hunting, and timber production that supports the logging industry.

CLIMATE CHANGE

ISSUE STATEMENT: Changes in climate may require adaptation strategies that facilitate the ability of ecosystems and species to adapt to changes in conditions (such as stream temperature, community vegetation composition, and invasive species). Forest management activities may exacerbate the impacts of climate change or mitigate the impacts through adding to or sequestering carbon or enhancing opportunities for alternative energy sources (wind, biomass, solar).

BACKGROUND: In developing management strategies to deal with a changing climate, it has been recognized that forests can play an important role in both mitigating and adapting to climate change. Mitigation measures focus on strategies such as carbon sequestration by natural systems, ways to increase carbon stored in wood products, ways to provide renewable energy from woody biomass to reduce fossil fuel consumption, and ways to reduce environmental footprints. Adaptation measures address ways to maintain forest health, diversity, productivity, and resilience under uncertain future conditions so that forest resources can better adapt to change. Based on current projections, the primary regional-level and state-level predicted effects of climate change that would impact the GWNF include: (1) warmer temperatures; (2) extreme weather events; and (3) increased outbreaks of insects, disease, and non-native invasive species. Comments suggested that the Plan should address reducing current threats to forest conditions, such as from non-native invasive species, pests and pathogens, acid deposition, and human uses of forest resources. Some comments identify the need to provide migration corridors, which include altitudinal gradients, for plant and animal species, especially those most vulnerable to changing climate conditions. Other comments requested that we evaluate how management activities may exacerbate, mitigate or enhance effects of a changing climate. Others identified the importance of the forest's role in carbon sequestration.

SUMMARY OF ISSUES DETERMINED TO BE NONSIGNIFICANT

WATER DEMAND

ISSUE STATEMENT: Granting requests for water withdrawals to meet increasing water needs may affect stream systems, water quality and groundwater dependent resources.

BACKGROUND: Demand for water, particularly high quality water is expected to increase in areas around the National Forest. This includes groundwater and surface water for drinking and opportunities for hydroelectric power. Many of these needs can likely be met downstream from National Forest System lands. Actual requests for access to develop drinking water sources have been very limited.

REASON FOR NON-SIGNIFICANT ISSUE: While water is becoming increasingly important in the eastern U.S., the Forest has not seen an increase in requests for water use. So this issue is of limited extent on the Forest. Provisions for addressing this issue in the future would occur through the environmental analysis that would accompany any request for a special use to allow water withdrawal.

AIR QUALITY

ISSUE STATEMENT: Management actions, especially fire management, may affect air quality, including Class I

and non-attainment areas. Air pollution from sources outside the Forest, such as ozone and acid deposition, may affect forest resources, like soil and water quality, nutrient cycling, and air pollution impacts to vegetation.

BACKGROUND: Forest resources are affected by air pollutants, such as ozone and acid deposition, from outside the Forest. Acid deposition has affected many of the Forest's sensitive watersheds and acidified streams. Some forest management activities, such as prescribed burning and wildfire management, can contribute to air pollution, particularly with fine particulates in smoke.

REASON FOR NON-SIGNIFICANT ISSUE: Impacts of management activities is partially addressed by law (Clean Air Act). The impacts of air pollution on forest resources will be addressed as management needs or current conditions. It is unlikely that alternatives will address responses to air quality in different ways, aside from different levels of activities. The effects of activities on air quality will be addressed in the analysis.

SCENERY

ISSUE STATEMENT: Various management activities could affect scenic resources across the forest through changes in vegetation and road and facilities construction.

BACKGROUND: Scenery is a key resource and much of the high use that the GW receives is due to pleasing scenery.

REASON FOR NON-SIGNIFICANT ISSUE: Scenery is a key component of the Forest. It is unlikely that alternatives will address scenery in different ways. All alternatives would require that scenic integrity objectives would be met.

GEOLOGY/KARST

ISSUE STATEMENT: Management activities may affect karst areas, ground and surface water, and biodiversity associated with karst areas and caves. Management activities may affect or be affected by geologic hazards.

BACKGROUND: Karst areas are landscapes formed in areas of carbonate rocks such as limestone or dolomite. These landscapes often have caves or sinkholes and the relationship of the area to groundwater is extremely important. Geologic hazards are potentially safety concerns related to the type, structure or location of geologic features. They include landslides, rock falls, floods and abandoned mines.

REASON FOR NON-SIGNIFICANT ISSUE: In all alternatives, measures will be prescribed to protect karst resources.

LANDS

ISSUE STATEMENT: The acquisition, disposition and exchange of National Forest System lands may affect access, trespass, fragmentation, and management activities.

BACKGROUND: Lands management includes acquisition of lands, exchange of federal lands for private lands, and the marking and maintenance of boundary lines.

REASON FOR NON-SIGNIFICANT ISSUE: This issue is limited in extent across the Forest and is unlikely to vary by alternative.

GRAZING

ISSUE STATEMENT: Concern about impacts of grazing on water quality and inhibiting restoration of bottomland hardwoods in floodplains.

BACKGROUND: Grazing currently occurs on five areas covering about 250 acres of the Forest. Four of the areas are along the South Fork of the Shenandoah River. Grazing is used on these areas to maintain open, pastoral settings.

REASON FOR NON-SIGNIFICANT ISSUE: This issue is limited in extent on the Forest since grazing occurs on less than 1,000 acres.

USER FEES

BACKGROUND: Some comments addressed the need for additional user fees on the forest or questioned why hunters and anglers were required to purchase a National Forest Stamp when other users were not required to pay a fee to enjoy their activities on the National Forest.

REASON FOR NON-SIGNIFICANT ISSUE: The issue of user fees will not be considered further in the revision effort for the following reasons. Congress passed a law (Federal Lands Recreation Enhancement Act) that provided limits on areas and sites where recreation fees can be charged. The Act prohibits certain fees for 1) general access to the national forest; 2) horseback riding, walking through, driving through, or boating through areas where no facilities or services are used; 3) access to overlooks or scenic pullouts; and 4) undesignated parking areas where no facilities are provided for; picnicking along roads or trails.

The agency did not create the "National Forest Stamp" for hunters and fisherman; the states created the laws that charge these recreationists for hunting and fishing on the National Forest.

LAW ENFORCEMENT

BACKGROUND: Some comments were received regarding the need for more law enforcement activities on the National Forest.

REASON FOR NON-SIGNIFICANT ISSUE: While law enforcement is a critical part of managing the National Forests, the level of law enforcement funding and specific activities of law enforcement officers are not forest plan decisions and so are outside the scope of this analysis.

EDUCATION

BACKGROUND: Some comments were received regarding the importance of providing environmental education opportunities on the Forest.

REASON FOR NON-SIGNIFICANT ISSUE: The level of activity provided for education is not a component of the Forest Plan and is outside the scope of the analysis. While environmental education is not a plan component, it is important to highlight the need for more emphasis on environmental education and to acknowledge the tremendous opportunities that the Forest provides to meet the need to educate youth about the Forest's resources.

PLANNING PROCESS RECORDS

The Forest's Interdisciplinary Team is responsible for developing the revised Forest Plan. Efforts were made to provide detailed explanations of each step of the revision in the form of process (or planning) records. This DEIS contains summaries of the process records and includes references to the parent records. Process records are on file in the Forest Supervisor's Office. To review these records, contact:

Forest Supervisor's Office
George Washington and Jefferson National Forests
5162 Valleypointe Parkway
Roanoke, VA 24019
(540)265-5100

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CHAPTER 2 ALTERNATIVES

INTRODUCTION

This chapter describes the seven alternatives considered in detail in this Environmental Impact Statement, as well as the process used to develop alternatives. The alternatives suggest a variety of scenarios for managing the George Washington National Forest and how they respond to the significant issues described in Chapter 1. This chapter also explains the alternative development process, provides reasons for why some alternatives were originally considered and then later eliminated from detailed study, describes those alternatives considered in detail, and compares how each alternative responds to the significant issues.

DEVELOPMENT OF ALTERNATIVES

National Forest Management Act regulations at 36 CFR 219.12(f) state that the interdisciplinary team will formulate a broad ranges of reasonable alternatives and that the primary goal in formulating alternatives, besides complying with NEPA procedures, is to provide an adequate basis for identifying the alternative that comes nearest to maximizing net public benefits, consistent with the resource integration and management requirements of 219.13 through 219.27.

The alternative development process began with the analysis of the need for change described in the Analysis of the Management Situation. From the need for change came an alternative that was briefly described in the Notice of Intent along with the current management, or No Action alternative. The No Action alternative became Alternative A and the alternative developed from the need for change analysis became Alternative B. After the scoping period initiated with the Notice of Intent (March 2010) was completed, the Interdisciplinary Team identified the significant issues. The Interdisciplinary Team then identified alternative ways to address the issues and a range of responses to the issues. This range of responses to the issues was then put together into Alternatives C, D, E and F. A public workshop was held with the Interdisciplinary Team to discuss the alternatives and the alternatives were further refined based on those discussions. Another public workshop was held in October 2010 to address the alternatives. The Forest Leadership Team and Interdisciplinary Team then met to discuss the alternatives to find a preferred alternative. The result of that meeting, and further discussions with the Responsible Official (Regional Forester), resulted in the development of Alternative G as the preferred alternative upon which the Draft Forest Plan is designed.

Public input supported a Forest Plan based on reasonable budgets so the alternatives were developed with realistic budget flexibilities and workforce capabilities in mind. All alternatives were also required to meet the purpose and need identified in Chapter 1 of the DEIS and address one or more of the significant issues.

ALTERNATIVES CONSIDERED BUT ELIMINATED FROM DETAILED STUDY

Some comments were made that alternatives should be developed that maximize certain resources or resource management activities. Given that the purpose of this analysis is to revise a current Forest Plan that is designed to continue to meet the multiple use mandate, maximization of resources at the expense of other resources does not meet the purpose and need. However, the benchmark analyses addressed in the Analysis of the Management Situation do identify some of the potential benefits and tradeoffs from maximizing some outputs.

Some comments were also made to consider an alternative that involves no management on the Forest, to let natural processes dominate without human intervention. This alternative was not considered in detail because it could not meet the purpose and need identified in Chapter 1 and it could not meet legal requirements of the National Forest Management Act of 1976, the Multiple-Use Sustained Yield Act of 1960 and the Endangered Species Act of 1973. However, Alternative C does consider a low level of management activities and is considered in detail.

Some comments expressed a desire to see a much higher level of timber production, in order to provide wood products and early seral conditions for wildlife. Although the Forest is capable of producing a sustained yield of a much higher level of timber production (as shown in the Maximum Timber Volume Benchmark in Appendix B), this alternative was not considered in detail, due to concerns that expected budgets could not support that level of production.

Another alternative that was proposed was to have a separate alternative that addresses the actual accomplishments achieved during the past implementation of the current plan. Since many aspects of the current plan were not achieved, this alternative would be different than Alternative A which represents the 1993 Forest Plan direction, rather than actual implementation of the Forest Plan. Rather than developing a separate alternative, this analysis identifies the places where Alternative A differs between its direction and its implementation.

CONSISTENCY WITH THE RENEWABLE RESOURCES PLANNING ACT

National Forest Management Act regulations at 36 CFR 219.12(f)(6) state that at least one alternative be developed which responds to and incorporates the Renewable Resource Planning Act (RPA) program tentative resource objectives. The Government Performance and Results Act (GPRA) of 1993 requires federal agencies to prepare strategic plans, which duplicated much of the RPA Program. The Agency no longer prepares an RPA Program but does periodically update its strategic plan that contains goals, outcomes, performance measures, and strategies that apply to management of the National Forest System. The Agency continues to periodically update the RPA Assessment, which presents national and regional analyses of the renewable resource situation, including projections of supply and demand. However, neither the RPA Assessment nor the Forest Service Strategic Plan contains recommended output targets applicable to individual National Forests. The alternatives evaluated in this DEIS incorporate the broad, strategic objectives of the Forest Service Strategic Plan 2007-2012.

DEVELOPMENT OF MANAGEMENT PRESCRIPTIONS

Developing a variety of Management Prescriptions with different desired conditions and standards to apply to distinct areas of the Forest was the primary method used to formulate a range of alternatives to address the significant issues. The management prescriptions were largely derived from the management prescriptions used for the Jefferson Forest Plan. The same naming conventions were used and a few changes were made to the desired conditions and standards. Table 2-1 lists the full set of management prescriptions allocated in the range of alternatives.

Table 2-1. Management Prescriptions Allocated in the Range of Alternatives

Prescription Code	Prescription Description
1A	Designated Wilderness
1B	Recommended Wilderness Study
2C2	Eligible Wild and Scenic River-Scenic
2C3	Eligible Wild and Scenic River-Recreation
4A	Appalachian Trail
4B1	Research Natural Area
4C1	Geologic Area
4D	Special Biological Area
4D1	Key Natural Heritage Community Area
4F	Mt Pleasant National Scenic Area
4FA	Recommended National Scenic Area
5A	Administrative Site
5B	Communication Site
5C	Utility Corridor
7A1	Scenic Byway
7B	Scenic Corridors and Viewsheds
7C	ATV Use Area
7D	Concentrated Recreation Areas
7E	Dispersed Recreation Areas
7E1	Dispersed Recreation Areas-Unsuitable for Timber Production
7E2	Dispersed Recreation Areas-Suitable for Timber Production
7F	Blue Ridge Parkway
7G	Pastoral Landscapes
8A1	Mix of Successional Habitats
8A1U	Mix of Successional Habitats-Unsuitable for Timber Production
8B	Early Successional Habitats
8BU	Early Successional Habitats-Unsuitable for Timber Production
8C	Black Bear/Remote Habitats
8CU	Black Bear/Remote Habitats-Unsuitable for Timber Production
8E4a	Indiana Bat-Primary Conservation Area
8E4b	Indiana Bat-Secondary Conservation Area
8E7	Shenandoah Mtn Crest-Cow Knob Salamander
9A1	Source Water Watershed Protection
10B	Timber Production
10BU	Timber Production-Unsuitable
12D	Remote Backcountry
13	Mosaics of Habitat-Suitable for Timber Production
13U	Mosaics of Habitat-Unsuitable for Timber Production

ALTERNATIVES CONSIDERED IN DETAIL

ALTERNATIVE A - NO ACTION ALTERNATIVE

The 36 CFR 219.12(f)(7)) 1982 regulations state that "at least one alternative shall reflect the current level of goods and services provided by the unit and the most likely amount of goods and services expected to be provided in the future if current management direction continues. Pursuant to NEPA procedures, this alternative shall be deemed the "no action" alternative."

Alternative A represents the 1993 Forest Plan, as amended through ten amendments. In this situation, 'no action' means no change from the current management direction and it provides the baseline for the effects analysis in the EIS. While Alternative A represents the 1993 Plan, it is important to note that annual budgets affect implementation of a Forest Plan. The Analysis of the Management Situation contains a table of accomplishments during the life of the 1993 Forest Plan. In this DEIS, where annual accomplishments have varied substantially from Forest Plan direction and assumptions, the actual accomplishment level will be noted.

The ten amendments to the 1993 Forest Plan included: Fore Mountain was added to the communication sites in Management Area 20; Laurel Fork Special Management Area was made no longer available for oil and gas leasing; Mount Pleasant was designated as a National Scenic Area; the Biological Opinion for the Indiana Bat was adopted; and Jerkemtight Road was relocated and dropped as featured Off-Highway Vehicle route; and the remaining amendments were errata or clarifications. The Priest and Three Ridges recommended wilderness study areas have been designated as Wilderness since 1993.

The 1993 Forest Plan provides a variety of resource benefits, including wood, wildlife, fish, range, dispersed recreation, developed recreation, minerals, wilderness and special uses, in a manner that maintains the diversity, productivity and long-term sustainability of ecosystems. Maintaining biological diversity is a major goal with standards designed to conserve specific elements of biodiversity and restore others. Conservation of biodiversity is an integral part of sustaining multiple uses of the Forest.

The following are highlights of Alternative A:

ACCESS

- Road construction 3-8 miles/year (Actual road construction has averaged 1.8 miles/year)

WATER, SOILS, RIPARIAN, AQUATIC DIVERSITY

- Streamside management zones (66' along perennial and 33' along intermittent streams)
- Municipal watersheds identified, but not highlighted; impaired streams and reservoirs not recognized.

RECREATION

- Three existing ATV/OHV use areas; one additional area planned at Archer Run
- Large increase in trail construction
- Featured OHV routes identified and managed for OHV use
- New developed recreation and expansions of existing sites
- Use of adopted ROS settings

WILDERNESS/ROADLESS

- One recommended wilderness study area remains - St Mary's Addition (South)
- Portions of the Inventoried Roadless Areas are allocated to active management (9%), rest allocated to remote backcountry, special biological areas.

- Remote backcountry prescriptions are not suitable for timber harvest, but do allow some salvage harvest. Road construction is generally prohibited, with limited exceptions.
- About 55% of the potential wilderness areas are in remote settings.

TIMBER HARVEST

- ASQ is 33 mmbf/year. Annual harvest program of 3,000 acres. Suitable acres are 348,000. (Actual average harvest program has been 1,525 acres/year)
- Utilize a management area with timber as primary management objective

TIMBER HARVEST, TERRESTRIAL DIVERSITY, FIRE

- Amount and location of early successional based on biodiversity, wood product demand, balanced age class concerns, increased game populations

TERRESTRIAL DIVERSITY

- Separate management areas for wildlife: early successional, remote habitat, mosaics of habitat, small game/watchable wildlife
- Special Biological Areas around 90,000 acres

OLD GROWTH

- No old growth management area.
- Old growth defined by Forest derived definitions.
- Allowed to harvest on suitable ground in old growth forest type - Dry-Mesic Oak

FOREST HEALTH

- Gypsy moth is main focus; use of Integrated Pest Management techniques

WIND

- The Plan has no specific direction for wind development

OIL AND GAS

- Approx 960,000 acres are available for leasing under standard or controlled surface occupancy stipulations
- No direction for Marcellus shale development

ECONOMICS AND LOCAL COMMUNITY

- Mix of ecosystem services and commodity outputs

FIRE

- Prescribed fire program is 3,000 acres/year. (Actual average prescribed burning has been 4,666 acres/year)
- Use of wildfire is allowed to achieve forest goals but no criteria developed

CLIMATE CHANGE

- No direction is specifically related to climate change.
- About 2/3 of Forest is managed to move towards late successional conditions.
- Active management of vegetation structure and composition is predominantly through timber harvest activities.
- Much of Forest is available for development of natural gas production.
- Soil and water improvement are important, but not prioritized by any specific watersheds.

ALTERNATIVE B

This alternative is based on changes to the current plan identified in the Analysis of the Management Situation. The analysis was based on an IDT evaluation of the 1993 Forest Plan direction, monitoring and evaluation results, new policies, best available science and an attempt to balance public issues that were identified as of March 2010. The need to change items that were listed in the Notice of Intent in March 2010 to begin preparation of the EIS included the following: 1) Identify desired conditions and objectives to maintain the resilience and function of nine identified ecological systems, determine the desired structure and composition of those ecosystems, and incorporate management direction to provide habitat for maintaining species viability and diversity across the forest; 2) Substantially increase the objective for using prescribed fire in ecosystem restoration and incorporate the use of wildfire for resource enhancement; 3) Move the remote backcountry boundaries to match the Inventoried Roadless Area boundaries; 4) Portions of a few Inventoried Roadless Areas (about 8,000 acres), where the boundary of the Inventoried Roadless Areas is along existing roads and the adjacent forest has been actively managed for many years, are proposed to remain in active management rather than in remote backcountry; 5) Manage the remote backcountry areas with standards to closely mirror the management restrictions on road construction and timber harvest that were described in the 2001 Roadless Area Conservation Rule, except that salvage of dead and dying trees without road construction is allowed if the roadless character of the area is maintained.

The following are highlights of Alternative B

ACCESS

- No net increase in open road miles.
- Road construction of about 1 mile per year
- Road decommissioning 16 miles/year for the first decade

WATER, SOILS, RIPARIAN, AQUATIC DIVERSITY

- Riparian Areas same as Jefferson NF (100' on perennial, 50' on intermittent streams) in all watersheds
- Drinking water supplies identified. Drinking water watersheds and watersheds above impaired streams and reservoirs negatively affected by acid deposition are a priority for restoration.

RECREATION

- Three existing ATV/OHV use areas; drop planned Archer Run area
- No net increase in trail miles or maintenance (can increase but would also have to decommission)
- Specific roads not featured for licensed OHV use but miles would stay at current level
- No new developed recreation sites; few expansions of existing sites
- Semi-primitive areas outside wilderness, recommended wilderness or backcountry areas not maintained through plan direction

WILDERNESS/ROADLESS

- Recommend St Mary's Addition (West), Little River, Rich Hole addition, and Ramsey's Draft addition (total 20,000 acres) for wilderness
- Portions of the Inventoried Roadless Areas are allocated to active management (4%), rest allocated to remote backcountry, special biological areas.
- Remote backcountry managed to limit timber harvest and road construction in a manner similar to Roadless Area Conservation Rule of 2001, except to allow salvage harvest.
- Most of the additional Potential Wilderness Areas in current active management would remain in active management.

TIMBER HARVEST

- ASQ around 33 mmbf/yr.
- Annual harvest program of 1,800-3,000 acres.
- Suitable acres around 476,000 acres.
- Primary purpose of timber harvest is to support other resource objectives

TIMBER HARVEST, TERRESTRIAL DIVERSITY, FIRE

- Amount and location of early successional habitat is based primarily on ecological objectives, restoration needs

TERRESTRIAL DIVERSITY

- One broad management area for wildlife habitat emphasis
- About 114,000 acres of Special Biological Areas

OLD GROWTH

- No old growth management area. Old growth defined by Regional definitions.
- Most of the stands meeting the old growth definition are unsuitable for timber production. Areas in the most common forest type (Dry-Mesic Oak Forests) that are on lands suitable for timber production could be considered for harvest.

FOREST HEALTH

- Increased recognition of non-native invasive species; use of Integrated Pest Management techniques

WIND

- Areas not suitable for wind development: Wilderness, recommended wilderness, National Scenic Area, Special Biological Areas, Indiana bat protection areas, Appalachian Trail corridor, remote backcountry areas

OIL AND GAS

- Moderate amount of areas (~700,000 acres) compared to current plan are available for leasing under standard or controlled surface occupancy stipulations
- Horizontal drilling (Marcellus shale development) allowed on all available acres but specific standards related to hydrofracking would be used

ECONOMICS AND LOCAL COMMUNITY

- Similar to Alternative A

FIRE

- Prescribed fire program between 12,000 and 20,000 acres/year
- Utilize fire to attain ecological objectives for biodiversity when appropriate

CLIMATE CHANGE

- Impaired streams and reservoirs are priority for restoration; actively restore (chestnut, yellow pine, hemlock, spruce, riverfront hardwoods, beaver meadows, fire dependent and adapted communities, open woodlands, TESLR species).
- Timber harvest, fire and grassland/shrubland maintenance are used to manage vegetation structure and composition to improve resiliency of the ecosystems.

ALTERNATIVE C

In this alternative, restoration and maintenance of sustainable ecological systems is accomplished predominantly through natural processes, with little human intervention. It also addresses the need for non-motorized recreation opportunities. This alternative emphasizes low-impact activities and passive restoration of natural communities at a slow rate. Active management is for the protection of Forest resources and meeting legal requirements, with limited exceptions. Recreation emphasis is on semi-primitive settings and opportunities. This alternative features the most area recommended for wilderness study. The character will be of a landscape evolving through successional stages toward a natural-evolving appearance. This alternative would also emphasize linking together movement corridors and large undisturbed areas for forest interior species and late-successional species. Effects of native insects and diseases would be accepted but non-native species would be controlled. Road network mileage would be reduced through closure or decommissioning of roads not needed for ecosystem stewardship, restoration or dispersed recreation use. Many of the closed roads would be used to supplement the trail system for non-motorized uses.

The following are highlights of Alternative C:

ACCESS

- Extensive road closure or decommissioning; but some access is still needed for non-motorized activities
- No road construction
- Road decommissioning 28 miles/year for first decade

WATER, SOILS, RIPARIAN, AQUATIC DIVERSITY

- Riparian areas are the same as Jefferson NF (100' on perennial, 50' on intermittent streams) but buffers would be larger in source drinking watersheds and along impaired streams
- Management areas assigned for drinking water watersheds as identified in comments. These management areas and watersheds above impaired streams and reservoirs are a priority for restoration and include management activity restrictions.

RECREATION

- Three existing ATV/OHV use areas; drop planned Archer Run area
- Increase in trails for non-motorized users but no net increase in maintenance (by relocating or decommissioning unsustainable trails)
- No management of roads for OHV use
- No new developed recreation sites, closure of some sites
- Maintain inventoried semi-primitive acres and move towards a primitive ROS setting in Shenandoah Mountain area

WILDERNESS/ROADLESS

- High level of recommended wilderness (380,000 acres), including all of the Potential Wilderness Areas
- Remote backcountry managed to limit timber harvest and road construction in manner similar to Roadless Area Conservation Rule of 2001.

TIMBER HARVEST

- No ASQ or suitable land base
- No commercial timber program but incidental harvest may occur

TIMBER HARVEST, TERRESTRIAL DIVERSITY, FIRE

- Creation of early successional habitat through harvest of trees very limited, only for Threatened and Endangered Species and limited Sensitive species habitat

TERRESTRIAL DIVERSITY

- No management area defined for wildlife or timber since most of the forest will provide for forest interior species and late-successional species; emphasis is to minimize fragmentation and edge effects
- About 114,000 ac of Special Biological Areas; add wood turtle habitat to Special Biological Areas

OLD GROWTH

- No old growth management area. Old growth defined by Regional definitions.
- No harvest of any stands meeting the definition of old growth forest

FOREST HEALTH

- Heavy emphasis on prevention of the introduction and minimizing the spread of non-native invasive species, especially in remote settings. Increased emphasis on non-motorized recreation may require aggressive prevention measures in concentrated use areas. Limited use of herbicides and insecticides

WIND

- No wind development allowed.

OIL AND GAS

- No areas available for oil and gas leasing.

ECONOMICS AND LOCAL COMMUNITY

- Fewer commodity outputs, focus is on remote non-motorized recreation and ecosystem services outputs

FIRE

- Very limited use of prescribed fire, for TES species
- Allow wildfires to burn as much as possible

CLIMATE CHANGE

- Passive restoration through natural processes; manage most of the forest to move towards late successional conditions;
- Reduction of access to the forest to limit introduction and spread of invasives;
- Decommissioning of roads to reduce potential sedimentation in streams;
- Less fragmentation to increase connectivity of migration corridors for species that rely on mature, closed canopy forests

ALTERNATIVE D

In this alternative, restoration and maintenance of natural ecological systems would use practices that also produce a higher level of commodities and offers amenities that enhance tourism for local communities that benefit economically from forest visitors and forest products. This alternative would have the highest level of timber production. A mixture of timber outputs would be focused on species/product combinations with strong demand. Mineral leasing decisions would respond to public need and maximize benefits to local communities. Mitigation measures for the effects of climate change could be met through providing opportunities for alternative energy, such as wind power, natural gas, timber and biomass. Public access (travelways, use corridors, waterways, and trails - including off-highway vehicles) would be increased in high-use areas and/or improved to provide for more opportunities for recreation and other forest uses to occur when compatible with other resources. Additional roads may be needed to support the production of wood products and natural gas development. Roads would still be analyzed for decommissioning but opportunities for using unneeded roads for trail access would be preferable. Habitats would be provided for game species, species with high public interest, species with demanding habitat requirements, species that are ecological indicators and keystone species. Management direction would support special use requests for facilities or developments that enhance economic development for local communities, such as communications towers or non-commercial wind towers. This alternative responds to public desires for more accessibility to national forest system lands.

The following are highlights of Alternative D:

ACCESS

- Some road construction to support tourism opportunities and commodity production
- Road construction about 4 miles/year
- Road decommissioning 8 miles/yr

WATER, SOILS, RIPARIAN, AQUATIC DIVERSITY

- Riparian areas same as Jefferson NF (100' on perennial, 50' on intermittent streams) in watersheds with threatened and endangered aquatic species. Current plan standards in rest of watersheds
- Drinking water watersheds identified per State designation are a priority for restoration activities, along with watersheds above impaired streams and reservoirs.

RECREATION

- Three existing ATV/OHV use areas; more than one area could be planned
- Increase in trails for tourism, such as long distance, connected trails for user events
- Featured OHV routes identified and managed for OHV use
- No new developed recreation sites but offer more amenities at existing sites
- Semi-primitive areas outside wilderness, recommended wilderness or backcountry areas not maintained through plan direction

WILDERNESS/ROADLESS

- Low level of recommended wilderness (14,000 acres), determined by additions, areas with unique visitor draws, and Rockbridge County Board of Supervisors recommended areas
- Portions of the Inventoried Roadless Areas are allocated to active management, rest allocated to remote backcountry, special biological areas. Most of the additional Potential Wilderness Areas in current active management would remain in active management
- Remote backcountry managed to limit timber harvest and road construction in a manner similar to Roadless Area Conservation Rule of 2001, except to allow salvage harvest.

TIMBER HARVEST

- ASQ higher than current plan to meet an annual harvest program of 3,000 - 5,000 acres/year.
- Suitable acres around 488,000 acres
- Utilize a management area with timber as primary management objective

TIMBER HARVEST, TERRESTRIAL DIVERSITY, FIRE

- Amount and location of early successional based on wood product demand, balanced age class concerns, increased game populations, restoration

TERRESTRIAL DIVERSITY

- Separate management areas for wildlife: early successional, remote habitat, mosaics of habitat, small game/watchable wildlife; perhaps add one specifically for grouse
- About 114,000 acres of Special Biological Areas

OLD GROWTH

- No old growth management area. Old growth defined by Regional definitions.
- Most of the stands meeting the old growth definition are unsuitable for timber production. Areas in the most common forest types (Dry-Mesic Oak Forests and Dry and Dry-Mesic Oak-PineForests) that are on lands suitable for timber production could be considered for harvest; can cut trees in other old growth forest types to actively restore structural conditions.

FOREST HEALTH

- Aggressive treatment of non-native invasive species; use of Integrated Pest Management techniques; emphasis on minimizing spread to adjacent private lands; aggressive prevention and control in disturbed areas or high use areas

WIND

- Wind development would be suitable across much of the forest with a high potential for wind development; several inventoried roadless areas would be available for wind development

OIL AND GAS

- Approx 720,000 acres are available for leasing under standard or controlled surface occupancy stipulations
- Horizontal drilling (Marcellus shale development) allowed on all available acres but specific standards related to hydrofracking would be used

ECONOMICS AND LOCAL COMMUNITY

- Increase in commodity outputs related to wood, minerals, alternative energy and on tourism, including motorized recreation

FIRE

- Prescribed fire on unsuitable acres and timber management on suitable acres to achieve ecological objectives
- Utilize fire to attain ecological objectives for biodiversity when appropriate, but minimize burning of lands suitable for timber production

CLIMATE CHANGE

- Increase opportunities for climate change mitigation (alternative energy sources such as wind, oil and gas leasing and Marcellus Shale development);
- Source drinking watersheds and impaired waters are priority for restoration;
- Actively restore (chestnut, yellow pine, hemlock, spruce, riverfront hardwoods, beaver meadows, fire dependent and adapted communities, open woodlands, TESLR species);
- Timber harvest, fire and grassland/shrubland maintenance are used to manage vegetation structure and composition to improve resiliency of the ecosystems.

ALTERNATIVE E

Alternative E would actively restore and maintain vegetative compositional and structural conditions needed to provide for a variety of terrestrial and aquatic species in certain areas of the forest. Prescribed fire, timber harvest and maintenance of grasslands and shrublands would all be used to provide a diverse mix of habitats in the ecological systems. In some areas of the forest large blocks of mature forest would predominate. Alt E emphasizes improving soil and water concerns in high priority watersheds. As a result of restoration treatments, commodities such as sawlogs, biomass, and fuelwood are available for local industry and individual needs. Restoration activities such as prescribed fire and thinning would be more intensive than in the other alternatives. A variety of recreation settings would occur in areas compatible with restoration activities. New recreation developments are limited; the emphasis is on maintaining existing developments.

The following are highlights of Alternative E:

ACCESS

- No net increase in open road miles.
- Road construction is 1 mile/year
- Road decommissioning 16 miles/year

WATER, SOILS, RIPARIAN, AQUATIC DIVERSITY

- Riparian Areas same as Jefferson (100' on perennial, 50' on intermittent streams) in all watersheds
- Priority watersheds identified based on water use (sensitive aquatic species, drinking water), impairment (particularly acid deposition), and sensitivity are a priority for restoration activities.

RECREATION

- Three existing ATV/OHV use areas; drop planned Archer Run area
- No net increase in trail miles or maintenance, focus on relocating or decommissioning of unsustainable trails
- No management of roads for OHV use
- No new developed recreation sites, closure of some sites located in floodplains
- Maintain inventoried semi-primitive acres

WILDERNESS/ROADLESS

- Recommended wilderness areas (24,000 acres) include Little River and additions to Rich Hole, Rough Mountain, Ramsey's Draft, St. Mary's, and Three Ridges
- Portions of the Inventoried Roadless Areas are allocated to active management, rest allocated to remote backcountry, special biological areas. Most of the additional Potential Wilderness Areas in current active management would remain in active management
- Remote backcountry managed to limit timber harvest and road construction in manner similar to Roadless Area Conservation Rule of 2001.

TIMBER HARVEST

- ASQ higher than current plan but not as high as Alternative D, to meet ecological restoration objectives; suitable acres around 383,000 acres.
- Annual harvest program of 1,800-3,000 acres.
- Primary purpose of timber harvest is to support other resource objectives

TIMBER HARVEST, TERRESTRIAL DIVERSITY, FIRE

- Amount and location of early successional based on ecological objectives, restoration

TERRESTRIAL DIVERSITY

- One broad management area for wildlife habitat emphasis
- About 114,000 acres of Special Biological Areas

OLD GROWTH

- No old growth management area. Old growth defined by Regional definitions.
- Stands meeting the definition of old growth forests are not suitable for timber production, but trees in these stands can be cut to actively restore structural conditions
- The Peters Mountain and Frozen Head areas (boundaries modified from the Virginia DCR proposal) are unsuitable for timber production

FOREST HEALTH

- Aggressive treatment of non-native invasive species; use of Integrated Pest Management techniques; emphasis on minimizing spread to adjacent private lands; aggressive prevention and control in disturbed areas or high use areas

WIND

- No wind development allowed.

OIL AND GAS

- Low amount (660,000 acres) compared to current plan are available for leasing under standard or controlled surface occupancy stipulations
- No areas available for horizontal drilling (Marcellus Shale development).

ECONOMICS AND LOCAL COMMUNITY

- Focus is on outputs of ecosystem services, but this results in some increase in timber commodity outputs

FIRE

- Prescribed fire program around 20,000 acres/year based on ecological objectives.
- Favor use of wildfire to achieve ecological objectives instead of aggressive suppression

CLIMATE CHANGE

- Increase activities to adapt to climate change (improve ecosystem resiliency, restore vegetation composition and structure, aggressive treatment of invasive species);
- source drinking watersheds and impaired waters are priority for restoration;
- relocation or closure of some recreation sites in floodplains;
- a factor to consider in amount of recommended wilderness areas is the desire for future flexibility;
- actively restore (chestnut, yellow pine, hemlock, spruce, riverfront hardwoods, beaver meadows, fire dependent and adapted communities, open woodlands, TESLR spp);
- Timber harvest, fire and grassland/shrubland maintenance are used to manage vegetation structure and composition to improve resiliency of the ecosystems.

ALTERNATIVE F

This alternative would restore and maintain the native ecological systems while also creating many opportunities for a variety of recreation settings. The emphasis is on recreation opportunities, scenery management, and wilderness designation, while focusing ecosystem health activities in support of wildlife based recreation. Resource management is designed to attract recreation users, both locally and from large population centers near the forest. A variety of recreation settings and experiences, both motorized and non-motorized would be provided. Developed recreation facilities would support dispersed recreation by providing access to water-based recreation, trailheads, cultural resource interpretation, and horse staging areas. In addition to open roads available for use, specific off-highway vehicle routes would be featured. Large blocks of unroaded areas would provide remote, backcountry experiences not available on private lands. Habitat for early successional species would be maintained in a manner that would be unnoticeable to most forest visitors. High scenic quality would be a major emphasis. Active resource management would be concentrated in certain locations and support recreation use and visual quality.

The following are highlights of Alternative F:

ACCESS

- No net increase in open road miles.
- Road construction 0.5 miles/year
- Road decommissioning 18 miles/year

WATER, SOILS, RIPARIAN, AQUATIC DIVERSITY

- Riparian Areas same as Jefferson (100' on perennial, 50' on intermittent streams) in all watersheds
- Drinking water watersheds identified per State designation are a priority for restoration activities, along with watersheds above impaired streams and reservoirs.

RECREATION

- Three existing ATV/OHV use areas; trails would be expanded in these areas; drop planned Archer Run area
- Increase in trails for all users but no net increase in maintenance (by relocating or decommissioning unsustainable trails)
- Specific roads not featured for OHV routes but miles would stay at current level
- No new developed recreation sites; few expansions of existing sites
- Maintain inventoried semi-primitive acres

WILDERNESS/ROADLESS

- High amount of recommended wilderness areas (112,000 acres) include Beech Lick, Three High Heads, Laurel Fork, Little Alleghany, Little River, Oliver Mountain, Potts Mountain, Three Sisters, Whites Peak and additions to Rich Hole, Rough Mountain, Ramsey's Draft, St. Mary's, and Three Ridges.
- Incorporate Shenandoah Mountain Proposal including National Scenic Areas and wilderness area recommendations
- All of the Inventoried Roadless Areas would be either recommended wilderness or remote backcountry, special biological areas. Some of the additional Potential Wilderness Areas in current active management would remain in active management
- Remote backcountry managed to limit timber harvest and road construction in manner similar to Roadless Area Conservation Rule of 2001.

TIMBER HARVEST

- ASQ around 33 mmbf/year.
- Annual harvest program of 1,000-1,800 acres.
- Suitable acres around 294,000 acres.
- Primary purpose of timber harvest is to support other resource objectives

TIMBER HARVEST, TERRESTRIAL DIVERSITY, FIRE

- Amount and location of early successional based on wildlife needs, ecological objectives, restoration

TERRESTRIAL DIVERSITY

- One broad management area for wildlife habitat emphasis
- About 114,000 acres of Special Biological Areas

OLD GROWTH

- Old growth would be allocated to management prescription for old growth. Old growth defined by Regional definitions.
- No harvest of any stands meeting the definition of old growth forest
- The Peters Mountain and Frozen Head areas (boundaries as identified by the Virginia DCR proposal) are unsuitable for timber production

FOREST HEALTH

- Aggressive treatment of non-native invasive species; use of Integrated Pest Management techniques; emphasis on minimizing spread to adjacent private lands; aggressive prevention and control in disturbed areas or high use areas

WIND

- Areas not suitable for wind development: Wilderness, recommended wilderness, National Scenic Area, Special Biological Areas, Indiana bat protection areas, Appalachian Trail corridor, remote backcountry areas

OIL AND GAS

- Low amount (630,000 acres) compared to current plan are available for leasing under standard or controlled surface occupancy stipulations
- Horizontal drilling (Marcellus shale development) allowed on all available acres (except within public water supplies) but specific standards related to hydrofracking would be used

ECONOMICS AND LOCAL COMMUNITY

- Similar to Alternative A

FIRE

- Prescribed fire program between 12,000 and 20,000 acres/year
- Utilize fire to attain ecological objectives for biodiversity when appropriate

CLIMATE CHANGE

- Source drinking watersheds and impaired waters are priority for restoration;
- actively restore (chestnut, yellow pine, hemlock, spruce, riverfront hardwoods, beaver meadows, fire dependent and adapted communities, open woodlands, TESLR spp);
- Timber harvest, fire and grassland/shrubland maintenance are used to manage vegetation structure and composition to improve resiliency of the ecosystems.

ALTERNATIVE G – Preferred Alternative

Alternative G was developed after reviewing public comments and agency concerns received and developed throughout the entire process, including the last public meeting in October 2010. Each significant issue was reviewed in relation to how it was addressed by the various alternatives, the environmental effects of the alternative in relation to the issue and the benefits or outputs related to the issue. This alternative contains aspects of each of the other alternatives.

This alternative provides a variety of resource benefits, including wood, wildlife, fish, range, dispersed recreation, developed recreation, minerals, wilderness and special uses, in a manner that maintains the diversity, productivity and long-term sustainability of ecosystems. It would actively restore and maintain vegetative compositional and structural conditions needed to provide for a variety of terrestrial and aquatic species in certain areas of the forest. Habitats would be provided for game species, species with high public interest, species with demanding habitat requirement, species that are ecological indicators and keystone species. It would substantially increase the objective for using prescribed fire in ecosystem restoration and incorporate the use of wildfire for resource enhancement. Prescribed fire, timber harvest and maintenance of grasslands and shrublands would all be used to provide a diverse mix of habitats in the ecological systems. In some areas of the forest large blocks of mature forest would predominate. Restoration treatments would focus on increasing structural diversity in ecological systems and on improving soil and water concerns in high priority watersheds. As a result of restoration treatments, commodities such as sawlogs, biomass, and fuelwood are available for local industry and individual needs.

Road network mileage would be reduced through closure or decommissioning of roads not needed for ecosystem stewardship, restoration or dispersed recreation use. Many of the closed roads would be used to supplement the trail system for non-motorized uses. Management of all Inventoried Roadless Areas would closely mirror the management restrictions on road construction and timber harvest that were described in the 2001 Roadless Area Conservation Rule.

Resource management is designed to attract recreation users, both locally and from large population centers near the forest. A variety of recreation settings and experiences, both motorized and non-motorized would be provided. Large blocks of unroaded areas would provide remote, backcountry experiences not available on private lands. High scenic quality would be a major emphasis.

The following are highlights of Alternative G:

ACCESS

- No net increase in open road miles.
- Road construction 1.5 miles/year
- Decommissioning 16 miles/year

WATER, SOILS, RIPARIAN, AQUATIC DIVERSITY

- Riparian Areas same as Jefferson (100' on perennial, 50' on intermittent streams) in all watersheds
- Priority watersheds identified based on sensitive aquatic species, drinking water use identified by state agencies, impairment identified by state agencies that can be addressed by management activities on the Forest are a priority for restoration activities.

RECREATION

- Three existing ATV/OHV use areas; drop planned Archer Run area
- No net increase in trail maintenance, focus on relocating or decommissioning of unsustainable trails
- High clearance roads remain available for OHV use at current levels
- No new developed recreation sites, few expansions at existing sites
- Maintain most of the inventoried semi-primitive acres through land allocations

WILDERNESS/ROADLESS

- Recommend St Mary's Addition (West), Little River, Rich Hole addition and Ramsey's Draft addition (total 20,000 ac) for wilderness

- All Inventoried Roadless Areas not recommended for wilderness designation or special biological areas are allocated to remote backcountry and managed to limit timber harvest and road construction in manner similar to Roadless Area Conservation Rule of 2001.
- Areas in Potential Wilderness Areas (and not in Inventoried Roadless Areas) are allocated to a variety of management prescription areas including remote backcountry and mosaics of wildlife habitat.

TIMBER HARVEST

- ASQ similar to current plan to meet ecological restoration objectives; suitable acres around 400,000 acres.
- Annual harvest program of 1,800-3,000 acres.
- Primary purpose of timber harvest is to support other resource objectives with a secondary purpose of providing wood products

TIMBER HARVEST, TERRESTRIAL DIVERSITY, FIRE

- Amount and location of early successional based on ecological objectives, restoration needs

TERRESTRIAL DIVERSITY

- One broad management area for wildlife habitat emphasis
- About 114,000 acres of Special Biological Areas

OLD GROWTH

- No old growth management area. Old growth defined by Regional definitions.
- Most of the stands meeting the old growth definition are unsuitable for timber production. Areas in the common forest types (Dry-Mesic Oak Forests and Dry & Dry-Mesic Oak-Pine Forests) that are on lands suitable for timber production could be considered for harvest.
- The Peters Mountain and Frozen Head areas (boundaries modified from the Virginia DCR proposal) are unsuitable for timber production

FOREST HEALTH

- Aggressive treatment of non-native invasive species; use of Integrated Pest Management techniques; emphasis on minimizing spread to adjacent private lands; aggressive prevention and control in disturbed areas or high use areas

WIND

- Areas not suitable for wind development: Wilderness, recommended wilderness, National Scenic Area, Special Biological Areas, Research Natural Areas, cultural/heritage areas, Shenandoah Mountain Crest-Cow Knob salamander area, special geologic areas, Indiana bat protection areas, Appalachian Trail corridor, Blue Ridge Parkway corridor, and remote backcountry areas

OIL AND GAS

- Low amount (660,000 acres) compared to current plan are available for leasing under standard or controlled surface occupancy stipulations
- No areas available for horizontal drilling (Marcellus Shale development).

ECONOMICS AND LOCAL COMMUNITY

- Focus is on outputs of ecosystem services, but this results in some increase in timber commodity outputs

FIRE

- Prescribed fire program between 12,000 and 20,000 acres/year
- Utilize wildfire to attain ecological objectives for biodiversity when appropriate

CLIMATE CHANGE

- Increase activities to adapt to climate change (improve ecosystem resiliency, restore vegetation composition and structure, aggressive treatment of invasives);
- source drinking watersheds and impaired waters are a priority for restoration;
- a factor to consider in amount of recommended wilderness areas is the desire for future flexibility;
- actively restore (chestnut, yellow pine, hemlock, spruce, riverfront hardwoods, beaver meadows, fire dependent and adapted communities, open woodlands, TESLR spp);
- Timber harvest, fire and grassland/shrubland maintenance are used to manage vegetation structure and composition to improve resiliency of the ecosystems.

COMPARISON OF ALTERNATIVES

Table 2-2 displays the allocation of management prescriptions by Alternative. The remainder of this section compares how each Alternative addresses the significant issues. This comparison provides a brief summary of Chapter 3 (Environmental Effects of Alternatives) of this Environmental Impact Statement.

Table 2-2. Land Allocation of Management Prescriptions by Alternative

		ALT A		ALT B		ALT C		ALT D	
Rx	RX DESCRIPTION	Acres	%	Acres	%	Acres	%	Acres	%
1A	Designated Wilderness	42,954	4%	43,049	4%	42,992	4%	42,992	4%
1B	Recommended Wilderness Study	1,413	0%	20,422	2%	386,786	36%	14,627	1%
2C2	Eligible Wild and Scenic River-Scenic	4,147	0%	3,101	0%	3,749	0%	3,881	0%
2C3	Eligible Wild and Scenic River-Recreation	4,117	0%	2,730	0%	4,663	0%	4,219	0%
4A	Appalachian Trail	8,945	1%	8,505	1%	6,783	1%	8,513	1%
4B1	Research Natural Area	1,979	0%	1,980	0%	1,979	0%	1,979	0%
4C1	Geologic Area	176	0%	178	0%	176	0%	176	0%
4D	Special Biological Area	24,454	2%	51,427	5%	21,303	2%	51,574	5%
4D1	Key Natural Heritage Community Area								
4F	Mt Pleasant National Scenic Area	7,753	1%	7,742	1%	7,744	1%	7,744	1%
4FA	Recommended National Scenic Area							8,241	1%
5B	Communication Site					13	0%	13	0%
5C	Utility Corridor	6,731	1%	6,750	1%	6,754	1%	6,754	1%
7A1	Scenic Byway	4,720	0%	4,954		4,956	0%	4,956	0%
7B	Scenic Corridors and Viewsheds	43,925	4%	38,286	4%	1,042	0%	35,403	3%
7C	ATV Use Area	11,399	1%	9,889	1%	9,933	1%	9,933	1%
7D	Concentrated Recreation Areas					664	0%	664	0%
7E	Dispersed Recreation Areas								
7E1	Dispersed Recreation Areas-Unsuitable	41,408	4%	30,550	3%	21,889	2%	21,348	2%
7E2	Dispersed Recreation Areas-Suitable	5,499	1%	4,181	0%			5,236	0%
7F	Blue Ridge Parkway			4,414	0%	4,147	0%	4,418	0%
7G	Pastoral Landscapes	6,012	1%	4,331	0%			4,112	0%
8A1	Mix of Successional Habitats	258,339	24%					316,872	30%
8A1U	Mix of Successional Habitats-Unsuitable	69,736	7%						
8B	Early Successional Habitats	38,885	4%					34,031	3%
8BU	Early Successional Habitats-Unsuitable	766	0%						
8C	Black Bear/Remote Habitats	74,421	7%					124,835	12%
8CU	Black Bear/Remote Habitats-Unsuitable	61,204	6%						
8E4a	Indiana Bat-Primary	1,672	0%	1,672	0%	1,671	0%	1,671	0%
8E4b	Indiana Bat-Secondary	11,056	1%	13,709	1%	13,713	1%	13,713	1%
8E7	Shen Mtn Crest-Cow Knob Salamander	43,137	4%	46,692	4%	20,343	2%	53,855	5%
9A1	Source Water Watershed Protection					142,612	13%		
10B	Timber Production	86,698	8%					91,257	9%
10BU	Timber Production-Unsuitable	4,685	0%						
12D	Remote Backcountry	198,858	19%	191,935	18%	113,852	11%	190,423	18%
13	Mosaics of Habitat-Suitable			569,421	53%				
13U	Mosaics of Habitat-Unsuitable					245,678	23%		
Water	Lake Moomaw	2,479	0%	2,479	0%	2,479	0%	2,479	0%
Total		1,065,918		1,065,918		1,065,918		1,065,918	

Table 2-2. Land Allocation of Management Prescriptions by Alternative (Cont'd)

Rx	RX DESCRIPTION	ALT E		ALT F		ALT G	
		Acres	% of Forest	Acres	% of Forest	Acres	% of Forest
1A	Designated Wilderness	42,992	4%	42,992	4%	42,992	4%
1B	Recommended Wilderness Study	24,325	2%	112,144	11%	20,314	2%
2C2	Eligible Wild and Scenic River-Scenic	3,834	0%	2,176	0%	3,848	0%
2C3	Eligible Wild and Scenic River-Recreation	4,088	0%	4,341	0%	4,179	0%
4A	Appalachian Trail	8,513	1%	8,513	1%	8,519	1%
4B1	Research Natural Area	1,979	0%	1,978	0%	1,979	0%
4C1	Geologic Area	3,879	0%	176	0%	3,881	0%
4D	Special Biological Area	51,574	5%	30,438	3%	51,565	5%
4D1	Key Natural Heritage Community Area					3,308	0%
4F	Mt Pleasant National Scenic Area	7,744	1%	7,744	1%	7,744	1%
4FA	Recommended National Scenic Area			127,940	12%		
5B	Communication Site	13	0%	13	0%	13	0%
5C	Utility Corridor	6,754	1%	6,754	1%	6,714	1%
7A1	Scenic Byway	4,956	0%	4,956	0%	4,956	0%
7B	Scenic Corridors and Viewsheds	34,045	3%	32,358	3%	34,876	3%
7C	ATV Use Area	9,933	1%	9,933	1%	9,933	1%
7D	Concentrated Recreation Areas	664	0%	615	0%	662	0%
7E	Dispersed Recreation Areas					27,915	2%
7E1	Dispersed Recreation Areas-Unsuitable	21,263	2%	14,524	1%		
7E2	Dispersed Recreation Areas-Suitable	4,086	0%	1,125	0%		
7F	Blue Ridge Parkway	4,418	0%	4,390	0%	4,418	0%
7G	Pastoral Landscapes	4,112	0%	4,107	0%	4,280	0%
8A1	Mix of Successional Habitats						
8A1U	Mix of Successional Habitats-Unsuitable						
8B	Early Successional Habitats						
8BU	Early Successional Habitats-Unsuitable						
8C	Black Bear/Remote Habitats						
8CU	Black Bear/Remote Habitats-Unsuitable						
8E4a	Indiana Bat-Primary	1,671	0%	1,671	0%	1,671	0%
8E4b	Indiana Bat-Secondary	13,698	1%	13,713	1%	13,698	1%
8E7	Shen Mtn Crest-Cow Knob Salamander	49,644	5%	23,382	2%	46,812	4%
9A1	Source Water Watershed Protection						
10B	Timber Production						
10BU	Timber Production-Unsuitable						
12D	Remote Backcountry	264,184	25%	147,622	14%	252,159	24%
13	Mosaics of Habitat-Suitable	491,763	46%	350,453	33%	507,006	48%
13U	Mosaics of Habitat-Unsuitable	3,308	0%	109,380	10%		
Water	Lake Moomaw	2,479	0%	2,479	0%	2,479	0%
Total		1,065,918		1,065,918		1,065,918	

Access

ISSUE STATEMENT: Forest management strategies may affect the balance between public and management needs for motorized access to Forest lands (for recreation, hunting, management activities, fire suppression) and protection of soil and water resources, wildlife populations and habitat, aesthetics, forest health, and desired vegetation conditions.

Although the road system of the GWNF is largely complete, there are still occasional needs for new roads to access trailheads, manage vegetation, or facilitate mineral development. Table 2-3 displays the estimated road construction miles, road decommissioning miles and the Minimum Roads System by the different alternatives.

Table 2-3. Comparison of the Access Issue by Alternative, miles

	Alternative						
Transportation System	**A**	**B**	**C**	**D**	**E**	**F**	**G**
Current System Roads	1,823	1,823	1,823	1,823	1,823	1,823	1,823
Special Use Roads-not part of the Minimum Roads System	50	50	50	50	50	50	50
Potential Forest Highways-not part of the Minimum Roads System	107	107	107	107	107	107	107
Road Construction (miles during 1st decade)	29	15	0	41	9	5	15
Road Decommissioning (miles during 1st decade)		160	160	80	160	160	160
Potential Additional Decommissioning from Future Wilderness Designation	0	0	124	3	1	17	1
Minimum Roads System after 1st decade	1,695	1,521	1,382	1,624	1,514	1,494	1,520

Watersheds, Soil and Water Quality, Riparian Resources and Aquatic Diversity

ISSUE STATEMENTS: Management activities may affect soil quality, water quality (surface and groundwater) and riparian resources, including drinking water watersheds and those watersheds with streams impaired due to activities off the Forest. Management activities may affect the maintenance and restoration of aquatic biodiversity and may affect species with potential viability concerns.

Table 2-4 highlights several factors associated with this issue. In project implementation, the application of standards for the riparian management prescription and channeled ephemeral stream standards should fully protect drinking water quality. No measureable direct or indirect effects on water quality should occur. In order to verify that these standards are adequate, some ground disturbing projects will be monitored for implementation of standards and for effectiveness of standards. All of the alternatives protect the floodplain/riparian ecological system, but Alternatives B, C, E, F, and G expand the width of the riparian corridor and so increase the area that will receive the riparian management objectives, desired conditions and objectives to protect, restore and maintain riparian resources.

Table 2-4. Comparison of the Watersheds, Soil and Water Quality, Riparian Resources and Aquatic Diversity Issue by Alternative

	Alternative						
	A	B	C	D	E	F	G
Soil and Water	Acres						
Areas of ground disturbance	254	292-384	79	635-785	189-275	260-323	315-407
Riparian Areas	Feet						
Riparian corridor width-perennial (ft)	66'+	100	100	66'+	100	100	100
Riparian corridor width-intermittent (ft)	33'+	50	50	33'+	50	50	50
Riparian corridor width-ephemeral (ft)		25	25		25	25	25

Terrestrial Biological Diversity

ISSUE STATEMENT: Forest Plan management strategies may affect the maintenance and restoration of the diverse mix of terrestrial plant and animal habitat conditions and may affect species with potential viability concerns.

Ecological communities provide the foundation for biological diversity. Ecosystems identified on the Forest include ecological communities that predominate on the landscape (e.g. Central Appalachian Dry Oak-Pine Forest); communities that are declining, rare, or unique (e.g. Caves and Karstlands); and communities that provide habitat for species with potential viability concerns (e.g. Special Biological Areas). By restoring and maintaining the key characteristics, conditions, and functionality of native ecological systems, the GWNF should be able to maintain and improve ecosystem diversity and also provide for the needs of diverse plant and animal species on the forest. Although there are 20 ecological systems on the Forest, for most purposes they can be combined in the following nine ecological system groups: Oak Forests and Woodlands; Pine Forests and Woodlands; Northern Hardwood Forests; Spruce Fir Forests; Cove Forests; Cliff, Talus and Shale Barrens; Mafic Glade and Barrens and Alkaline Glades and Woodlands; Caves and Karstlands; and Floodplains, Wetlands, and Riparian Areas.

Structure and tree age diversity are both characteristics that are important to all forested ecological systems. Table 2-5 compares the structural diversity provided in the alternatives.

Table 2-5. Projected Habitat Components at 10 Years by Alternative

Habitat Component	Current Condition	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Early Successional Forest	3%	4%	2-3%	2%	3-5%	2-3%	2-3%	2-3%
Open Woodlands	2%	5%	11%	2%	8%	11%	11%	11%
Grassland/Shrublands	0.05%	0.05%	0.06%	0.02%	0.05%	0.06%	0.06%	0.06%
Mid- to late successional Hard Mast Producing Forest	90%	89%	89%	92%	88%	90%	91%	89%
Total acres of combined active management habitat components	5%	8%	14 - 15%	3%	13-14%	13-14%	13 - 14%	13-14%

Old Growth

ISSUE STATEMENT: Forest management strategies may affect the potential biological and social values associated with the abundance, distribution and management of existing and future old growth.

There are a variety of viewpoints about old growth forests on public lands. Some viewpoints state the spatial distribution and linkages of patches with varying sizes are important, that old growth communities are underrepresented on private lands, and that the national forests have the best opportunity to provide for these communities. There is also a debate about how old growth should be managed, maintained, or restored. Many people state that old growth areas should be protected or "preserved" and that there should be no harvesting within these areas.

There are many values that people associate with old growth, some of which are compatible, and others that present conflict. Old growth provides both biological and social values. Old growth communities provide large den trees for wildlife species such as black bear, large snags for birds and cavity nesters, and large cover logs for other wildlife. Ecologically, old growth provides elements for biologic richness, gene conservation, and riparian area enhancement. Old growth areas provide for certain recreational experiences, research opportunities, and educational study. Other areas have associated historical, cultural, and spiritual values. Some may never visit an old growth site but will receive satisfaction from "just knowing" that it exists. On the other hand, old growth areas are a source of large-diameter, high-value hardwoods, which are limited in supply and in high demand for such products as furniture and finish construction work. Others say that insect and disease risk can be relatively high in old growth stands and could (for some community types) threaten the retention of those stands as old growth. There is concern that fire exclusion could favor a buildup of fire-intolerant, but shade-tolerant, species that could eventually replace the original old growth type. Another view is that active management, including timber harvest and prescribed fire, could be used to accelerate the development of old growth attributes.

In Alternatives C, E, and F all Old Growth Forest Types are unsuitable for timber production. In Alternatives A and B possible and existing OGFT 21 (Dry Mesic Oak) stands on suitable ground remain suitable. In Alternatives D and G possible and existing old growth in both OGFT 21 and 25 (Dry and Dry Mesic Oak-Pine) stands on suitable ground remain suitable. Each alternative includes management prescriptions that either have the intent of protecting possible old growth and expanding it, or of providing old growth indirectly as the result of management focused on other values, such as primitive recreation. Table 2-6 compares land allocations that have potential for old growth being found in larger blocks by alternative. Alternative C contains the greatest acreage within potential future old growth since over one-third of the total Forest acreage is in Recommended Wilderness. This is followed by Alternatives F, A, E, and G respectively. Alternatives B and D provides the least amount of potential old growth.

Table 2-6. Acreage in key Management Prescriptions that will provide for most large blocks (>= 2,500 acres) of old growth, by Alternative

Management Prescription		Alternative						
		A	B	C	D	E	F	G
1A	Designated Wilderness	42,954	43,049	42,992	42,992	42,992	42,992	42,992
1B	Recommended Wilderness Study	1,413	20,422	386,786	14,627	24,325	112,144	20,314
4B1	Research Natural Area	2,808	1,980	1,979	1,979	1,979	1,979	1,979
4D	Special Biological Area	24,454	51,427	21,303	51,574	51,574	30,438	51,565
4D1	Key Natural Heritage Community Area	0	0	0	0	3,308	0	3,308

Management Prescription		Alternative						
		A	B	C	D	E	F	G
4F	Mt Pleasant National Scenic Area	7,753	7,742	7,744	7,744	7,744	7,744	7,744
4FA	Recommended National Scenic Area	0	0	0	8,241	0	127,940	0
8A1U	Mix of Successional Habitats – Unsuitable	69,736	0	0	0	0	0	0
8CU	Black Bear / Remote Habitats - Unsuitable	61,204	0	0	0	0	0	0
8E7	Shenandoah Mtn Crest – Cow Knob Salamander	43,137	46,692	20,343	53,855	49,644	23,382	46,812
12D	Remote Backcountry	198,858	191,935	113,852	190,423	264,184	147,622	252,159
13U	Mosaics of Habitat - Unsuitable	0	0	245,678	0	0	109,380	0
Total Acres		452,317	363,247	840,677	371,435	445,750	603,621	426,873

Forest Health

ISSUE STATEMENT: Forest Plan management strategies may affect the spread and control of non-native invasive species, forest pests, and pathogens, all of which have the potential to affect long-term sustainability, resiliency, and composition of forest ecosystems.

While not all non-native species are known to disrupt native ecosystems, of particular concern are those that are successful at invading and rapidly spreading through natural habitats. Invasive plants create a host of harmful environmental effects to native ecosystems including: displacement of native plants; degradation or elimination of habitat and forage for wildlife; extirpating rare species; impacting recreation; affecting fire frequency; altering soil properties; and decreasing native biodiversity. Invasive plants spread across landscapes, unimpeded by ownership boundaries. Even without active management NNIP infestations will occur across the Forest. Insect and disease outbreaks, wildfires, storm events (including wind thrown trees, flooding, landslides, and ice damage) encourage NNIP establishment. Alternative A follows the current Plan which is not as aggressive in controlling NNIP as Alternatives D, E, F and G. Alternative B only includes integrated pest management and is less aggressive at controlling NNIP than D, E, F and G. Alternative C would result in the least amount of ground disturbance which could reduce the potential for NNIP infestations; however, the decrease in accessibility in Alternative C could result in less aggressive treatment of NNIP infestations. Alternatives D, E, F and G all have similar language regarding pre-treatment of areas that will be disturbed. Therefore, the potential for NNIP infestations from ground disturbing activities could be offset by aggressive NNIP treatments.

The GWNF has experienced gypsy moth defoliation since 1987, through 3 to 4 outbreak cycles with a total of about 1.5 million acres defoliated. Many areas have been defoliated several times, resulting in severe mortality. Although the front of the gypsy moth infestation has passed the forest, the gypsy moth will likely be a part of the Forest's ecosystem for many years to come. Approximately 867,000 acres of the GWNF is comprised of forest types susceptible to gypsy moth infestation (types where oak either dominates or is a significant portion of the stand). This represents approximately 72% of the forest in a moderate or severely susceptible host type. While suppression of gypsy moth populations would be permissible under all Alternatives, the economic cost and concern for environmental impacts of widespread use of current treatment

tactics, primarily the aerial application of insecticides, would result in only a very small amount of the Forest receiving such management actions. Timber harvest and prescribed fire can help reduce gypsy moth risk in upland oak and mixed oak-pine stands. Table 2-7 shows how the alternatives vary in their effect on gypsy moth risk at the end of 50 years of management. Alternative D would have the highest potential to reduce gypsy moth impacts with approximately 45% of the GWNF in a high or extreme gypsy moth risk. Similar conclusions can be made about the effects on oak decline since oak species are the most susceptible to gypsy moth.

Table 2-7. Gypsy Moth Risk at the end of 50 years of Plan implementation

Activity in Susceptible Types	Alternative						
	A	B	C	D	E	F	G
Acres Regenerated (1st decade)	17,000	11,000	0	23,000	11,000	8,000	11,000
Acres Thinned (1st decade)	6,000	4,000	0	8,000	4,000	2,000	4,000
Total Acres Harvested (1st decade)	23,000	15,000	0	31,000	15,000	10,000	15,000
% Acres at High Risk (1st decade)	37%	38%	38%	37%	38%	38%	38%
% Acres at High Risk (5th decade)	34%	37%	39%	32%	36%	38%	36%
% Acres at Extreme Risk (1st decade)	19%	20%	20%	19%	20%	20%	20%
% Acres at Extreme Risk (5th decade)	15%	19%	21%	13%	17%	19%	17%

Unfortunately, most of the hemlocks on the Forest have succumbed to the hemlock woolly adelgid. In some areas, white pine may be able to fill this ecological niche, but it will take time for white pine to fully occupy the sites formerly held by hemlock. Loss of cover is likely to also adversely affect a myriad of bird and wildlife species on the GWNF. Therefore, the difference in the effects on riparian habitat from other management activities between the alternatives is the best way to look at the effects from the hemlock woolly adelgid.

Southern pine beetle (SPB) (*Dendroctonus frontalis*) is a native pest whose infestations have occurred cyclically throughout recorded history in the South. Managers can control both the proportion of susceptible species and the radial growth of trees through vegetation manipulation activities. Thinning and/or regeneration harvests can alter both species composition and radial growth of the trees within a stand. However, thinning in these stands that often occur on relatively poor sites is rarely economically, or even logistically, viable. Many of these stands occur on lands unsuitable for timber production. The use of prescribed fire can reduce stand density, similar to a thinning, and ultimately increase radial growth on the residual stems. Fire can also regenerate some forest types, especially table mountain and to a lesser extent pitch pine. Thus, while timber harvest can help to lower SPB risk, the use of prescribed fire can treat the most acres and represents our best tool in lowering SPB risk. Table 2-8 shows how the risk to Southern Pine Beetle varies among the alternatives.

Table 2-8. Acres in Southern Appalachian Montane Pine Forest and Woodland and Central Appalachian Pine-Oak Rocky Woodland Ecological Systems burned, regenerated, and thinned and at risk from oak decline effects at the end of the next decade by alternative.

Activity in Susceptible Types	Alternative (acres)						
	A	B	C	D	E	F	G
Acres Managed by Fire	3,000	16,000	10,000	12,000	70,000	16,000	70,000
Acres Regenerated by Harvest	2,000	700	0	3,000	1,500	1,000	1,500
Acres Thinned by Harvest	0	0	0	0	200	102,000	200
Total Acres Vulnerable/High Risk	114,000	102,000	109,000	104,000	48,000	102,000	48,000

Wind Energy

ISSUES STATEMENT: Responding to opportunities to develop wind energy generation may result in effects on a wide variety of resources (including birds, bats, scenery, trail use, soils on ridgetops, water, noise, remote habitat, local communities/economies, and social values).

Alternative A, the current Forest Plan does not address this issue. No areas are considered to be unsuitable for wind energy development, though management area guidance would limit road construction and clearing activities in some areas. Alternatives B, F, and G would allow consideration of wind energy development proposals on some areas of the Forest but the following areas are unsuitable for wind energy development: Wilderness, Recommended Wilderness, Special Biological Areas, Research Natural Areas, Special Geologic Areas, Shenandoah Mountain Crest – Cow Knob Salamander Area, Indiana Bat Protection Areas, Appalachian Trail Corridor, Blue Ridge Parkway Scenic Corridor, Remote Backcountry Areas and Mount Pleasant National Scenic Area. Alternative D is similar to Alternatives B, F, and G except that wind energy development proposals would be considered in several remote backcountry areas because of the high potential for wind energy development. Alternatives C and E prohibit the development of wind energy across the Forest.

Table 2-9 highlights the differences in the estimated potential for wind development, including an infrastructure, among the alternatives.

Table 2-9. Comparison of Potential Wind Energy Development by Alternative

Area in Wind Power Classes 3 through 7, Suitable for Consideration of Wind Energy Development (acres)						
Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
116,871	46,625	0	54,533	0	40,841	39,236

Alternatives A, C, and E would have no wind energy development. They would not address the need for alternative energy sources.

Effects of the development on soils, scenery, aquatic resources, geologic resources and water are addressed in those sections of the EIS. Potential effects on wildlife include the long term occupation of the ridgelines with openings, roads and turbines. Ridgelines are used by many birds and bats during migrations and during resident activities.

Oil and Gas Leasing

ISSUE STATEMENT: Use of National Forest System lands to support energy needs through federal oil and gas leasing may affect forest resources and impact adjacent private lands.

In response to Marcellus Shale concerns, additional stipulations were developed and applied differently to the alternatives. The Horizontal Drilling Moratorium Stipulation and the Horizontal Drilling Operations Control Stipulation are described below.

- The Horizontal Drilling Moratorium Stipulation states that the surface management agency (USDA-Forest Service) has a moratorium on processing Surface Use Plan of Operations of an Application for Permit to Drill for any horizontal well and associated hydraulic fracturing. The moratorium will end on May 1, 2013.

- The Horizontal Drilling Operations Control Stipulation states that applicants for Surface Use Plan of Operations of APD for any horizontal well and associated hydraulic fracturing will supply a list of the quantity and chemical composition of all materials proposed for use in drilling and hydraulic fracturing, as well as several other design assessment criteria. Surface disposal of hydraulic fracturing materials on NFS lands will not be authorized. Based on an environmental analysis, the USDA-Forest Service will determine whether subsurface disposal of hydraulic fracturing materials in an EPA-approved underground injection well on NFS lands will be authorized or prohibited.

Alternative C does not allow any federally oil and gas leasing, except what is currently under lease. All other alternatives allow for vertical drilling leases. The first four rows of Table 2-10 display the number of acres that could be federally leased under four different surface occupancy leasing options (standard terms, controlled, timing, and no surface) for each alternative. The determination of the type of surface occupancy leasing option depends on the management prescription. For example, leasing is allowed in a Scenic Corridor and Viewshed area but only with a no surface occupancy stipulation. The next two rows address horizontal drilling and hydrofracturing concerns, by applying additional stipulations. Alternatives E and G do not allow any horizontal drilling and hydrofracturing. Alternative F allows horizontal drilling, except for in public water supply areas. Alternative A allows horizontal drilling with no additional stipulations. Alternatives B and D allow horizontal drilling, with the Moratorium Stipulation and the Operations Control Stipulation.

Table 2-10 Federal Oil and Gas Leasing Availability by Alternative (thousands of acres)

	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Standard Lease Terms*	145	625.1	0	614.4	541.2	496.3	555.9
Controlled Surface Use Stipulation*	825	151.8	0	161.6	159.6	105.3	161.0
Timing Stipulation*	0	13.7	0	13.7	13.7	13.7	13.7
No Surface Occupancy Stipulation*	41	202.4	0	200.9	274.7	158.1	262.7
Horizontal Drilling Moratorium Stipulation Horizontal Drilling Operations Control Stipulation	0	993.0	0	990.6	0	742.0	0
No Horizontal Drilling Stipulation	0	0	0	0.0	989.2	31.5	993.2
Administratively Unavailable	3.1	22.1	1,015.2	24.5	26.0	241.8	22.0
Legally Unavailable	50.7	50.8	50.7	50.7	50.7	50.7	50.7

* In Alternatives B, D, E, F and G the lease is restricted by Stipulations on horizontal drilling.

Note: The Horizontal Drilling Stipulations acres apply to same acres with Stipulations (CSU, Timing, NSO) and Standard Lease terms for vertical wells.

Note: The No Horizontal Drilling Stipulation acres in Alt F are in public water supply watersheds.

To determine the effects of federal oil and gas leasing activity in the future, the Bureau of Land Management (BLM) projected post-leasing activity with a Reasonable Foreseeable Development Scenario (RFD) that estimated that a maximum of 319 natural gas wells, with associated surface disturbance, including well pads, roads, and pipelines, could occur over a 15 year planning horizon on the Forest. This projection of future oil and gas activity was based on the assumption that all the Forest except areas withdrawn from leasing by law would be available for oil and gas leasing under standard lease terms and conditions. Because each alternative will have more restrictive constraints on availability of federal oil and gas leasing by applying different stipulations, each alternative will project less oil and gas activity than the GWNF baseline RFD (as shown in Table 2-11.

Table 2-11 Federal Oil & Gas Lease Activity by Alternative

		Number of wells	Roads (miles)	Pipelines (miles)	Water use for drilling (1,000s of gallons)	Water use for hydraulic fracturing (1,000s of gallons)
Alt A	Develop wells (vertical)	39	39	43	787	15,731
	Develop wells (horizontal)	198	132	145	19,767	988,350
Alt B	Develop wells (vertical)	30	30	33	609	12,177
	Develop wells (horizontal)	153	102	112	15,267	763,350
Alt C	Develop wells (vertical)	0	0	0	0	0
	Develop wells (horizontal)	0	0	0	0	0
Alt D	Develop wells (vertical)	30	30	33	608	12,158
	Develop wells (horizontal)	153	102	112	15,267	763,350
Alt E	Develop wells (vertical)	27	27	29	534	10,676
	Develop wells (horizontal)	0	0	0	0	0
Alt F	Develop wells (vertical)	22	22	24	436	8,722
	Develop wells (horizontal)	114	76	83	11,367	568,350
Alt G	Develop wells (vertical)	27	27	30	550	10,992
	Develop wells (horizontal)	0	0	0	0	0

Fire

ISSUE STATEMENT: The management of fire to achieve goals related to protection of property, wildlife habitat, ecosystem diversity and fuels management may affect air quality, non-native invasive species, recreation, water quality, wildlife, and silviculture.

Table 2-12 displays the acres of prescribed fire by alternative in an average year over the next decade.

Table 2-12 Prescribed Burning by Alternative

	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Acres Prescribed Burned annually	3,000	12,000-20,000	Limited	5,000-12,000	20,000	12,000-20,000	12,000-20,000

Alternative E would be the largest prescribed burn program since it is the restoration alternative and biologically driven. Alternative C would generate the smallest prescribed burn program as prescribed burning would be limited to managing threatened, endangered and sensitive species habitats. Alternative A has the acres estimated to be prescribed burned annually in the current Plan. Alternative D has an emphasis on commodity production and opportunities for prescribed burning would be limited. Alternatives B, F, and G have a program that includes an emphasis on restoration while taking into account fluctuations in weather and funding that may limit the number of acres likely to be burned annually.

Recreation

ISSUE STATEMENT: Forest management strategies should determine an appropriate mix of sustainable recreational opportunities (including trail access) that responds to increasing and changing demands and also provides for public health and safety and ecosystem protection (such as soil and water resources, nesting animals, riparian resources and spread of non-native invasive species).

Local and regional visitors use the forest for a variety of recreational opportunities, from primitive hiking and camping to developed recreation sites and motorized travel. Developed recreation is not a significant issue and it does not vary significantly by alternative. Demand for long-distance trails for special recreation events, such as long-distance mountain bicycling, equestrian endurance rides and runner marathons, has increased in recent years. The demand is greatest among the equestrian and mountain biking communities. There is more demand than supply for motorized trail opportunities. Some comments stated that OHV/ATV use is not appropriate at all on the Forest due to the noise, potential environmental damage, and the need could be met commercially on private lands. Table 2-13 highlights some of the differences between alternatives for dispersed recreation opportunities.

Table 2-13. Comparison of the Recreation Issue by Alternative

Type of Recreation Activity	ALT A	ALT B	ALT C	ALT D	ALT E	ALT F	ALT G
Hiking, Pack-and-Saddle, Mountain Bicycling	Increase 0-3% <30 miles	No net change	Increase <3% <30 miles	Increase 5-10% 50-100 miles	No net change	Increase <3% <30 miles	Increase <3% <30 miles
Effect of Wilderness Designation on Mountain Bicycling*	No change	Loss of 9 miles of trail	Loss of 434 miles of trail	Loss of 1 mile of trail	Loss of 11 miles of trail	Loss of 70 miles of trail	Loss of 9 miles of trail
All-Terrain Vehicles and Motorcycles	Increase 10-25%; or 6-16 miles	No change	No change	Increase 25-60%; or 16-40 miles	No change	Increase up to 10%; or 6 miles.	Increase 5-10%; or 3-6 miles
Off-Highway Vehicles	Increase 0-25 miles; roads are featured for OHVs.	No featured OHV roads; current level of high clearance roads	No roads managed for OHVs	Increase 20-40 miles; roads are featured for OHVs	No roads managed for OHVs	No featured OHV roads; current level of high clearance roads	Current level of high clearance roads

* The allocation of land to Recommended Wilderness will not affect mountain bike use in those areas. However, if Recommended Wilderness Areas are designated as Wilderness by Congress, then all mechanical and motorized transport forms of recreation, such as mountain bicycling, will be prohibited according to the Wilderness Act of 1964.

The alternative with the most emphasis on expanding the existing overall trails program is Alternative D. It provides the greatest increases in the dispersed recreation trail systems, including hiking, mountain biking, horseback riding, ATV, OHV and interpretive trails. Alternative A increases trail construction of both motorized and non-motorized trails and identifies featured OHV roads. Alternatives B and E include no significant increase or decrease in the current motorized or non-motorized miles of trail. Specific OHV roads are not featured in Alternative B, but high clearance roads will continue to be provided for OHV use at the current level. Under Alternative E, no roads are managed for OHVs. Alternative C has the greatest potential for decreased miles of trail available to mountain bicycling users in the future. Mountain bikes will continue to be allowed in Recommended Wilderness areas, but are prohibited by law when Congress designates an area as Wilderness. Alternative C provides for increased miles of non-motorized trail, as long as there is no increase in trail maintenance costs. Alternative C makes maintenance of the trail system more challenging, as hand tools must be used rather than power tools in areas designated as Wilderness. Alternative F focuses on improving the existing miles of non-motorized trails and improves and expands the existing ATV/OHV trail systems. It promotes a sustainable trails program that allows for expansion only when the resulting level of maintenance will be equivalent to or less than the existing maintenance needs. Alternative G provides for increased motorized and non-motorized trail miles when it is beneficial for the resources (such as relocations off of steep slopes and wet areas) and the extra miles result in no net increase in maintenance. Alternative G does not identify specific featured OHV routes, but provides for the current level of high clearance roads to be maintained for OHV use.

Wilderness/Roadless

ISSUE STATEMENT: Forest management strategies may affect the balance between the desires for permanent protection of remote areas and the desires for management flexibility and ability to respond to changes in

ecological, social and economic conditions when identifying areas to be recommended for Wilderness and determining how potential wilderness areas and other remote areas should be managed.

Wilderness

Table 2-14 lists the Recommended Wilderness Study Areas by alternative. With the exception of Whites Peak, all of the areas are either an Inventoried Roadless Area or Potential Wilderness Area, or both. Whites Peak is a remote area recommended for wilderness study by the local county Board of Supervisors.

Table 2-14. Recommended Wilderness Study Areas by Alternative

Area Recommended for Wilderness Study (Rx 1B) *	Alternative						
	A	B	C	D	E	F	G
Adams Peak (PWA, IRA)			8,200				
Archer Knob (PWA)			7,100				
Beards Mountain (PWA, IRA)			10,100				
Beech Lick Knob (PWA)			14,100			11,600	
Big Schloss (PWA, IRA)			28,400			7,200	
Crawford Knob (PWA, IRA)			14,900				
Dolly Ann (PWA, IRA)			9,600				
Duncan Knob (PWA)			6,000				
Elliott Knob (PWA, IRA)			11,100				
Galford Gap (PWA)			6,700				
Gum Run (PWA, IRA)			14,500				
High Knob (PWA, IRA)			5,600				
- Dry Run (IRA)			7,200				
- Skidmore (IRA)			5,600			5,600	
Jerkemtight (PWA, IRA)			27,300				
Kelley Mountain (PWA, IRA)			12,900				
Laurel Fork (PWA, IRA)			10,200			10,200	
Little Alleghany (PWA, IRA)			15,400			15,400	
Little Mare Mountain (PWA)			11,900				
Little River (PWA, IRA)		12,600	30,100		12,700	12,700	9,300
Massanutten North (PWA, IRA)			16,600				
Oak Knob-Hone Quarry Ridge (PWA, IRA)			16,300				
Oliver Mountain (PWA, IRA)			13,100			8,700	
Paddy Knob (PWA)			6,000				
Potts Mountain (PWA)			7,000			4,200	
Ramsey's Draft Add. (PWA, IRA)		3,100	19,100		3,100	12,400	6,100
Rich Hole Addition (PWA, IRA)		4,700	12,100	4,700	4,700	11,100	4,700

Area Recommended for Wilderness Study (Rx 1B) *	Alternative						
	A	B	C	D	E	F	G
Rich Patch (PWA)			900				
Rough Mountain Add. (PWA, IRA)			2,000		2,100	2,100	
St Mary's North (PWA)			3,000				
St Mary's South (PWA, IRA)	1,500		1,700		1,700	1,700	
St Mary's West (PWA)		300	300	200	200	200	300
Shaws Ridge (PWA)			7,300				
Shawvers Run Add (PWA)			100				
Three Ridges Add North (PWA)			100			100	
Three Ridges Add South (PWA)			200			200	
Three Ridges Add SW (PWA)			9			9	
Three Ridges Add West (PWA)			100			100	
Three Sisters (PWA, IRA)			9,900	5,500		5,500	
Southern Massanutten (IRA)			12,100				
The Friars (IRA)			2,000				
Whites Peak				4,200		4,200	
TOTAL ACRES	1,500	20,700	386,809	14,600	24,500	113,209	20,400

* PWA = Potential Wilderness Area; IRA = 2001 Inventoried Roadless Area

Alternative C recommends all of the Inventoried Roadless Areas and Potential Wilderness Areas for wilderness study. Alternatives B, E, and G focus on stand-alone wilderness areas and wilderness area additions that result in wilderness areas of a size and scale where natural processes can begin to be the dominant influence on the areas. Alternative F was based on recommendations from a number of wilderness advocacy groups. Many of the Potential Wilderness Area boundaries were adjusted to accommodate important bicycle trails, roads and other uses that would be excluded with wilderness designation. This alternative would result in about 14 percent of the GWNF in Wilderness.

National Scenic Area Recommendation

Since the actual management of any National Scenic Area (NSA) would be determined by the legislation, it is assumed for this analysis that the legislation would be similar to that used to designate other NSAs in Virginia. Designation as a National Scenic Area would prevent the construction of roads, the harvest of timber, the development of minerals, and construction associated with special use permits. Non-motorized recreation would continue, including bicycle use and hunting. The use of prescribed fire would be allowed. In Alternative D the 8,000 acre Adams Peak areas is recommended as a National Scenic Area. In Alternative F National Scenic Area recommendations include the Virginia portion of Shenandoah Mountain between Highway 33 and Highway 250, Kelley Mountain, and Adams Peak for a total of 130,000 acres.

Potential Wilderness Areas and Inventoried Roadless Areas

The GWNF has 23 Inventoried Roadless Areas (IRAs) with a total of 242,278 acres. As part of the revision process, the Forest has identified 37 areas as Potential Wilderness Areas (PWAs) with a total of 372,631 acres. The PWA inventory includes all of the IRAs, with the exception of Southern Massanutten and The Friars. For these remote areas that are not identified for Recommended Wilderness Study or recommended for National Scenic Area designation by Congress, some people would like to see them managed according to the

direction in the 2001 Roadless Area Conservation Rule (RACR) and others would like to see them actively managed for wildlife habitat and timber production.

Alternative A does not have guidelines that require that all IRAs retain their roadless characteristics, yet the management prescribed for the areas accomplishes nearly the same result. Ninety-five percent of the IRAs are classified as unsuitable for timber production in Alternative A and road construction is prohibited on 88 percent of the areas with some exceptions to provide for site-specific needs. In Alternative C, all of the Inventoried Roadless Areas are recommended for wilderness designation. In Alternatives F and G all of the Inventoried Roadless Areas that are not recommended for Wilderness have direction to maintain their roadless character as in the 2001 Roadless Conservation Rule. In Alternatives B, D and E, most of the Inventoried Roadless Areas that are not recommended for Congressional designation have the same direction as described for Alternatives F and G. However, in a few of the areas (nine in Alternative B, six in Alternative D and two in Alternative E) active management (including road construction and timber harvest) would be allowed where active management has occurred along existing roads over the past forty years. These areas are identified in Table 2-15. All other areas of Inventoried Roadless Areas would have management direction to maintain their roadless character. In addition, Alternatives B and D allow salvage harvest from existing roads with no new road construction in any of the Inventoried Roadless Areas.

Table 2-15. Inventoried Roadless Areas Allowing Management (Including Timber and Roads) by Alternative

Inventoried Roadless Area	Area	Portion of Area Without Requirement to Maintain Roadless Character						
		Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Name	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres
Crawford Mountain	9,852	N/A	1,200		1,400			
Dolly Ann	7,866	N/A	800		600			
Dry River (WV)	7,254	N/A	500					
Elliott Knob	9,391	N/A	200					
Jerkemtight	16,849	N/A	800		800			
Little Alleghany	10,207	N/A	700		1,000	1,000		
Little River	27,180	N/A	1000					
Mill Mountain/Rich Hole Addition	10,919	N/A	1,500		1,500	1,500		
Oak Knob	10,852	N/A	800		1,200			

Most of the Potential Wilderness Areas expanded the boundaries of the Inventory Roadless Areas from the 2001 Roadless Area Conservation Rule, with a few PWAs being entirely new areas. The discussion of how management of just the IRAs was presented above; however the management of the 144,500 acres in the Potential Wilderness Area inventory that are outside of the IRA boundaries varies among the alternatives. Some of the acres are Recommended Wilderness Study Areas, some are allocated to management prescriptions that maintain the remote character of the area and some are allocated to management prescriptions that allow road construction and timber production. This last category is displayed in Table 2-16.

Table 2-16. Potential Wilderness Area Acreage Allowing Management by Alternative

Potential Wilderness Area Name	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Adams Peak (PWA, IRA)	900				800		800
Archer Knob (PWA)	7,100	7,100		7,100		7,100	2,200
Beards Mountain (PWA, IRA)	2,600			1,800		1,800	1,800
Beech Lick Knob (PWA)	14,100	8,500		8,500			5,800
Big Schloss (PWA, IRA)	7,600	7,600		7,400	7,400		7,400
Crawford Knob (PWA, IRA)	4,400	5,000		5,000	2,500	2,500	5,000
Dolly Ann (PWA, IRA)	1,700	1,700		1,700	1,200	1,200	1,200
Duncan Knob (PWA)	6,000	6,000		5,900	2,300	1,300	2,600
Elliott Knob (PWA, IRA)	1,700	1,700		1,700	1,700		1,700
Galford Gap (PWA)	6,700	6,700		6,700	6,700		6,700
Gum Run (PWA, IRA)	1,900	1,900		1,400			
High Knob (PWA, IRA)	5,600	5,600		5,300			4,100
Jerkemtight (PWA, IRA)	10,500	10,500		10,400	4,300	4,300	3,600
Kelley Mountain (PWA, IRA)	5,200	5,200		300	300	300	2,800
Laurel Fork (PWA, IRA)	200	200					
Little Alleghany (PWA, IRA)	5,200	5,200		5,200	5,200		5,000
Little Mare Mountain (PWA)	11,900	11,900		11,700		5,400	7,400
Little River (PWA, IRA)	3,000	3,000		2,400		2,400	1,500
Massanutten North (PWA, IRA)	7,100	7,100		5,000	5,000	5,000	5,000
Oak Knob-Hone Quarry Ridge (PWA, IRA)	5,500	5,500		4,400			
Oliver Mountain (PWA, IRA)							
Paddy Knob (PWA)	6,000	6,000		5,100	5,100		5,100
Potts Mountain (PWA)	7,000	7,000		7,000			7,000
Ramsey's Draft Add. (PWA, IRA)	6,300	6,300		5,400	4,700		3,400
Rich Hole Addition (PWA, IRA)	1,200	1,200		1,200	1,200		1,000
Rich Patch (PWA)	900	900					
Rough Mountain Add. (PWA, IRA)	900	900		800			900

Potential Wilderness Area Name	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
St Mary's North (PWA)	3,000	3,000					
St Mary's South (PWA, IRA)	200	200					200
St Mary's West (PWA)	300						
Shaws Ridge (PWA)	7,300	7,300		7,200			
Shawvers Run Add (PWA)	100	100					100
Three Ridges Add North (PWA)	100	100					
Three Ridges Add South (PWA)	200	200					
Three Ridges Add SW (PWA)	9	9					
Three Ridges Add West (PWA)	100	100					
Three Sisters (PWA, IRA)	1,700	1,700		1,100	1,500		1,500
TOTAL ACRES	144,209	135,409	0	119,700	49,900	31,300	83,800

Timber Harvest

ISSUE STATEMENT: Forest Plan management strategies may affect: a) the amount and distribution of land suitable for the sustainable harvest of timber products; b) the amount of timber offered by the Forest; c) the role of timber harvest in benefitting local economies and other multiple use objectives; and d) the methods used to harvest the timber. If the Forest responds to needs for biomass for energy production, whole tree harvesting may affect nutrient cycling, wildlife habitat, and soil productivity and stability. Timber harvest may have effects on other resources.

Table 2-17 compares several indicators for this issue by alternative. The Allowable Sale Quantity is the maximum amount of timber that can be sold on lands suitable for timber production during the first decade of implementing any alternative. The purposes of timber production for Alternative A are to provide early successional habitat for: terrestrial species biodiversity, wood product demand, balanced age class concerns, and increased game populations. Alternatives B, E and F focus the timber program on providing early successional habitat based on terrestrial species biodiversity, ecosystem restoration and other ecological objectives.

Alternative D is the alternative that focuses the most emphasis on providing commodities, jobs and income to the local economies; therefore it has the greatest amount of timber production. Alternative C does not allow for a timber production program.

Table 2-17. Comparison of the Timber Harvest Issue by Alternative

	Alternative						
	A	B	C	D	E	F	G
Age Class Distribution in 2040	Percent of Forested Acres						
0-10 (1% in 2010)	3	3	0	5	2	1	2
11-40 (9% in 2010)	7	7	1	10	5	3	5
41-80 (7% in 2010)	10	10	10	8	10	10	10
81-100 (36% in 2010)	1	1	1	1	1	1	1
101-130 (33% in 2010)	34	34	40	34	35	38	35
131-150 (8% in 2010)	25	25	27	24	26	26	26
150+ (6% in 2010)	20	20	21	18	21	21	21
Timber Management	Acres In Thousands						
Lands Suitable for Timber Production	350	486	0	482	366	278	439
	Acres In Thousands						
Acres Harvested (Total First Decade)	30	30	0	42	18	10	18
	MMBF						
Allowable Sale Quantity (Total First Decade)	235	271	0	505	155	102	271
	MMCF						
Allowable Sale Quantity (Total First Decade)	47	54.3	0	101	31.1	20.4	54.3
	Percent of Current Annual Demand of GWNF Timber						
Timber Sale Program Quantity as a Percent of Demand	18	21	0	36	12	8	21

Economics and Local Community

ISSUE STATEMENT: Management activities may affect the economic role of the Forest, particularly the role it plays in the economy of local communities, including the production of ecosystem services and commodity outputs. Increasing population and development near the Forest may influence access to the National Forest and management activities such as special use requests, fire management, and responses to additional recreation demands.

Table 2-18 highlights the differences between the alternatives' effect to the local communities with respect to economic impacts, such as jobs and income.

Table 2-18 Comparison of the Economics and Local Community Issue by Alternative

	Alternative						
	A	B	C	D	E	F	G
Average Annual Jobs Contributed by Forest Service Management, Decade 1	1,087	1,037	578	1,169	752	895	836
Average Annual Labor Income from Forest Service Management (thousands of dollars) , Decade 1	$42,004	$39,303	$16,437	$44,589	$25,187	$32,702	$28,421
Cumulative Decadal Present Net Values of Benefits and Costs (millions of dollars, 4% discount rate cumulative to midpoint of 5th decade)	$1,640	$1,669	$1,399	$1,796	$1,546	$1,738	$1,695

Climate Change

ISSUE STATEMENT: Changes in climate may require adaptation strategies that facilitate the ability for ecosystems and species to adapt to changes in conditions (such as stream temperature, community vegetation composition, and invasive species). Forest management activities may exacerbate the impacts of climate change or mitigate the impacts through adding to or sequestering carbon or enhancing opportunities for alternative energy sources (wind, biomass, solar).

Based on current projections, the primary regional-level and state-level predicted effects of climate change that would impact the GWNF include: (1) warmer temperatures; (2) extreme weather events; and (3) increased outbreaks of insects, disease, and non-native invasive species. Whether temperatures rise or moisture regimes become drier or wetter, most people support the development of a plan that maintains or restores healthy and resilient ecosystems that can adapt to future changes. Comments suggest that the Plan should address reducing current threats to forest conditions, such as from non-native invasive species, pests and pathogens, acid deposition, or human uses of forest resources. Some comments identify the need to provide migration corridors, which include altitudinal gradients, for plant and animal species, especially those most vulnerable to changing climate conditions. Another adaptation strategy is to reduce other stressors to species that are vulnerable to climate change impacts. Other comments requested that we evaluate how management activities may exacerbate, mitigate or enhance effects of a changing climate. Others identified the importance of the forest's role in carbon sequestration.

The alternatives provide different emphases on both adaptation (ways to maintain forest health, diversity, productivity, and resilience under uncertain future conditions) and mitigation (such as carbon sequestration by natural systems, ways to provide renewable energy to reduce fossil fuel consumption, and ways to reduce environmental footprints). These emphases focus on:

1) Reducing vulnerability by maintaining and restoring resilient native ecosystems;

2) Providing watershed health;

3) Providing carbon sinks for sequestration;

4) Reducing existing stresses;

5) Responding to demands for cleaner energy including renewable or alternative energy; and

6) Providing sustainable operations and partnerships across landscapes and ownerships.

Reduce Vulnerability by Maintaining and Restoring Resilient Native Ecosystems

Alternative C focuses on passive restoration and relies predominantly on natural processes to reduce

vulnerability. Alternative C will do some active restoration in reducing roads which may improve the ability for some species to disperse, reduce sedimentation in streams, and reduce the spread of non-native invasive species. The reduction of roads would also reduce access to areas for management activities that could improve diversity and address recreation needs. Alternatives A, B, D, E, F, and G all use a mix of active and passive restoration strategies. Alternative E has the most aggressive approach to active restoration with the largest prescribed fire program and active vegetation management through timber harvest and maintenance of grasslands and shrublands. Alternatives A, B, D, E, and G maintain management options to address changes in the sensitive spruce system in Laurel Fork. Alternatives B, C, D, E, F, and G all utilize the Ecological Sustainability Evaluation tool to develop strategies to maintain and restore the nine ecological systems and the species with special needs. All of these alternatives incorporate the use of wildfire as a tool for achieving resource management desired conditions. All of these alternatives utilize planting of blight-resistant American chestnuts as a restoration tool (Alternatives B, D, E, F, and G allow for more opportunities for planting in open conditions which are likely more conducive to establishment of stands of American chestnut). Alternatives B, D, E, F, and G all maintain or restore ecological conditions that are rare on the GWNF, such as high elevation grasslands and early successional habitat, open woodlands, and old fields. These alternatives all identify the need to address shortleaf pine restoration opportunities.

Watershed Health

Alternative A places a high priority on protecting water quality through the identification of riparian areas and standards that fully protect water quality. This alternative did not address many of the practices and objectives discussed for the other alternatives, but these practices and objectives would be in keeping with the goals of Alternative A.

Alternatives B, C, D, E, F, and G all incorporate the following:

- Beaver meadows, wetlands, and floodplains are protected and restored to improve natural storage, reduce flood hazards, and prolong seasonal flows.
- Riparian forests are protected and restored to moderate changes in stream temperature, maintain stream bank stability, and provide instream habitat.
- Aquatic migration barriers are removed and habitat connectivity re-established so that species can move to more suitable habitat, or move to or from refugia.
- Flood and wildfire risks are reduced in vulnerable watersheds to prevent increased surface erosion and mass wasting leading to aggradation of river channels.
- Roads are improved or decommissioned to reduce adverse impacts during large storms to prevent surface erosion and fill slope failure and landslides. Stream crossings and bridges are constructed to withstand major storm and runoff events.
- Standards are included to assess geologic hazards for management activities, including potential landslide hazards and risks, particularly as the population and infrastructure continue to increase in areas adjacent to the National Forest.
- Bare soil is revegetated as soon as possible and suspend or eliminate recreation uses that are causing elevated sediment levels to streams and large areas of long term loss of soil productivity outside the designated use area.
- Riparian buffers are increased and standards included for protecting channeled ephemeral streams.
- Soils highly sensitive to acid deposition and nutrient loss are identified. Whole tree harvesting is not allowed in those areas.

Alternative C would have fewer opportunities to restore stream channels, address acidified streams, address geologic hazards and address fire risks than the other alternatives due to the greater acreage in wilderness.

Carbon Sequestration

Alternative C relies on old-aged forests to sequester carbon. The other alternatives use a mix of old-aged forests and harvest to regenerate new forests. The regeneration also has the advantage of creating a diversity of ages and structure in the forest to provide multiple strategies for addressing carbon storage. All of the alternatives are skewed to emphasize a substantial portion of the forest to be in older aged stands.

Forest management in Alternatives A, B, D, E, F and G can increase the ability of forests to sequester atmospheric carbon while enhancing other ecosystem services, such as improved soil and water quality. Planting new trees and improving forest health through thinning and prescribed burning will increase forest carbon in the long run.

Existing Stresses

Aside from the stresses identified in watershed health and restoring resilient native ecosystems, non-native invasive species is a key existing stress on systems. Alternatives B, C, D, E, F, and G all take an aggressive approach to controlling non-native invasive species and preventing their introduction and spread. An early detection and response strategy associated with non-native invasive species will be critical to limit new introductions. Aggressive treatment of established invasive species, along with the control of insects and diseases, are likely to become more critical to maintaining desired conditions for healthy forests under a changing climate. Due to the fragmented land ownership patterns, success in reducing forest pests will sometimes require going beyond national forest boundaries, and continued work with partners will be needed. In addition, management practices (such as thinning and age class diversity) that sustain healthy forests and provide adequate nutrients, soil productivity, and hydrologic function promote resilience and reduce opportunities for disturbance and damage. Alternative C would reduce the spread of many non-native invasive species by restricting management that creates openings in the forest canopy. However, it also restricts the ability to use some control activities in wilderness and to use silvicultural techniques to manage pests like the southern pine beetle.

Alternative Energy Demands

The sources of renewable or alternative energy that can be provided on the GWNF include wind energy, solar energy, and natural gas leasing. Alternative A has the largest area of the GWNF available for gas leasing. Alternative C allows no gas leasing. The other alternatives allow for an intermediate level of development. Development of wind energy is allowed in some areas of the GWNF in alternatives B, D, F and G with the most area available in Alternative D. Alternatives C and E do not allow the development of wind energy on the GWNF.

Sustainable Operations and Partnerships

Under all of the alternatives the GWNF will work with the state of Virginia to incorporate the greenhouse gas emissions from our management activities into a State inventory, just as we have done with the fine particulates inventory. The Forest will continue striving to reduce its environmental footprint and decrease the greenhouse gases emitted through day-to-day operations, including the use of more fuel-efficient vehicles, reducing the number of miles driven and making facilities more energy-efficient. The Forest will also continue working with partners, including other federal agencies, State and local governments, non-governmental organizations and other stakeholders to be more effective in efforts to adapt lands, ecosystems, and species to climate change. Examples are the Nature Conservancy in the Fire Learning Network and the Chesapeake Bay Partnership.

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CHAPTER 3 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

INTRODUCTION

Chapter 3 describes the existing environment of the GWNF (George Washington National Forest) and the scientific and analytic basis for comparing the alternatives. Each section begins with a description of the affected environment including physical, biological, social, and economic characteristics.

Environmental consequences related to the significant issues are discussed in the short- and long-term. Although a Forest Plan based on any alternative would guide management for 10 to 15 years, effects beyond the first decade also must be considered. This information helps reveal implications of implementing an alternative over the long-term. Sections not related to significant issues may not have an environmental consequences discussion (e.g. the Description of Ecological Units).

The chapter concludes by describing irreversible and irretrievable commitments of resources, and unavoidable adverse effects.

CHAPTER STRUCTURE

The remainder of this chapter is organized into four sections: A) Physical Environment; B) Biological Environment; C) Social and Economic Environment; and D) Federal Oil and Gas Leasing Availability Decision. Each resource section is organized and presented in the format described below.

Affected Environment - Describes the current conditions of the resources. This section may also include history, development, past disturbances, natural events, and interactions that have helped shape the current conditions. It can also describe the geographic area or areas for the analysis of effects. Areas may vary in size depending on the resource, issue, or anticipated activities. This section also describes the time frame over which effects were assessed.

Environmental Consequences
Direct and Indirect Effects – Analyzes the amount and intensity of direct and indirect effects by alternative. Direct effects are caused by an action and occur at the same time and place as that action. Indirect effects are caused by an action but occur later in time or farther removed in distance. This section also looks at the relationship of temporary (0-3 years), short-term (3-10 years), and long-term (>10 years) effects.

Cumulative Effects – Analyzes the cumulative effects to the resource that may result from the incremental impacts of the alternatives when added to other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes the other actions.

SECTION A - PHYSICAL ENVIRONMENT

The physical environment is the non-living portion of the environment upon which the living organisms depend—air, soil, water, geology, and climate. This section begins with a description of the ecological classification of the GWNF. Ecological classification is a system that classifies land and water at various scales through integrating information about climate, geology, landform, soils, water, and vegetation. This classification is a tool to provide a more ecological and scientific basis in land and resource management planning.

Ecological classification is useful for:

- Evaluating the inherent capability of land and water resources.
- Predicting changes occurring over time.
- Evaluating effects of management.
- Allocating land to management areas.
- Selecting appropriate management indicators.
- Discussing and analyzing ecosystems and biodiversity at multiple scales.

The reader will see this ecological classification referred to throughout this chapter. It provides an ecological context for the affected environment descriptions and a more specific and sensitive effects analysis.

A1 - DESCRIPTION OF ECOLOGICAL UNITS

The National Hierarchical Framework of Ecological Units is a classification and mapping system for dividing the Earth into progressively smaller areas of increasingly similar ecology. Ecological units are mapped based on patterns of climate, soils, hydrology, geology, landform and topography, potential natural communities and natural disturbances. These various components take on greater or lesser importance as the mapping scale changes. Conditions dominant at broad scales such as climate and geology are continually related to conditions at finer scales such as biologic communities and soil characteristics.

The GWNF lies within the Central Appalachian Broadleaf Forest - Coniferous Forest - Meadow Province of the Humid Temperate Domain, Hot Continental Division. Most of the James River, Warm Springs, North River and Lee Ranger Districts are located within the Northern Ridge and Valley Section (Ridge and Valley Subsection). Massanutten Mountain lies within the Great Valley Subsection of the Northern Ridge and Valley Section. The western portion of the James River and Warm Springs lie in the Eastern Allegheny Mountain and Valley Subsection and Laurel Fork lies in the Northern High Allegheny subsection of the Allegheny Mountains section. The Blue Ridge Mountain Section contains the Pedlar Ranger District (Northern Blue Ridge Mountains Subsection).

NORTHERN RIDGE AND VALLEY SECTION (M221A)

Ridge and Valley Subsection (M221Aa), Great Valley Subsection (M221Ab)

The Ridge and Valley sections are characterized by long belts of parallel mountains and valleys, the landforms being closely related to the lithology and structure of the bedrock. The ridges consist of sandstone, shales, and siltstone with the occasional bands of limestone on the lower slopes. The valleys are composed of limestone, dolomite and shales. Agriculture and urban areas dominate the valleys, while forestry is the primary use on the oak-hickory covered ridges. These Appalachian oak-hickory and oak-pine forests forming many high gradient, deeply incised streams. Extensive areas of metamorphosed sedimentary rocks occur on the western flank. Deeply weathered bedrock, called saprolite, occurs in some areas of the Blue Ridge. Mesic oak forests predominate, but large pockets of northern hardwoods and spruce-fir can also be found at the highest elevations. Ice, wind and fire are major natural disturbances throughout this section.

BLUE RIDGE MOUNTAINS SECTION (M221D)

Northern Blue Ridge Subsection (M221Da)

The Blue Ridge Mountains Section is the oldest on the Forest. These tectonic uplifted mountain ranges are composed of Proterozoic-Paleozoic igneous and metamorphic rock, forming many high gradient, deeply incised streams. Extensive areas of metamorphosed sedimentary rocks occur on the western flank. Deeply weathered bedrock, called saprolite, occurs in some areas of the Blue Ridge. Mesic oak forests predominate, but large pockets of northern hardwoods and spruce-fir can also be found at the highest elevations. Ice, wind and fire are major natural disturbances throughout this section.

ALLEGHENY MOUNTAINS SECTION (M221B)

Northern High Allegheny Mountains Subsection (M221Ba), Eastern Allegheny Mountain and Valley (M221Bd)

This Section comprises part of the Appalachian Plateaus geomorphic province. It is a maturely dissected plateau characterized by high, sharp ridges, low mountains, and narrow valleys. It has a prominent structural and topographic grain created by broad, northeast to southwest trending folds in the bedrock. Sandstone and some of the tougher carbonates hold up most of the upland portions; weaker carbonates and shale underlie most valleys. Soils are dominantly Ultisols, Inceptisols, and Alfisols, with mesic temperature regime and udic moisture regime. They are derived from heavily weathered shales, siltstones, sandstone residuum and colluvium, and limestone residuum. Spodosols with frigid temperature regime and aquic moisture regime occur in isolated pockets at the highest elevations. Strongly influenced by elevation and aspect, the vegetation of the Allegheny Mountains can be placed in four broad groups: red spruce, northern hardwoods, mixed mesophytic, and oaks. On average, this Section is notably moister than the Northern Ridge and Valley Section.

A2 – GEOLOGIC RESOURCES

AFFECTED ENVIRONMENT

GEOLOGY

Geology is the foundation for a variety of ecosystems. Geologic processes, geologic materials and geologic structures control or influence a host of ecological factors, such as slope aspect, slope steepness, the areal extent of landforms and associated vegetation, the distribution and composition of soil parent material, the structure and composition of vegetation, the physical character of floodplains, wetlands, riparian area, and stream substrates, the quantity and quality of stream water and groundwater, natural disturbance regimes, and the nature and condition of watersheds. Geological diversity is the foundation of ecosystem diversity and biological diversity.

Surface geologic processes are an important part of the natural disturbance regime in the Forest. These processes include: the erosion, transport and deposition of sediment; mass wasting or landslides; flooding; stream processes; groundwater movement; and the formation of caves, sinkholes and other karst features. These processes are part of the natural disturbance regime in the mountains and affect the Forest in varying degrees every year. Some processes are geologic hazards that create risks to the public.

The interaction of the surface geologic processes with the different geologic formations and geologic structures produced different landforms and different geological settings. Geological diversity is the foundation of biological diversity. The Forest is subdivided into physiographic or geomorphic provinces based on landform, rock types and geologic structure.

VALLEY AND RIDGE PHYSIOGRAPHIC PROVINCE

Most of the Forest is in the Valley and Ridge Physiographic Province, which is a long belt of parallel mountain ridges and valleys trending in a northeast direction. Geologic forces squeezed the originally flat-lying sedimentary layers and folded them into a series of arches (anticlines) and troughs (synclines). Erosion of these folds over geologic time has produced a distinctive repeating landscape of ridges and valleys.

Most of the Forest is located on the strike ridges, which are linear, asymmetric ridges formed by the differential erosion of inclined bedrock layers. One flank of the strike ridge is a steep slope cutting across several bedrock layers (anti-dip or scarp slope). In contrast, the other side of the ridge is a less steep slope conforming to the slope of the underlying bedrock layer (dip slope).

Resistant sandstone or conglomerate forms the top of strike ridges and the mid-to-upper area of the dip slopes. In contrast, the lower flanks of the ridges are underlain by shale, and in some areas, by carbonate bedrock (limestone and dolomite). The valleys are underlain by shale and carbonate bedrock. Some limestone areas contain caves, sinkholes, and other karst features.

Along the western edge of Valley and Ridge Province on the Forest, such as along the Virginia/West Virginia border in Highland, is a transition zone to the Appalachian Plateau Physiographic Province.

BLUE RIDGE PHYSIOGRAPHIC PROVINCE

The eastern portion of the Forest (Pedlar Ranger District) is located in the Blue Ridge Physiographic Province, in which the northeast-trending Blue Ridge Mountains tower above the eastern border of the Valley and Ridge Province. Granite and other igneous rocks dominate the upper slopes of the Blue Ridge Mountains. Quartzite, sandstone, shale occur on the western slopes of the Blue Ridge as well as large alluvial fans on the lowest slopes.

GEOLOGIC RESOURCES

The Forest has a wide range of geologic resources including, but not limited to, groundwater, groundwater-dependent ecosystems, springs, caves, sinkholes, disappearing streams, unusual landforms, waterfalls, fossils (paleontological resources), field records of catastrophic events (floods, landslides, ground collapses, and other geologic hazards), and field records of climatic changes and Quaternary ecosystems. Geologic resources are geologic features, areas, or conditions that have significance to natural resource management or human health and safety or have use or value to society. Geologic resources are identified and managed for scientific, ecological, educational, interpretative, scenic, paleontological, recreational, historic, and other values.

Geologic resources include the foundation for ecosystems: the diversity of geologic processes, structures, and materials that are the basis for the diversity of ecosystems. Twenty ecological systems, as defined by NatureServe's International Ecological Classification Standards, are identified for the analysis of biological resources. Because many of these ecological systems have similar key attributes, indicators, species associates and resulting forest plan components, the biological analysis combined the 20 ecological systems into 9 major forest communities. As discussed in the biological sections, including the Terrestrial Viability Evaluation, some of these major forest communities (Alkaline and Mafic Glade and Barrens; Cliff, Talus and Shale Barrens; Floodplains, Wetlands and Riparian; Cave and Karstlands) highlight the geologic foundation of the ecological systems.

Karst and Groundwater

The Forest's geologic resource includes karst terrain underlain by carbonate bedrock (limestone and dolomite). Caves, sinkholes, and sinking streams are characteristic of karst terrain, and provide direct access for surface water to flow directly into the ground water. The geologic resource of groundwater, including in groundwater in karst areas, is discussed in the Water section.

Karst terrain is widely distributed across the Forest and occurs on every Ranger District (Figure A.1). These geologic map units containing karst (carbonate bedrock) are estimated to encompass 109,308 acres in Virginia and 9,906 acres in West Virginia. Karst areas may be less than 100% of the geologic map unit because other types of bedrock may be present. These geologic map units indicate 11% of the Forest (about 119,000 acres) with geologic formations containing karst and karst-related groundwater.

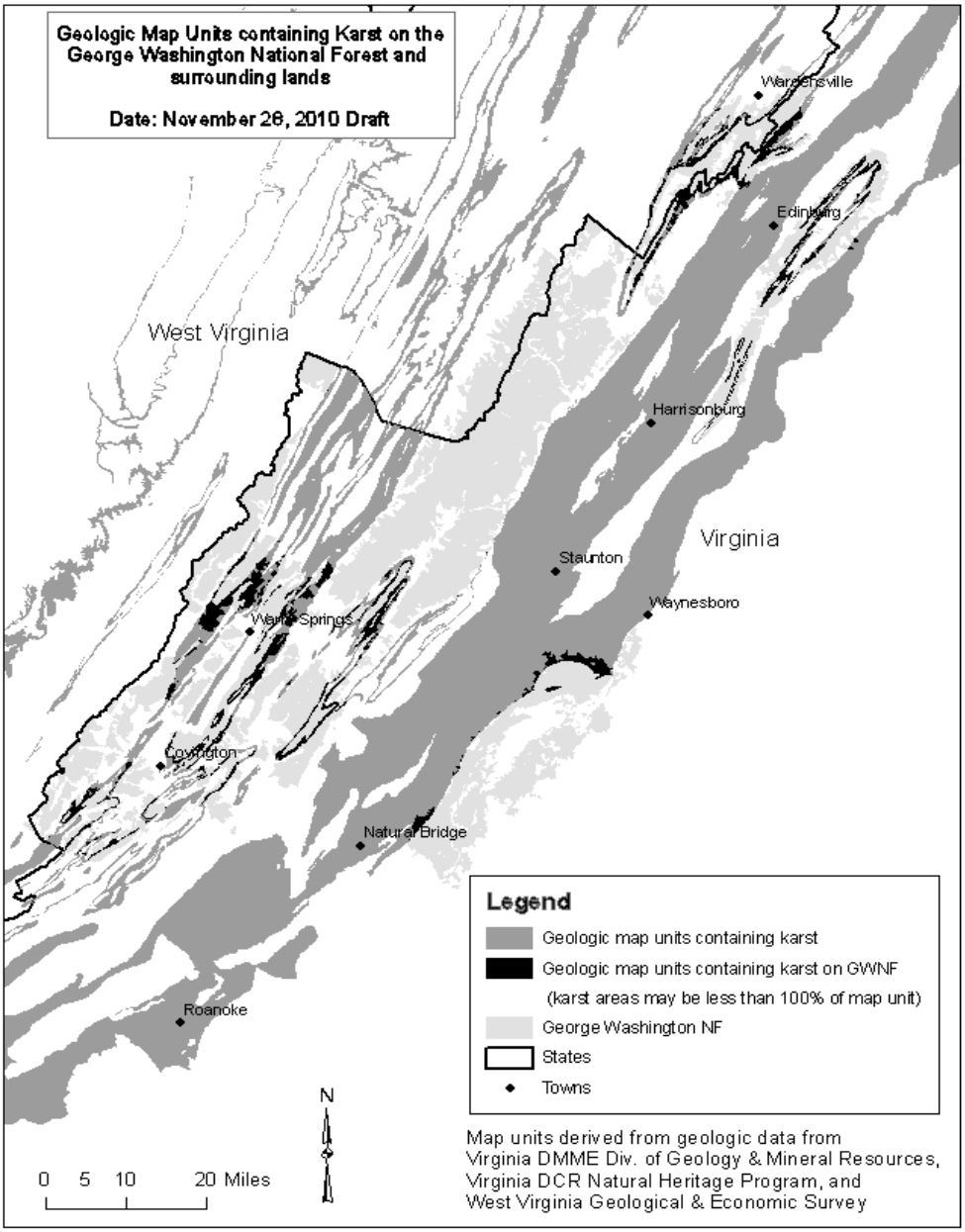


Figure A.1- Geologic Map Units Containing Karst.

Trout Pond, a sinkhole pond, may be the only natural lake or pond in West Virginia, and is part of the karst landscape interpreted at the Trout Pond Recreation Area. Maple Flats sinkholes ponds are unusual karst features in an alluvial fan overlying carbonate bedrock. Augusta Springs is a featured nature walk in a karst

spring area. Several caves are found on the Forest. The Virginia Department of Conservation and Recreation, Natural Heritage Program, identified 19 cave (and surrounding karst landscape) conservation sites on the Forest. The biological section has more information on cave resources.

Karst groundwater systems are complex, and are even more complex when surficial deposits, such as alluvial fans, mantle the karst bedrock. A notable example is the large alluvial fan along the Coal Road in the Maple Flats area on the north end of the Pedlar District. Thick deposits of sand and gravel overlie Shady dolomite in the Maple Flats sinkhole ponds area and create a complex karst groundwater setting. Another example of a complex karst groundwater setting is the Trout Pond Recreation Area on the Lee District where alluvial deposits overlie karst bedrock.

Geologic Features and Special Interest Areas

Under the current Forest Plan, the Forest has designated two Geologic Special Interest Areas (176 acres total): Devils Garden on the Lee Ranger District (unusual rock pillars, separated by deep fissures), and Rainbow Rocks on the James River Ranger District (huge rainbow of sedimentary strata: anticline).

Some examples of the variety of interesting geologic features on the Forest are:

- Ice Age block fields on Massanutten Mountain are featured in “Glimpses of the Ice Age from I-81” brochure in Geologic Wonders of the Forest series published by U.S. Geological Survey.
- Massanutten Mountain Geologic Story Trail has interpretive displays telling the geologic story of mountain-building, erosion, and geologic history of Massanutten Mountain.
- The Woodstock Observation Tower provides the classic view of the famous Seven Bends of the North Fork Shenandoah River, a geologic text book example of river meanders.
- Jingling Rocks are talus rocks that jingle like wind chimes when wind blows.
- Crabtree Falls, the highest falls in Virginia, has five major cascades and a number of smaller ones that fall a total of distance of 1200 feet.

The Forest has worked in partnership with the U.S. Geological Survey to develop interpretative and education brochures on the Forest’s geologic resources in a Geologic Wonders of the Forest series of brochures.

Paleontological Resources

The Forest contains paleontological resources, primarily Paleozoic invertebrate fossils such as brachiopods, crinoids, coral, gastropods, and scolithus. Recently Congress passed the Paleontological Resources Preservation Act of 2009 which establishes a framework for management and protection of paleontological resources on federal lands. In the Act, the term `paleontological resource' means “any fossilized remains, traces, or imprints of organisms, preserved in or on the earth's crust, that are of paleontological interest and that provide information about the history of life on earth, except that the term does not include--

> (A) any materials associated with an archaeological resource (as defined in section 3(1) of the Archaeological Resources Protection Act of 1979 (16 U.S.C. 470bb(1)); or
>
> (B) any cultural item (as defined in section 2 of the Native American Graves Protection and Repatriation Act (25 U.S.C. 3001)).”

The Act requires a permit to collect paleontological resources on federal lands except no permit is required for casual collecting where such collection is consistent with the laws governing the management of the federal land and the Act. In the Act, the term `casual collecting' means “the collecting of a reasonable amount of common invertebrate and plant paleontological resources for non-commercial personal use, either by surface collection or the use of non-powered hand tools resulting in only negligible disturbance to the Earth's surface and other resources.” The Forest Service is preparing draft regulations for the Act.

GEOLOGIC HAZARDS

Forest Service planning regulations require evaluation of existing or potential watershed conditions that will influence hazardous events (36 CFR 219.23(e)). Geologic conditions are part of watershed conditions. Geologic hazards are geologic conditions or phenomena (naturally occurring or altered by humans) that present a risk or are a potential danger to life and property. Geologic hazards on the National Forests, like fire hazards, affect public safety and property on the Forest and off the Forest in adjacent communities (Collins, 2005). The increase in population and infrastructure next to the Forest increases the risks to public safety from geologic hazards associated with the Forest and adjacent private land.

On June 11, 2010 a tragic flash flood on the Ouachita National Forest in Arkansas resulted in 20 fatalities in the Albert Pike Campground area. In the aftermath the Forest Service Washington Office requested the Regions and Forests to conduct an assessment of developed recreation sites to ensure that hazards of all types are considered and that actions are taken to address the hazards. As a result, the Southern Region is conducting a multi-phase assessment of hazards, including geologic hazards, at developed recreation sites.

The Forest's main geologic hazards relate to floods, landslides (especially debris flows), landslide dams or woody debris dams, waterfalls, abandoned mines, and karst hazards (sudden ground collapse, sinkhole flooding, and groundwater pollution).

Floods

Flooding is a geologic process and natural disturbance that plays a major role in the Forest's watersheds. Flooding also is a key part of geologic processes such as erosion, sediment transport and deposition, and in formation and dynamic changes of floodplains, alluvial fans, and riparian areas. When intense rainfalls occur in the mountains, the steep slopes allow rapid runoff of storm water; the storm waters can overflow creek banks, and then flood across narrow floodplains in narrow valleys. The forests and soils covering the Forest's watershed do moderate runoff and flooding to some extent, but major floods, including flash floods, still occur in the Forest's watersheds. Because the Forest's watersheds are mainly mountainous watersheds with rapid runoff and narrow floodplains, flooding is a geologic hazard on this Forest.

The Water section discusses floods, and mentions notable floods in 1936, 1942, 1949, 1969, 1972, 1985, and 1996. Past floods have damaged Forest roads, trails, developed recreation sites, dams, and other facilities on the Forest. Floods, especially flash floods, create risks to public safety on the Forest, for example, people camping overnight at some developed recreation sites, or people driving roads subject to flash flooding. Preliminary assessments indicate several developed recreation sites are subject to flooding.

Flooding in the mountains of the George Washington Forest is part of a larger geologic process and natural disturbance regime where flooding in mountains contributes to flooding in the valleys and to related geologic processes in the valleys such as erosion, sediment transport and deposition, and changes in floodplains, alluvial fans, and riparian areas. Flooding on the Forest contributes to flooding off the Forest downstream in the watershed. The Forest's watersheds are mainly mountainous watersheds where streams discharge flood waters, bed load, and large woody debris onto private lands in the valleys. As a result, flooding, including flash flooding, on the Forest is a geologic hazard potentially affecting people and infrastructure downstream on private lands.

Over the past decades, flooding on private lands downstream from the Forest has from time to time raised an issue about alleged effect of Forest management activity on flooding on private lands. As population and development increases on private lands, including on floodplains and alluvial fans, downstream from the Forest, these issues can be expected to continue.

A debris flood is a flood that incorporates, transports, and deposits so much solid material (such as landslide debris, valley fill, bed load, and/or large woody debris) that the solid material is a major component of the flood, drastically increasing the destructive power of the flood and the resulting flood damage. When infrequent, intense rains fall on the Forest and cause flooding, the mountain watersheds can add into the flood waters both inorganic (rocky debris) and organic (woody debris) materials that can increase the destructiveness of the flood on the Forest and off the Forest.

The role of landslides in creating debris floods was discussed in the Landslide section. The role of woody debris during floods is complex and sometimes contradictory. Large logs and whole trees in flood waters can act as battering rams, eroding the stream banks. This woody debris can form log jams and dams causing severe scour of the channel, mass failure of the stream bank, dam-induced flooding outside of stream channel banks, and debris flood surges due to dam failure. During floods, logs and trees are geologic agents of erosion, just as the flood waters, the suspended load, and the bed load are geologic agents of erosion. However, logs and trees are also normal components of the stream system. At lower stream flows they can provide stability to the stream channel, reduce the sediment load in streams and improve aquatic habitat. This increase in stability and sediment reduction can also allow the stream system to withstand higher stream flows. Stream channels that are capable of transporting higher flows under stable conditions can reduce the amount of rocky and woody debris that enters the system from eroding stream banks and adjacent landslides.

Landslides

Because the Forest's watersheds are mainly mountainous watersheds, landslides are an important natural disturbance that plays a major role in flooding, sedimentation, and the functioning of riparian areas. Landslides include a wide range of mass movements such as debris slides, debris flows, slumps, rockslides, rockfall, and stream channel bank failures.

Virginia's deadliest natural disaster occurred on the night of August 19, 1969, when swarms of landslides triggered by the remnants of Hurricane Camille swept down the Blue Ridge and killed 153 people. Hundreds of landslides (debris slides/debris flows) originated on the steep slopes on intermingled private lands and National Forest lands in Nelson, Amherst, and Rockbridge counties. The landslides scraped the rock, soil and trees off the mountainsides and dumped these deadly landslide masses into storm-swollen streams and valleys. Countless buildings were destroyed and more than a hundred bridges were swept away in parts of Nelson, Amherst, and Rockbridge counties (Virginia Division of Minerals and Geology, 2006).

These Hurricane Camille landslides are a particularly dangerous type of landslide, called a "debris flow". A debris flow typically originates high on a mountainside as a debris slide that gouges down the mountainside (scraping off the soil, weathered bedrock, and trees) and snowballs into a much larger landslide; as this landslide mass sweeps down slope it liquefies into a highly destructive debris flow that can travel hundreds or thousands of feet down slope and downstream from its source area. The Forest typically occupies the steep mountains above populated valleys. As a result, the Forest is a source area for natural debris flows that are a risk to people and infrastructure on and off the Forests.

For example, a June 27, 1995 rainstorm triggered more 40 landslides (debris flows) on the Pedlar Ranger District between Buena Vista and Glasgow on the west side of the Blue Ridge. The debris flows originated on the steep slopes of the National Forest, swept down Belle Cove and other drainages, and discharged destructive masses of rock, earth, and woody debris onto private lands and public roads, including State Highway 501. Sas and Eaton (2008) studied geologic factors affecting these debris flows in Rockbridge County.

The June 27, 1995 rainstorm triggered similar debris flows in the Shenandoah National Park and private lands on the east side of the Blue Ridge in Madison County, Virginia. The U.S. Geologic Survey (USGS) conducted field investigations and produced a series of scientific reports to understand the conditions that cause debris flows and to suggest methods to mitigate future events (Morgan et al., 1997). The USGS also produced a Fact Sheet to help the public and government officials understand and plan for debris flow hazards (U.S. Geological Survey, 1996). One purpose for this major scientific effort by the USGS is to help government officials at all levels (federal, state, and local) in Virginia and other parts of the Appalachians understand the important role that land-use planning can have in avoiding or mitigating landslide hazards.

The debris flow hazard also exists on ridges of the Valley and Ridge Province throughout the Forest. For example, June 17-18, 1949 storm triggered more than 100 debris slides/debris flows in the Little River watershed on the North River Ranger District in Augusta and Rockingham Counties, Virginia (Hack and Goodlet, 1960)

Debris slide/debris flow landslides originating the Forest have a potential to cause mass fatalities. These fast-moving landslides start on a steep slope as a failure of colluvium and weathered bedrock (debris slide), and then liquefy and accelerate to speeds as great as 35 miles per hour or more (debris flow), flowing down slope into stream channels, and then downstream. As the debris slide/debris flow moves down slope, it often gouges into the mountainside, scrapping the slopes bare, becoming a much larger landslide, a fast-moving destructive mass that can destroy infrastructure and kill people down slope and in valleys more than two miles from debris slide source. In the mountainous watersheds typical of the Forest, the destructive power of debris flows is even greater than floods or flash floods. When debris flows occur, they often occur at the time of floods or flash floods; as a result, much of the damage and fatalities due to debris flows sometimes is hidden under the general rubric of "floods", "flood damage", and "flood fatalities". But debris flows are a different type of geologic hazard than water floods or flash floods, and require a more comprehensive geologic assessment. Research in the Appalachian region (Jacobson et al. 1989) indicates that the most catastrophic of geomorphic events will be "those in which conditions simultaneously promote landslides and high flood discharges."

In addition to natural landslides, some landslides may be caused or influenced by human activities. For example, excavation for road construction on a steep slope can undercut and remove some support from the hillside. In some geologic settings (adverse bedrock structures or weak surficial materials), this undercut and removal of support may lead to failure of the road cut-slope. Or, construction of a road fill or log landing fill on a steep slope may lead to a failure of the fill-slope. Slope failures of road cut-slope or fill-slope occur occasionally, generally during intense rainstorms when natural landslides also occur. A geologic hazard related to management activities of special concern are debris flows caused by failure of fill slopes. Destructive debris flows that can sweep hundreds or thousands of feet down slope can be caused not only by failure of natural slopes but also by failure of fill slopes (roads, log landings). On the National Forests of North Carolina in September 2004 Hurricanes Frances and Ivan triggered many road fill failures on Forest Service roads as well as on the Blue Ridge Parkway that resulted in debris gouging destructive paths long distances, endangering people and damaging infrastructure (Collins, T.K., 2008). Road fills (or log landings fills) on steep slopes may be marginally stable, but vulnerable to failure during intense rainstorms. As demonstrated in September 2004, road fills on a steep slope high on a mountain are a special concern because of the snowball effect as the fill failure transforms to a debris flow and bulldozes the soil, weathered rock, and trees into a larger destructive mass as it gouges down the mountainside. Such debris flows caused by fill failures can travel a mile or two down slope just like debris flows caused by natural slope failures, endangering people and infrastructure down slope and in the valleys.

Landslide Dams and Woody Debris Dams

The landslide dams and woody debris dams can occur during intense rainfall, often at times of flooding. In the mountainous terrain with narrow valleys typical of most of the Forest, when a landslide, such as a debris slide, sweeps down slope into a drainage, there is a potential for a landslide dam to form, and soon, to fail as storm water fills upstream of the unstable dam. Woody debris dams also can form and then fail during flooding in forested mountain drainages. The failure of temporary landslide dams or woody debris dams can send a surge of water and debris downstream, and create a different type of "flash flood".

Karst

Karst geology (sinkholes, caves, disappearing streams, etc.) creates multiple geologic hazards:

- Ground collapse at existing sinkholes or new sinkholes can occur at any time, but certain events create elevated threat of catastrophic ground collapse, such as during or shortly after intense rainstorms, or when a new groundwater well or sewage disposal system is placed in operation.
- Sinkholes create unique flood and flash flood hazards. Intense storm waters can suddenly turn dry depressions into ponds or lakes.
- Karst geology creates risk of contamination of ground water and water wells at a developed recreation site as well as down gradient from the site, including private land. Contamination can result from operation and maintenance of the recreation site, such as sewage leakage, or from certain events such as flooding carrying polluted storm water into sinkholes.

For example, sinkhole activity (ground collapse) has occurred in part of these developed recreation sites: Trout Pond Recreation Area on Lee RD; Locher tract on the Glenwood/Pedlar RD; Augusta Springs on the North River RD.

Waterfalls

Waterfalls are a geologic hazard with a recurring incidence of death or injury to individuals on the Forest. The slick rock, strong current, steep slopes, hidden rocks in the pool beneath the waterfalls, rockfall, ice-covered rocks, and icicle or ice falls are natural hazards at waterfalls. Visitors who venture too close to the waterfalls have a risk of serious injury or death. Crabtree Falls on the Pedlar RD is a popular recreation site with these natural hazards.

Abandoned Mines

The Forest has hundreds of abandoned mine workings, primarily from historic mining of iron. Most abandoned mines are in remote locations where Forest visitors generally do not venture. Some abandoned workings, such as shafts or adits, are physical hazards with a risk of falling into a deep shaft or being hit by falling rock in an adit. The Forest has reclaimed hazardous mine workings, and continues this work every year as funding allows. Some reclamation involves bat gates to provide bat habitat.

DIRECT AND INDIRECT EFFECTS

GEOLOGIC RESOURCES

Management activities that involve ground disturbance, such as construction of roads and developed recreation facilities, have the potential to adversely affect geologic resources. All the Alternatives have Forest Plan standards to protect the Forest's geologic resources, including groundwater, groundwater-dependent ecosystems, springs, caves, sinkholes, disappearing streams, unusual landforms, waterfalls, fossils (paleontological resources), field records of catastrophic events (floods, landslides, ground collapses, and other geologic hazards), and field records of climatic changes and Quaternary ecosystems. The Forest Plan standards to protect geologic resources are in various sections of the Forest Plan, including Geologic Resources, Geologic Hazards, Water, Soil, Caves and Karstlands, and Indiana Bat Management. Standards under all Alternatives provide that the location and design of management activities will evaluate measures to avoid, minimize, or mitigate adverse effects on geologic resources with identified values (scientific, scenic, paleontological, ecological, recreation, drinking water, groundwater and groundwater dependent ecosystems).

Under all Alternatives, those management prescriptions that severely restrict or prohibit ground disturbing activity also protect geologic resources located in those management prescription areas, for example, Wilderness, Recommended Wilderness Study Area, National Scenic Areas, Special Biological Areas, and Remote Backcountry Areas. Also, the measures addressing Terrestrial Viability Evaluation under all Alternatives also protect geologic resources because geologic resources are a prominent foundation of ecosystems such as Alkaline and Mafic Glade and Barrens; Cliff, Talus and Shale Barrens; Floodplains, Wetlands and Riparian; and Cave and Karstlands,

Each Alternative also has a Geologic Area management prescription (4C1) which highlights and provides additional protection for geologic resources. Under the current Plan (Alternative A), the Forest has designated two Geologic Special Interest Areas (176 acres total): Devils Garden on the Lee Ranger District and Rainbow Rocks on the James River Ranger District. These two Geologic Special Interest Areas (176 acres total) also would be designated in Alternatives B, C, D, E, F, and G. Alternative E and G would add more Geologic Special Interest Areas. The Virginia Department of Conservation and Recreation, Natural Heritage Program, identified 19 cave and surrounding conservation areas on the Forest. Two sites are within Special Biological Areas, two are within Indiana bat protection areas, and one is in Wilderness, leaving about 3,700 acres outside of these protected areas. Alternatives E and F would designate 14 cave and surrounding conservation areas (about 3,700 acres total) as Geologic Areas.

The potential ground-disturbing activities associated with management activities will be used as an indicator of potential impact on geologic resources. Using this indicator, Alternative C has the lowest potential and Alternative D has the highest potential for impact on geologic resources; Alternatives F, B, E, G, and A have intermediate levels of potential impact.

GEOLOGIC HAZARDS

Geologic hazards are geologic processes or conditions (naturally occurring or altered by humans) that present a risk or potential danger to public safety, infrastructure, and property. Geologic hazards may affect or be affected by Forest management activities. Thus, Forest management activities have potential for two types of effects relating to geologic hazards:

> Type 1) Forest management activities have the potential to increase risk to public safety and infrastructure by not considering natural geologic hazards in the location, design, and maintenance of Forest management activities. For example, a natural landslide (such as a debris flow) may damage or destroy a developed recreation site, and injure or kill Forest visitors and employees. Different geologic settings have different geologic hazards. If siting, design, and maintenance of Forest management activities do not consider the geologic setting and potential geologic hazards, then public safety and infrastructure may be inadvertently and unnecessarily put at risk.
>
> Type 2) Forest management activities have the potential to increase risk to public safety and infrastructure by not considering human-induced geologic hazards in the location, design, and maintenance of Forest management activities. Forest management activities have the potential to 1) create human-induced geologic hazards, or 2) trigger or aggravate natural geologic hazards. In addition to natural landslides, some landslides are caused or influenced by human activities. For example, excavation for road construction on a steep slope can undercut and remove some support from the hillside. In some geologic settings (adverse bedrock structures or weak surficial materials), this undercut and removal of support may lead to failure of the road cut-slope and hillside upslope. Or, construction of a road fill or log landing fill on a steep, geologically unstable slope may lead to a failure of the fill-slope. Such fill failures can transform into a debris flow and travel hundreds or thousands of feet down slope, endangering people and infrastructure far away from the fill failure. If siting, design, and maintenance of Forest management activities do not consider the geologic setting and potential geologic hazards, then public safety and infrastructure may be inadvertently and unnecessarily put at risk.

Mitigation of these potential impacts under each Alternative is a challenge because there is no federal law with specific requirements that federal agencies consider the effects of ground disturbing activities on geologic hazards and associated risks to public safety. There are federal laws with specific requirements for federal agencies to consider and to protect plants, animals, artifacts, and fossils. But there is no federal law with specific requirements for federal agencies to consider and to protect public safety in regard to the wide range of geologic hazards on this Forest and other National Forests Systems lands.

Executive Order 11988 for floodplains is a useful tool that can help mitigate potential effects related to floods, but it is not a law and it does not cover the wide range of geologic hazards and associated risks to public safety and infrastructure. To address the wide range of geologic hazards and to reduce the potential for impacts from management activities, each Alternative has Forest-wide Standards that provide:

- When locating, designing, and maintaining trails, roads, other facilities, and management activities, avoid, minimize, or mitigate geologic hazards and potential impact on infrastructure and public safety.
- For ground-disturbing projects on slope gradients of 50% or greater located upslope and within one-half mile of Forest external boundary, conduct a geologic hazard and risk assessment of off-Forest public safety for landslides, including debris flows.

Each Alternative varies the treatment of developed recreation sites, from no new sites to adding new sites, from expanding sites to closing sites. Using this treatment as an indicator for potential impacts (Type 1) relating to geologic hazards at developed recreation sites, Alternatives E and C have the lowest potential and

Alternative A has the highest potential for impacts relating to geologic hazards; Alternatives D, F, B, and G have intermediate levels of potential impact.

The potential ground-disturbing activities associated with management activities will be used as an indicator of potential impacts (Type 2) of management activities relating to geologic hazards. Using this indicator, Alternative C has the lowest potential and Alternative D has the highest potential for impacts relating to geologic hazards; Alternatives F, B, E, G, and A have intermediate levels of potential impact.

CUMULATIVE EFFECTS

In the 19th and early 20th century the private lands in the East that eventually would be purchased to become federal land (National Forests in the East) were heavily used to supply wood to a wood-based, agrarian society. Vast tracts of lands were clear-cut logged, deforested, cut-and burned, and denuded. Railroads were constructed into steep mountain drainages to cut all the trees off the mountainsides and steep hollows. In some areas, the forests were cleared and the ground plowed to farm on the hillsides. Even as society began to industrialize, the demand for wood supply continued to grow as wood was used for industrial fuel and for construction (rail ties, wooden bridges, wooden factories, etc.). Iron was mined by excavating the limestone and sandstone on the mountainsides; tens of thousands of trees were cut to make charcoal as industrial fuel for iron furnaces on the Forest; streams were diverted to supply water. All these land disturbances taking place over decades in the largely unregulated environment of the 19th and early 20th century had adverse impacts on some geologic resources and geologic hazards.

It was severe impacts on watersheds and flooding in the East that was one of the key reasons for the Weeks Act of 1911 and the creation of National Forests in the East such as the George Washington National Forest. As the federal government purchased private lands in the 1920s and 1930s to establish the National Forest System, the National Forest restored the deforested land and watersheds over the following decades, resulting in extensive reforested landscapes that reduced the effects of natural floods and landslides.

From the 1950s to the 1980s substantial road construction occurred as part of timber harvesting and recreational access and recreational development on the Forest. From the 1990s to the present, the levels of road construction and timber harvest have decreased substantially compared to previous decades. Since the 1930s these Forest activities occurred under various federal laws and regulations, including regeneration requirements, and were distributed across the landscape in space and time. At the same time these Forest activities were occurring, the overall Forest landscape was reclaimed and reforested from the deforestations of the 19th and early 20th century.

Most of the Forest's permanent road system is already constructed. The Forest's road system currently is about 1,800 miles. One indicator of the cumulative effects on geologic resources and geologic hazards is the amount of past, present, and future management activity on the Forest. The amount of roads is an indicator of the amount of ground-disturbing management activity. Alternative C would not construct any system road, and would not add to existing cumulative impacts. Road construction in Alternatives A, B, D, E, F, and G would add small increments to the existing 1,800 miles of Forest Service System roads and associated cumulative impacts.

About 281 miles of the 1,800 miles of Forest Service System roads are within the 11% of the Forest with geologic formations containing karst. Road construction in Alternatives A, B, D, E, F, and G would add small increments to the 281 miles within the 11% of the Forest with geologic formations containing karst and karst-related groundwater. Alternatives E and F would designate 14 cave and surrounding conservation areas (about 3,700 acres total) as Geologic Special Interest Areas, and thus increase protection of karst groundwater areas.

In summary, the cumulative effects on geologic resources and geologic hazards are largely from past activity.

A3 – CLIMATE

AFFECTED ENVIRONMENT

For the George Washington National Forest and much of the southeastern United States, climate variability and weather events such as strong winds and heavy rains from hurricanes, droughts, heat waves, episodes of warm winters, floods, ice storms, and lightning storms have long been part of the natural environment. From a climate perspective, the southeast has some of the warmest temperatures, generally receives more rainfall than any other region, and experiences many extreme climate events (U.S. Global Change Research Program 2001).

These climate variables and associated disturbances have always influenced the makeup and geographical distribution of many ecological communities and landscapes across the South. However, the increasing changes in climate and disturbances projected for the future are expected to lead to substantial alterations in our forests and the services they provide (U.S. Climate Change Science Program, 2008a). The International Panel on Climate Change (IPCC 2007) has identified future impacts of temperature warming, changes in precipitation, extreme weather events, severe droughts, earlier snowfall, rising sea levels and other changes that could significantly affect forest ecosystems.

Forest Service scientists have been studying various aspects of climate change on forests for many years. Yet, our knowledge of how plants and ecosystems respond to the threats of a changing climate and how to react appropriately at local levels where management actions are most effective is still very limited (Solomon 2008). Uncertainties about outcomes will require flexibility, and land management strategies based on current or historical conditions will need to be adjusted or replaced with approaches that support adaptation to changing conditions (USDA Forest Service, October 2008).

It has been recognized that forests can play an important role in both mitigating and adapting to climate change. Mitigation measures focus on strategies such as carbon sequestration by natural systems, ways to increase carbon stored in wood products, ways to provide renewable energy from woody biomass to reduce fossil fuel consumption, and ways to reduce environmental footprints. Adaptation measures address ways to maintain forest health, diversity, productivity, and resilience under uncertain future conditions. Adaptation and mitigation activities must also complement each other and balance with other ecosystem services (USDA Forest Service, October 2008).

At this time, the science of climate change modeling is at the stage of stepping down global models to regional scales (Davis 2007), so a combination of national projections, regional-level climate trends for the southeastern United States, and a recent report prepared for the state of Virginia provides the most reliable context for describing expected climate changes and impacts for the George Washington National Forest. Specifics regarding many mitigation measures, such as the appropriate calculations for carbon offsets and how to consider carbon sequestration rates, are still being developed, so most of our focus at the forest level for now will be on using management options to improve resilience and adaptability of native ecosystems under changing conditions. Then, over the 15-year life of the Plan, as issues are better understood and appropriate measures are identified, climate change strategies can be adjusted through the adaptive management process.

NATIONAL CLIMATE CHANGE TRENDS AND EXPECTATIONS

Warming temperatures, altered precipitation patterns, rising sea levels, and increases in the number and intensity of extreme weather events are already causing observed ecological responses across the United States (U.S. Climate Change Science Program, 2008a). Although there are variations by region, overall temperatures across the nation warmed during the 20th century, with 11 of the 12 years from 1995-2006 among the warmest since instrumental record keeping was started in 1850 (U.S. Climate Change Science Program, 2008b; IPCC, 2007). Precipitation patterns and distribution also vary regionally, but the total annual precipitation in the contiguous United States has increased 6.1 percent over the last century, with about half of the increase attributed to increased storm intensity (U.S. Climate Change Science Program, 2008b; Karl and Knight, 1998). Warming temperatures, along with land subsidence, contribute to sea level rise. Relative sea

levels have risen 3-4 mm per year in the Mid-Atlantic States and 5-10 mm per year in the Gulf states (U.S. Climate Change Science Program, 2008b; U.S. Environmental Protection Agency, 2007).

Anticipated increases in extreme weather events outside the historic range of natural variability may alter the frequency, intensity, duration, and timing of disturbances such as fire, drought, invasive species, and insect and pathogen outbreaks. Changes in forest composition and growth may also have associated impacts on wildlife habitats, the supply of wood products, specialty markets, and recreational opportunities (U.S. Climate Change Science Program, 2008b; Marques 2008).

Forests provide a wealth of services and products including clean water, clean air, biological habitats, recreation opportunities, carbon storage, timber, specialty commodities, fuel, and aesthetic and cultural values. Scientists have indicated that a changing climate can affect the future biodiversity and alter the function of the forest ecosystems that support these services and products (U.S. Climate Change Science Program, 2008a). Species distributions may shift, some species are likely to decline while others expand, and whole new communities may form. Forest productivity may be reduced in some instances due to a decline in photosynthesis caused by increased ozone, and productivity may be enhanced in other settings where elevated levels of carbon dioxide (CO_2) have a fertilizing effect on overall tree growth.

The overwhelming majority of studies of regional climate effects on terrestrial species reveal consistent responses to warming trends, including poleward and elevational range shifts of flora and fauna. Responses of terrestrial species to warming across the Northern Hemisphere are already well documented by changes in the timing of growth stages (i.e., phenological changes), especially the earlier onset of spring events, migration, and lengthening of the growing season (IPCC 2007).

Mammalian responses to rising temperatures and other climate changes are diverse. Many small mammals are coming out of hibernation and breeding earlier in the year than they did several decades ago, while others are expanding their ranges to higher altitudes. Some show trends toward larger body sizes, probably due to increasing food availability and higher temperatures. On the other hand, reproductive success in polar bears has declined due to melting Arctic sea ice (IPCC 2007).

Birds are an important part of many functioning ecosystems because of their roles in seed dispersal, pollination, and as both predator and prey. Scientists have observed that birds are breeding and laying their eggs earlier and that migratory species have altered their wintering and/or critical stopover habitats. For example, warmer springs have led to earlier nesting for 28 migrating bird species on the east coast of the U.S. (IPCC 2007).

A range shift toward the poles (northward in the Northern Hemisphere) or to higher elevations has occurred among many invertebrates that are considered pests or disease organisms (IPCC 2007).

Habitat ranges for butterflies in North America have shifted northward and in elevation as temperatures increased. In some cases, such as the Edith's Checkerspot Butterfly, local populations have become extinct in the southern portion of their range (IPCC 2007).

Fishing is highly valued in the U.S. as both a commercial enterprise and as a recreational sport. Fish populations and other aquatic resources are likely to be affected by warmer water temperatures, changes in seasonal flow regimes, total flows, lake levels, and water quality. These changes will affect the health of aquatic ecosystems, with impacts on productivity, species diversity, and species distribution (IPCC 2007).

Stream habitats are projected to decline across the U.S. by 47 percent for coldwater, 50 percent for cool-water, and 14 percent for warm-water species. In the southern Great Plains, summer water temperatures already approach the limits for survival of many native stream fish (IPCC, 2002). An 8°F increase in average annual air temperature is projected to eliminate more than 50 percent of the habitat of brook trout in the southern Appalachian Mountains. The Northern pike, which spawn in flooded meadows in early spring and whose young remain in the meadows for about 20 days after hatching, would be especially affected by low spring water levels. Higher winter temperatures have been observed to decrease the survival rate of the eggs of yellow perch (a coldwater species). On the other hand, one study found that higher winter temperatures (by 2ºC) were

beneficial for rainbow trout but the same temperature increase in summer caused negative effects (IPCC 2007).

The ability of reptiles and amphibians to adapt to changes in climate depends in part on their ability to move to more suitable habitat. A European study found that most reptile and amphibian species could expand their ranges in a warmer climate if dispersal were unlimited, but if they were unable to disperse then the ranges of nearly all species (more than 97 percent) would become smaller (IPCC 2007).

SOUTHERN REGION CLIMATE CHANGE TRENDS AND EXPECTATIONS

Over the past decade, a number of models have been developed to simulate climatic effects anticipated in the future. These scenarios are based on historical data, trends, and analysis of different plausible assumptions. While climate model simulations are continuing to be developed and refined, climate projections typically do not yet accurately address expected conditions below the regional scale in the United States. In the report by the United States Global Change Research Program on Climate Change Impacts on the United States (2001), the two principal models that were found to best simulate future climate change conditions for the various regions across the country were the Hadley Centre model (developed in the United Kingdom) and the Canadian Climate Centre model. Unless otherwise noted, the following discussions of climate change expectations for the southeastern United States are based on findings from the 2001 U.S. Global Change Research Program report and more recent projections in the U.S. Climate Change Science Program Reports (SAP 4.3, May 2008a; SAP 4.4, June 2008b).

The climate is going to get warmer, especially warmer minimum winter temperatures. Both the Hadley and Canadian models show increased warming in the southeast but at different rates (see inset on Future Climate Scenarios for the southeast). Overall regional temperature changes are projected to be equivalent to shifting the climate of the Southern U.S. to the central U.S. and the central U.S. climate to the northern U.S.

The heat index, which is a measure of comfort based on temperature and humidity, is going to rise. The principal climate model simulations agree that the heat index will increase more in the southeast than in other regions. By 2100, the heat index under the Hadley model is projected to increase by as much as 8-10F and by over 15F in the Canadian model. The Northeast may feel like the southeast does today, the southeast is likely to feel more like today‘s south Texas coast, and the south Texas coast is likely to feel more like the hottest parts of Central America.

Threats to coastal areas will increase, including rising sea levels, beach erosion, subsidence, salt water intrusion, shoreline loss, and impacts to urban development.

Precipitation is more likely to come in heavy, extreme events.

For other aspects, models tend to differ on expectations. The southeast is the only region where climate models are simulating large and opposite variations in precipitation patterns over the next 100 years. The Canadian model projects more extensive and frequent droughts in the southeast, starting with little change in precipitation until 2030 followed by much drier conditions over the next 70 years. The Hadley model, in contrast, suggests there will be a slight decrease in precipitation over the region during the next 30 years followed by increased precipitation. There is also uncertainty over the extent of effects of El Nino and La Nina cycles. El Nino events typically result in cooler, wetter winters in the southeast and fewer Atlantic tropical storms, while La Nina events tend to have the opposite effects with warmer, drier winters and more hurricanes.

Unexpected interactions among multiple disturbances happening at the same time add to the level of uncertainty. For example, tree growth is generally projected to be stimulated by increases in CO_2, but limits on availability of water and soil nutrients during droughts often weaken tree health leading to insect infestations or disease, which in turn promotes future fires by increasing fuel loads and further weakening tree health (Marques 2008).

Based on current projections, the following discussion highlights some of the potential impacts of a changing climate on forests in the southeastern United States and on the George Washington National Forest.

Forest productivity – In general, biological productivity of southeastern forests will likely be enhanced by increased levels of CO_2, as long as there is no decline in precipitation and as long as any increases in moisture stress due to higher air temperatures are low enough to be offset by CO_2 benefits. Hardwoods are more likely to benefit from increased CO_2 and modest temperature increases than pines, since pines have greater water demands than hardwoods on a year-round basis. Without management adaptations, simulations using the Hadley model show pine forest productivity will likely increase 11 percent by 2040 and then exhibit a declining trend to an 8 percent increase by 2100 compared to 1990 productivity estimates. Hardwood productivity will likely continue to rise, with projections of a 22 percent increase by 2040 and 25 percent by 2100. This shift in productivity could have significant effects in the South. Forest productivity increases may be offset, however, by escalating damage from forest pests and more extreme weather disturbances.

Forest pests – The potential for a changing climate to increase the distribution of forest insect and disease pests is a concern, particularly for pests that already cause widespread damage such as Southern pine beetles. Higher winter temperatures are expected to increase over-wintering beetle survival rates, and higher annual temperatures will produce more generations each year leading to increased beetle infestations. Other factors, however, complicate projections of future infestation levels. Field research has demonstrated that moderate drought stress increases pine resin production thus reducing colonization success, while severe drought stress reduces resin production and increases pine susceptibility to beetle infestation. Insufficient evidence currently exists to predict which of these factors will control future beetle populations and impacts (McNulty et al. 1998).

Fires – Fire frequency, size, intensity, and seasonality are directly influenced by weather and climate conditions. Nationwide projections show seasonal fire severity is likely to increase by 10 percent over the next century, with possibly larger increases in the southeast. At least two ecosystem models run under the Canadian climate change scenario suggest a 25-50 percent increase in fires, and a shift of some southeastern pine forests to pine savannas and grasslands due to moisture stress. Under a hotter, drier climate, an aggressive fire management strategy could prove critical to maintaining regional vegetation patterns.

Shifts in major vegetation types for the Southeast – The broad variety of ecosystem types found across the southeast ranges from coastal marshes to mountaintop spruce-fir forests. Although the South is one of the fastest growing population regions in the country, forests are still common in many parts of the southeast, and forestland averages approximately 30 percent of each state. Potential changes in vegetation distribution due to climate change vary with different model scenarios. Under the Hadley model, forests remain the dominant natural vegetation in the southeast, but the mix of forest types changes. Under the Canadian model, savannas and grasslands expand and replace parts of the southeastern pine forests along the Coastal Plain due to increased moisture stress. In this scenario, the current southeastern forest moves into the north-central part of the United States. Both drought and increased fire disturbance play an important role in the potential forest breakup.

Weather-related stresses on human populations – Low-lying Gulf and Atlantic coastal areas are particularly vulnerable to flooding. With floods already the leading cause of death from natural disasters in the southeast, increased flooding from more active El Nino/La Nina cycles could have greater adverse impacts. Even if storms do not increase in frequency or intensity, sea level rise alone will increase storm surge flooding in virtually all southeastern coastal areas. Another concern is the prolonged effect of elevated summertime heat events, which coupled with drought conditions, not only causes elevated heat stress to humans but also increases smog levels.

Increased forest disturbances – Increases in extreme events and changes in disturbance patterns may have more significant impacts, at least in the near future, than long-term changes in temperature or precipitation. Natural disturbances that may be associated with climate change include hurricanes, tornadoes, storms, droughts, floods, fires, insects, diseases, and non-native invasive species. Although disturbances are a natural and vital part of southern ecosystems, it is the change in frequency, intensity, duration, and timing exceeding the natural range of variation that is a concern (Marques 2008). Multiple disturbances interact and further exacerbate damages. Hurricanes can cause severe disturbance that not only results in direct loss of biological communities and habitat, but the widespread damages can also shift successional direction leading to higher rates of species change and faster biomass and nutrient turnover. Invasive species and insect pests often

have high reproductive rates, good dispersal abilities, and rapid growth rates enabling them to thrive in disturbed environments.

Water stresses – The difficulty in predicting whether precipitation will increase or decrease in the southeast over the next 30-100 years extends to uncertainties over future water quantity and quality conditions. Current water quality stresses across the southern region of the country are primarily associated with intensive agricultural practices, urban development, and coastal processes such as saltwater intrusion. Although water quality problems are generally not critical under current conditions, stresses are expected to be more frequent under extreme conditions, particularly in low stream flow situations associated with droughts. Under the Hadley model, stream flow in the southeast has been projected to decline as much as 10 percent during the early summer months over the next 30 years. The Chattahoochee and Tombigbee River basins are projected to have decreased water availability over the next 50 years, and as stream flow and soil moisture decrease, agricultural fertilizer applications and irrigation demands tend to increase creating further stress and conflicts over competing uses. Parts of the southeast that depend more on ground water are particularly vulnerable to depletion of aquifers, which can take centuries to recharge after chronic drought conditions (Hoyle 2008).

Outdoor recreation – Outdoor recreation opportunities are likely to be impacted by climate change but would vary by location and activity. Higher summer temperatures could extend summer activities such as swimming and boating but may also reduce other outdoor activities such as hiking and trail use in hot, humid sections of the South. Warmer waters would increase fish production and fishing opportunities for some species but decrease fishing for other cold water species. Summer recreation activities are likely to expand in cooler mountainous areas as temperatures warm along the coastal plain and lowland elevations. Skiing opportunities are likely to be reduced in the South, and some marginal ski areas may close due to fewer cold days and snow events.

LOCAL LEVEL CLIMATE CHANGE TRENDS AND EXPECTATIONS

The Template for Assessing Climate Change Impacts and Management Option (TACCIMO) was used to estimate the range of changes in precipitation and temperature that can be expected on the GWNF. The template uses models from Canadian Centre for Climate Modeling & Analysis (Canadian), Hadley Centre for Climate Prediction and Research (Hadley), and US Dept of Commerce/NOAA/Geophysical Fluid Dynamics Laboratory (Commerce). The models are run using three scenarios regarding the level of carbon emissions.

Table A3.1 Climate Change Model Scenarios

Emissions Path	Description
"Higher" emissions path	Technological change and economic growth more fragmented, slower, higher population growth
"Middle" emissions path	Technological change in the energy system is balanced across all fossil and non-fossil energy sources, where balanced is defined as not relying too heavily on one particular energy source
"Lower" emissions path	Rapid change in economic structures toward service and information, with emphasis on clean, sustainable technology. Reduced material intensity and improved social equity

Based on data from TACCIMO, the predicted changes in precipitation and temperature are shown in the following tables:

Table A3.2 Predicted Changes in Precipitation on the GWNF

Precipitation, annual average from 2009-2099 (in)			
Emissions Path	Commerce Model	Canadian Model	Hadley Model
Middle Emissions	46.3	43.9	47.7
Higher Emissions	47.0	43.9	44.7
Lower Emissions	44.4	44.8	45.8
Average of all emission options	45.9	44.2	46.1
Historical Average (PRISM 1970-2000)	43.5	43.5	43.5

Table A3.3 Predicted Changes in Temperature on the GWNF

Average temperature (°F, Monthly Average spanning 2009 – 2099)			
Emissions Path	Commerce Model	Canadian Model	Hadley Model
Middle Emissions	56.3	56.8	57.7
Higher Emissions	56.8	57.0	57.2
Lower Emissions	55.2	55.2	56.1
Average of all emission options	56.1	56.5	57.0
Historical Average (PRISM 1970-2000)	52.5	52.5	52.5

All of the models predict an increase in precipitation ranging from less than a half inch to more than four inches per year. All of the models also predict an increase in temperature ranging from 2.7° F to 5.2° F.

In December 2008, the Governor's Commission on Climate Change released a "Final Report: A Climate Change Action Plan" for the state of Virginia. The report included expected impacts of climate change on Virginia's natural resources, the health of its citizens, and the economy which included the industries of forestry and tourism. It also identified what Virginians can do to prepare for the likely consequences of climate change as well as an estimation of the amount of, and contributors to, the state's greenhouse gas emissions through 2025. The Governor's Executive Order 59 (2007) set a greenhouse gas emission target of 30% below the business-as-usual projection of emissions by 2025.

The Governor's Commission on Climate Change used the Intergovernmental Panel on Climate Change's (IPCC) Fourth Assessment Report as the primary reference point on the science of climate change, and also included testimony of a variety of experts. Estimates provided in the recent Chesapeake Bay Program Scientific and Technical Advisory Committee (STAC) report, "Climate Change and the Chesapeake Bay: State-of-the-Science Review and Recommendations" (Pyke et al. 2008) were also incorporated because of its regionally-specific nature. The findings of the expected impacts of climate change for Virginia from the Commission's report, as they relate to national forest management in Virginia include the following. These impacts could be further compounded by Virginia's growing human population. As of July 2009, the Virginia Employment Commission

estimates that, between 2010 and 2030, Virginia's human population will increase by almost 23 percent (http://www.vec.virginia.gov/vecportal/lbrmkt/plugins/lmiapp.cfm/popproj#).

Virginia should prepare for a minimum of a 3.6°F increase in air and water temperatures but these temperatures could increase as high as 10.8°F by 2100. Changes in precipitation and weather patterns are more difficult to estimate, although there has been scientific consensus that most of Virginia will experience a slight (0-10%) increase in precipitation and an increase in coastal storm intensity (IPCC, 2008; Pyke et al., 2008).

There will likely be a projected sea level rise for coastal Virginia of 2.3–5.2 feet by 2100. Oxygen levels in the Chesapeake Bay are expected to decrease due to increasing temperatures and increasing storm runoff. Acidification of the Bay and Atlantic Ocean also is a concern as waters absorb more carbon dioxide (CO_2). Though the George Washington National Forest lies along the western mountains of Virginia, all of the forest is in the headwaters of the Chesapeake Bay watershed.

At varying rates, vegetation ranges will move from current locations to higher altitudes and latitudes, such that suitable habitat for some species will decline, other species will become extirpated, and other species will become extinct. Virginia's freshwater streams and high elevation areas currently offer essential habitat to many species that require cooler conditions. As temperatures increase and precipitation patterns change, these habitats will no longer support the same suite of species they do today.

Threats already faced by Virginia's ecosystems, such as invasive species, pathogens and pollution will become exacerbated. Many new exotic or invasive species may move into Virginia and existing pest species may flourish and cause more widespread damage than they are now.

There is a lack of research and specific information on the impacts of climate change on Virginia's forestry industries, and commercial and sport fishing industries.

Virginia's forestlands sequester approximately 23 million metric tons of CO_2 per year but an average of 27,000 acres of forestland is lost annually to development. The George Washington National Forest encompasses about 1 million acres (or seven percent) of the forestlands in the state. The Jefferson encompasses another five percent, making both forests the largest land manager in the state. The GW also includes about 105,000 acres in West Virginia.

Extreme weather events could lead to compromised water and food supplies for people. Unstable weather patterns could also cause periods of drought that threaten municipal water supplies.

Climate change is expected to increase the incidence of human diseases associated with air pollutants and aeroallergens that exacerbate other respiratory and cardiovascular conditions.

The three largest sources of greenhouse gas emissions in Virginia are electricity generation, transportation, and non-utility uses of fuel in industrial, commercial and residential facilities. Demands for electricity, transportation and fuel would likely increase as population increases.

The Virginia Department of Mines, Minerals and Energy (DMME) projects that natural gas consumption will grow 3.6 percent from 2007 through 2016 under a business-as-usual scenario. Natural gas increasingly is being used for electric generation because it is the cleanest of the fossil fuels, which may cause an even greater increase in demand for natural gas supply.

KEY CLIMATE CHANGE FACTORS AND EFFECTS FOR THE GEORGE WASHINGTON NATIONAL FOREST

Based on current projections, the primary regional-level and state-level predicted effects of climate change that would impact the Forest include: (1) warmer temperatures; (2) extreme weather events; and (3) increased outbreaks of insects, disease, and nonnative invasive species.

Increased variation in temperature and moisture can cause stress and increase the susceptibility of forest ecosystems to invasions by insects, diseases, and non-native species. New environmental conditions can lead to a different mix of species and tend to be favorable to plants and animals that can adapt their biological functions or are aggressive in colonizing new territories (Whitlock 2008). However, changes in adaptability may be too slow given the predicted rate of change. Species that are already broadly adapted may become more prevalent, and species with narrow adaptability may become less prevalent. Disturbance factors that create more vulnerability in native ecosystems or require extensive controls to maintain the status quo are likely to affect desired conditions for healthy and diverse forests.

Desired conditions for healthy forests include resilience to dramatic change caused by abiotic and biotic stressors and mortality agents (particularly the southern pine beetle, gypsy moth, hemlock woolly adelgid and emerald ash borer on the GWNF) and a balanced supply of essential resources (light, moisture, nutrients, growing space). For the GWNF, gypsy moth epidemics have caused the greatest insect damage to date. The hemlock woolly adelgid affects only one species of trees but the loss of hemlocks in the riparian corridors has had widespread impacts, especially when coupled with the continuing effects of acid deposition. The forest has experienced several localized outbreaks of southern pine beetle. Emerald ash borer has been found in the northern parts of Virginia so far.

One of the natural disturbances that are an integral part of the forest is fire. Many of the native ecosystems that make up the George Washington National Forest, such as the pine and pine-oak forests, are adapted to or dependent on some level of periodic fire. Fire frequency, size, intensity, seasonality, and severity are highly dependent on weather and climate. As noted earlier, model results predict that seasonal severity of fire hazard is likely to increase by 10 percent over much of the United States during the 21st century, with possibly larger increases in the southeast (U.S. Global Climate Change Program 2001). The warmer Canadian model scenario which anticipates increased drought stress, projects a 30 percent increase in fire severity for the southeast. If extreme events such as hurricanes further increase forest fuel levels with widespread downed trees, there is a potential for larger, more catastrophic fires that could impact many of the desired conditions for the George Washington National Forest.

Warmer temperatures may lead to increased visitation to the George Washington National Forest for cooler, mountainous temperatures or for water-based recreational opportunities. A longer warm season could lengthen the recreation season on the Forest. Hunting and fishing seasons may be longer. Maintenance needs for roads and infrastructure could be greater. Demand for more highly developed recreation facilities (electricity) may increase. These effects would also be exacerbated by increasing population levels.

Scenery is one of the most valued quality of life benefits for life in the mountains of Virginia and West Virginia. Climatic effects on air quality could alter the visibility of landscapes.

Increases in extreme weather events have the potential for the occurrence of landslides and debris flows. The potential effects may be more important as the population and infrastructure continue to increase in areas adjacent to the National Forest.

The expected effects of climate change to aquatic systems can be described by predicted changes to physical processes and the potential impacts to physical and biological systems (Bakke 2008). For the area covered by the George Washington National Forest, these include:

1) Increased storm intensity, including intensity of precipitation, would increase surface erosion, increase the magnitude and variability of peak flows, and increase sediment load to rivers;

2) Changes to total annual precipitation amount and seasonal distribution, could cause an increase in winter precipitation, a decrease in summer precipitation, an increase in average runoff in winter and spring months, and decreased summer base flows;

3) Increased flood risk and resultant channel instability, would increase channel migration and associated streambank erosion, and shift 100 year floodplain boundaries;

4) Increase in average water temperature would shrink usable habitat for cold water species and shift habitat types. Warmer water temperatures would mean lower dissolved oxygen, and there would be a disproportionate importance of groundwater-fed systems to cold water species. A recent study (Flebbe et al. 2006) projects that rising temperature changes from climate change (and the loss of hemlock along streams) will shrink native trout habitat. Using the Hadley Centre model (2.5°C air temperature increase) and the Canadian Centre model (5.5°C air temperature increase), Flebbe found that between 53 and 97 percent of wild trout habitat could be lost as streams become warmer by the year 2100.

5) Increased evapotranspiration and loss of soil moisture would reduce baseflow in rivers, reduce groundwater recharge, and result in loss of wetland area, including conversion of perennial to seasonal wetlands;

6) Changes in vegetation cover and species composition could change long-term wood dynamics, alter erosion rates, and change riparian cover and energy inputs (Bakke 2008).

Aquatic systems may not only be affected by changes in the above physical processes in response to climate change, but also by the following changes in human management of land and natural resources:

- Increased demand for structural streambank protection
- Increased groundwater withdrawals in response to declining surface water resources
- Increased demand for irrigation water
- Increased demand for surface water storage and flood control reservoirs
- Increased renewable energy development, impacting new areas on the landscape (Bakke 2008)

Even with more stringent air quality controls, acid deposition is expected to continue to impact the Forest. Research is currently evaluating the link between soil acidification and the nesting success of high elevational birds since female songbirds need large amounts of calcium (from snail shells) to produce eggs (SRS Compass, Issue 10). Much of the high elevational habitat for songbirds is found on the GWNF and is one of the more vulnerable habitats to acid deposition on the forest.

In the Aquatic Sustainability Analysis report, watersheds on the Forest were categorized for their sensitivity to acidification. About 67% of the perennial streams on the Forest were found to be within highly sensitive watersheds, based on underlying geology and deposition rates. The smallest streams at the highest elevations, with non-carbonate bedrock were the most susceptible to acidification.

In summary, our more vulnerable ecosystems include:

- Spruce forests (sensitive to acid deposition, occupy higher elevations, habitat for sensitive species)
- Trout streams (sensitive to stream temperatures)
- Pine ecological systems (declining now, susceptible to southern pine beetle, fire-dependent)
- Higher elevation habitats
- Acid sensitive streams
- Acid sensitive soils

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

We have always experienced droughts, flooding, extreme weather events, catastrophic fire, insects and diseases, and to a more gradual degree, movement in the ranges of flora and fauna species. Many of our current management strategies already strive to maintain or enhance the health and resiliency of various forest resources to better withstand environmental stresses and human-induced pressures. However, the effects of an accelerated rate of change and an increase in the intensity of these impacts on forest resources and ecosystems are still unpredictable. Climate change effects are multiple, varied, and interact with many

other stressors/variables. Therefore, an adaptive management approach that monitors forest resource conditions, and monitors the current state of scientific knowledge related to responses to climate change, is needed to allow us to proactively adjust current strategies or adopt new strategies as needed.

The effects of the alternatives focus on both adaptation (ways to maintain forest health, diversity, productivity, and resilience under uncertain future conditions) and mitigation (such as carbon sequestration by natural systems, ways to provide renewable energy to reduce fossil fuel consumption, and ways to reduce environmental footprints). These effects focus on: 1) reducing vulnerability by maintaining and restoring resilient native ecosystems; 2) providing watershed health; 3) providing carbon sinks for sequestration; 4) reducing existing stresses; 5) responding to demands for cleaner energy including renewable or alternative energy; and 6) providing sustainable operations and partnerships across landscapes and ownerships.

Reduce Vulnerability by Maintaining and Restoring Resilient Native Ecosystems

Alternative C focuses on passive restoration and relies predominantly on natural processes to reduce vulnerability. Passive restoration is an important component to any management strategy, but reliance as the main tool is problematic for several reasons. Disturbance regimes do not currently operate at the large scale they did in the past. For example, due to the intermixed ownership, naturally ignited fires do not spread very far on the landscape or remain burning for a very long time period. Without large scale disturbances, large blocks of forest tend towards the same age and condition, making them more susceptible to damage by insects or disease. In addition, the rapid change in climate that is predicted may result in changes in community composition and natural processes may not be able to adapt to these changes due to the rapid pace.

Alternative C will do some active restoration in reducing roads which may improve the ability for some species to disperse, reduce sedimentation in streams, and reduce the spread of non-native invasive species. The reduction of roads would also reduce access to areas for management activities that could improve diversity and address recreation needs.

Alternatives A, B, D, E, F, and G all use a mix of active and passive restoration strategies. Alternative E has the most aggressive approach to active restoration with the largest prescribed fire program and active vegetation management through timber harvest and maintenance of grasslands and shrublands.

Alternatives A, B, D, E, and G maintain management options to address changes in the sensitive spruce system in Laurel Fork. It also allows for opportunities to expand the spruce ecosystem.

Alternatives B, C, D, E, F, and G all utilize the Ecological Sustainability Evaluation tool to develop strategies to maintain and restore the nine ecological systems and the species with special needs. All of these alternatives incorporate the use of unplanned fire ignitions as a tool for achieving resource management desired conditions. All of these alternatives utilize planting of blight-resistant American chestnuts as a restoration tool (Alternatives B, D, E, F, and G allow for more opportunities for planting in open conditions which are likely more conducive to establishment of stands of American chestnut).

Alternatives B, D, E, F, and G all maintain or restore ecological conditions that are rare on the GWNF, such as high elevation grasslands and early successional habitat, open woodlands, and old fields. These alternatives all identify the need to address shortleaf pine restoration opportunities.

Watershed Health

Projected climate changes to the hydrologic cycle through warmer water temperatures, more intense storms, and greater inter-annual variability in precipitation, indicate the importance of maintaining and protecting healthy watersheds. Bakke (2008) describes three key components relating climate change processes to management and conservation of aquatic resources; resilient habitat, refugia, and restoration.

Alternative A places a high priority on protecting water quality through the identification of riparian areas and standards that fully protect water quality. This alternative did not address many of the practices and objectives

discussed for the other alternatives, but these practices and objectives would be in keeping with the goals of Alternative A.

In Alternatives B, C, D, E, F, and G:

- Beaver meadows, wetlands, and floodplains are protected and restored to improve natural storage, reduce flood hazards, and prolong seasonal flows. Beaver ponds and wetlands recharge groundwater, raise the water table, retain sediment and organic matter, store water during floods and release it slowly, mitigate low flows and drought, reduce carbon turnover rate, raise pH and ANC, while reducing SO_2, Al, and NO_3 .
- Riparian forests are protected and restored to moderate changes in stream temperature, maintain stream bank stability, and provide instream habitat.
- Aquatic migration barriers are removed and habitat connectivity re-established so that species can move to more suitable habitat, or move to or from refugia.
- Flood and wildfire risks are reduced in vulnerable watersheds to prevent increased surface erosion and mass wasting leading to aggradation of river channels.
- Roads are improved or decommissioned to reduce adverse impacts during large storms to prevent surface erosion and fill slope failure and landslides. Stream crossings and bridges are constructed to withstand major storm and runoff events.
- Standards are included to assess geologic hazards for management activities, including potential landslide hazards and risks, particularly as the population and infrastructure continue to increase in areas adjacent to the National Forest.
- Bare soil is revegetated as soon as possible and suspend or eliminate recreation uses that are causing elevated sediment levels to streams and large areas of long term loss of soil productivity outside the designated use area.
- Riparian buffers are increased and standards included for protecting channeled ephemeral streams.
- Soils highly sensitive to acid deposition and nutrient loss are identified. Whole tree harvesting is not allowed in those areas.

Alternative C would have fewer opportunities to restore stream channels, address acidified streams, address geologic hazards and address fire risks than the other alternatives due to the greater acreage in wilderness.

Carbon Sequestration

Trees and forests represent major biological “carbon sinks,” places where carbon is sequestered. Carbon accrues in trees, soil, and wood products and the use of wood-based substitutes for fossil fuel-based products decreases the amount of greenhouse gas emissions.

The single most important aspect for sequestering carbon is to keep forests as forests – avoid the loss of forests. All of the alternatives meet this objective. Older forests sequester large quantities of carbon. Forests (particularly older forests) generally store carbon better than forest products, so harvesting old-growth forests for their forest products is not an effective carbon conservation strategy (Harmon et al. 1990). However, harvest and regeneration of young to middle-aged forests for long-lived forest products can help with carbon storage (Ryan 2008). Alternative C relies on old-aged forests to sequester carbon. The other alternatives use a mix of old-aged forests and harvest to regenerate new forests. The regeneration also has the advantage of creating a diversity of ages and structure in the forest to provide multiple strategies for addressing carbon storage. All of the alternatives are skewed to emphasize a substantial portion of the forest to be in older aged stands.

Forest management in Alternatives A, B, D, E, F and G can increase the ability of forests to sequester atmospheric carbon while enhancing other ecosystem services, such as improved soil and water quality. Planting new trees and improving forest health through thinning and prescribed burning will increase forest carbon in the long run.

The issue of carbon balance in the forest is complicated and affected by many factors. While it is true that forest management activities such as prescribed burning release carbon dioxide into the atmosphere, growing forest vegetation recaptures carbon dioxide. A prescribed burn is, by definition, a low-severity fire that leaves the large trees alive and intact where they continue to store carbon. These fires also tend to stimulate re-growth of grasses and other herbaceous vegetation, which recapture carbon. And low-intensity fires have little effect on the large stores of carbon in the soil. The Environmental Protection Agency (US Environmental Protection Agency, 2010) has concluded that when forest management activities (including fire emissions) are considered together with storage/sequestration activities (reforestation, etc) the cumulative result is a net sequestration of carbon dioxide. This assumes that the proposed activity does not change the land use and the area remains forested, as is the case with prescribed burning on the George Washington National Forest.

Existing Stresses

Aside from the stresses identified in watershed health and restoring resilient native ecosystems, nonnative invasive species is a key existing stress on systems. Alternatives B, C, D, E, F, and G all take an aggressive approach to controlling non-native invasive species and preventing their introduction and spread. An early detection and response strategy associated with nonnative invasive species will be critical to limit new introductions. Aggressive treatment of established invasive species, along with the control of insects and diseases, are likely to become more critical to maintaining desired conditions for healthy forests under a changing climate. Due to the fragmented land ownership patterns, success in reducing forest pests will sometimes require going beyond national forest boundaries, and continued work with partners will be needed. In addition, management practices (such as thinning and age class diversity) that sustain healthy forests and provide adequate nutrients, soil productivity, and hydrologic function promote resilience and reduce opportunities for disturbance and damage.

Alternative C would reduce the spread of many non-native invasive species by restricting management that creates openings in the forest canopy. However, it also restricts the ability to use some control activities in wilderness and to use silvicultural techniques to manage pests like the southern pine beetle.

Alternative Energy Demands

Using cleaner energy reduces greenhouse gases. Renewable energy development plays a significant role in the agency's implementation of the Energy Policy Act of 2005, Public Law 109-58 (Testimony by Sally Collins, Associate Chief Forest Service, before the Committee on Energy and Natural Resources, United States Senate, Renewable Energy on Federal Lands, July 11, 2006). The sources of renewable or alternative energy that can be provided on national forest system lands include: wind energy, solar energy, and natural gas leasing.

Alternative A has the largest area of the GWNF available for gas leasing. (See Minerals Section for details) Alternative C allows no gas leasing. The other alternatives allow for an intermediate level of development.

Development of wind energy is allowed in some areas of the GWNF in alternatives B, D, F and G with the most area available in Alternative D. Alternatives C and E do not allow the development of wind energy on the GWNF.

Sustainable Operations and Partnerships

Under all of the alternatives the GWNF work with States to incorporate the greenhouse gas emissions from our management activities into State inventories, just as we have done with the fine particulates inventory. The Forest will continue striving to reduce its environmental footprint and decrease the greenhouse gases emitted through day-to-day operations, including the use of more fuel-efficient vehicles, reducing the number of miles driven and making facilities more energy-efficient. The Forest will also continue working with partners, including other federal agencies, State and local governments, non-governmental organizations and other stakeholders to be more effective in efforts to adapt lands, ecosystems, and species to climate change. Examples are the Nature Conservancy in the Fire Learning Network and the Chesapeake Bay Partnership.

A4 – SOILS

AFFECTED ENVIRONMENT

The soils are essential to the viability of all organisms occurring on the Forest. Soil develops slowly from various parent materials and is modified by time, climate, macro- and micro-organisms, vegetation and topography. Soils are complex mixtures of minerals, organic compounds, living organisms, air and water. They are a primary component of all ecosystems on the George Washington National Forest.

Past land use has impacted many of the soils on the Forest. Intensive logging, mining, grazing and farming occurred on these lands in the late 1800's and early part of the 1900's. Clearcutting and roading to remove timber for sawmills, iron furnaces and mine props were commonly done over vast acreages. Mining and exploration for iron, manganese, sand, and coal occurred throughout the Forest during the same time period, resulting in many acres being affected by these uses. Some areas were timbered and farmed or grazed prior to Forest Service management, sometimes resulting in soils with gullies and thin topsoil due to erosion.

The distinct surface geology and topography of each Major Land Resource Area (MLRA) occurring on the Forest are described below. These are important factors in the formation of soils on the Forest

NORTHERN BLUE RIDGE

The Pedlar Ranger District is located within this area. Roanoke is the southern extent of this MLRA. The rugged mountains of this area have steep slopes, sharp crests and narrow valleys. The soils are mainly derived from metamorphic and igneous rocks. Igneous soil parent material is from granite and gneiss rock types. The metamorphic material is quartzite and shale rocks.

The soils of the ridgetops and upper one-third of the slopes generally have less depth and are less productive than soils forming on the lower slopes. Rock outcrops are common. Aspect plays a key role in site productivity and available moisture, as northerly aspects tend to be moister and more productive. This is because there is less evapotranspiration and lower soil temperatures on these slopes. Ridgetops and slopes of the higher elevations have soils with a thick, dark organic surface layer. The growing season is shortened at these higher elevations, in part because of lower mean annual soil temperatures.

Some soils derived from granite on upper slopes on the Pedlar Ranger District are underlain by highly weathered granite rock (saprolite). This material has no structure and is unstable on steep slopes when exposed. Soils forming in areas underlain by quartzite have lower productivity on most upper slopes because of low fertility associated with this rock type. Upper slopes on the western front of this area have rock outcroppings and soils are shallow and very droughty. Lightning strike fires are common due to dry conditions.

Many of the lower and gentler slopes have deeper soils and higher productivity than the soils on the upper slopes. Clay content tends to be higher, as is moisture holding capacity in soils on lower landscapes. Some of these soils have a high rock content, both in surface and subsurface layers. Hardened layers (fragipans) have formed in some colluvial (gravity deposited) soils that produce seasonal high water tables.

Alluvial (water deposited) soils, associated with larger streams, have some floodplain areas where soil drainage is slow. Watertables may be seasonally high, or have small wetlands occurring. Larger floodplains have a variety of drainage conditions. The smaller drainages have alluvial soils that have very narrow floodplains and better drainage. Rock content in soils of the smaller drainages can be high. Productivity of the alluvial soils in this section is usually high. Plant species are influenced by fluctuating soil watertables and varying soil drainage conditions.

NORTHERN APPALACHIAN RIDGES AND VALLEYS

The remainder of the Forest is located within this MLRA. It is a folded and faulted area of parallel ridges and valleys. Sandstone and shale ridges are separated by narrow to moderately broad limestone and shale valleys. The topographic orientation of these valleys and ridges is dominantly northeast to southwest. Soils have

developed from sedimentary rocks, such as shales, sandstones and limestones. Residual soils of the ridgetops and upper slopes are predominantly derived from sandstone. Soil depths are generally 10-to-40 inches to hard bedrock. Productivity is low, water holding capacity is low and soils are very porous. Rock outcrops and high rock content within the soil are common. Upper slopes, dominated by shale rocks, have very shallow soil depths. This causes rapid runoff during storm events. Most of the shale bedrock is rippable and not hard.

Midslopes are mixed shales and sandstones, relating to extensive folding and faulting of the bedrock layers. The Forest has very little area with soils derived from limestone. Where they occur, these soils have more clay, are variable in depth and very productive. Other midslope soils are generally 20-to-60 inches deep to sandstone and less deep when underlain by shale. Soils derived from the shale have a high runoff potential due to shallow depths and steep slopes. Productivity varies as deeper shale-derived soils and soils on northerly aspects have moderate-to-high productivity, and sandstone derived soils and southerly aspects have moderate-to-low productivity.

Lower slopes have deeper soils and more clay in the subsoil. Water-holding capacity is better and productivity is generally higher. Some colluvial soils on gentle slopes have formed cemented layers (fragipans), which cause perched watertables during the winter and early spring months. Many of the colluvial soils on toeslopes and along drainages have very high rock content throughout the soil profile. Surface stones and boulders are common.

Alluvial soils are commonly well drained along most streams. Larger streams have broader areas of floodplain soils with various drainage conditions. Small areas of organic soils are associated with upland bogs and slackwater areas, which generally form at the edges of floodplains and nearly level headwater areas of some watersheds. Wetlands are usually small in areal extent, and some have been formed behind old beaver dams.

OTHER INFORMATION ON THE SOILS

In the lowest parts of the landscape are the soils associated with riparian areas and wetlands. These soils are of limited extent on the Forest, but important for biodiversity and water quality. Riparian-wetland soils constitute one of the largest freshwater reservoirs on Earth. They are an important component of both standing water (lentic) systems, such as swamps, marshes, bogs, and running water (lotic) systems such as rivers, streams, and springs. Riparian-wetland areas are the “green zones” or links, between aquatic environments and upland, terrestrial ecosystems. Healthy riparian-wetland areas provide several important ecological functions. These functions include water storage and aquifer recharge, filtering of chemical and organic wastes, sediment trapping, streambank building and maintenance, flow energy dissipation, and primary biotic (vegetation and animal) production.

Riparian – wetland areas are intimately related to their adjacent waterways since the presence of water for all or part of the growing season is their distinguishing characteristic. In fact, the nature and condition of a riparian-wetland area fundamentally affects the aquatic ecosystem. In addition to water, there are three other essential components of the riparian-wetland areas: soil, vegetation, and landform. In a healthy riparian-wetland ecosystem, the four are in balance and mutually supporting one another.

Because of the presence of water, riparian-wetlands have soil properties that differ from upland areas. For example, most upland areas are derived from in-place weathering processes and relatively little soil material is derived from offsite sources. In contrast, riparian–wetland soils are constantly changing because of the influx of new material being deposited by different storm events and by overland flow. As a result, great variability in soil types can occur in short distances.

This great variation in soils has an effect on hydrology, vegetation, as well as on erosion and deposition. The soil in streambanks and floodplains, and the substrate under the channel, act as a sponge to retain water. This stored water is released as subsurface water or ground water over time, extending the availability of water in the watershed for a longer period in the summer or recharging the underground aquifer. Water restricting soil types such as clay or hardpans often have impermeable layers that support the water table of standing water riparian-ecosystems. Water movement over, into, and through the soil is what drives hydrology.

Vegetative composition of riparian-wetland areas is also strongly influenced by the amount of moisture and oxygen levels in the soil. For example, the type of riparian-wetland soil, the amount of soil organic matter, the depth to which the water table will rise, the climate, and the season and duration of high water will determine the kinds of plants that will grow in riparian-wetland areas.

Sediment, though necessary in some amounts, must be in balance with the amount of water and vegetation to prevent excessive erosion or deposition. Soils, interacting with geology, water, and vegetation, play a critical role in determining the health and, thus, the rate of erosion and deposition in riparian-wetland areas.

Research indicates that soil productivity is sustained through nitrogen and carbon fixation, mineral release from weathering parent material, decaying organic matter, and translocation of nutrients. Displacement, erosion and compaction can affect long-term and short-term soil productivity. The Forest has a completed detailed soil survey. Soil productivity improvement opportunities exist in watersheds with deteriorating soil conditions associated with human and natural causes. Many of these conditions are caused by eroding abandoned roads, eroding trails, abandoned minespoils, illegal vehicle use, trash dumps, and dispersed camping.

The soils on the Forest are important to local and regional communities in these ways:

- Soils support vegetation, which supports wildlife, timber, and varied vegetative ecosystems.
- Soils, in good condition, produce little sediment to streams and reservoirs.
- Suitable soils are essential to any recreation use and development.
- Suitable soils are essential to a successful road and trail system.
- Watershed improvement project work can help local economies through purchases of supplies, equipment and labor.
- Soils on the Forest are an essential ecosystem component to consider in all the multiple uses the Forest provides to communities in our region.

Specific issues regarding impacts to soils were identified during public scoping for this Forest Plan. They are summarized here.

- Effects to soil productivity from motorized access use, soil movement (erosion), changes in dedicated use of the land, road decommissioning, illegal vehicle use, ATV and OHV use areas, dispersed recreation use.
- Management activities on the Forest may affect soil productivity. Soils could be impacted by acid deposition, road construction and decommissioning, trails and dispersed recreation use, watershed improvements, soils low in natural fertility, steep slopes and conservation of soil organic matter.
- Wind energy development. Construction and operation of wind farms on ridgetops and steep slopes.
- Fire prescribed management and containment with dozers.
- Recreation use impacts from trail construction and closure, illegal motorized use and dispersed use in riparian corridors.
- Timber management impacts from whole tree harvest, nutrient removal and wood product transport from stump to roads.
- Climate change and impacts from using carbon sequestration with wetland creation (beaver) and restoration (of artificially drained land), woody biomass and whole tree harvests for biofuel.

The most important soil resource issue/concern regarding the effects from the management activities proposed in the various alternatives of the Forest Plan Revision is soil productivity. Ensuring that the quality of the soil resources across the George Washington National Forest is maintained or improved is what will be discussed and displayed in this EIS. We will describe impacts to soil productivity with estimates of areal extent (acres). Some of the impacts will be short term (<100 years) and some will be long term.

We will show how each alternative will impact the long term productivity of the soil and to what extent. A significant impact to soil productivity will be an estimated fifteen percent reduction in productivity for areas that we actively manage. The threshold for allowable impacts to soil productivity has been identified by most regions of the Forest Service as 15 percent of an activity area. Long-term soil productivity must be maintained on at least 85 percent of an activity area. The activity area for this EIS varies by alternative since each one proposes different levels of management on different areas of the Forest. When long term soil productivity is reduced on fifteen percent or more of an area, then this would not be in compliance with the laws and policy guiding FS protection of soil productivity and ecosystem sustainability.

By determining the acres of long term effects to soil productivity for each alternative, we can compare the alternatives and show how extensive the effects are. Each alternative affects long term soil productivity to some degree. Key indicators used for determining effects to the soil resource were:

- Acres of timber harvest
- Miles of road construction
- Acres of prescribed burning
- Miles of trail construction
- Acres of soil improvement
- Acres of mineral lease development
- Acres of dispersed recreation
- Miles of road decommissioning

The scope for the soil resource effects analysis for the proposed actions and the alternatives is calculated using potential areas of disturbance (activity areas) below. These vary by alternative and will be used as a basis to display the percent of the activity area that is estimated to have long term impacts to soil productivity. Activity Areas will be used to describe the scope of this analysis.

Table A4.1 Acres Considered for Potential Soil Disturbance on GWNF (Activity Area) by Alternative

	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
GW Acres included in Activity Area*	991,328	945,909	610,203	952,091	938,690	861,267	726,192

*Activity Area calculated by subtracting acres in: Prescription Areas: 1A and 1B, Designated Wilderness and Recommended Wilderness Areas; 4B1, Research Natural Areas; 4C1 Geologic Areas; 4D Special Biological Areas and Water, from the total Forest acres (1,065,918). The prescription areas vary by alternative.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

The Forest Service is directed by a number of laws, executive orders and policies to protect or enhance long term soil productivity, while providing for the various uses of the National Forests. The Forest and Rangeland Renewable Resources Planning Act (RPA, 1974) requires an assessment of the present and potential productivity of the land. Regulations are to specify guidelines for land management plans developed to achieve the goals of the program that "...insure that timber will be harvested from National Forest System lands only where ...soil, slope or other watershed conditions will not be irreversibly damaged." The National Forest Management Act (1976) amended RPA by adding sections that stressed the maintenance of productivity, the protection and improvement of soil and water resources and avoidance of permanent impairment of the productive capability of the land.

Soil productivity is the inherent capacity of the soil to support the growth of plants and can be measured in terms of biomass produced. We will not measure impacts to soil productivity with biomass, since it is difficult to

quantify. We will describe impacts to soil productivity with estimates of areal extent (acres). Some of the impacts will be short term (<100 years) and some will be long term. We want to show how each alternative will impact long term soil productivity and if these cumulative impacts will be extensive. A significant impact to soil productivity will be a fifteen percent reduction in productivity in areas where we do management. When long term soil productivity is reduced on fifteen percent or more of the GWNF activity area by any alternative, then this would be a significant impact to the soil resource and would not be in compliance with the laws guiding FS policy on protecting soil productivity. By identifying impacts to soil productivity and minimizing the extent of the impacted area, we can protect the soil's ability to function as an important part of the Forest's ecosystems.

The threshold for significant impacts to soil quality/productivity has been identified in Forest Service Handbook 2509.18 Sec.2.05 as 15 percent of an activity area. Long-term soil productivity must be maintained on at least 85 percent of an activity area. Activity areas are where potential soil disturbances are most likely to occur and they are also expected to produce biomass in the future. By determining the extent (acres) of long term effects to soil productivity for each alternative, we can compare the alternatives and show how extensive the effects are. Each alternative affects long term soil productivity to some degree. Key indicators used for determining effects to the soil resource from management were:

Soil productivity can be affected by various factors and conditions resulting from management activities on the Forest. Compaction, erosion, topsoil removal (displacement), land use changes (forestland to trailhead parking) and soil improvement (fertilization/liming) can result from actions we take and all of these impacts the local productivity of the soil. Natural geologic weathering processes (rock to soil), organic decomposition (breakdown of dead biomass), fire, nutrient cycling and atmospheric (precipitation) additions are also influencing soil productivity across the Forest. All effects to soils from proposed actions will also be analyzed at the project level.

Table A4.2 Types of Effects to Soil Productivity from FS Actions

DIRECT EFFECTS	INDIRECT EFFECTS
Compaction	Erosion/soil movement
Land use change	Nutrient cycling
Displacement (Topsoil removal)	Prescribed fire use
Soil improvement	

Compaction. Soil compaction is dependent upon soil texture, soil structure, soil moisture, ground cover, rock content and the type of activity. Soils are most susceptible to compaction when moisture content is high. Fine textured soils without rock fragments are more at risk. Research has shown that biomass production (a measure of soil productivity) is reduced on compacted soils in the early stages of site recovery. Rutting, increased runoff, erosion and reduced root/plant growth can occur on severely compacted soils. Large areas of the Forest have surface soil characteristics that reduce their susceptibility to compaction. Low clay content and high rock content of the surface soil layers help reduce impacts to soil productivity from compaction. If topsoil removal occurs, generally compaction is more likely, since the subsoil layers of many soils on the Forest have higher clay content and have less rockiness. However, if topsoil removal has occurred, then soil productivity has already been reduced on the area. Compaction is considered a short term (less than 100 years) effect on soil productivity, since research has shown even severely compacted soils can recover in ten to sixty years where mitigation measures of tilling and reestablishing vegetation have been used. Depth of compaction does not commonly exceed six inches with the kinds of equipment being used on the Forest. Actions that can produce soil compaction associated with Forest Plan Alternatives are skid trail (unbladed access routes) use, timber harvesting, grazing and trail use.

Land Use Change. If a soil on the Forest has the ability to produce biomass, it then has soil productivity. If this same soil, for example, is converted to a parking lot, building site, road or into some other use that prevents it from producing biomass, then it has lost some or all of its productivity for a long time. Land use change is considered a long-term impact to soil productivity.

Displacement (Topsoil Removal). Topsoil removal is considered a long-term effect to soil productivity because it involves the loss of the most fertile part of the soil. The organic layer and the mineral A-horizon beneath it are where most of the feeder roots are located for plants and where most of the nutrients needed for soil productivity are found. Many of the Forest's soils are formed in sandstones and shales that are naturally low in nutrients used by plants. Many are also acidic (low in soil pH). This means the upper layers of soil, where most of the organic material and microorganisms are found, are very important in maintaining the soil's productivity. Many years are needed for the soil to recover its original productivity when the upper layers are removed. Soil formation typically occurs at a rate of one inch per 200-1000 years and depends on many local environmental factors.

However, areas where topsoil is disposed will be enriched with this added soil material and organic matter. Productivity on these topsoil disposal areas will be improved by increasing soil depth, rooting depth, moisture holding capacity and organic matter. This is not to say that where topsoil is removed (long term reduced soil productivity), soil productivity will be offset by areas where topsoil is deposited (long term improved soil productivity). It is mentioned here as an indirect effect of excavation activities and to document that not all effects from excavation are negative. Topsoil disposal areas will not be used to show any positive effects of excavation, since the extent of these areas is not easily estimated or displayed. Actions which can produce topsoil removal associated with Forest Plan Alternatives are temporary road and skid road construction, log landing construction, developed recreation construction and use, new trail construction and relocation, and fireline construction using bulldozers.

Soil Improvement. The Forest works to improve soil conditions and reduce soil movement on about 40 acres per year. The Forest also decommissions roads annually. Special emphasis is given to riparian areas to help reduce sediment delivery to stream channels, floodplains and wetlands. Some watersheds may be targeted for this work to tie in with priority watersheds, watershed partnerships, species habitats and public water sources. The effects of soil improvement will be considered a long-term positive effect on soil productivity and an improvement of existing soil conditions. Soil improvement work will help these treated soils toward recovery of their inherent soil productivity. Actions which would be considered soil improvement associated with Forest Plan Alternatives include, road decommissioning, slope stabilization, erosion control structures and vegetation, road and trail decommissioning, illegal traffic use areas treated for compaction and erosion, abandoned mined land reclamation and trash dumpsite cleanups.

Prescribed Fire Use. Prescribed burning impacts soils in two ways. One way the fire itself burns up portions of the soil's organic layer, an important part of soil productivity. Hotter fires with large fuel loads will burn up more of the organic matter than cooler fires. A few soils on the Forest, with thin organic layers, can lose their entire organic layer when a fire burns hot. Typically, these would be shallow, rocky soils at or near ridge tops on steep slopes. In most cases, on this Forest, the effects of fire on the soil are a short-term effect. Organic layers are replenished by leaf fall and native vegetation takes advantage of a temporary increase in available soil nutrients from the fire, and an existing root system to recover.

Associated with prescribed burning is the construction of bladed firelines to control the burned area boundary. This is considered topsoil removal and is a long-term impact to soil productivity. Not all firelines are bladed with dozers.

Erosion/Soil Movement. An indirect effect of removing a soil's vegetative cover and its organic layer is erosion, meaning soil movement. An undisturbed soil with soil layers intact and growing biomass is not very susceptible to erosion. When soils are disturbed in some way to expose bare mineral soil (A-horizon and lower), then soils on slopes become susceptible to raindrop impact, soil displacement and downslope flow of soil with water. These forces can cause soil to move, sometimes into stream channels, where it then becomes sediment and is incorporated into the bed load of the stream channel. Exposed slopes with low clay soils and soils without many rock fragments are most susceptible to soil movement.

Erosion is considered here as soil movement and not soil loss. Soil material may or may not move from a site or to a stream channel. Many factors influence soil movement and when soil moves, it is deposited somewhere. Depositional areas may benefit from the addition of this eroded soil. Gully erosion is the extreme case of soil movement and would be considered a long-term effect to soil productivity. Gully erosion is evidence that large amounts of soil have moved away and will not be replaced in the short term (<100 years). Other forms of erosion are not as impactive and would only last until a vegetative cover is established. Gully erosion is difficult to predict and depends on several factors. Erosion will be considered a short-term effect and will be estimated mainly to consider sediment delivery to stream channels.

Nutrient Cycling. When vegetation is removed from a site, a portion of the potential organic matter and its available nutrients to the soil is removed with it and the resulting condition of a reduced canopy (shade) can have an effect on soil temperature, soil moisture and nutrient cycling. This situation will normally occur with a timber harvest. The bole of the tree is removed from the site and the forest canopy opens up to allow more sunlight and moisture to reach the soil surface. Other parts of the tree will remain onsite to recycle into the soil nutrient system over time. Loss of trees will reduce canopy cover and evapotranspiration and increase soil moisture. Loss of canopy will increase soil temperature in the topsoil. These conditions will increase soil organic matter decomposition and increase available nutrients on the treated area. Much of this increase in plant available nutrients will be taken up by the stump sprouting of hardwood trees and by the root systems of the remaining vegetation on the treated area. Some nutrients may be leached from the site and reach local streams in ground water. This leaching effect is short term and research has shown that removal of the tree main stem alone will not reduce long-term soil productivity. Most tree nutrients are in smaller branches and leaves, which normally remain on site after a timber harvest. Short-term losses are made up by leaf fall, atmospheric additions and weathering of parent material. Any increased leaching of nutrients from the soil would be very short term (<5 years). Long-term productivity can be reduced with whole tree harvesting with short rotations on soils with poor natural fertility so these soils are not available for whole tree harvesting.

The cumulative effects to soil productivity from the actions taken during the first decade of a new Forest Plan by each alternative are displayed in Table A4.3 below. As shown, the alternatives vary in their impact to long-term soil productivity on the Forest. It shows that soil productivity is being maintained on more than 99% of the Forest area. Cumulative effects to the soils considered past management actions taken prior to plan implementation and anticipated actions taken by the alternatives for the first 10 years.

Table A4.3 Cumulative Effects to Soil Productivity by GWNF Forest Plan Alternatives over first 10 years of the Plan.

Effects to Soil Productivity	Acres by Alternative						
	A	B	C	D	E	F	G
Long Term Effects	810	630-960	15	1190-1710	590-870	450-690	670-1000
Improved Soil Productivity	600	769	1045	584	869	815	869
Existing (Past) Long Term Effects	6003	6103	6103	6103	6103	6103	6103
Cumulative Long Term Effects*	6913	6733-7063	6118	7293-7813	6693-6973	6553-6793	6773-7103
Percent of the GWNF Activity Areas** with Long Term Effects after 10 yr	0.7%	0.7-0.8%	1.0%	0.7-0.8%	0.6-0.7%	0.7--.8%	0.9-1.0%

*Long Term Effects generated by Alternatives plus Existing Long Term Effects. **Activity Area explained in the Scope of Analysis section above.

A5 – AIR

AFFECTED ENVIRONMENT

The 1977 and 1990 Amendments to the Clean Air Act (CAA) afford special protection from air pollution to designated Class I areas. The George Washington National Forest (Forest) does not manage any Class I areas, however James River Face Wilderness, managed by the Jefferson National Forest, adjoins the Forest to the south. Other Class I areas near the George Washington National Forest are the Shenandoah National Park, and Dolly Sods and Otter Creek Wildernesses on the Monongahela National Forest. The Prevention of Significant Deterioration section of the Clean Air Act (CAA) requires Federal Land Managers to identify Air Quality Related Values (AQRV), or resources important to the Class I areas that might be affected by air pollution. For the Class I areas near the Forest these include visibility, water quality and vegetation. The term AQRV will be used broadly to apply to any resources within the Forest boundary that might be affected by air pollution.

Through a series of legislative and regulatory requirements, federal land management agencies have the unique responsibility to not only protect the air, land, and water resources under their respective authorities from degradation associated with the impacts of air pollution emitted outside the borders of Agency lands (Clean Air Act 1990), but to protect those same resources from the impacts of air pollutants produced within those borders (Clean Air Act 1990, Organic Act 1977, Wilderness Act 1997). Activities from within the forest such as prescribed burning, road construction/maintenance, oil and gas development, recreational use, and timber harvesting all have an impact on the air quality of the forest. It is the responsibility of federal land managers to minimize the impact of these activities on the forest's AQRV, as well as the forest's contribution to air pollution. In light of this responsibility, it is important for federal land managers to understand the impacts of pollution from activities within the National Forest, and also to be familiar with the impacts from pollution sources outside the forest boundary.

The George Washington National Forest is located in an area of the United States that continues to grow in population with an associated demand for electricity and transportation. The Forest is located downwind of two major areas of coal-fired power generation, the Ohio River Valley and the Tennessee Valley Authority; and within a day's drive of a large percentage of the United State's population and numerous major cities. Washington DC and Richmond are among the larger urban areas within 125 miles of the Forest. The heavily traveled interstate highway 81 runs the length of the Forest. Nitrogen oxide, sulfur dioxide and fine particulates are the main pollutants emitted from these sources that are affecting resources on the Forest.

Nitrogen oxides are an important contributor to the formation of ground-level ozone on hot sunny days (Chameides and Cowling 1995). The Forest operates an ozone monitor at the Glenwood/Pedlar District Office in cooperation with the Virginia Department of Environmental Quality (VDEQ). Data collected since 1999 indicates this area is currently in compliance with the one-hour and 8-hour ozone National Ambient Air Quality Standards (NAAQS). The NAAQS are regularly reviewed and modified by EPA, and a reduction in the ozone standard is expected in the fall of 2010. Final attainment/nonattainment decisions will be made sometime in the future and will be based on monitoring data that has not yet been collected. However, current ozone concentrations at monitors near the Forest exceed at least the most stringent proposed 8-hour ozone NAAQS (Figure A5.1 - 2009 AQ Report to Forest). There is also a proposed secondary ozone standard in the form of a seasonal exposure index, W126; a measurement that recognizes the cumulative impacts that ozone concentrations have on sensitive vegetation. Recent monitoring results show that some sites could exceed the proposed secondary NAAQS indicating pollution levels high enough to be harmful to vegetation.

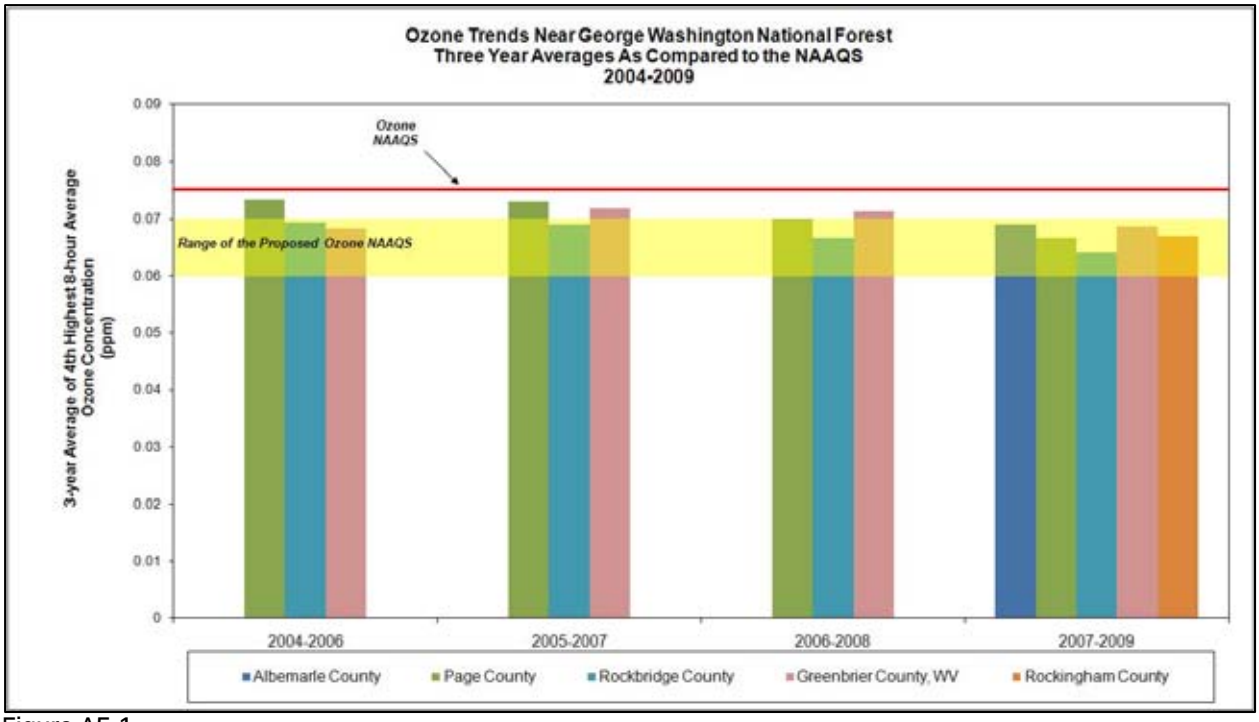


Figure A5.1

About a third of nitrogen oxides affecting the Forest are from power plants (especially during hot summer days when electricity is needed to cool homes and businesses), and another third are from highway vehicles. The rest are from industrial sources.

Laws, rules, and regulations are in place that are resulting in lower nitrogen oxide emissions in Virginia and neighboring states. Annual NOx emissions from sources in Virginia and West Virginia have declined 68 percent from 2000 levels (about 147,000 to 47,000 tons in 2008) and 76 percent from 1990 levels (200,000 tons) (EPA 2008). These reductions have resulted from implementation of the Acid Rain Program and the NOx Budget Trading Program. Further nitrogen oxide reductions are anticipated as State and local air pollution control agencies seek ways to attain new ozone standards in urban areas near the Forest, and in cities to the south and west of the Forest. These further reductions in nitrogen oxides will benefit the health of people visiting or living within the Forest, as well as the vegetation.

Acid compounds in clouds, fog, rain and haze are having an adverse impact on visibility and the ability of the soils and streams to buffer acid inputs. Further discussion of the current effects of acid deposition on aquatic resources can be found in the Water Resources and the Fisheries and Aquatic Habitats Sections. Sulfates (sulfur compounds that originate from sulfur dioxide) are the predominant pollutants causing these impacts. Approximately 80% of the sulfur dioxide emissions affecting the Forest are released from coal-fired power plants. Power plants in the Ohio River Valley, Virginia, and West Virginia are most likely to be influencing the acidity and sulfate concentration of rainfall on the George Washington National Forest (SAMI 2002). However, as a result of Title IV of the Clean Air Act Amendments of 1990 (the Acid Rain Program) and the 1999 Regional Haze Rules, power plants throughout the United States, including those near the George Washington National Forest, have installed pollution control devices to reduce emissions of sulfur dioxide and other pollutants that cause acidic deposition such as nitrogen oxides. Emissions of sulfur dioxide declined by roughly 50% between 2005 and 2009 (EPA CAMD), with about half of that reduction occurring in 2009. (Part of the emissions decline is attributed to reduced energy demand in 2009 relate to the recession.) Additional emission reductions are expected in the future as the provisions of the Regional Haze Rule are implemented, as discussed below.

With the reduction of sulfur dioxide and nitrogen oxide emissions, sulfate and nitrate deposition has also decreased, as would be expected. Wet deposition monitors located near the Forest show that annual sulfate deposition was about 8 kg/ha in 2009; down from about 15 kg/ha in 2000. Even though sulfur deposition is decreasing, acid neutralizing capacity, or the stream's ability to buffer acid inputs, is predicted to continue to decrease in high elevation headwater streams (SAMI 2002, Sullivan et al. 2010). This happens because most soils on the Forest continue to retain at least part of the sulfur that is deposited. Even though sulfur deposition may decrease, soils have been retaining sulfates that will continue to be released and move out of the soil into the stream water. As sulfates are released into the soil water, base cations, such as calcium, may also be removed from the soils. Removal of calcium and other base cations can lead to nutrient depletion and a reduction in soil productivity.

The beautiful mountain scenery is one of the reasons tourists visit the George Washington National Forest and other areas in Appalachia. However many days of the year a uniform haze-like white or gray veil obscures the scenery. In 1997 Congress determined that all Class I areas in the nation were suffering from some level of visibility impairment; that there has been a significant reduction in how far a person can see distant views, as well as the clarity of that view. The estimated natural background visibility for the eastern United States is 93$\pm$28 miles (NAPAP 1991) and median visibility measured at James River Face Wilderness in 2008 was only 38 miles. While this still represents impairment from the natural condition, it is an improvement over the median visibility in the late 1990's of 26 miles. Median visual range at Shenandoah National Park has been improving as well and was about 47 miles in 2008. This improvement in visibility is a direct result of emissions reductions achieved through the Acid Rain program and other efforts. Further reductions are expected as the Regional Haze State Implementation Plans are adopted and implemented (Virginia Regional Haze State Implementation Plan, 2010). The Regional Haze SIP sets goals for improving the worst visibility conditions while preserving the clearest conditions.

Regional haze and reduced visibility observed in the mountains is caused mostly by air pollution, primarily sulfates that originate from coal-fired power plants. The fine particles ($PM_{2.5}$) primarily responsible for visibility impairment are formed when combustion gases are chemically transformed into particles. In the eastern United States, sulfate particles (transformed sulfur dioxide) from coal-fired power plants comprise the largest component of measured fine particle mass (IMPROVE 2001) affecting visibility. The clearest days in 2008 at James River Face had 69 miles visibility and the lowest fine particle mass (4.48 ug/m3). The days with the highest concentration of mass (16.31 ug/m3) showed visibility was reduced significantly to only 19 miles. The days with the poorest visibility are most likely to occur starting in May and continue through September (http://views.cira.colostate.edu/web/Trends/) during the time when most people are visiting the Forest. Sulfates are still the most important fine particles contributing to visibility impairment. On the clearest days they comprise 30% of the total mass while on the haziest days the sulfates are 38% of the total. Organics (released primarily from vegetation as volatile organic compounds) are the second most important fine particles measured, and if organics were the most abundant particulate species, then there would be a bluish cast to the mountains, hence the name Blue Ridge Mountains.

The fine particles that cause visibility impairment can also be unhealthy for people, because high concentrations aggravate respiratory conditions, such as asthma. Fine particles are closely associated with increased hospital admissions and emergency room visits for heart and lung disease, increased respiratory disease and symptoms such as asthma, decreased lung function, and even premature death (EPA 1997). Sensitive groups at greater risk include the elderly, individuals with cardiopulmonary disease, and children. For this reason, fine particle levels are monitored. Monitoring results for fine particulates include both primary particulate (that are emitted directly from a source) and secondary particulate (resulting from transformation of gases in the atmosphere). The Environmental Protection Agency has established NAAQS for fine particles ($PM_{2.5}$) based on three-year averages of monitored data. Monitors near the Forest indicate that both the annual average $PM_{2.5}$ and the 24-hour average standard are not exceeded (Figure A5.2 - 2009 Air Quality Report for the George Washington and Jefferson National Forests), however EPA is required to reassess the standards every few years and proposal of a more stringent standard is anticipated.

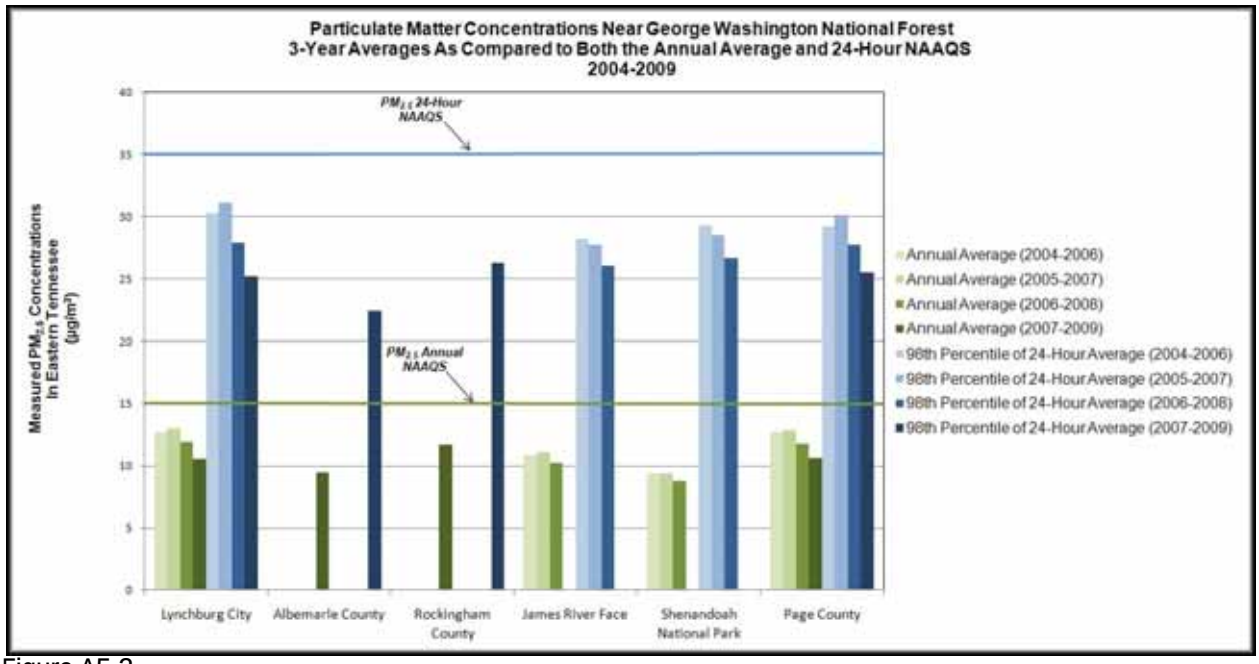


Figure A5.2

The Environmental Protection Agency will ultimately decide if any other areas affecting the Forest will be designated as non-attainment for fine particles or ozone. It is of particular importance for fire managers to mitigate prescribed fire emissions, to the greatest extent practical, during those days characterized by existing or predicted high ambient air pollution. The $PM_{2.5}$ standard may require fire managers to be even more vigilant in smoke management to protect the health and welfare of citizens on and off Forest lands from the effects of particulate matter emissions associated with prescribed fire.

Once an area is designated non-attainment, a State Implementation Plan (SIP) is developed in an attempt to bring the area back into attainment of the standard. This usually involves placing controls on various sources that contribute to the pollutant of concern in order to lessen or minimize their emissions. SIPs are developed based on emission inventories of contributing sources of pollution. Considering that 70% of the particulate emissions from prescribed fires are fine particles, and nitrogen oxides and volatile organic compounds are also released, state air regulators will be interested in these emissions. The Forest will need to interact closely with the Virginia Department of Environmental Quality to ensure that Forest prescribed fire emissions (and perhaps other Forest activities) are accurately considered in State Implementation Plan development.

DIRECT AND INDIRECT EFFECTS

As an ecological process, wildland fire is essential in creating and maintaining functional ecosystems and achieving other land use objectives. However, smoke is a byproduct of prescribed fire that affects air quality. All emissions from wildland fires are generated from the incomplete combustion of fuel, and include: particulate matter, carbon monoxide, carbon dioxide, nitrogen oxides and hydrocarbons (Hardy, et al. 2001). The single-most important emission in smoke is fine particulate matter less than 2.5 microns in diameter ($PM_{2.5}$) because it limits visibility, absorbs harmful gases, and aggravates respiratory conditions in sensitive individuals. Fine particulates ($PM_{2.5}$) make up more than 70% of the mass of particulate matter produced by wildland fire. Environmental Protection Agency (EPA) routinely reviews air quality standards for ozone and $PM_{2.5}$ and adopts more stringent standards to protect human health, if research indicates this is necessary. In 2006 the $PM_{2.5}$ standard was reduced, and lower ozone standards are expected to be finalized by the end of 2010. The challenge in using wildland fire is balancing the public interest objectives of protecting human health and

welfare (from air pollution) and sustaining ecological integrity. The EPA recognizes this challenge and developed an interim air quality policy on wildland and prescribed fires with the public policy goal to allow fire to function as much as possible in its natural role in maintaining healthy wildland ecosystems, and to protect public health and welfare by mitigating the impacts of air pollutant emissions on air quality and visibility (EPA 1998).

In order to minimize the negative effects of smoke and associated pollutants on human health and visibility, smoke management plans are a required part of every prescribed fire burn plan. The negative effects of smoke can be reduced by planning and executing prescribed fires on days that maximize smoke dispersion and avoid smoke-sensitive areas. For each prescribed burn conducted, the Forest Service determines smoke dispersion characteristics that must be met in the weather forecast for the day of the burn. These characteristics include: the depth of the atmosphere available for smoke mixing (dispersion), transport wind speed and direction, and the probability of air mass stagnation during the day. Forest Service smoke management guidelines include:

- Predicting smoke behavior for the weather conditions anticipated during the burn.
- Determining if there are smoke-sensitive targets (public or private ownership) within the probable smoke impact area and coordinating with them to avoid or mitigate problems.
- Monitoring the actual weather conditions and smoke behavior to make sure burn continues to be within the prescription.
- Being prepared to cease ignition and/or initiate suppression if the weather changes from the forecast and causes smoke behavior problems that cannot be mitigated.

Application of the precautionary and mitigation measures described above will limit the risk and severity of any problems that might occur from prescribed fire smoke.

Fine particulate emissions were estimated for each Alternative and compared to current prescribed fire emissions and the background condition. Background condition is the fine particulate from all sources of primary fine particulate emissions within the counties containing national forest system lands. These counties are referred to as the "analysis area".

Direct effects on air quality were assessed by comparing $PM_{2.5}$ emissions estimates from each Alternative to emissions from the current prescribed fire program. Emissions were calculated for the minimum and maximum number of planned acres in each Alternative using best estimates of fuel type, fuel consumption and emissions rates. Actual acres burned in any given year, and resulting $PM_{2.5}$ emissions, will depend on weather conditions and other factors that must be considered prior to initiating a prescribed fire. Background $PM_{2.5}$ emissions are from the 2005 National Emissions Inventory (EPA 2005)

On average, the Forest has burned 5,800 acres annually since 2006, and estimated $PM_{2.5}$ emissions from this program would be 406 tons. Alternatives B, D, E, F, and G propose increasing the use of prescribed fire which would result in an emissions increase of roughly 100 - 250 percent over current levels (Table A5.1). Alternatives A and C would actually use prescribed fire on fewer acres and result in less emissions than the current program.

Table A5.1. Annual fine particulate matter (PM2.5) emissions by Alternative, as compared to current fire program and inventoried background primary PM2.5 emissions within counties containing George Washington National Forest system lands.

			Percent Change in $PM_{2.5}$ Emissions			
	Estimated annual $PM_{2.5}$ emissions in tons		Direct/Indirect Effects: Alternatives compared to Current Fire Program		Cumulative Effects: Alternatives Compared to All Other Sources	
Alternative	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
A	210	210	-48	-48	-2	-2
B	1,089	1,425	168	251	7	10
C	25	25	-94	-94	-4	-4
D	375	865	-8	113	0	5
E	1,448	1,448	257	257	10	10
F	865	1,425	113	251	5	10
G	865	1,425	113	251	5	10
Current Fire Program	406	406				

The largest prescribed fire program on the Forest occurred in 2009 when 9,526 acres were burned. $PM_{2.5}$ emissions that year were estimated at approximately 670 tons. Emissions from the minimum burn program for any proposed Alternative would be equal to or less than those in 2008. The maximum program for all Alternatives, except E, would exceed the 2008 emissions by 20-65%.

CUMULATIVE EFFECTS

Emissions from prescribed fire are only one of many sources of $PM_{2.5}$ pollution. Fine particulates can be emitted directly into the atmosphere or can be created from gaseous pollutants that are chemically transformed into particulates (sulfur dioxide is transformed into sulfate particles). Only those particulates emitted directly into the atmosphere (primary pollutants) are tracked in emission inventories. The most recent emissions inventory available from the Environmental Protection Agency estimates primary $PM_{2.5}$ emissions within the analysis area at 10,067 tons (EPA 2005). Emissions from proposed Alternatives B, D, E and F could account for 5-10% increase in primary $PM_{2.5}$ emissions in the analysis area (Table A5.1). Alternatives A and C could result in a slight decrease (2-4%) in $PM_{2.5}$ emissions in the analysis area. In reality the changes in ambient $PM_{2.5}$, the pollution that people are exposed to, would be even less. This is because a large amount of monitored $PM_{2.5}$ is secondary particulate formed from gaseous pollutants such as sulfur dioxide. Secondary particulates are not included in the emission inventory. If they were, the contribution of emissions from prescribed fires would be reduced.

Another way to evaluate the cumulative effects of prescribed fire on air quality is to compare monitored fine particulate concentrations to prescribed fire emissions. Figure A5.3 (2009 Air Quality report to Forest) shows that although there were periods of increased prescribed fire emissions from 2005 through 2009, there was a decrease in monitored fine particulate concentration for both the annual and 24-hour averaging periods. This shows that local and regional $PM_{2.5}$ concentrations do not appear to be correlated with $PM_{2.5}$ emissions from prescribed fires on the Forest.

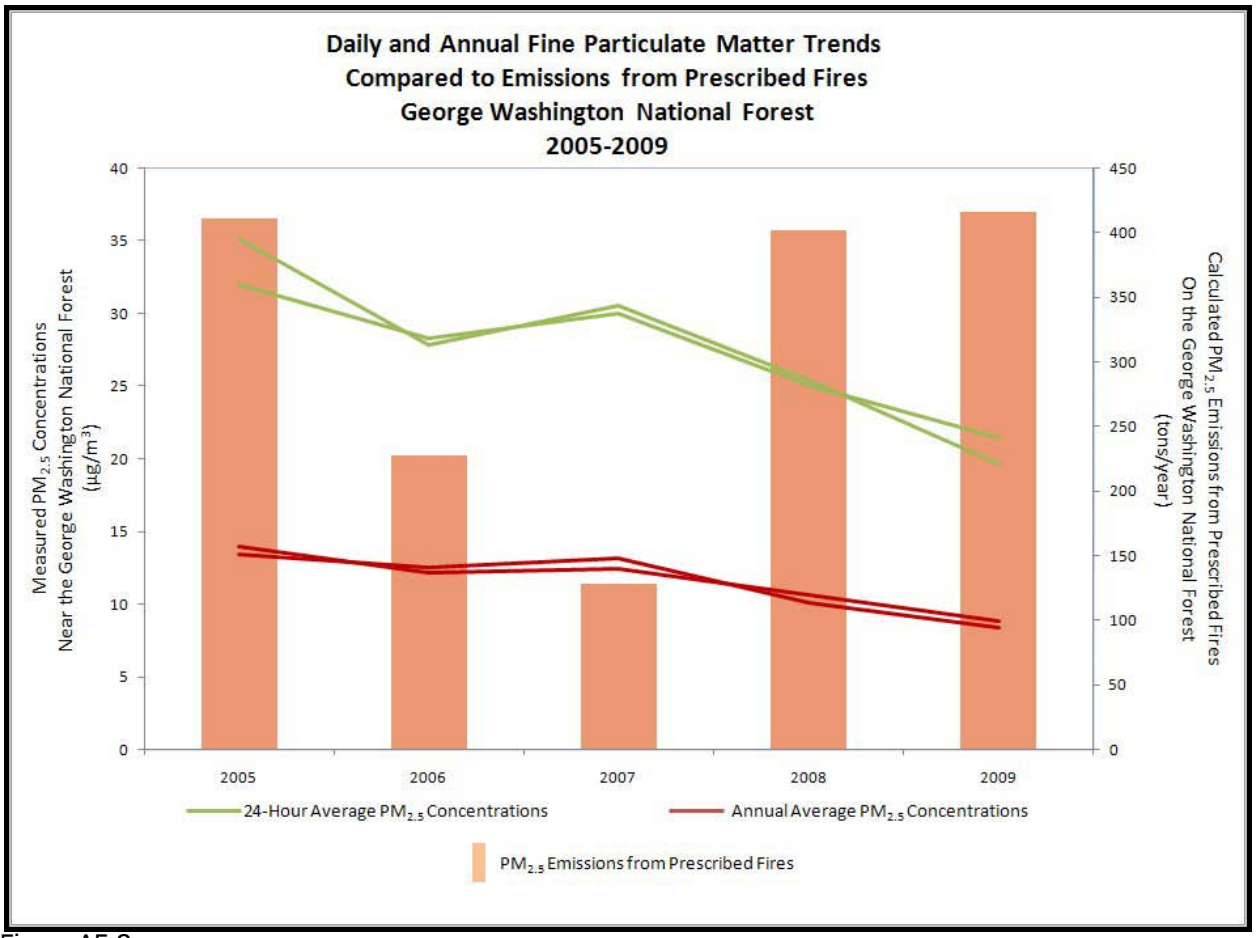


Figure A5.3

The projected emissions from prescribed fires are not expected to be a large contributor to total fine particulate matter mass nor any exceedence of the fine particle National Ambient Air Quality Standard (NAAQS). However, the Forest will be expected to follow Conformity Determination rules and disclose any prescribed fire emissions for activities planned in designated non-attainment areas.

A6 – WATER

AFFECTED ENVIRONMENT

The Forest is almost equally divided between the Potomac and James River basins. Tributaries of the Potomac in the vicinity of the Forest include South Fork South Branch of the Potomac and the Lost, Cacapon, Shenandoah (North and South forks), Dry, North, and Middle rivers. Rivers tributary to the James include the Jackson, Bullpasture, Cowpasture, Calfpasture, Maury, South, St. Mary's, Pedlar, Buffalo, and Tye.

National forest system lands are typically the mountainous headwaters in each of these systems. As such, the streams on the national forest are typically small high-gradient, high-energy systems. Water yield for the Forest averages 16.6 area-inches per year. This is not distributed uniformly in time or space. Based on streamflow information from the U.S. Geological Survey stream gauging stations, the average annual runoff from the national forest varies from approximately 11 area-inches to over 27 area-inches.

Streamflow represents a "leftover" of precipitation minus evaporation and water use by growing vegetation. As such, it is extremely variable. Streamflow varies by year and by time of year. May and July are the months most likely to have the highest precipitation. However, in a typical year, March is the month with highest streamflows. This occurs because the high precipitation months are also during the growing season when much of the precipitation is used by vegetation. Streamflows are typically lowest in late summer and early autumn at the end of the growing season. January and February are the months with lowest precipitation.

FLOODS AND DROUGHTS

The watersheds of the George Washington National Forest periodically experience extreme flow events. Virginia lies in the path of cyclone storms that originate in the Gulf of Mexico and the Atlantic Ocean and carry large amounts of moisture. Flooding is common in the state, especially in the western mountain regions, where high precipitation and steep topography produce rapid runoff. The lands of the Forest have been touched by floods of magnitude greater than 50 year recurrence interval in 1936, 1942, 1949, 1969, 1972, 1985, and 1996. Most of these were produced by hurricanes. The potential for flooding is greatest when soils are near saturation as they are in the spring or at any time of year following several days of rain. The presence of a forest canopy in a watershed can reduce flood peaks from small-to-moderate storms during the growing season because the growing trees utilize soil moisture and transpire it to the atmosphere. This soil moisture difference becomes negligible during large-storm events. A small mountain watershed on the George Washington National Forest can produce flood peaks approaching 1,000 cubic feet per second, per square mile. In contrast, a larger river basin like the James River at Holcomb Rock will have a maximum peak discharge of only 50 cubic feet per second, per square mile.

Low flows typically occur during late summer and early autumn when precipitation is low and soil moisture is utilized by growing vegetation. Water in the stream represents the release of water from groundwater and soil storage. Because of the wide range in topography, rock types, and soils, there is a wide variation of low flows in the streams of the George Washington National Forest. Where soils are deep, slopes are gentle, and drainage density is low, precipitation can be stored within the watershed and released slowly. Thus, peak flows are moderated and low flows are sustained. As greater flow contributions are from groundwater, water temperature is usually lower and less variable. Based on years of data from USGS stream gages across the Forest, low flows are higher in the Blue Ridge.

WATER QUALITY

Water quality on the George Washington National Forest is affected by nonpoint sources of pollution that can affect the physical, chemical, or biological integrity of Forest streams. Collectively, these factors make up the water's aquatic ecological integrity. Nonpoint sources of pollution on the Forest include road construction and maintenance, timber harvest, dispersed and developed recreation management, and fisheries and wildlife habitat improvement. The largest potential impact on water quality from our management activities is from an increase in sediment in streams that can affect the physical integrity of streams. Monitoring has not been

conducted to characterize stream condition or trend relative to sediment from management activities. Activities off the Forest are affecting the chemical integrity of Forest streams. Acid deposition from industry and automobiles are causing many streams to become more acidic. (See the discussion in the Fisheries and Aquatic Habitat section.) A more extensive monitoring program is underway to characterize the chemistry and stream insects of most of the Forest's streams.

IMPAIRED WATERS

The 2008 303d reports for Virginia and West Virginia list 53 streams and 4 reservoirs on the Forest as being impaired. The sources of these impairments are off-Forest (including acid deposition), or are described as "natural." None of the impairments can be attributed to Forest management activities.

Table A6.1. Impaired waters on the George Washington National Forest

Water Name	Cat.	Use	Impairment	Source
Pedlar River	5A	Recreation	E. coli	Non-point source
Cub Run [10th Leg. quad]	4A	Recreation	Fecal coliform, E. coli	Agriculture, NPS, wildlife
Big Run	5A	Recreation	E. coli	Agriculture, NPS, wildlife
North River	5A	Aquatic Life	pH	Atmospheric deposition
Thorny Branch	4A	Recreation	Fecal coliform	Non-point source
Briery Branch	5C	Aquatic Life	pH	Natural conditions
Narrow Passage Creek	5A	Recreation	Fecal coliform	Agriculture, NPS, wildlife
Cedar Creek	5A	Aquatic Life	Benthic macro bioassessments	Unknown
Loves Run	5A	Aquatic Life	pH	Atmospheric deposition
Pine Run	4A	Recreation	E. coli	NPS, wildlife
Back Creek	5A	Aquatic Life	Benthic macro bioassessments	Unknown
South Fork Shenandoah R	5A	Fish Consumption	Mercury in fish tissue	Contaminated sediments
Falls Hollow	4C	Aquatic Life	Benthic macro bioassessments	Drought-related impacts
Tunnel Hollow x-trib	4C	Aquatic Life	Benthic macro bioassessments	Drought-related impacts
Beaver Creek	4A	Recreation	Fecal coliform	NPS, wildlife
Beaver Creek	4C	Aquatic Life	Temperature	Natural conditions
Rocky Run	5A	Aquatic Life	pH	Atmospheric deposition
Union Spring Run	5A	Aquatic Life	pH	Atmospheric deposition
Wolf Run	5A	Aquatic Life	Benthic macro bioassessments	Atmospheric deposition
Wolf Run	5A	Aquatic Life	pH	Atmospheric deposition

Water Name	Cat.	Use	Impairment	Source
Dry River	5A	Aquatic Life	pH	Atmospheric deposition
Skidmore Fork	4C	Aquatic Life	Benthic macro bioassessments	Drought-related impacts
Coles Run	5A	Aquatic Life	pH	Atmospheric deposition
Johns Run	5A	Aquatic Life	pH	Atmospheric deposition
Kennedy Creek	5A	Aquatic Life	pH	Atmospheric deposition
Mills Creek	5A	Aquatic Life	Benthic macro bioassessments	Atmospheric deposition
Orebank Creek	5A	Aquatic Life	pH	Atmospheric deposition
Toms Branch	4C	Aquatic Life	Benthic macro bioassessments	Drought-related impacts
Cub Run [Elkton W quad]	5A	Recreation	Fecal coliform, E. coli	Agriculture, NPS, wildlife
Boone Run	5A	Recreation	Fecal coliform	NPS, wildlife
Little Dry River	4A	Recreation	Fecal coliform	NPS, wildlife
Little Dry River	5A	Aquatic Life	pH	Atmospheric deposition
Fridley Run	5A	Aquatic Life	Benthic macro bioassessments	Atmospheric deposition
Fridley Run	5A	Aquatic Life	pH	Atmospheric deposition
Mountain Run	4A	Recreation	Fecal coliform, E. coli	Agriculture, NPS, wildlife
Mountain Run	5A	Aquatic Life	Benthic macro bioassessments	Atmospheric deposition
Mill Creek [R'ham Co.]	4A	Recreation	Fecal coliform	Agriculture, NPS, wildlife
Mill Creek [R'ham Co.]	4A	Aquatic Life	Benthic macro bioassessments	Unknown
Laurel Run [Shen Co.]	5A	Aquatic Life	Benthic macro bioassessments	Atmospheric deposition
Little Stony Creek	5A	Aquatic Life	Benthic macro bioassessments	Atmospheric deposition
Stony Creek	4A	Recreation	Fecal coliform	Agriculture, NPS, wildlife
Stony Creek	5A	Aquatic Life	Benthic macro bioassessments	Agriculture, NPS, wildlife
Stony Creek	5A	Aquatic Life	Temperature	Unknown
Passage Creek	5A	Recreation	Fecal coliform	Agriculture, NPS, wildlife
Tye River	5A	Aquatic Life	Temperature	Unknown
Tye River South Fork	5A	Aquatic Life	Temperature	Unknown
Jackson River	5C	Aquatic Life	Temperature	Natural conditions
Jackson River	5A	Recreation	E. coli	NPS, wildlife

Water Name	Cat.	Use	Impairment	Source
Laurel Run [Bath Co.]	5A	Aquatic Life	pH	Atmospheric deposition
Panther Run	4C	Aquatic Life	Benthic macro bioassessments	Drought-related
Pheasanty Run	4A	Aquatic Life	Benthic macro bioassessments	Aquaculture (permitted)
Porters Mill Creek	5A	Aquatic Life	pH	Atmospheric deposition
South Fork Pads Creek	4C	Aquatic Life	Benthic macro bioassessments	Drought-related
Calfpasture River	5A	Recreation	E. coli	Agriculture, NPS, wildlife
Mill Creek [Bath Co.]	5A	Recreation	Fecal coliform, E. coli	Agriculture, NPS, wildlife
Little Calfpasture River	5A	Recreation	Fecal coliform	NPS, wildlife
Saint Mary's River	5A	Aquatic Life	pH	Atmospheric deposition
Wilson Creek	5C	Aquatic Life	Temperature	Drought-related impacts; unknown
Potts Creek	5A	Recreation	E. coli	Livestock, septic systems, wildlife
Potts Creek	5C	Aquatic Life	pH (> 9.00)	Unknown
Coles Run Reservoir	5A	Aquatic Life	pH	Atmospheric deposition
Elkhorn Lake	5A	Aquatic Life	pH	Atmospheric deposition
Staunton Dam Lake	5A	Aquatic Life	pH	Atmospheric deposition
Switzer Lake	5A	Aquatic Life	pH	Atmospheric deposition
Switzer Lake	5A	Aquatic Life	Temperature	Unknown
Capon Run	5		Biological	Unknown
Hawes Run	5		Biological	Unknown
Miller Run	5		Biological	Unknown

Category 4A - water is impaired or threatened for one or more designated uses; TMDL has been completed.
Category 4C - impairment is not caused by a pollutant and/or is caused by natural conditions; no TMDL is required.
Category 5A - water is impaired or threatened for one or more uses by a pollutant(s); TMDL is required.
Category 5C - water quality standard is not attained due to "suspected" natural conditions; may require a TMDL; WQ Standard may be reevaluated due to the presence of natural conditions.
Category 5 - water is impaired, and a TMDL is needed (West Virginia).

The 2008 Water Quality Assessment for Virginia lists 65 impairments on the Forest, affecting 50 streams and four reservoirs. For 11 of the stream impairments, the cause is a natural condition, and no Total Maximum Daily Load (TMDL) allocation is required; or the cause is a "suspected" natural condition, and a TMDL may or may not be required. For an additional 21 stream impairments, the source is atmospheric deposition.

For all the other 28 stream impairments, much more of the stream's length is on private land than on Forest Service land, and almost all the samples on which these impairments were based were collected miles

downstream from Forest Service land. The predominant sources for these impairments are agriculture, nonpoint sources, and wildlife. For seven impairments, the source is listed as unknown.

TMDL reports have been completed for five of the impairments. One deals with aquaculture. The other four, which are for bacteria, identify agriculture as the main source of pollution, with wildlife as a secondary source. None of these TMDL reports identify activities related to forest management as a significant source.

In summary, none of the stream impairments can be attributed to Forest management activities.

For Coles Run Reservoir, Elkhorn Lake, Staunton Dam Lake, and Switzer Lake, the impairment is low pH, due to atmospheric deposition. Switzer Lake is also listed with a temperature impairment, with the source being unknown. Again, none of the impairments can be attributed to Forest management activities.

The 2008 West Virginia Integrated Water Quality Monitoring and Assessment Report lists three impaired streams that are on the Forest: Capon Run, Hawes Run, and Miller Run. For all of these streams, the criterion affected is biological, the source is unknown, and a TMDL is needed. For each of these, most of the stream's length is on private land, and the impairment cannot be attributed to Forest management activities.

DRINKING WATER

Water quality in streams is a priority on the National Forest. Since 1988, almost 6,000 water samples have been analyzed from George Washington and Jefferson National Forest streams. Some streams have been part of a long term monitoring program and are sampled quarterly; others have had only one or two samples taken to characterize their chemical habitat. In response to concerns over the quality of water from the George Washington National Forest related to drinking water, Virginia water quality standards (State Water Control Board 2008) were compared to 5,532 water samples collected from streams on the national forest. To get a complete picture related to the public water supply water quality standards, measurements from both the George Washington and Jefferson National Forests, during all seasons, and all years were included in the analysis.

There are three chemical parameters listed in the Virginia water quality standards (VA WQS) that have been sampled consistently across the Forests; they are chloride, nitrate, and sulfate. A box and whisker plot was developed for each of these parameters from the National Forest dataset; in addition, the VA WQS was shown as a red horizontal bar in the charts. The top and bottom of the boxes in the plots represent the 25th and 75th percentiles (50% of all values fall within the box), the bar in the center of the box represents the median, whiskers represent the 10th and 90th percentiles (80% of all values fall within the whiskers), and closed circles represent the entire range of the data.

As seen in Charts 1-3, none of the 5,532 samples exceeded VA water quality standards for public water supply. In fact, as shown by the box, 90% of the samples are far below the water quality standard threshold.

Chart 1. Chloride measurements from 5,532 stream water samples taken on the GWJ National Forest related to the VA water quality standards for public water supply.

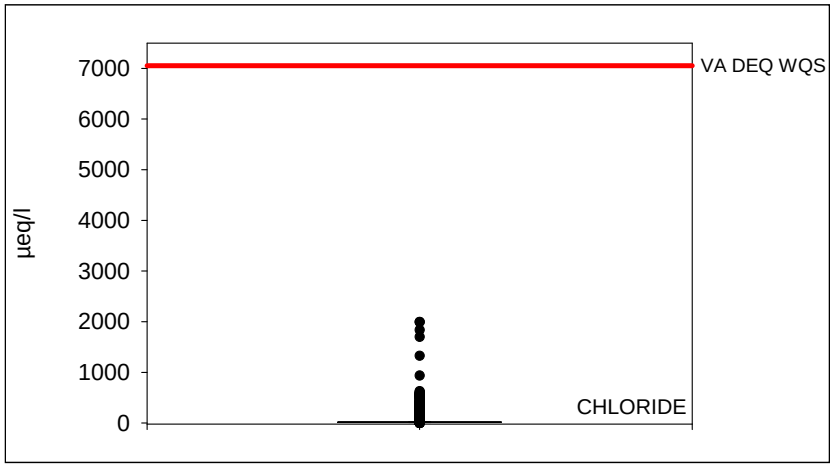


Chart 2. Nitrate measurements from 5,532 stream water samples taken on the GWJ National Forest related to the VA water quality standards for public water supply.

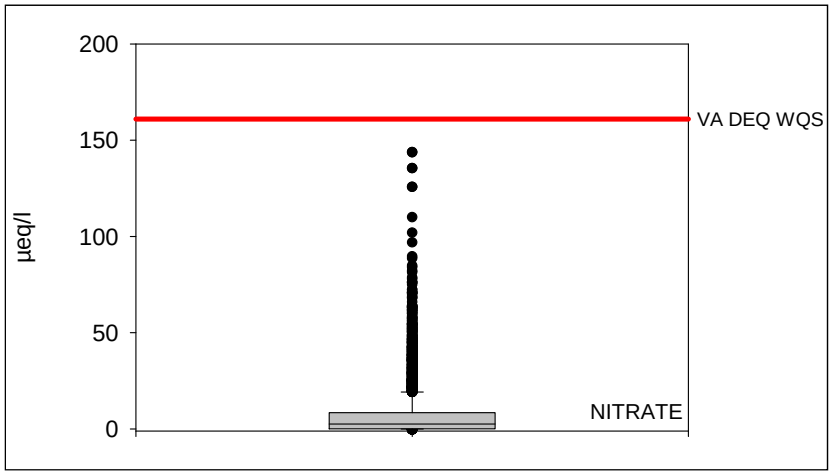
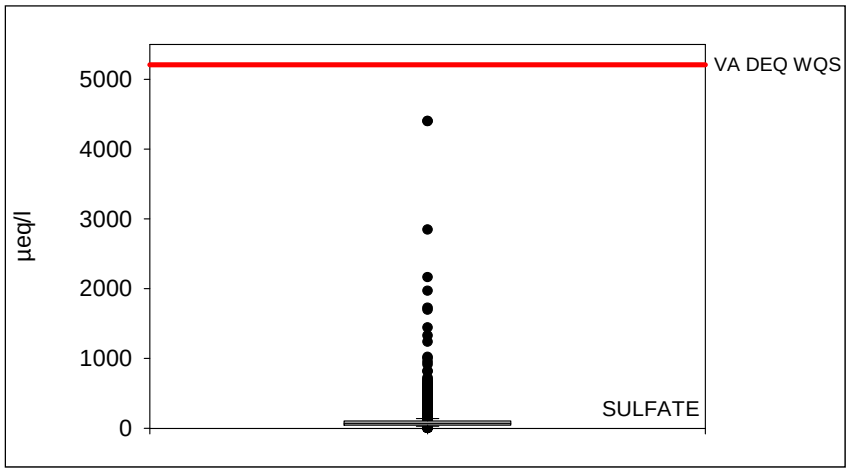


Chart 3. Sulfate measurements from 5,532 stream water samples taken on the GWJ National Forest related to the VA water quality standards for public water supply.



Reference:
2008. STATE WATER CONTROL BOARD. 9 VAC 25-260 Virginia Water Quality Standards. Statutory Authority: § 62.1-44.15 3a of the Code of Virginia. WITH AMENDMENTS EFFECTIVE October 2008

OUTSTANDING NATIONAL RESOURCE WATERS

Other streams are recognized for their high quality waters. As part of the anti-degradation provisions of Virginia water quality standards, waters which constitute an outstanding national resource or waters of exceptional recreational or ecological significance are designated as "Tier III" waters. Currently, there are 14 Virginia streams on the Forest that have been so designated: Brown Mountain Creek, Laurel Fork, North Fork of the Buffalo River, Pedlar River, Ramsey's Draft, Blue Suck Branch, Downy Branch, North Branch Simpson Creek, Roberts Creek, Shady Mountain Creek, Cove Creek, Little Cove Creek, Rocky Branch, and North River. In West Virginia, all high quality waters or naturally reproducing trout streams located within national forests are designated Tier III waters.

WATER USES

Water on the George Washington National Forest is needed for recreation, wildlife, domestic livestock watering, and administrative uses by the Forest Service. Additionally, instream flow quantities and timing are necessary to maintain the capacity of the channels to transport water and sediment, for fisheries, recreation, and visuals. Water sources on the Forest and adjacent to it are utilized for individual water supplies. Individual supplies for human consumption generally come from shallow-drilled wells or springs.

Numerous communities withdraw drinking water from streams and reservoirs on the Forest or from rivers downstream from the Forest. The Virginian Water Quality Standards designate as Public Water Supplies the following waters that are at least partially on George Washington National Forest land:

- Coles Run from Augusta County's raw water intake to its headwaters
- Dry River from Harrisonburg's raw water intake to a point 5 miles upstream
- North River from Staunton Dam to its headwaters
- North Fork Shenandoah River and its tributaries from the Winchester raw water intake to points 5 miles upstream (to include Cedar Creek and its tributaries to their headwaters)
- North Fork Shenandoah River and its tributaries from Strasburg's raw water intake to points 5 miles upstream
- North Fork Shenandoah River and its tributaries from Woodstock's intake to points 5 miles upstream
- Pedlar River and its tributaries from Lynchburg's raw water intake (near Lynchburg Reservoir) to points 5 miles upstream
- Smith Creek and Clifton Forge Reservoir from Clifton Forge's raw water intake to their headwaters
- Jackson River and its tributaries from Covington's raw water intake to points 5 miles upstream

Five water supply reservoirs are located in the George Washington National Forest – Coles Run Reservoir, Switzer Lake, Clifton Forge Reservoir, Staunton Reservoir, and Lynchburg Reservoir. Switzer Lake is located seven miles upstream from Harrisonburg's intake.

Additional downstream drinking water supplies were noted in comments. These have intakes on rivers in the vicinity of the Forest, and their watersheds are partially within the Forest:

- Broadway (North Fork Shenandoah River)
- Food Processors Water Cooperative Inc. (North Fork Shenandoah River)
- Front Royal (South Fork Shenandoah River)
- Harrisonburg (North River)
- Bridgewater (North River)

- Lynchburg (James River)
- Amherst (Buffalo River)
- Maury Service Authority (Maury River)

Areas upstream of all of these drinking water supplies were identified in comments, and totaled approximately 425,874 acres of George Washington National Forest land. In reality, the entirety of the Forest is encompassed in watersheds of rivers from which drinking water is withdrawn downstream (e.g., the James and Potomac Rivers).

GROUNDWATER

In 2006 the Forest Service established new direction for ground water resource management, with an objective (FSM 2882.02) to: Protect, manage, and improve ground water and ground-water dependent ecosystems, recognizing their unique values, while implementing land management activities. Ground Water-dependent Ecosystems (GDEs) are communities of plants, animals, and other organisms whose extent and life processes are dependent on access to or discharge of ground water in areas such as.

- Springs, seeps and wetlands
- Ground water-fed streams/lakes and associated riparian areas
- Shallow water table areas
- Cave and karst systems

Ground Water-dependent Ecosystems relating to biological resources are discussed in biological sections of Chapter 3. This section focuses on groundwater.

The groundwater resources of the Forest vary depending on the different hydrogeologic characteristics of the physiographic provinces and associated bedrock and surficial deposits, such as alluvium and colluvium. Most of the Forest is located on the ridges in the Valley and Ridge Province, where the ridges are dominated by sandstone and shale (Devonian, Silurian, and Mississippian); limestone, such as the Helderberg group, occurs less commonly. The Forest valleys in this Province are dominated by limestone or shale (deep aquifers) overlain by alluvium (shallow aquifers). Shale and sandstone generally are poor to fair groundwater producers. The carbonates are highly variable groundwater producers but where water has dissolved the rock into underground solution channels, the carbonates are moderate-to-large groundwater producers.

In the Valley and Ridge Province, geologic structures (fold, faults, and fractures) are important influences on the occurrence of groundwater. Hinkle and Sterrett (1976) in a groundwater study of Rockingham County noted, "Anticlines (up-folds in the rock strata) may bring good water-bearing beds near the surface along their axes and bury them along the flanks (Plate 5A). Similarly, synclines (down-folds in rock beds) may bring water-bearing units near the surface on the flanks or may cause them to descend to great depths along the axis (Plate 58)."

The Forest's Pedlar District is in the Blue Ridge Province, dominated by granitic bedrock except on the western flank underlain by quartzite, sandstone, and shale. Granitic bedrock generally has small amounts of good quality groundwater available from the fractured crystalline bedrock. The quartzite and other clastic bedrock (Chilhowee Group) are poor aquifers due to cementation. Catoctin Greenstone, a basaltic lava flow, along the crest of the Blue Ridge also is a poor water producer (Hinkle and Sterrett, 1978).

Surficial deposits, such as alluvium, alluvial fans, and colluvium, are found in all the Physiographic Provinces, and may serve as aquifers as well as recharge zones to underlying bedrock.

Quality of groundwater varies depending on whether the well is drilled in shale, sandstone, granite, limestone, or surficial deposits. Most of the rural population near the Forest receives water supplies from groundwater. Since most of the population is in the valleys, most of the water wells are also in the valleys. The Forest generally is located in the sparsely populated mountains. So there are few drilled wells on the Forest, primarily for recreation and administrative facilities. Because the Forest occupies the mountains above the valleys, the Forest is a part of the recharge area for groundwater in valleys.

The Forest has 21 active groundwater wells supplying water to recreation sites. Groundwater withdrawals range from about 40 gallons per day to 2,000 gallons per day. The Forest also has 9 inactive groundwater wells.

The Forest has 26 active special use authorizations for groundwater wells or springs supplying water to non-federal users, a mixture of public water supply districts and private users. For example, in 2002 the Forest issued a Permit for a groundwater well to a public water supply district; for the period 2007-2009 the annual pumpage (groundwater withdrawal) ranged from 34-41 million gallons per year. In 1996 commercial use of two springs for water bottling was authorized as part of a special use Permit. The use of the two springs for commercial bottling or potable water was rescinded in 2009.

Requests for groundwater wells for public water supply on the Forest are expected to continue due to several factors: 1) State restrictions on use of springs as public water supply sources, 2) recognition of stress on reservoirs, streams, or other sources during periods of drought, 3) dam safety requirements and expenses, 4) increase in population in counties near the Forest. For example, in 2009 a public water service authority requested the Forest consider exploration and development of groundwater sources.

GROUNDWATER IN KARST

The Forest's groundwater resource that is most vulnerable to contamination is groundwater in karst geologic terrain underlain by carbonate bedrock (limestone and dolomite). Caves, sinkholes, and sinking streams are examples of openings in karst terrain that provide direct access for surface water to flow directly into the ground water. In karst terrain the flow of surface water into openings into the groundwater is a natural geologic process in the formation and development of karst terrain. Karst terrain where surface waters flow into sinkholes or disappearing streams is a groundwater recharge area. Karst terrain can also be groundwater discharge areas, such as where springs are present. A karst map with more discussion about karst is in Geology section.

Karst terrain and associated groundwater is widely distributed across the Forest and occurs on every Ranger District (Geologic Map Units Containing Karst figure in Geologic Resources section). These geologic map units indicate 11% of the Forest (about 119,000 acres) with geologic formations containing karst and karst-related groundwater.

Karst groundwater systems are complex, and are even more complex when surficial deposits, such as alluvial fans, mantle the karst bedrock. A notable example is the large alluvial fan along the Coal Road in the Maple Flats area on the north end of the Pedlar District. Thick deposits of sand and gravel overlie Shady dolomite in the Maple Flats sinkhole ponds area and create a complex karst groundwater setting. Another example of a complex karst groundwater setting is the Trout Pond Recreation Area on the Lee District where alluvial deposits overlie karst bedrock.

DIRECT AND INDIRECT EFFECTS

The following discussion provides some background information regarding the environmental effects common to soil and water resources from management activities. Any activity that disturbs the land surface, decreases cover or alters vegetation can affect soils, water yield and water quality. The primary management activities that could affect the soil resource, water yield, and water quality are:

- Roads and Trails
- Vegetation Management
- Mineral Exploration and Development
- Fire Management
- Wind Energy Development

Roads and Trails. Roads and trails directly and indirectly affect water by increasing sedimentation and concentrating runoff. Roads and trails expose and compact soils, alter surface and subsurface water flow, and can alter stream channels during construction. When left open they will contribute to higher erosion and sedimentation rates than closed roads and trails.

Vegetation Management. Vegetation management activities that typically affect soil and water are timber harvesting and associated landing and skid trail construction. Loss of the protective soil cover (litter) from ground disturbance can increase erosion and sedimentation while decreasing soil productivity. Water yield also increases because of reduced transpiration and raindrop interception.

Mineral Exploration and Development. Mineral exploration and development can affect soil and water by increasing erosion and sedimentation, soil compaction, and water yield. In many cases soil productivity is reduced and sediment can affect water quality. The potential seepage or spillage of toxic substances from mining facilities or disposal areas may also pose a threat to water quality. Effects of oil and gas exploration and development are discussed separately in Section D of this Chapter.

Fire Management. Prescribed burning directly affects soil and water by removing a portion of the vegetative cover, which exposes soil to erosion. Control lines also expose mineral soil. These factors can reduce soil productivity and increase stream sedimentation. The magnitude of effect varies widely depending on the soils, topography and the intensity of burn.

Wind Energy Development. Development of wind energy requires clearing the turbine sites, constructing or improving roads to the sites, and constructing power transmission lines. These activities can increase erosion and sedimentation and can concentrate runoff.

There is a great deal of variability in sediment yield from year to year, which is termed "interannual variability." In part, this is because sediment yield is much greater during high runoff years with more stormflow to erode and transport sediment. Conversely, sediment yield is much less during drought years when high flows may be less than bankfull. However, interannual variability is a function of much more than the weather.

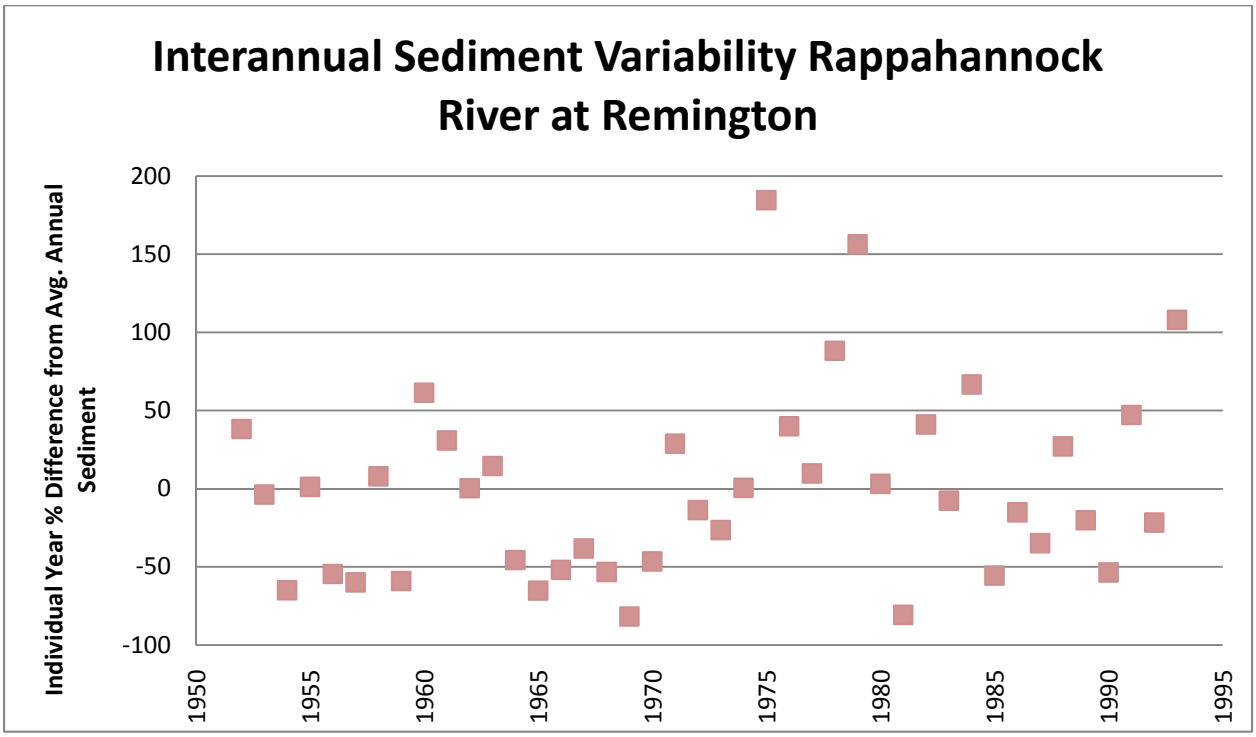
Data from the USGS gage on the Rappahannock River at Remington provides an expression of the variability of annual sediment yield. For the 42 years with flow and sediment data, each year's percent difference from the long-term mean ranges from plus 184 percent to minus 82 percent. A change of annual sediment yield of plus or minus 60 percent represents one standard deviation from the long-term mean. This value is also termed the coefficient of variation. According to Bunte and MacDonald (1999), "very few records of annual sediment yield have a coefficient of variation of less than 50%, and most values are closer to 100%." Therefore, the data from the Rappahannock provide a good but conservative estimate of the coefficient of variation for watershed systems on the George Washington National Forest. Figure A6.1 displays the interannual sediment variability for the Rappahannock River at Remington.

The interannual variability of sediment determines the magnitude of change that can be detected during a given time period. Bunte and MacDonald (1999) state that the number of years of monitoring needed to detect a sediment increase of "z" percent at the 95% confidence interval is given by the formula:

Number of sampling years = $\{(1.96/\text{"z"}) \times (\text{coefficient of variation})\}^2$

This responds to the question of whether there will be a detectable change in the sediment load of any of the rivers considered in this analysis. For example, it would take at least 556 years of monitoring data to detect a 5 percent increase in sediment in the Rappahannock River or in other rivers in Virginia. For a sediment increase to be detectable, it would have to exceed the range of interannual variability for the watershed. According to the formula, it would require four years of annual sediment data to detect an increase of 59 percent at the 95% confidence interval, and more than a year to detect an increase of 100 percent. Sediment increases would have to exceed the interannual variability before they become reasonably detectable.

Figure A6.1. Interannual Sediment Variability Rappahannock River at Remington



Shorter sediment records from the James River at Buchanan and the South Fork Shenandoah River at Front Royal also show the high degree of variability in sediment yield from year to year (Table A6.2).

Table A6.2. Annual Sediment (tons), James River and South Fork Shenandoah River

	1952	1953	1954	1955	1956
James River	198,056	214,575	157,450	378,870	41,028
South Fk Shenandoah			77,129	591,805	4871

In view of the high interannual variability of sediment and the difficulty in accurately modeling sediment production, sediment, as such, will not be used as a measure of effects. Rather, acres of disturbance are used as a measure to indicate the relative effects of the alternatives on sediment and water quality (Table A6.3).

Table A6.3 Acres of Soil Disturbance by Alternative

Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
254	292 – 384	79	635 – 785	189 – 275	260 – 323	315 - 407

DRINKING WATER

Alternative A specifies wider riparian areas when they are adjacent to or within one mile upstream of municipal water supply reservoirs.

In Alternatives B, D, E, F, and G, drinking water supplies are identified, using State designations (i.e., Public Water Supplies). Drinking water watersheds are included among those watersheds that are a priority for restoration.

In Alternative C, management areas are assigned for drinking water watersheds as identified in comments. Drinking water watersheds are included among those watersheds that are priority for restoration.

In project implementation, the application of standards for the riparian management prescription and channeled ephemeral stream standards should fully protect drinking water quality. No measureable direct or indirect effects on water quality should occur. In order to verify that these standards are adequate, some ground disturbing projects will be monitored for implementation of standards and for effectiveness of standards.

GROUNDWATER

Management activities that involve ground disturbance, such as construction of roads and developed recreation facilities, have the potential to adversely affect groundwater, particularly in karst geologic areas. All the Alternatives have Forest Plan standards to protect the Forest's groundwater, including groundwater-dependent ecosystems. The Forest Plan standards to protect groundwater are in various sections of the Forest Plan, including Geologic Resources, Geologic Hazards, Water, Soil, and Caves. Standards under all Alternatives provide that the location and design of management activities will evaluate measures to avoid, minimize, or mitigate adverse effects on geologic resources such as groundwater and groundwater dependent ecosystems.

Under all Alternatives, those management prescriptions that severely restrict or prohibit ground disturbing activity also protect groundwater located in those management prescription areas, for example, Wilderness, Recommended Wilderness Study Area, National Scenic Areas, Special Biological Areas, and Remote Backcountry Non-Motorized areas. Also, the measures addressing Terrestrial Viability Evaluation under all Alternatives also protect groundwater indirectly because groundwater is part of ecosystem or protected habitat in such areas as Alkaline and Mafic Glade and Barrens; Cliff, Talus and Shale Barrens; Floodplains, Wetlands and Riparian; and Cave and Karstlands,

Each Alternative also has a Geologic Area management prescription (4C1) which highlights and provides addition protection for geologic resources. Under the current Plan (Alternative A), the Forest has designated two Geologic Areas (176 acres total): Devils Garden on the Lee Ranger District and Rainbow Rocks on the James River Ranger District. These two Geologic Areas (176 acres total) also would be designated in Alternatives B, C, D, E, F, and G. Alternative E and G would add more Geologic Special Interest Areas in karst and karst groundwater areas. The Virginia Department of Conservation and Recreation, Natural Heritage Program, identified 19 cave and surrounding conservation areas on the Forest. Two sites are within Special Biological Areas, two are within Indiana bat protection areas, and one is in Wilderness, leaving about 3,700 acres outside of these protected areas. Alternatives E and F would designate 14 cave and surrounding conservation areas (about 3,700 acres total) as Geologic Areas, and thus increase protection of karst groundwater areas.

Karst groundwater areas are widely distributed across the Forest on every District. Potential road construction miles, reflecting ground-disturbing activities associated with management activities will be used as an indicator of potential impact on groundwater. Using this indicator, Alternative C has the lowest potential and Alternative D has the highest potential for impact on groundwater; Alternatives F, B, E, G, and A have intermediate levels of potential impact.

The potential groundwater withdrawals for Forest use (primarily for developed recreation sites) and/or for authorizations for non-federal groundwater use varies by Alternative. Alternative C has the lowest potential and

Alternative A has the highest potential for groundwater withdrawals; Alternatives F, D, B, E, and G have intermediate levels of potential for groundwater withdrawals.

CUMULATIVE EFFECTS

Cumulative effects address the environmental consequences from activities implemented or projected within the watersheds in the past, present and reasonably foreseeable future. The combination of activities on NFS, state and private lands can create an effect at a watershed scale that otherwise would not be perceived as a problem at the project or sub-watershed scale. In addition to their natural variability, watersheds differ by their management history, ownership patterns, and the types and levels of contemporary management activity. The combination of natural variables, ownership patterns and management activities contribute to the cumulative effects on water quality within the analysis area. Given the variability in watershed conditions, both natural and management related, the discussion of cumulative effects will be general in nature.

Current water quality in the analysis area is a reflection of the cumulative effects of past and present actions. Future activities can contribute to these effects or alleviate some of the problems. On NFS lands, the reasonably foreseeable future actions are considered to be the continuation of existing programs such as timber management, roads, developed and dispersed recreation, gas and mineral development, grazing allotments, special uses, and other activities. On a broad scale, the effects of future management on NFS lands may result in some localized effects, but overall should not contribute to any measurable downstream impacts. This is due in part to Forest Plan direction for the protection of soil, water, and riparian resources, the continued natural recovery of watershed conditions across the Forest, and the implementation of watershed restoration projects. The level of potential harvest, and its distribution across watersheds, should not result in any measureable water quality effects at the watershed scale. Opportunities also exist to improve watershed conditions.

One concern is that future ground-disturbing activities have the potential to contribute to existing sediment sources, primarily associated with the Forest-wide transportation system. Roads continue to be a chronic source of sediment and additional inputs may be detrimental to water quality. The recovery of disturbed soils can be relatively quick, which reduces the erosion potential following the disturbance. But sediment that enters a channel can remain in the system for years, even decades, depending on the level of inputs and channel characteristics. Potential new sources could be off-set, in part or wholly, by correcting existing problems and reducing current inputs.

The influence of NFS land on cumulative effects for waters draining the analysis area largely depends on the level of ownership. NFS lands are typically located in the higher elevations and headwaters, and the influence of state and private lands increases going downstream. In watersheds where NFS lands are limited, the influence of state and private activities is greater.

Water quality is affected by activities on state and private lands, including roads, rural and agricultural developments, logging, mining, and housing developments. State and local Watershed Improvement Plans developed to meet pollution limits for the Chesapeake Bay have the potential to reduce pollutants (nutrients and sediment).

Implementation of Forest-wide standards and guidelines would minimize the potential effects of land management activities on NFS lands and the Forest's potential contribution to cumulative effects. The existing transportation system continues to affect water quality, and foreseeable actions that improve road-related problems can reduce the potential effects and the contribution to cumulative effects. Foreseeable harvest activities have the potential to contribute to sedimentation and cumulative effects associated with conventional logging and road-related impacts. Future harvest activities also provide an opportunity to correct or reduce existing road-related problems and sediment source. Alternative C has the lowest potential for ground-disturbing activities associated with management activities, followed by Alternatives E, A, F, B, G and D.

One indicator of the potential cumulative effects on groundwater is the amount of past, present, and future management activity in karst, the geologic areas most sensitive to groundwater impacts. The amount of roads is an indicator of the amount of ground-disturbing management activity. The Forest has about 1,800 miles of

Forest Service System roads, of which about 281 miles are within the 11% of the Forest with geologic formations containing karst. Alternative C would not construct any system road, and would not add to existing cumulative impacts. Alternatives A, B, D, E, F, and G would add small increments to the existing 1,800 miles of Forest Service System roads, and small increments to the 281 miles within the 11% of the Forest with geologic formations containing karst and karst-related groundwater. Alternatives E and F would designate 14 cave and surrounding conservation areas (about 3,700 acres total) as Geologic Special Interest Areas, and thus increase protection of karst groundwater areas.

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SECTION B- BIOLOGICAL ENVIRONMENT

B1 – ECOLOGICAL SYSTEMS DIVERSITY

AFFECTED ENVIRONMENT

Twenty ecological systems, as defined by NatureServe's International Ecological Classification Standards, are identified for the analysis of biological resources. However, because many of these ecological systems have similar key attributes, indicators, species associates and resulting forest plan components, we combined the 20 ecological systems into 9 major communities. Additional information on ecological diversity can be found in Appendix E – Ecosystem Diversity Report.

SPRUCE FORESTS

This system is dominated by red spruce (*Picea rubens*) and may contain a Balsam fir (*Abies balsamea*) component. Red spruce begins to occur in stands with northern hardwoods (yellow birch, *Betula lutea*; beech, *Fagus grandifolia;* maple spp. *Acer*; etc.) at elevations around 4,500 feet. It becomes more dominant with increasing elevation, and may be the dominant species between 5,000 and 5,500 feet. Common shrub associates of this ecological system include *Rhododendron catawbiense*, *Vaccinium erythrocarpum* and *V. constablaei, Rubus canadensis,* and *Viburnum alnifolium.* The herb layer commonly includes *Oxalis montana, Dryopteris campyloptera, Aster divaricatus, Clintonia borealis, Solidago glomerata, Carex pennsylvanica* and *Maianthemum canadense,* as well as a variety of other species. This community is characterized by relatively high moisture levels, short growing seasons, acidic soils with low levels of nutrients, and are often subject to strong winds and other extreme weather conditions.

Spruce-fir forests are low disturbance systems, with most of the area under forest canopy. Adverse affects caused by air pollution have caused significant mortality of overstory trees in many areas throughout its range, making quality examples of this community very rare and threatening the persistence of many associated species. The George Washington National Forest has not experienced significant mortality to date.

The forests provide key habitat for the Virginia northern flying squirrel, *Glaucomys sabrinus fuscus.* Isolated populations of several birds--the northern saw-whet owl *(Aegolius acadicus),* the black-capped chickadee *(Parus atricapillus)*, the red crossbill *(Loxia curvirostra)* and possibly the olive-sided flycatcher (*Contopus borealis*)--occur at these high elevations and are uncommon or rare elsewhere in the southeast.

Within the Southern Appalachians, the southern extent of this habitat association coincides approximately with the state lines where Tennessee, North Carolina and Georgia come together. The northern extent of the association is roughly coincident with the northern boundary of the Monongahela National Forest. These forests are confined to the highest peaks of Virginia, Tennessee, and North Carolina. They provide a cool, moist habitat similar to the boreal forests found at more northern latitudes.

There are about 85,000 acres of spruce-fir forest in the region (SAMAB 1996:168-169). Of this total, 11,700 acres are on national forests. These stands occur on the George Washington, Jefferson, and Cherokee National Forests, and the National Forests in North Carolina. Of the remainder, 62,700 acres are in other public ownership (mostly National Park Service), and 10,600 acres are in private or corporate ownership. Most of the public land (including 39% of the NFS land) is in late successional stage (81 yrs. +) forests. At the time of the Southern Appalachian Assessment (1996), four percent of the National Forest acres were in the sapling/pole (11-40 yrs.) stage and 57% were in the mid-successional (41-80 yrs.) stage. All of the private holdings are in either the sapling/pole stage or the mid-successional stage.

There are approximately 500 acres of spruce forest on the GWNF located in the Laurel Fork area of Highland County, VA. This area is currently identified as a Special Management Area to be managed to maintain or enhance the special biological features of the area, including the Central and Southern Appalachian Spruce-Fir Forest.

Management Indicators

Total acres of spruce forests and acres of spruce forest restored will be used as management indicators to assess effects to this community. Because little active management would occur in this type, no management indicator species (MIS) were chosen to reflect effects of management on this community.

NORTHERN HARDWOOD FORESTS

Hemlock and Northern Hardwood forests are broadly defined to include those forested communities that are either dominated or co-dominated by eastern hemlock (*Tsuga canadensis*) or sugar maple (*Acer saccharum*), American beech (*Fagus grandifolia*), and associates. For the purposes of this analysis, forests with a significant component of eastern hemlock are classified as hemlock forests, even where white pine may be dominant. This division puts priority on the presence of hemlock as a key habitat component. Northern Hardwood forests generally occur as the Sugar maple-beech-yellow birch forest type on the GWNF.

Eastern hemlock forests typically occur on acidic soils and often have a dense shrub layer composed of ericaceous species. These communities are typically low in herbaceous diversity, but may support rich bryophyte communities. The combination of a largely evergreen canopy and a dense midstory in naturally occurring hemlock provide for a variety of benefits, including shading and cooling of riparian systems, thermal cover for wildlife, and nesting and foraging habitat for several species of neotropical migrant birds dependent upon the layered canopy structure and understory thickets (Rhea and Watson 1994). There is some evidence that forests provide necessary habitat components for the long-term conservation of red crossbills (Dickson 2001). Eastern hemlock forests may also be important refugia for species typically adapted to higher elevations. Dickson (2001) states that red-breasted nuthatches, winter wrens, and golden-crowned kinglets are found in late successional hemlock forests down to elevations of 2,000 feet, and several species of rare bryophytes that are known to occur primarily within the spruce/fir zone are also found at lower elevations in humid gorges often under a canopy that includes eastern hemlock (Hicks 1992). Unfortunately, a vast majority of these forests have been severely impacted by the hemlock woolly adelgid resulting in severe or total mortality of hemlock. While it is not known what percentage of these older aged stands has succumbed to this non-native pest, we can assume that little or no hemlock forest remains unaffected or wholly intact.

A number of bird species, including the cerulean warbler (Dendroica cerulea) favor mature, northern hardwood forests with a diverse and well-developed canopy structure including canopy gaps and associated midstory and understory structural diversity (Hunter, et al 2001; Rodewald and Smith, 1998). This structural diversity may be characteristic of the decadent, patchy conditions found in old growth forests, to which these species have presumably adapted. While a growing portion of the landscape in the Southern Appalachians consists of large hardwoods, most sites have very simple canopy structures (Runkle, 1985). This lack of structure is likely the result of previous even-aged timber management, resulting in forest stands of approximately equally-aged trees with low mortality and few canopy gaps. Most of these mid- and late successional forests have not yet begun to develop the canopy gaps characteristic of old growth forests. It may be many centuries before such structure develops through natural succession. For the Southern Appalachian Assessment area, the majority of the northern hardwood forests are currently in older age classes. Across all ownerships, approximately 75-80% of maple-beech-birch (northern hardwoods) is in mid- and late-successional stages. On the GWNF approximately 11,000 acres, or 1% of the forest, is found in northern hardwood forests. Approximately 98% of this forest type is in mid- and late-successional forest.

Management Indicators

The hooded warbler (*Wilsonia citrina*) – a Management Indicator Species - is a neotropical migrant that is fairly common to common throughout the southeastern United States during the breeding season (Hamel 1992). It is found in mixed hardwood forests of beech, maple, hickory and oaks with dense undergrowth (DeGraaf et al. 1991). It nests in saplings, shrubs or herbaceous vegetation. It also has been identified as a MIS for Northern hardwood forests with canopy gaps and structurally diverse understories. The hooded warbler is relatively common and evenly distributed throughout the GWNF. Key habitat variables identified for this community are total acres of mid- and late successional mesic deciduous forests and total acres treated to create canopy gaps.

COVE FOREST

This system is dominated by yellow poplar (*Liriodendron tulipifera*) and may contain white pine (*Pinus strobus*), various species of ash (*Fraxinus spp.*), and basswood (*Tilia Americana*) as associates. This community is characterized by relatively low levels of disturbance, and from a habitat perspective, their primary value is providing habitat for a variety of species dependant on mid- and late successional forest stages. It should be noted that the more mesic oak forest types are not addressed in this section, but are analyzed in the Oak and Oak Pine section.

The cove forests addressed in this section are relatively uncommon in the Southern Appalachian Assessment area, comprising just over 10% of the land area (SAMAB 1996:23). Cove forest communities such as mixed mesophytic and bottomland hardwood forests comprise 8.4%, and 1.2%, respectively, of the land area of the SAA area. While these forest communities occur throughout the entire forest, approximately 6% of the GWNF is comprised of cove forests.

A number of bird species, including the cerulean warbler (*Dendroica cerulea*) favor mature, cove forests with a diverse and well-developed canopy structure including canopy gaps and associated midstory and understory structural diversity (Ramey, 1996; Buehler and Nicholson, 1998; Rodewald and Smith, 1998; Nutt, 1998). This structural diversity may be characteristic of the decadent, patchy conditions found in old growth forests, to which these species have presumably adapted. While a growing portion of the landscape in the Southern Appalachians consists of large hardwoods, most sites have very simple canopy structures (Runkle, 1985). This lack of structure is likely the result of previous even-aged timber management, resulting in forest stands of approximately equally-aged trees with low mortality and few canopy gaps. Most of these mid- and late successional forests have not yet begun to develop the canopy gaps characteristic of old growth forests. It may be many centuries before such structure develops through natural succession.

Management Indicators

The hooded warbler (*Wilsonia citrina*) is a neotropical migrant that is fairly common to common throughout the southeastern United States during the breeding season (Hamel 1992). It is found in mixed hardwood forests of beech, maple, hickory and oaks with dense undergrowth (DeGraaf et al. 1991). It nests in saplings, shrubs or herbaceous vegetation. It also has been identified as a MIS for mesic deciduous forests with canopy gaps and structurally diverse understories. The hooded warbler is relatively common and evenly distributed throughout the George Washington National Forest. Key habitat variables identified for this community are total acres of mid- and late successional mesic deciduous forests and total acres treated to create canopy gaps.

OAK FORESTS AND WOODLANDS

The major species include chestnut oak (*Quercus montana*), northern red oak (*Q. rubra*), black oak (*Q. velutina*), white oak (*Q. alba*), and scarlet oak (*Q. coccinea*) (USDA Forest Service, 1997). The drier sites contain oak-pine forests which are oak-dominated forests containing a significant pine component. Predominant pine species include white pine (*Pinus strobus*), shortleaf pine (*P. echinata*), and Virginia pine (*P. virginiana)*

Complexes of woodlands, savannas, and grasslands were once a frequent occurrence across the southeastern landscape, maintained with frequent fire on xeric ridge-tops and south-facing slopes (DeSelm and Murdock 1993; Davis et al. 2002). Woodlands are open stands of trees, generally forming 25 to 60 percent canopy closure (Grossman et al. 1998:21) and may be of pine, hardwood (typically oak), or mixed composition. Savannas are usually defined as having lower tree densities than woodlands; grasslands are mostly devoid of trees. All of these conditions typically occurred in mixed mosaics within a fire maintained landscape. In all cases, a well-developed grassy or herbaceous understory is present.

Because existing woodland, savanna, and grassland complexes are rare, do not conform to existing definitions of community types, and are not consistently tracked, the current acreage in such condition is not well documented. This vegetative condition is not a community type in and of itself, but rather, could occupy some sites allocated to other formally defined community types. The woodlands, savannas, and grasslands are

expected to occupy the most xeric sites of the dry and xeric oak forest, woodland, and savanna and the xeric pine and pine-oak forest and woodland community types. These community types are most likely to occupy sites that historically supported woodlands, savannas, and grasslands.

Existing remnants of this habitat and several associated rare species in both the Southern Appalachians and Piedmont are limited primarily to roadsides and powerline rights-of-way (Davis et al. 2002) due to reductions in fire frequency across most landscapes.

The abundance of these forests in the future will be primarily dependant on the management of existing oak stands to maintain oak dominance. However there also are opportunities to increase the availability of these forests, especially the mixed oak-pine types, through various regeneration techniques and supplemental planting of pine species.

Across the Southern United States, about 50% of the upland hardwood forests (predominantly oak-hickory) and 30% of the natural oak-pine forests are in mid- and late successional stages (41+ years of age) (USDA Forest Service 2001). However, only about 1% of the planted oak-pine forests are in mid- and late successional stages. For the Southern Appalachian Assessment Area, approximately 75% of oak-hickory forests are in mid- and late successional stages (SAMAB 1996: 165).

The age class distribution on the GWNF follows a pattern common to many other Southern Appalachian Forests. However, on the GWNF, this pattern is a little more extreme with over 90% of these community types in a mid-late successional stage.

The structural condition of these oak forests and woodlands is a key factor in the maintenance of these communities. Research indicates that these forest communities may not perpetuate themselves without some level of disturbance, especially on mesic sites (Loftis 1991). Treatments such as shelterwood harvest combined with prescribed burning (Brose et al. 1999) or basal area reduction from below using herbicides (Loftis 1990) have been shown to create conditions that promote adequate oak regeneration. Once established and grown to an average height of approximately 4.5 feet, oak advanced regeneration should be released and provided relatively full sunlight to encourage quick growth into the canopy of the regenerated stand. Oak dominance can be maintained with suitable tree densities and moderate fire return intervals.

Mid- and late successional oak forests and woodlands provide an important source of hard mast and dens. Acorns are a critical fall and winter food for numerous wildlife species (Martin et al. 1951). The availability of acorns has been shown to strongly influence population dynamics of species such as black bear (Pelton, 1989), squirrels (Nixon et al. 1975), white-tailed deer (Wentworth et al. 1992) and white-footed mice (Wolff 1996). The large diameter hollow trees and snags found in older oak forests also are an important source of dens for black bears (Carlock et al. 1983). Hard mast production is an important habitat feature for a several wildlife species in demand for sport hunting. These include white-tailed deer, wild turkey, squirrels, and bear.

Management Indicators

Several management indicators have been identified for assessing effects to oak forests and woodland communities. These indicators include both Management Indicator Species (MIS) and key habitat variables. The hooded warbler (*Wilsonia citrina*) is a neotropical migrant that is fairly common to common throughout the southeastern United States during the breeding season (Hamel 1992). It is found in mixed hardwood forests of beech, maple, hickory and oaks with dense undergrowth (DeGraaf et al. 1991). It nests in saplings, shrubs or herbaceous vegetation. It has been identified as a MIS for managed oak forest containing a well developed understory. Also, the scarlet tanager (*Piranga olivacea*) has been identified as an MIS for drier oak forests that have more of an open condition.

Restoration efforts are tracked by the annual acreage of oak and oak-pine forest restored to appropriate sites currently occupied by other forest types. It should be noted; however, that there is little or no need for restoration of this community type on the GWNF as this type is quite plentiful, well distributed, and generally occupies appropriate sites. Restoration of this type is more meaningful in those areas where pine plantations, usually white pine plantations, occupy sites that were historically oak or oak-pine sites.

Management indicators used to assess management effects to woodland components of this community: 1) the acres burned to restore complexes of woodlands and savannas; 2) acres burned to restore grasslands; and 3) expected impacts to populations of the eastern towhee (*Pipilo erythrophthalmus*), the Management Indictor Species (MIS) chosen to represent desired conditions within this vegetative condition.

PINE FORESTS AND WOODLANDS

These systems are often referred to as southern yellow pine forests and occur on a variety of landforms at a wide range of elevations. Historically, in the Blue Ridge Physiographic Province, these communities occupied areas that were subject to natural fire regimes and typically occurred on ridges and slopes with southern exposures (NatureServe 2002). However, due to a combination of previous land use, fire exclusion, and intensive forestry (plantations), many pine species that do not tolerate fire well have expanded beyond their normal sites and today, pine-dominated communities can be found on a variety of landforms and aspects. Meanwhile, pine species, such as table mountain pine, that benefit from, or depend upon fire, have been reduced in abundance.

Complexes of woodlands, savannas, and grasslands were once a frequent occurrence across the southeastern landscape, maintained with frequent fire on xeric ridge-tops and south-facing slopes (DeSelm and Murdock 1993; Davis et al. 2002). Woodlands are open stands of trees, generally forming 25 to 60 percent canopy closure (Grossman et al. 1998:21) and may be of pine, hardwood (typically oak), or mixed composition. Savannas are usually defined as having lower tree densities than woodlands; grasslands are mostly devoid of trees. All of these conditions typically occurred in mixed mosaics within a fire maintained landscape. In all cases, a well-developed grassy or herbaceous understory is present.

Because existing woodland, savanna, and grassland complexes are rare, do not conform to existing definitions of community types, and are not consistently tracked, the current acreage in such condition is not well documented. This vegetative condition is not a community type in and of itself, but rather, could occupy some sites allocated to other formally defined community types. This vegetative type forms a subset of the oak, oak-pine, and pine-oak forests analyzed in depth elsewhere in this document. The woodlands, savannas, and grasslands are expected to occupy the most xeric sites of the dry and xeric oak forest, woodland, and savanna and the xeric pine and pine-oak forest and woodland community types. These community types are most likely to occupy sites that historically supported woodlands, savannas, and grasslands.

Existing remnants of this habitat and several associated rare species in both the Southern Appalachians and Piedmont are limited primarily to roadsides and powerline rights-of-way (Davis et al. 2002) due to reductions in fire frequency across most landscapes.

During the last 50 years across the southeastern United States, pine plantations have increased in importance in terms of a supply of wood products, expanding from 1% of the total pine forest acres to 48% of those acres (USDA Forest Service 2001: 1). It should be noted, however, that this expansion has occurred primarily in the piedmont and coastal plains of the south; relatively few pine plantations have been established on the GWNF or in the mountains of Virginia. At the same time, the 20-year trend reported for the Southern Appalachian Assessment area (SAMAB 1996: 27) shows a downward trend of 16% for southern yellow pine forests. This trend is not, however, reflected in monitoring of this community type on the George Washington and Jefferson National Forests (GWJNF). The number of acres in this community type inventoried through FSVeg on the GWJNF has decreased less than 1% over the past decade (George Washington and Jefferson National Forest 2001). However, Forest Inventory and Analysis data indicate a substantial decrease in the acres of Virginia, pitch, and table mountain pines on the GWJNF since 1977 (George Washington and Jefferson National Forest 2001). So, while the decrease in the yellow pine community may not have been significant over the past decade, it has been dramatic over the past 30 years, indicating that much of the loss occurred prior to the past decade. A shift from more fire tolerant yellow pines to less fire tolerant pines may also be masked in this data. The GWNF currently contains approximately 160,000 acres in the xeric pine forest and woodland community type, representing about 15% of the GWNF.

Portions of the GWNF experienced a southern pine beetle epidemic in the mid 1990's. While the exact acreages of southern yellow pine forests that were severely impacted are not known, this insect pest certainly

resulted in a recent significant impact in terms of the condition or quality of existing yellow pine stands. Many of the sites impacted were densely stocked stands of Virginia, table mountain, and/or pitch pine that had proliferated beyond their normal sites due to fire suppression and land management practices of the past 70 years. Historical data suggests that large areas that have become occupied by even-aged stands of yellow pine would have naturally supported mixed stands with varying levels of hardwoods. Some areas experiencing frequent fire would have contained open understories with grassy and/or herbaceous ground cover. These natural communities are maintained by low intensity fires originating on ridgetops and southern exposures (NatureServe 2002). Other areas with less frequent fire would contain a mix of pine and hardwood species. With large-scale mortality in these communities due to pine beetle effects, the opportunity now exists to restore the condition and/or quality of these sites to a more open pine woodlands or natural mixed pine hardwood community. On the GWNF, the pine forest and woodland community is well distributed throughout the ridge and valley province. However, this type is currently less abundant on the richer Blue Ridge Province soils of the Pedlar District.

The Southern Appalachian Assessment (SAMAB 1996) summarizes the age class distribution of southern yellow pine forests across the Southern Appalachian Assessment Area by a variety of land ownerships. Similar information is derived from queries of the GWNF FSVeg Database. This data indicates that this community type is very strongly skewed to the older age classes as compared to the Southern Appalachian Assessment area as a whole.

While public lands support the majority of late successional acres, the structure and composition of these forests has been altered due to years of fire suppression resulting in less than optimal habitat conditions. Fire intolerant species such as Virginia pine have proliferated while other pines (shortleaf, pitch, table mountain) have seen dramatic reductions (Nature Serve 2002, Martin et al. 1993). In the absence of fire, hardwoods, shrubs, and vines have replaced the open, grassy, herbaceous layer that is characteristic of frequently burned areas, and hardwoods have encroached into the midstory further affecting forest structure. This change in forest structure and resulting habitat condition has had a direct effect on species dependent upon these communities. Populations of several bird and reptile species associated with southern pine forests are in decline (Dickson 2001) as various habitat components are lost. In addition to declines in species dependent upon specific habitat attributes, entire pine communities are experiencing a reduction in abundance. Recent studies show that acreage of table mountain pine communities (considered a rare community in the southern Appalachians) has decreased due to fire suppression (Turrill and Buckner 1995) and that many remaining examples have substantial hardwood invasion. However, recent monitoring of the table mountain pine types on the GWJNF indicates the decline of table mountain pine has stabilized since 1977 (George Washington and Jefferson National Forest 2001).

Management Indicators

The pine warbler (*Dendroica pinus*) is selected as a management indicator species (MIS) to represent pine and pine-oak forests. The pine warbler is closely associated with pine and pine-oak forests, generally occurring only where some pine component is present. In addition, because fire plays such a prominent role in the maintenance and restoration of this community type, the other management indicator identified for assessing effects to pine and pine-oak forest communities will be the number of acres of xeric pine and pine-oak forests and woodlands burned. This activity indicates the level of effort directed at maintaining or restoring the xeric pine and pine-oak communities.

Management indicators used to assess management effects to woodland components of this community: 1) the acres burned to restore complexes of woodlands and savannas; 2) acres burned to restore grasslands; and 3) expected impacts to populations of the eastern towhee (*Pipilo erythrophthalmus*), the Management Indictor Species (MIS) chosen to represent desired conditions within this vegetative condition.

ALKALINE AND MAFIC GLADES AND BARRENS

These systems are characterized by thin soils and exposed parent material that result in localized complexes of bare soils and rock, herbaceous and/or shrubby vegetation, and thin, often stunted woods. During wet periods they may include scattered shallow pools or areas of seepage. Glades, barrens, and associated woodlands

differ from rock outcrop communities by exhibiting soils and vegetative cover over the majority of the site, and differ from the more widespread woodland communities in that they occur on geologic substrates which are unique for the region, including limestone, dolomite, amphibolite, greenstone, mafic rock, serpentine, sandstone, or shale. Associated communities include Calcareous Woodlands and Glades, Mafic Woodlands and Glades, Serpentine Woodlands and Glades, and Shale Barrens as defined in the Southern Appalachian Assessment (SAMAB 1996). At minimum, this rare community complex includes rare associations within the following ecological groups as defined by NatureServe (2001a): 401-17 Appalachian Highlands Calcareous/Circumneutral Dry-Mesic Hardwood Forest

CLIFF, TALUS AND SHALE BARRENS

These systems are a variable group of sparse woodlands, shrublands, and open herbaceous rock outcrops occurring on Ridge and Valley shales and Blue Ridge metashales of the Central Appalachian Mountains. These small-patch communities range from western Virginia and eastern West Virginia to southern Pennsylvania. In Virginia, they occur at elevations from 850 to 3,040 feet. Although stunted trees of several species (*e.g.*, *Quercus pinus*, *Pinus virginiana*, and *Caria glare*) are common, shale barrens are strongly characterized by their open physiognomy and by a suite of uncommon to rare plants found almost exclusively in these habitats. Endemic or near-endemic shale barren species include *Arabic serotonin*, *Clematis alb coma*, *Clematis viticaulis* (also endemic to Virginia), *Eriogonum allenii*, *Oenothera argillicola*, *Packera antennariifolia* (= *Senecio antennariifolius*) and *Trifolium virginicum*. Habitats generally occur on steep (~ 30 degree) slopes with south to west aspects. The steep, xeric slopes and friable nature of the shale create poorly vegetated hillsides of bare bedrock and loose channery visible from afar. Continual undercutting of thick but relatively weak shale strata by streams maintain shale barrens. Less common, densely graminoid-dominated variants occurring on steep spur ridge crests and mountain summits are sometimes referred to as “shale ridge balds.” Shale barrens are considered globally uncommon and host many locally rare species including the butterflies Appalachian grizzled skipper (*Pyrgus wyandot*) and Olympia marble (*Euchloe olympia*) and the federally listed plant *Arabis serotina*. The primary threat to these communities is probably invasion by non-native invasive species, but examples of these communities near roads are also threatened by quarrying.

FLOODPLAINS, WETLANDS AND RIPARIAN AREAS

This system includes floodplains, streams, riparian areas, wetlands, bogs, fens, seeps, lakes, and ponds that may be found in both the Appalachian and Piedmont regions, and are characterized by: 1) soils that may be semi-permanently to permanently saturated as a result of groundwater seepage, perched water tables, rainfall, or beaver activity, and alluvial processes; and 2) presence of wetland-associated species such as sphagnum, ferns, and sedges. Dominant vegetation may be herbs, shrubs, trees, or some complex of the three. Ponds in this group include limesink, karst, and depression ponds, which may hold areas of shallow open water for significant portions of the year. Also included are all impoundments and associated wetlands resulting from beaver activity. Artificial impoundments are not included, unless they support significant populations or associations of species at risk. The primary management need is that of protection from activities that could disrupt wetland hydrology or other community structures and functions. Some sites may require periodic vegetation management to maintain desired herbaceous and/or shrubby composition. Rare mountain wetland communities include Mafic and Calcareous Fens, Sphagnum and Shrub Bogs, Swamp Forest-Bog Complex, Mountain Ponds, Seasonally Dry Sinkhole Ponds, and Beaver Pond and Wetland Complex as defined in the Southern Appalachian Assessment (SAMAB 1996), and all Associations within the following Ecological Groups as defined by NatureServe (2001):

CAVE AND KARSTLANDS

This system includes the terrestrial and aquatic subterranean habitat. The landscapes are formed in limestone and dolostone bedrock and are generally found in valley bottoms but occasionally on ridges and mountains depending on bedrock geology, strata location and outcrops. Passages are formed by water flowing over many millennia. It is not a separate ecological system from the others, since it has vegetation defined by the previously discussed systems. It is the underground environment and the features that sometimes manifest themselves at the surface, like sinkholes, caves and springs. The location is defined by broad scale geologic mapping, so the actual areas of caves and karst terrain occupy only a small portion of the entire area.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

Effects of the alternatives on the ecological systems of the GWNF are based on modeling of the extent of the ecological systems across the Forest. Objectives of timber harvest and prescribed burning were modeled through the next 50 years for each alternative. The current conditions of the systems are then compared to the modeled results. These results are compared to the biophysical settings identified through LANDFIRE for the systems on the GWNF.

LANDFIRE (also known as Landscape Fire and Resource Management Planning Tools) is interagency vegetation, fire, and fuel characteristics mapping program, sponsored by the United States Department of the Interior (DOI) and the United States Department of Agriculture, Forest Service. The Biophysical Settings (BpS) layer represents the vegetation that may have been dominant on the landscape prior to Euro-American settlement and is based on both the current biophysical environment and an approximation of the historical disturbance regime. It attempts to incorporate current scientific knowledge regarding the functioning of ecological processes – such as fire – in the centuries preceding non-indigenous human influence. Map units are based on NatureServe's Ecological Systems classification, which is a nationally consistent set of mid-scale ecological units (Comer and others 2003). LANDFIRE's use of these classification units to describe biophysical settings differs from their intended use as units of existing vegetation. As used in LANDFIRE, map unit names represent the natural plant communities that may have been present during the reference period. Each BpS map unit is matched with a model of vegetation succession, and both serve as key inputs to the LANDSUM landscape succession model (Keane and others 2002). The LANDFIRE BpS concept is similar to the concept of potential natural vegetation groups used in mapping and modeling efforts related to fire regime condition class (Schmidt and others 2002; www.frcc.gov).

The current conditions and expected conditions for each alternative are displayed in Tables B1.1 and B1.2. All of the alternatives protect the floodplain/riparian ecological system, but Alternatives B, C, E, F, and G expand the width of the riparian corridor and so increase the area that will receive the riparian management objectives, desired conditions and objectives to protect, restore and maintain riparian resources. Alternatives B, C, D, E, F, and G all prescribe direction for management of the caves and karstlands. Alternative C provides some level of increased protection of caves and karstlands due to the reduced levl of ground disturbing activities. The spruce forests are protected in all alternatives, but the Laurel Fork wilderness recommendation in Alternatives C and F could impede restoration efforts aimed at actively expanding the spruce component of Laurel Fork.

None of the alternatives restore the other ecological systems to their LANDFIRE biophysical conditions. For example, LANDFIRE indicates that about 50 percent of area in the mid-late successional stage should have an open canopy structure, but the maximum that any alternative provides is 20 percent after fifty years. However, the prescribed burning in Alternatives B, E, F, and G move those systems closer to their appropriate structural conditions and vegetation composition by returning more acreage to its historic fire regime. Alternatives D and C also accomplish this, but at a slower pace. The timber harvest in Alternatives D moves the systems towards their LANDFIRE regeneration biophysical condition better than the other alternatives, with Alternatives A, B, E and G following behind. Alternative C relies solely on natural processes to achieve regeneration and open canopy conditions. The interspersed nature of GWNF lands with private lands, past and projected development on those lands, changes in the flora and fauna of the area, and past fire suppression efforts makes it extremely difficult for natural processes to perform at the scale they did before European settlement. Therefore, the ecological systems cannot be restored to their historical conditions without active management activities.

In comparing alternatives, it is important to remember that Alternative A is defined as the management direction for the current plan. The actual accomplishments achieved under current management are closer in scope to Alternative D for prescribed fire and Alternative F for timber harvest.

Table B1.1 Ecological Systems – Indicators by Alternative at End of First Decade

Ecosystem Indicator	Current Condition (acres)	LandFire Condition (% of area)	Condition of Indicator at end of 10 years						
			Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Mafic Glade and Barrens and Alkaline Glades and Woodlands	933								
Acres Burned at Desired Frequency	0%	83%	19%	39%	0%	20%	39%	39%	39%
Caves and Karstlands	119,000								
Total Occurrences at Desired Condition	100%		100%	100%	100%	100%	100%	100%	100%
Cliff, Talus and Shale Barrens	23,401								
Acres of Open and Open Canopy	4%	100%	9%	25%	0%	13%	25%	25%	25%
Cove Forest	60,296								
Acres in mid to late successional stages	98%	96%	98%	98%	100%	97%	99%	98%	98%
Acres of Regenerating Forest	2%	4%	2%	2%	0%	3%	1%	2%	2%
Acres of open canopy in mid to late successional stages	2%	9%	2%	2%	2%	2%	2%	2%	2%
Northern Hardwood Forest	10,723								
Acres in mid to late successional stages	98%	90%	99%	99%	98%	98%	98%	98%	99%
Acres of Regenerating Forest	1%	10%	1%	1%	2%	2%	2%	2%	1%
Acres of open canopy in mid to late successional stages	4%	10%	5%	5%	5%	5%	5%	5%	5%
Oak Forests and Woodlands	756,267								
Acres in mid to late successional stages	96%	78%	94%	94%	97%	92%	95%	97%	94%
Acres of Regenerating Forest	3%	22%	5%	5%	2%	7%	4%	2%	5%
Acres of open canopy in mid to late successional stages	2%	50%	6%	13%	2%	9%	12%	12%	13%
Acres of open grasslands or forbs	1%	4%	1%	1%	1%	1%	1%	1%	1%
Pine Forests and Woodlands	159,660								
Acres in mid to late successional stages	97%	87%	97%	97%	99%	98%	97%	95%	97%
Acres of Regenerating Forest	2%	13%	3%	3%	1%	2%	3%	4%	3%
Acres of open canopy in mid to late successional stages	2%	79%	5%	13%	1%	8%	13%	13%	13%
Floodplains, Wetlands and Riparian Areas	53,560								
Compliance with Riparian Guidelines	Yes								
Spruce Forest	526								
Total System Acres at Desired Condition	100%		100%	100%	100%	100%	100%	100%	100%

Table B1.2 Ecological Systems – Indicators by Alternative at End of Fifth Decade

Ecosystem Indicator	Current Condition (acres)	LandFire Condition (% of area)	Condition of Indicator at end of 50 years						
			Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Mafic Glade and Barrens and Alkaline Glades and Woodlands	933								
Acres Burned at Desired Frequency	0%	83%	34%	95%	0%	44%	95%	95%	95%
Caves and Karstlands	119,000								
Total Occurrences at Desired Condition	100%		100%	100%	100%	100%	100%	100%	100%
Cliff, Talus and Shale Barrens	23,401								
Acres of Open and Open Canopy	4%	100%	16%	49%	0%	28%	49%	49%	49%
Cove Forest	60,296								
Acres in mid to late successional stages	98%	96%	98%	98%	100%	96%	99%	97%	98%
Acres of Regenerating Forest	2%	4%	2%	2%	0%	4%	1%	3%	2%
Acres of open canopy in mid to late successional stages	2%	9%	2%	2%	2%	2%	2%	2%	2%
Northern Hardwood Forest	10,723								
Acres in mid to late successional stages	98%	90%	98%	98%	99%	81%	99%	99%	98%
Acres of Regenerating Forest	1%	10%	2%	2%	1%	19%	1%	1%	2%
Acres of open canopy in mid to late successional stages	4%	10%	5%	5%	5%	6%	5%	5%	5%
Oak Forests and Woodlands	756,267								
Acres in mid to late successional stages	96%	78%	94%	94%	97%	92%	95%	96%	94%
Acres of Regenerating Forest	3%	22%	5%	5%	2%	7%	4%	3%	5%
Acres of open canopy in mid to late successional stages	2%	50%	7%	20%	2%	14%	20%	19%	20%
Acres of open grasslands or forbs	1%	4%	1%	1%	1%	1%	1%	1%	1%
Pine Forests and Woodlands	159,660								
Acres in mid to late successional stages	97%	87%	97%	97%	99%	95%	97%	98%	97%
Acres of Regenerating Forest	2%	13%	3%	3%	1%	5%	3%	2%	3%
Acres of open canopy in mid to late successional stages	2%	79%	6%	22%	1%	14%	22%	22%	22%
Floodplains, Wetlands and Riparian Areas	53,560								
Compliance with Riparian Guidelines	Yes								
Spruce Forest	526								
Total System Acres at Desired Condition	100%		100%	100%	100%	100%	100%	100%	100%

B2 – TERRESTRIAL SPECIES DIVERSITY

B2A - TERRESTRIAL VIABILITY EVALUATION

AFFECTED ENVIRONMENT

National Forest Management Act (NFMA) regulations, adopted in 1982, require that habitat be managed to support viable populations of native and desirable non-native vertebrates within the planning area (36 CFR 219.19). USDA regulation 9500-004, adopted in 1983, reinforces the NFMA viability regulation by requiring that habitats on national forests be managed to support viable populations of native and desired non-native plants, fish, and wildlife. These regulations focus on the role of habitat management in providing for species viability. Supporting viable populations involves providing habitat in amounts and distributions that can support interacting populations at levels that result in continued existence of the species well-distributed over time.

Because NFMA regulations require providing habitat for species viability within the planning area, focus of this evaluation is on habitat provided on national forest land. Surrounding private lands may contribute to, or hinder, maintenance of species viability on national forest land, but are not relied upon to meet regulation requirements.

Evaluation of migratory birds focused on breeding populations only, unless otherwise indicated. This focus does not mean that wintering and migrating populations were not considered during planning, but that viability evaluation makes most sense when viewed in terms of the relative stability of breeding populations.

VIABILITY EVALUATION PROCESS

The ecological and species sustainability framework is built on the principle that by restoring and maintaining the key characteristics, conditions, and functionality of native ecological systems and by identifying and managing for additional needs for key species, the GWNF will be able to maintain and improve ecosystem diversity, provide for the needs of diverse plant and animal species on the forest, and provide management direction to support viable populations of native and desirable plants, fish and wildlife.

The Ecosystem Diversity Report (Appendix E) describes the analysis process used to identify, evaluate, and develop guidance for sustaining ecological diversity. The overall goal for ecological sustainability is to sustain native ecological systems and support diversity of native plant and animal species. Ecosystem diversity is defined as the variety and relative extent of ecosystem types including their composition, structure, and processes. The major characteristics of forest-wide ecosystem diversity and descriptions of the 20 ecological systems found across the GWNF are presented in this Ecosystem Diversity Report.

While most plant and animal species' needs are expected to be met by sustaining ecosystem diversity, a corresponding species-specific analysis was also conducted to evaluate whether additional provisions were needed for federally listed species, sensitive species and locally rare species. This species-specific sustainability analysis is described in more detail in the Species Diversity Report (Appendix F). This report and the Ecosystem Diversity Report focus on the terrestrial environment. The analysis of the aquatic systems is covered in the Aquatic Ecological Sustainability Analysis (Appendix G).

The following steps were used to build an ecological sustainability framework. Each step is documented within the Ecological Sustainability Evaluation (ESE) tool, a relational database developed by the Forest Service and based on the structure used by The Nature Conservancy in their Conservation Action Planning. Although these steps are presented sequentially, the process required much iteration.

1. Identify and define ecological systems

To define terrestrial ecosystem diversity, all terrestrial ecological systems on the GWNF were identified using NatureServe's International Ecological Classification Standards (NatureServe 2005). Each system was defined

in terms of existing Forest Service forest types and in terms of the LANDFIRE Vegetation Dynamic Models. Current acreage of each system was calculated using Forest Service GIS data. All identified terrestrial ecological systems were included in the ecological sustainability framework. These systems also relate to the Virginia Department of Conservation and Recreation Natural Heritage Program Vegetation Community types. The framework for diversity of aquatic ecological systems is described in the Aquatic Ecological Sustainability Analysis (Appendix G).

2. Identify stresses and threats to the ecological systems

Major stresses and threats to the ecological systems were identified.

3. Identify species

To assess species diversity, a comprehensive list of plant and animal species was compiled by combining species lists from a variety of sources. These sources included federally-listed threatened and endangered (T&E) species obtained from the U.S. Fish and Wildlife Service, Virginia Department of Conservation and Recreation Natural Heritage Program, Virginia and West Virginia State Comprehensive Wildlife Conservation Strategies, the Birds of Conservation Concern list compiled by the U.S. Fish and Wildlife Service, and the Forest Service's list of sensitive species. Species were then screened for inclusion in the framework. The criteria and process for identifying, screening and grouping species are detailed in the Species Diversity Report (Appendix F).

4. Identify stresses and threats to the species

Major stresses and threats were identified for each species in regard to their populations on the GWNF.

5. Identify and define characteristics of ecosystem diversity and related performance measures

To identify key characteristics and performance measures for terrestrial ecological systems, Forest Service biologists reviewed information in NatureServe, LANDFIRE, Virginia Department of Conservation and Recreation Natural Heritage Program community types, and other information.

6. Link species to the ecological systems and identify any additional needs of species

Species were then linked to terrestrial ecological systems. Where useful, species were grouped before linking them to systems. Where ecological conditions for these species were not covered by the ecosystem diversity framework, additional characteristics, performance measures, and rating criteria were added to the framework to cover these needs. All species have at least some of their needs covered by ecosystem diversity, but some species required additional plan components based on their major limiting factors. The ways in which individual species needs were addressed by ecosystem diversity components and additional Plan provisions are described in the Species Diversity Report (Appendix F).

7. Assess current condition of the indicators for the ecological systems and species groups

Current values and ratings of all performance measures were estimated using a variety of methods. Many current values were derived through analysis of existing GIS databases. Assumptions and methods for determining current values and ratings are recorded in the ESE tool.

8. Develop Forest Plan components to address the stresses and threats and provide management direction in the Forest Plan to maintain habitat components

In this step, Forest Plan components were developed to provide desired conditions, objectives, standards and guidance for managing ecosystem diversity and ecological conditions for species. This Plan direction was then linked with characteristics and conditions within the ESE tool. We ensured that all elements of the framework were addressed by appropriate management direction.

Nineteen native ecosystems were identified for the GWNF using NatureServe's International Ecological Classification Standards (NatureServe 2004a, 2004b). A system was added to cover caves and karstlands. Current acreage of each system was calculated using Forest Service GIS data.

As we developed the ecosystem diversity analysis, we identified that many of the ecological systems had similar key attributes, indicators, species associates and resulting forest plan components. For purposes of analysis we combined the systems into the following Ecological System Groups:

Table B2.1 Ecological Systems

Ecological System Groups	Ecological System
Spruce Forest	Central and Southern Appalachian Spruce-Fir Forest
Northern Hardwood Forest	Appalachian (Hemlock)-Northern Hardwood Forest
Cove Forest	Southern and Central Appalachian Cove Forest
Oak Forests and Woodlands	Northeastern Interior Dry-Mesic Oak Forest
	Central and Southern Appalachian Montane Oak Forest
	Central Appalachian Dry Oak-Pine Forest
Pine Forests and Woodlands	Southern Appalachian Montane Pine Forest and Woodland
	Central Appalachian Pine-Oak Rocky Woodland
Mafic Glade and Barrens and Alkaline Glades and Woodlands	Southern and Central Appalachian Mafic Glade and Barrens
	Central Appalachian Alkaline Glade and Woodland
Cliff, Talus and Shale Barrens	North-Central Appalachian Circumneutral Cliff and Talus
	North-Central Appalachian Acidic Cliff and Talus
	Appalachian Shale Barrens
Floodplains Wetlands and Riparian Areas	Central Appalachian Floodplain
	Central Appalachian Riparian
	Central Interior Highlands and Appalachian Sinkhole and Depression Pond
	Southern and Central Appalachian Bog and Fen
	North-Central Appalachian Acidic Swamp
	North-Central Appalachian Seepage Fen
Caves and Karstlands	Caves and Karstlands

The major stresses and threats to each of these systems were identified. Key attributes and indicators were identified for each of these systems to determine if the systems are performing to their desired conditions.

The GWNF started with statewide species lists compiled from a variety of sources including the Birds of Conservation Concern list, Virginia and West Virginia State Heritage Programs tracked plant and animal lists, Virginia and West Virginia State Comprehensive Wildlife Strategy species of greatest conservation need list, Regional Forester's Sensitive Species list, federally listed Threatened and Endangered Species, and demand species. The original list consisted of about 474 plant and animal species with ranges occurring throughout the states.

Appendix F lists the 97 species which were removed from the list because they did not occur or have potential to occur on NFS-administered land based upon suitable habitat, range, or expert taxonomic consensus. If

these species are found to occur on the GWNF, they will be re-evaluated. Of the remaining species an additional 82 species were not analyzed further because: a) the species is unaffected by management; b) the Forest is of marginal importance to conservation of the species; c) knowledge of species' ecology is insufficient to support conservation strategy; d) species' taxonomy is too uncertain to develop conservation strategy; or d) species is common and demonstrably secure on the Forest.

The remaining 295 species are addressed in this analysis.

These species were placed in groups based on similar habitat needs or on similar management requirements. The major stresses and threats to each of these species were identified. Key attributes and indicators were identified for each of the species groups to evaluate alternatives and develop plan direction.

In addition to noting the Global and State ranks of each of the species, a unit rank, or rank of rarity on the GWNF was also assigned to each species. The U ranks are as follows:

Unit Rank	Unit Rank Description
U1	Critically Imperiled—Critically imperiled on the unit because of extreme rarity (often 5 or fewer occurrences) or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the unit.
U2	Imperiled—Imperiled on the unit because of rarity due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors making it very vulnerable to extirpation from the unit.
U3	Vulnerable—Vulnerable on the unit due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors making it vulnerable to extirpation on the unit.
U4	Apparently Secure—Uncommon but not rare; some cause for long-term concern due to declines or other factors.
U5	Secure—Common, widespread, and abundant on the unit.
UU	Unrankable—Species or system is known to occur on the unit, but is currently unrankable due to lack of information or due to substantially conflicting information about status or trends.
UH	Possibly Extirpated (Historical)—Species or system occurred historically in unit, and there is some possibility that it may be rediscovered. Its presence may not have been verified in the past 20-40 years. A species or system could become UH without such
UX	Presumed Extirpated—Species or system is believed to be extirpated from the unit because it has not been located despite intensive searches of historical and other appropriate sites; there is virtually no likelihood that it will be rediscovered.
UP	Possibly Present--There are no known current or historical occurrences, but the unit is within the range of the species or system and there is some chance it may occur.
UNP	Not Present--Species or system is not known, and is not expected, to occur on the unit.
UNR	Not Ranked—A unit rank has not yet been assigned.
UNA	Not Applicable—A unit rank is not applicable because rarity or vulnerability is not the conservation issue for the species or system (e.g., cowbirds or invasive species).

Viability outcomes can be expressed in terms of the abundance and distribution of species or their habitat. By definition, all of the species that are being addressed (except for the demand species) have limited distribution and limited abundance on the GWNF. The ESE tool generated a priority ranking for all of the species based on the global, state and unit ranks.

Different strategies were used in different alternatives to address habitat needs of the species. The way the alternative affected the indicators for the ecological systems and the species groups are displayed.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

Many of the risks to viability of species on the GWNF are related to factors outside the management direction for the Forest. Many of the species are at the limits of their ranges, utilize habitat from an area much larger than the Forest itself, or are affected by large scale influences like climate change. In these cases, the best that can be done on the GWNF is to maintain and restore resiliency in habitat conditions so that species have the ability to utilize the habitat to the extent they can.

Table H.1 in Appendix H displays each of the species evaluated, the global and unit conservation rankings and the species groups to which each species are associated. Outcomes for the attributes and indicators for the ecological systems are summarized in Tables B1.1 and B1.2. Outcomes for the attributes and indicators for the species groups are summarized in Tables B2.2 and B2.3. They are displayed for the current condition and for 10 years and 50 years of plan implementation under each alternative.

In comparing alternatives, it is important to remember that Alternative A is defined as the management direction for the current plan. The actual accomplishments achieved under current management are closer in scope to Alternative D for prescribed fire and Alternative F for timber harvest.

Table B2.2 Terrestrial Species Groups – Indicators by Alternative at End of First Decade

Species Group Indicator	Current Condition	Condition of Indicator at end of 10 years						
		Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Alkaline glades and barrens		See mafic and alkaline grades ecological system						
Area Sensitive Grassland and Shrubland and Open Woodlands								
Total acres of area sensitive grasslands, shrublands or open woodlands	24,341	58,215	121,389	22,360	86,859	121,389	121,389	121,389
Shrublands > 40 acres	367	367	367	367	367	367	367	367
Area Sensitive Grasslands								
Area sensitive open Habitat grasslands greater than 100 ac	2,358	2,358	2,358	2,358	2,358	2,358	2,358	2,358
Area Sensitive Grasslands								
Area sensitive open habitat grasslands greater than 40 ac	2,744	2,744	2,744	2,744	2,744	2,744	2,744	2,744
Area Sensitive Shrubland and Open Woodlands								
Area sensitive open habitat shrubland and open woodland greater than 100 ac	21,339	55,213	118,387	19,358	83,857	118,387	118,387	118,387
Shrublands > 100 acres	109	109	109	109	109	109	109	109
Area Sensitive Mature Coniferous, Deciduous, and/or Mixed Forest Associates								
Cove, spruce, pine, oak, northern hardwood and riparian ecological systems	899,645	878,879	878,879	907,616	866,882	890,309	881,576	890,309
Calciphiles								
Total High-Quality Habitat Type Acres	6,823	6,823	6,823	6,823	6,823	6,823	6,823	6,823

Species Group Indicator	Current Condition	Condition of Indicator at end of 10 years						
		Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Caves		See caves and karstlands ecological system						
Cavity Trees, Den Trees and Snags								
Compliance with den/cavity tree and snag guidelines	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cliff and Talus and large rock outcrops								
Compliance with cliff, talus and large rock outcrop guidelines	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Cove Forests		See cove forests ecological system						
Fire Dependent and Fire Enhanced								
Acres burned at desired frequency in all systems	18,376	35,855	99,029	0	64,499	99,029	99,029	99,029
Grasslands								
Existing grasslands in open conditions	4,861	4,861	4,861	2,431	4,861	4,861	4,861	4,861
Total grasslands acres	4,861	5,963	7,227	2,815	6,536	7,227	7,227	7,227
Hard and Soft Mast Dependent								
Total shrubland acres	15,213	31,503	31,503	1,562	43,582	19,562	11,503	31,503
Regenerating forest, pine + oak	29,411	45,306	45,306	16,722	57,183	34,292	25,382	45,306
Mature Oak	652,219	626,690	626,690	652,236	613,267	637,705	632,362	626,690
Open canopy pine + oak	17,788	50,289	109,633	16,722	78,038	109,633	109,633	109,633
High Elevation Coniferous, Deciduous and/or Mixed Forests								
Total acres of oak, cove or pine ecosystems in mid-late succession at elevations >3000 feet	156,312	156,312	156,312	156,312	156,312	156,312	156,312	156,312
High Elevation Openings, grassy or shrubby or open woodlands								
Total High Elevation Grassland acres	891	891	891	891	891	891	891	891
Total high elevation shrubland acres	151	151	151	151	151	151	151	151
Regeneration at high elevation	1,018	1,561	1,561	563	1,964	1,163	894	1,561
Late Successional Hardwood Dominated Forest								
Mature and late successional oak, cove and northern hardwoods	690,022	669,611	669,611	695,568	656,069	681,042	675,062	669,611
Lepidopterans -								
Compliance with lepidopteron guidelines	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Mafic Rocks		See mafic and alkaline grades ecological system						
Occurrence Protection								

Species Group Indicator	Current Condition	Condition of Indicator at end of 10 years						
		Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Compliance with Species Occurrence Guidelines	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Open Woodlands								
Open canopy pine, oak, mafic, cliff, riparian, cove, northern hardwood systems	21,230	55,104	118,278	19,249	83,748	118,278	118,278	118,278
Regenerating Forests								
Regenerating forest, pine, oak, cove, northern hardwood systems	30,539	46,829	46,829	16,888	58,908	34,888	26,829	46,829
Riparian		See riparian ecological system						
Ruderal								
Compliance with ruderal species guidelines	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Sandstone Glades and Barrens								
Compliance with sandstone glades species guidelines	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Sensitive to Over-Collection								
Compliance with guidelines for over collection	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Sensitive to Recreation Traffic								
Compliance with recreation traffic guidelines	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Shale Barrens		See cliff, talus and shale barrens ecological system						
Shrublands								
Total shrubland acres	15,213	31,503	31,503	1,562	43,582	19,562	11,503	31,503
Total maintained Shrubland acres	1,503	1,503	1,503	1,503	1,503	1,503	1,503	1,503
Species in a Special Biologic Area								
Special Biological Area Managed for the habitat needed by the species	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table B2.3 Terrestrial Species Groups – Indicators by Alternative at End of Fifth Decade

Species Group Indicator	Current Condition	Condition of Indicator at end of 50 years						
		Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Alkaline glades and barrens		See mafic and alkaline grades ecological system						
Area Sensitive Grassland and Shrubland and Open Woodlands								
Total acres of area sensitive grasslands, shrublands or open woodlands	24,341	65,080	193,160	22,360	131,032	193,160	193,168	193,160
Shrublands > 40 acres	367	367	367	367	367	367	367	367
Area Sensitive Grasslands								
Area sensitive open Habitat grasslands greater than 100 ac	2,358	2,358	2,358	2,358	2,358	2,358	2,358	2,358
Area Sensitive Grasslands								
Area sensitive open habitat grasslands greater than 40 ac	2,744	2,744	2,744	2,744	2,744	2,744	2,744	2,744
Area Sensitive Shrubland and Open Woodlands								
Area sensitive open habitat shrubland and open woodland greater than 100 ac	21,339	62,078	190,158	19,358	128,030	190,158	190,166	190,158
Shrublands > 100 acres	109	109	109	109	109	109	109	109
Area Sensitive Mature Coniferous, Deciduous, and/or Mixed Forest Associates								
Cove, spruce, pine, oak, northern hardwood and riparian ecological systems	899,645	891,856	891,864	996,149	815,558	922,743	962,257	921,827
Calciphiles								
Total High-Quality Habitat Type Acres	6,823	6,823	6,823	6,823	6,823	6,823	6,823	6,823
Caves		See caves and karstlands ecological system						
Cavity Trees, Den Trees and Snags								
Compliance with den/cavity tree and snag guidelines	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cliff and Talus and large rock outcrops								
Compliance with cliff, talus and large rock outcrop guidelines	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cove Forests		See cove forests ecological system						
Fire Dependent and Fire Enhanced								
Acres burned at desired frequency in all systems	18,376	42,720	170,808	0	108,680	170,808	170,808	170,808

Species Group Indicator	Current Condition	Condition of Indicator at end of 50 years						
		Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Grasslands								
Existing grasslands in open conditions	4,861	4,861	4,861	2,431	4,861	4,861	4,861	4,861
Total grasslands acres	4,861	6,100	8,662	2,815	7,419	8,662	8,662	8,662
Hard and Soft Mast Dependent								
Total shrubland acres	15,213	31,119	31,119	1,503	52,583	19,503	11,503	31,119
Regenerating forest, pine + oak	29,411	44,958	44,958	16,722	63,571	34,302	24,663	44,958
Mature Oak	652,219	625,470	625,470	723,901	558,694	654,172	694,015	625,470
Open canopy pine + oak	17,788	55,369	175,145	16,722	118,464	175,145	175,145	175,145
High Elevation Coniferous, Deciduous and/or Mixed Forests								
Total acres of oak, cove or pine ecosystems in mid-late succession at elevations >3000 feet	156,312	156,312	156,312	156,312	156,312	156,312	156,312	156,312
High Elevation Openings, grassy or shrubby or open woodlands								
Total High Elevation Grassland acres	891	891	891	891	891	891	891	891
Total high elevation shrubland acres	151	151	151	151	151	151	151	151
Regeneration at high elevation	1,018	1,548	1,548	561	2,263	1,161	894	1,548
Late Successional Hardwood Dominated Forest								
Mature and late successional oak, cove and northern hardwoods	690,022	682,588	681,756	784,101	609,346	711,795	751,488	681,756
Lepidopterans								
Compliance with lepidopteron guidelines	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mafic Rocks		See mafic and alkaline grades ecological system						
Occurrence Protection								
Compliance with Species Occurrence Guidelines	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Open Woodlands								
Open canopy pine, oak, mafic, cliff, riparian, cove, northern hardwood systems	21,230	61,969	190,049	19,249	127,921	190,049	190,057	190,049
Regenerating Forests								
Regenerating forest, pine, oak, cove, northern hardwood systems	30,539	46,445	46,437	16,829	67,901	34,821	26,829	46,437
Riparian		See riparian ecological system						
Ruderal								
Compliance with ruderal species guidelines	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Species Group Indicator	Current Condition	Condition of Indicator at end of 50 years						
		Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Sandstone Glades and Barrens								
Compliance with sandstone glades species guidelines	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sensitive to Over-Collection								
Compliance with guidelines for over collection	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sensitive to Recreation Traffic								
Compliance with recreation traffic guidelines	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Shale Barrens		See cliff, talus and shale barrens ecological system						
Shrublands								
Total shrubland acres	15,213	31,119	31,119	1,503	52,583	19,503	11,503	31,119
Total maintained Shrubland acres	1,503	1,503	1,503	1,503	1,503	1,503	1,503	1,503
Species in a Special Biologic Area								
Special Biological Area Managed for the habitat needed by the species	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

The following descriptions of the alternatives in relation to species groups are based on comparisons to the current conditions, so they do not include Alternative A.

Alkaline Glades and Barrens species group is addressed through the desired conditions and management objectives for the mafic/alkaline glades ecological system, and so is dependent upon management actions to move these systems to their desired condition. Alternatives B, D, E, F, and G all do this through prescribed burning, though Alternative D does so at a slower pace. The lack of a prescribed burning program in Alternative C limits the development of the open woodland conditions in this Alternative. In addition, key glades are established as Special Biologic Areas.

Area Sensitive Grassland and Shrubland and Open Woodlands species group is addressed through maintaining existing large maintained grassland and shrubland conditions and expanding habitat through the prescribed burning program. All of the alternatives maintain existing conditions, but Alternatives B, D, E, F, and G all expand open woodlands through prescribed burning with alternative D achieving less than the others. The lack of a prescribed burning and timber harvest program in Alternative C limits the development of the open woodland conditions in this Alternative.

Area sensitive grasslands species group is addressed through maintaining existing large maintained grassland conditions. All of the alternatives are expected to maintain the existing occurrences of this habitat.

Area Sensitive Shrubland and Open Woodlands species group is addressed through maintaining existing large existing shrublands and achieving the desired the desired conditions and management objectives for the cliff/talus/shale barren, mafic/alkaline glades, oak, pine and cove ecological systems in regard to regenerating forests and creation of open woodlands. This is dependent upon management actions to move these systems to their desired condition. Alternatives B, D, E, F, and G all do this through timber harvest and prescribed burning, with Alternative D at a slower pace of burning. The lack of a prescribed burning and timber harvest program in Alternative C limits the development of the open woodland and shrubland conditions in this Alternative.

Area Sensitive Late Successional Coniferous, Deciduous and/or Mixed Forests species group is addressed through achieving the desired the desired conditions and management objectives for the spruce, oak, pine, riparian and cove ecological systems in regard to mature forest conditions. All of the alternatives respond similarly with a large percentage of the forest in this habitat type.

Calciphiles species group is addressed through the cave and karstland standards and through the establishment of Special Biological Areas for the most representative calciphile sites. All of the alternatives provide protection and management of this group in the same way.

Caves species group is addressed through the establishment of cave and karstland standards that are part of all of the alternatives. These standards are designed to protect the physical (including the hydrology), chemical and biological characteristics of the caves and karstlands. In addition, in Alternatives E and G, caves (and defined areas around the caves) identified by the Virginia Natural Heritage Program are established as special geologic areas.

Cavity Trees, Den Trees and Snags species group is addressed through the establishment of standards to protect cavity and den trees and snags when management activities will remove trees. Given the mature and late successional stage of most of the forest, this habitat type is well represented throughout the forest. All of the alternatives provide protection and management of this group in the same way.

Cliff and Talus and Large Rock Outcrops species group is addressed through the establishment of a standard to assess the impacts of any activities proposed in this habitat type on the species identified as part of this group. All of the alternatives provide protection and management of this group in the same way.

Cove forests species group is addressed through the desired conditions and management objectives for the cove forest ecological system, and so is dependent upon management actions to move this system to its desired condition. Alternatives B, D, E, F, and G all do this through timber management, though Alternatives E and G do so at a slower pace. The lack of a timber harvest program in Alternative C limits the development of the diverse age and structural conditions to meet the desired conditions.

Fire Dependent and Fire Enhanced species group is addressed through the desired conditions and management objectives for the mafic/alkaline glades, cliff/talus/shale barren, pine, and oak ecological systems in regard to are burned at desired frequency, and so is dependent upon management actions to move these systems to their desired condition. Alternatives B, D, E, F, and G all do this through prescribed burning, though Alternative D does so at a slower pace. The lack of a prescribed burning program in Alternative C limits the active restoration of this habitat in this Alternative which relies on naturally ignited fire to achieve restoration of fire communities.

Grasslands species group is species group is addressed through maintaining existing grasslands. All of the alternatives, except Alternative C, are expected to maintain the existing occurrences of this habitat. In Alternative C, maintenance of existing grasslands is reduced below current levels.

Hard and Soft Mast Dependent species group is addressed through maintaining existing shrublands and achieving the desired the desired conditions and management objectives for the oak, pine and cove ecological systems in regard to regenerating forests and the oak systems for mature forest. This is dependent upon management actions to move these systems to their desired condition. Alternatives B, D, E, F, and G all do this through timber harvest with Alternative D achieving the highest level and Alternative F a smaller level than B, E, and G. The lack of a timber harvest program in Alternative C limits the development of the soft mast component and could reduce the hard mast through oak stands aged past their prime acorn bearing years and through the replacement of oak with shade tolerant trees.

High Elevation Coniferous, Deciduous and/or Mixed Forests species group is addressed through maintaining the acreage of these forest types. All of the alternatives are expected to maintain the existing occurrences of this habitat.

High Elevation Openings, Grassy or Shrubby or Open Woodlands species group is addressed through maintaining existing grasslands and achieving the desired the desired conditions and management objectives for the oak, pine, northern hardwood and cove ecological systems in regard to regenerating forests. This is dependent upon management actions to move these systems to their desired condition. Alternatives B, D, E, F, and G all do this through timber harvest with Alternative D achieving the highest level and Alternative F a smaller level than B, E, and G. The lack of a timber harvest program in Alternative C limits the development of additional habitat for this group.

Late Successional Hardwood Dominated Forest species group is addressed through achieving the desired the desired conditions and management objectives for the oak, northern hardwood and cove ecological systems in regard to late successional forest conditions. All of the alternatives respond similarly with a large percentage of the forest in this habitat type.

Lepidopterans species group is addressed through the establishment of standards to protect against impacts from spraying for gypsy moth and from prescribed burning. All of the alternatives provide protection and management of this group in the same way.

Mafic Rocks species group is addressed through the desired conditions and management objectives for the mafic/alkaline glades ecological system, and so is dependent upon management actions to move these systems to their desired condition. Alternatives B, D, E, F, and G all do this through prescribed burning, though Alternative D does so at a slower pace. The lack of a prescribed burning program in Alternative C limits the development of the open woodland conditions in this Alternative. In addition, key mafic rock locations are established as Special Biologic Areas.

Occurrence Protection species group is addressed through the establishment of standards to guide review and assessment of activities that could affect species in this group. All of the alternatives provide protection and management of this group in the same way. Due to the fewer ground disturbing activities allowed in Alternative C, it is likely to have fewer potential impacts on these species.

Open Woodlands species group is addressed through achieving the desired the desired conditions and management objectives for the cliff/talus/shale barren, mafic/alkaline glades, oak, and pine ecological systems in regard to creation of open woodlands. This is dependent upon management actions to move these systems to their desired condition. Alternatives B, D, E, F, and G all do this through prescribed burning, with Alternative D at a slower pace of burning. The lack of a prescribed burning and timber harvest program in Alternative C limits the development of the open woodland conditions in this Alternative.

Regenerating Forests species group is addressed through achieving the desired the desired conditions and management objectives for the oak, pine, northern hardwood and cove ecological systems in regard to regenerating forests. This is dependent upon management actions to move these systems to their desired condition. Alternatives B, D, E, F, and G all do this through timber harvest with Alternative D achieving the highest level and Alternative F a smaller level than B, E, and G. The lack of a timber harvest program in Alternative C limits the development of additional habitat for this group.

Riparian species group is addressed through the establishment of standards to guide management of activities in riparian areas. Alternatives B, C, E, F, and G provide protection and management of this group in the same way by expanding the riparian areas to the same level as the Fish and Mussel Conservation Plan used in the Jefferson Forest Plan. Alternative D only expands the riparian areas in watersheds that support Threatened and Endangered aquatic species.

Ruderal species group is addressed through the establishment of standards to manage the old home sites, roadsides, and old fields where members of the ruderal species group are found in conditions that maintain their open character. All of the alternatives provide protection and management of this group in the same way.

Sandstone Glades and Barrens species group is addressed through the establishment of Special Biological Areas for high quality examples of this habitat. All of the alternatives provide protection and management of this group in the same way.

Sensitive to Over-Collection species group is addressed through the establishment of standards to limit collection of the species in this group. All of the alternatives provide protection and management of this group in the same way.

Sensitive to Recreation Traffic species group is addressed through the establishment of standards to reduce impacts of recreation activities on the species in this group. All of the alternatives provide protection and management of this group in the same way.

Shale barrens species group is addressed through the desired conditions and management objectives for the cliff/talus/shale barren ecological system, and so is dependent upon management actions to move these systems to their desired condition. Alternatives B, D, E, F, and G all do this through prescribed burning, though Alternative D does so at a slower pace. The lack of a prescribed burning program in Alternative C limits the development of the open woodland conditions in this Alternative. In addition, key shale barren locations are established as Special Biologic Areas.

Shrublands species group is addressed through maintaining existing maintained shrublands and achieving the desired the desired conditions and management objectives for the oak, pine and cove ecological systems in regard to regenerating forests. This is dependent upon management actions to move these systems to their desired condition. Alternatives B, D, E, F, and G all do this through timber harvest with Alternative D achieving the highest level and Alternative F a smaller level than B, E, and G. The lack of a timber harvest program in Alternative C limits the development of additional habitat for this group.

Species in a Special Biologic Area is addressed through the establishment of Special Biologic Areas to protect rare communities. All of the alternatives generally provide protection and management of this group in the same way. However, recommended wilderness could affect Special Biologic Areas. If an area were designated, the ability to provide management activity, if it were needed, could be prohibited, or made difficult to achieve.

The relative changes in habitat for each species are then displayed in Table H.2 in Appendix H based on the effects to the various species groups. The table shows species effects from the addition of standards to protect species and the effects from management actions proposed in the alternatives.

The table shows that almost all of the species benefit from each alternative, other than Alternative A, due to the additional species group protections that are common to all the other alternatives. About half of the species need management action to create the composition or structure of vegetation that they need. The needs of the other half are largely met through standards to protect their habitat. Many of the species that need the protection standards are riparian species. If the riparian species are not considered, then about three-quarters of the terrestrial species considered in the analysis, need some level of vegetation management. All of the alternatives provide a large portion of the forest in remote settings with little management activity. All of the alternatives except Alternative C provide for active vegetation management in the form of timber harvest and prescribed burning. The lack of this vegetation management in Alternative C makes it the only alternative that does not address the viability needs of all of the species on the Forest.

Despite similarities among Alternatives A, B, D, E, F, and G, some differences in effects of alternatives are apparent. Since Alternative A continues current direction, it does not have the advantage of the additional protection and management guidance developed to support ecosystem and species diversity that is part of all of the other alternatives. Since Alternative D does not expand the riparian areas the same level as Alternatives B, C, E, F, and G, it does not provide the same level of protection to the riparian species. Alternatives B, E, F, and G have similar levels of prescribed burning and Alternatives E and G have similar levels of timber harvest. Alternatives E and G provide the best mix of habitat management and habitat protection to create resilience and diversity of habitat to maintain viability of the species on the GWNF.

The data in Table B2.3 can be summarized as descriptive viability outcome ratings. The data is summarized into the following categories.

Table B2.4 Categories of Outcome Ratings

Outcome Rating	Global and Unit Conservation Ranks Included in the Rating
Outcome A. Species is globally secure or apparently secure and it is reasonably distributed and relatively abundant on the Forest. Likelihood of maintaining viability is high.	G4 or G5 and U3 or U4
Outcome B. Species is globally secure or apparently secure. Species is potentially at risk on the Forest due to limited distribution. Therefore, likelihood of maintaining viability is moderate.	G4 or G5 and U1, U2, or UP/UH
Outcome C. Species is vulnerable globally, but is reasonably distributed on the Forest. Therefore, species viability on the Forest is moderate.	G3 and U3 or U4
Outcome D. Species is vulnerable globally and is potentially at risk on the Forest due to limited distribution. Therefore, species viability may be at risk.	G3 and U1, U2, or UP/UH
Outcome E. The species is imperiled or critically imperiled globally. Therefore, species viability may be at risk.	G1 or G2

The expected changes in viability ratings based on implementation of each alternative are displayed in Table B2.5.

Table B2.5 Number of Species Whose Viability Outcome Changes by Alternative

Viability Outcome Groups	Number of Species						
Indicator	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Outcome Group A							
Total in group		44	44	44	44	44	44
Benefit from direction for additional protection		44	44	44	44	44	44
Small improvements in habitat due to effects of management activities		2	0	9	1	1	2
Improvements in habitat due to effects of management activities		7	0	0	7	7	7
Reductions in habitat due to effects of management activities		0	10	0	0	1	0
Minimal change in habitat due to effects of management activities		2	1	2	3	2	2
Outcome Group B							
Total in group		41	41	41	41	41	41
Benefit from direction for additional protection		40	40	40	40	40	40
Small improvements in habitat due to effects of management activities		1	1	9	0	0	1
Improvements in habitat due to effects of management activities		8	0	0	8	8	8
Reductions in habitat due to effects of management activities		1	9	1	1	2	1
Minimal change in habitat due to effects of management activities		2	2	2	3	2	2

Viability Outcome Groups	Number of Species						
Indicator	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Outcome Group C							
Total in group		12	12	12	12	12	12
Benefit from direction for additional protection		12	12	12	12	12	12
Small improvements in habitat due to effects of management activities		1	1	3	0	1	1
Improvements in habitat due to effects of management activities		2	0	0	2	2	2
Reductions in habitat due to effects of management activities		1	3	1	1	1	1
Minimal change in habitat due to effects of management activities		0	0	0	1	0	0
Outcome Group D							
Total in group		188	188	188	188	188	188
Benefit from direction for additional protection		170	170	170	170	170	170
Small improvements in habitat due to effects of management activities		23	1	57	11	12	23
Improvements in habitat due to effects of management activities		36	0	2	36	34	36
Reductions in habitat due to effects of management activities		1	59	1	1	11	1
Minimal change in habitat due to effects of management activities		9	9	9	21	12	9
Outcome Group E							
Total in group		17	17	17	17	17	17
Benefit from direction for additional protection		12	12	12	12	12	12
Small improvements in habitat due to effects of management activities		3	0	9	3	5	3
Improvements in habitat due to effects of management activities		6	0	0	6	2	6
Reductions in habitat due to effects of management activities		0	9	0	0	0	0
Minimal change in habitat due to effects of management activities		3	3	3	3	5	3

Planning for, and evaluation of, species viability for forest plan revision has focused primarily on providing desired abundance and distributions of habitat elements, in compliance with NFMA regulations. Risks to species viability can be much reduced by additional provisions present in existing law and policy. These include specific consideration of effects to federally listed threatened and endangered species, those proposed for such listing, and Regional Forester's Sensitive Species; and in biological assessments and evaluations conducted as part of all national forest management decisions. These assessments and evaluations identify where additional protective measures are warranted to provide for continued existence of the species on national forest land. Projects that may affect federally listed or proposed species must be coordinated with the US Fish and Wildlife Service. In support of these requirements, these species are also often the focus of inventory and monitoring efforts.

Additional species-based provisions included in all Forest Plan alternatives supplement existing law and policy. All alternatives include general and species-specific provisions for federally listed species, developed through coordinated planning with the US Fish and Wildlife Service.

In conclusion, high-risk species/habitat relationships are primarily a result of historical influences that have reduced distribution and abundance of some habitat elements and species populations, and of future impacts from forest health threats. In general, effects of proposed management strategies are small relative to

historical impacts and future external threats. In general, risks to species viability are minimized by forest plan revision alternatives that provide a balanced mix of low-disturbance and disturbance-dependant habitat elements. Some elements in this mix are best provided through passive management and protection, while others require active management for restoration and maintenance.

B2B– FEDERALLY LISTED THREATENED AND ENDANGERED SPECIES

INDIANA BAT

AFFECTED ENVIRONMENT

A Biological Assessment was written in April 1997 to analyze effects to the Indiana bat resulting from continued implementation of the George Washington and Jefferson National Forest Plans. Formal Consultation with the Annapolis Field Office of the U.S. Fish and Wildlife Service was requested on May 12, 1997 which included a request for incidental take. On September 16, 1997 a Biological Opinion was issued that included incidental take provisions along with Terms and Conditions and Conservation Recommendations. The George Washington Forest Plan was amended (Amendment #6) to include provisions resulting from that formal consultation. Information presented in the 1997 Biological Assessment and Biological Opinion is still pertinent to the current revised George Washington Forest Plan and is therefore incorporated by reference.

On March 11, 1967, the Indiana bat was listed as a federal endangered species under the Endangered Species Preservation Act (ESPA) of 1966. Species listed under ESPA carried over and became listed by the Endangered Species Act when it became law in 1973. A recovery plan for the species was completed on October 14, 1983. In October 1996, the Indiana Bat Recovery Team released a Technical Draft Indiana Bat Recovery Plan. In October 1997, a preliminary version entitled "Agency Draft of the Indiana Bat Recovery Plan," which incorporated changes from the 1996 Technical Draft, was released. Subsequently, an agency draft entitled "Indiana Bat (*Myotis sodalis*) Revised Recovery Plan" was distributed for comments in March 1999. A final revision has never been completed.

Critical habitat was designated for the species on September 24, 1976 and includes 11 caves and 2 abandoned mines in Illinois, Indiana, Kentucky, Missouri, Tennessee, and Hellhole Cave in Pendleton County, West Virginia. No critical habitat is on or near the GWNF. The distribution of Indiana bats is generally associated with limestone caves in the eastern U.S. (Menzel et al. 2001). Within this range, the bats occupy two distinct types of habitat. During winter, the Indiana bat hibernates in caves (and occasionally mines) referred to as hibernacula. Bats are often readily found and easily counted at this time. Census of hibernating Indiana bats is the most reliable method of tracking population trends rangewide. As such, winter distribution of the Indiana bat is well documented. Less is known about the abundance and distribution of the species during the summer maternity season, and even less is known about its migratory habits and associated range. During summer months, maternity colonies of more than 100 adult females roost under sloughing bark of dead and partially dead trees of many species, often in forested settings (Callahan et al. 1997). Reproductive females may require multiple alternate roost trees to fulfill summer habitat needs. Adults forage on winged insects within three miles of the occupied maternity roost. Swarming of both males and females and subsequent mating activity occurs at cave entrances prior to hibernation (MacGregor et al. 1999). During this autumn period, bats roost under sloughing bark and in cracks of dead, partially dead and live trees.

The U.S. Fish and Wildlife Service in 2007 reported the total population of Indiana bats at a recent historic high of approximately 468,181 individuals. This total is still less than half the estimated population in 1960. The 2009 population of Indiana bats was estimated to be 387,835 individuals. Reasons for the decline from 2007 are unknown, but some speculation is that the decline was caused by White Nose Syndrome (WNS) which is causing severe bat mortality in the eastern U.S. In 2007 Indiana bats were known to hibernate in approximately 281 hibernacula in 19 states (USFWS, 2009). Indiana has 49% of hibernating individuals

followed by Kentucky 15%, Illinois 14%, New York 8%, West Virginia 4%, Missouri 4%, Tennessee 3%, Ohio 2% and the remaining eight states with hibernacula (including Virginia) <1%. The eight largest "Priority One" hibernacula (recorded population >30,000 since 1960) contain 199,000 Indiana bats, or 52 percent of the total known population. The 69 hibernacula classified as "Priority Two" (recorded population >500 but <30,000 bats since 1960) contain 174,000 Indiana bats, or 45 percent of the total known population. The remaining 259 caves known to have been occupied by Indiana bats contain only 15,000 bats, less than 4 percent of the total population (the four hibernacula on or near the Forest – Starr Chapel, Mountain Grove, Clarks, and Hupman's Saltpetre Caves - are in this category). Although the winter range is large, the known population of the species has been found in only 336 hibernacula in an area with tens of thousands of caves (and mines). Within 5 miles of the George Washington & Jefferson National Forests, eleven hibernacula for Indiana bats are known from 7 counties in Virginia (Bath, Bland, Craig, Highland, Lee, Tazewell, and Wise) and 1 county in West Virginia (Monroe). The Virginia Fish and Wildlife Information Service has additional historic records of Indiana bats wintering in Dickenson, Giles, Montgomery, and Shenandoah counties. Critical habitat for the Indiana bat has not been designated in Virginia. Currently all 12 caves have been gated to reduce or eliminate human disturbance. All 12 caves continue to support varying numbers of Indiana bats.

The Indiana bat has been documented in Virginia since the mid-1960's. In the early 1960's, the state's Indiana bat population was estimated at over 5,000. Dalton (1987) found 2,500 Indiana bats hibernating in eight caves during a 10-year survey of 170 caves in 22 counties. In 1997 the state's population was estimated to be 1,840 bats. The following table illustrates population numbers in VA and WV since 2001:

Table B2.6 Estimated Indiana Bat Populations

	2001	2003	2005	2007	2009
Virginia	969	1,158	769	723	730
West Virginia	9,714	11,444	13,417	14,745	14,855

All four caves that occur on or near the Forest that support hibernating Indiana bats are gated to control human access. The following table displays numbers of bats seen during winter survey counts conducted over the past 40 years in four caves in or near the Forest.

Table B2.7 Indiana Bats in Hibernacula on or Near the GWNF
(Caves with Primary and Secondary Cave Protection Areas on land managed by GWNF)
(Number of Bats Counted per Rick Reynolds - VDGIF)

Winter Survey Year	Starr Chapel Cave	Mt. Grove Cave	Clarks Cave	Hupman's Saltpetre Cave
1960	600			
1962	600			
1972	35			
1974	30			
1978	2			
1979	1			
1980	0			
1981		0		
1982	16	0		
1983	29			
1984				

Winter Survey Year	Starr Chapel Cave	Mt. Grove Cave	Clarks Cave	Hupman's Saltpetre Cave
1985	30			
1986		0	21	
1987	5		52	
1988			31	0
1989	36			
1990	37	5	22	26
1991	23			0
1992	38	23	0	220
1993	31	0		
1994	42	1	20	300
1995	60			
1996			0	225
1997	54			
1998		2		
1999	55		1	
2000				
2001		2		5
2002				
2003	67		47	4
2004				
2005	57		50	0
2006				
2007	68		49	
2008				
2009	61		48	
2010				
2011	*	*	*	*

Blank cells = no survey done that winter.
* Survey for 2011 still ongoing as of 2-15-2011

Numbers fluctuate from count-to-count but those caves that have lower numbers of bats seem to maintain low numbers while those with higher numbers maintain relative higher numbers of bats. Steps have been taken by the GWNF to protect these caves for the Indiana bat. Since 1995, bat gates have been installed on all significant caves used by T&E bats on the Forest. Starr Chapel Cave and Mountain Grove Cave on the Warm Springs Ranger District are the only caves on National Forest land which serve as hibernacula for Indiana bats. Clarks Cave and Hupman's Saltpeter Cave are on private land, but within 2-miles of Forest land. Therefore portions of the primary and/or secondary cave protection areas extend onto the Forest. Over the past 15-years Rick Reynolds of the Virginia Department of Game and Inland Fisheries has assisted the Forest in monitoring bats during winter surveys and assisting with other studies.

It is difficult to quantify summer roosting habitat for Indiana bat at a range-wide, regional, or local level due to the variability of known roost sites and lack of knowledge about landscape scale habitat characteristics. Forest

management practices that affect occupied roost trees may have local impacts on Indiana bat populations. However, the bats live in highly altered landscapes, depend on an ephemeral resource (dead and dying trees) and appear to be very adaptable. Anecdotal evidence suggests that these bats may respond positively to some degree of habitat disturbance (USDI Fish and Wildlife Service 1999). General standards that would help ensure adequate roost habitat include retention of snags and suitable roost trees whenever possible, prescribed burning to restore and maintain open midstory foraging conditions (using only cool season backing fires in karst areas), and ensuring a continuous supply of oaks, hickories, and ash as well as other trees with exfoliating bark (Menzel et al. 2001).

During summer, reproductive females form maternity colonies in trees. Maternity colonies may be formed hundreds of miles from the hibernacula, and females from a maternity colony may come from more than one hibernaculum. In contrast, males often use wooded areas near the hibernaculum, occasionally visiting the hibernaculum throughout the summer. Males sometime migrate long distances to summer habitat, although they tend to be less migratory than females, and often, though not always, remain geographically close to the hibernacula. During this time, males often roost individually, and likely use trees similar in character to those used near hibernacula in autumn and spring. Wooded lands closer to hibernacula are more likely to support males in summer than areas farther away, but essentially all of the George Washington National Forest may provide suitable summer habitat. Although most of the lands within the Forest provide suitable summer habitat for the Indiana bat, based on observations and field surveys, no juveniles or lactating females have been found. There is no evidence to date that maternity colonies occur in Virginia or within the GWNF. The core summer range of the Indiana bat is southern Iowa, northern Missouri, northern Illinois, northern Indiana, southern Michigan, and western Ohio. West Virginia is within the eastern maternity range, but not within the core range. Maternity colonies are known to occur in some eastern states, such as Kentucky and North Carolina. In the summer of 1995, six male Indiana bats were captured in Tucker County, West Virginia. These captures represent the first documented summer use in West Virginia by Indiana bats and suggest that males in West Virginia use areas near the hibernacula during summer. Until 2004 the best evidence of maternity activity in West Virginia was the discovery of a juvenile male on August 5, 1999 (Kiser et al. 1999b). This is outside the defined maternity period and likely represents a juvenile migrating to a nearby hibernaculum. Then during the summer of 2004 surveys found a maternity colony estimated at 25 Indiana bats in Tucker County, West Virginia within two-miles of a known hibernaculum (USFS, 2009). That same summer three male Indiana bats were captured on the Monongahela National Forest in Pendleton County and tracked to a roost tree where 23 other bats were subsequently counted (USFS 2009). To date no maternity colonies or reproductive female Indiana bats have been captured in Virginia during the summer reproductive season. In summer 1993, Chris Hobson of the Virginia Division of Natural Heritage surveyed areas of Bath, Bland, Highland, Lee, Tazewell, and Wise counties in proximity to known hibernacula. No female Indiana bats were captured and seven males were captured at five sites. One of the males, captured on July 28, 1993 in Cumberland Gap National Historic Park, Lee County, was a juvenile, suggesting that a maternity colony may be located in the Cumberland Gap area of Virginia, Kentucky, or Tennessee. These captures are the only documented summer Indiana bat occurrences in Virginia and suggest that males, at the least, use areas near the hibernacula during summer in western Virginia (Hobson, 1993). Brack and others analyzed summer netting efforts 1995 to 2000 to identify summer reproductive populations in Virginia, West Virginia, and portions of Pennsylvania considered within the summer range of the Indiana bat. Over 3,000 net nights of effort failed to produce evidence of any maternity colonies.

Autumn swarming and spring staging typically occur in woodlands near the hibernacula with use of the hibernacula increasing as autumn progresses towards winter and decreasing as spring progresses towards summer. Little is known about the habitat used by either sex during migration, although it is generally presumed to include a variety of wooded habitats. The following is an excerpt from the USDI Fish and Wildlife Service (1999) Revised Draft Indiana Bat Recovery Plan: “Although certain migration patterns may be inferred from limited band returns, they should be interpreted with caution. The sparse band recovery records, all of which are from the Midwest, indicate that females and some males migrate north in the spring upon emergence from hibernation (Hall 1962; Barbour and Davis 1969; LaVal and LaVal 1980), although there is also evidence that movements may occur in other directions. However, summer habitats in the eastern and southern United States have not been well investigated; it is possible that both sexes of Indiana bats occur throughout these regions. Very little is known about Indiana bat summer habitat use in the southern and eastern United States, or how many Indiana bats may migrate to form maternity colonies there. Most summer captures of reproductively active Indiana bats (pregnant or lactating females or juveniles) have been made

between April 15 and August 15 in areas generally north of the major cave areas. While these observations suggest that many or most female Indiana bats in the Midwest migrate north in the spring and south in the fall, potentially significant numbers also migrate in other directions." When Indiana bats are captured in spring or autumn, especially when caught near a cave or mine, there is generally no way to determine why the bat was in the area. Indiana bats may use caves and mines during the non-maternity season (autumn through spring) for one or more reasons: 1) winter hibernation (and "preparation" for hibernation); 2) autumn swarming; 3) spring staging; and 4) vagrant or migratory use. Hibernacula tend to have higher use in spring and autumn, and larger winter concentrations typically produce greater spring and autumn use. In West Virginia, a male juvenile caught on August 5, 1999 (Kiser et al. 1999b) was likely migrating to a nearby hibernaculum. As noted above, Indiana bats hibernating in mountainous regions of West Virginia may travel to warmer areas in the western part of the state or states to the west to raise their young. Brack and others indicated that nursery colonies were less likely in higher elevations and areas of cooler temperatures. During a survey of coal mining operations in Wise County Virginia, a consulting firm documented use of an abandoned coalmine by a female Indiana bat on April 14, 2001 which may have been a migratory individual. During autumn swarming and spring staging, Indiana bats use the cave hibernacula and nearby wooded habitats. In autumn, use of woodlands decreases over time as bats enter hibernation. The converse is true in spring. Two recent telemetry studies documented use of a variety of habitats within 2 miles of two caves on the Jefferson National Forest. In late September 1999 four Indiana bats (3 males, 1 female) were trapped and fitted with radio transmitters at the entrance of Rocky Hollow Cave in Wise County. From September 23rd to October 13th (21 days) three roost trees were located (all on private land) that were used by two of the bats (one male and one female). The female used two different trees in open woodlands approximately 1.5 miles southwest of the cave near the Lonesome Pine Country Club. One was a shagbark hickory 19" DBH (diameter breast height) and the other was a yellow poplar with peeling bark next to a skid-road that had been damaged during a logging operation. The tree occupied by the male bat was used as a roost on multiple days and was a pignut hickory 27.9" DBH located 0.15 miles north of the cave. Other observations made during the course of the study included extensive foraging activity over hayfields and along edges of forests and fields. During September and October of 2000 an extensive survey was made of fall swarming activity near Newberry-Bane Cave in Bland County, Virginia as part of the proposed American Electric Power (AEP) 765 kV Wyoming (WV) to Jacksons Ferry (VA) powerline project. This work was conducted by Virgil Brack of Environmental Solutions and Innovations, Cincinnati, Ohio and is documented in the Appendix to the Biological Assessment for the EIS associated with that project. Of 27 Indiana bats captured (24 males and 3 females) at the mouth of Newberry-Bane Cave, 17 (14 males and 3 females) were fitted with transmitters. Radio-tagged bats were monitored between September 9th and October 21st within 2-miles of the cave entrance.

Information gathered on foraging ecology found that Indiana bats most frequently used agricultural land (44.7%), intermediate deciduous forests (22.6%), and open deciduous forests (19.0%) habitats types, comprising 86.3% of all habitat types used for foraging during the survey. The bats' activity areas included proportionally more agricultural lands and open forests than was available in the study area. Closed canopy woodlands were not used by foraging bats to the extent they were available. The study concluded that Indiana bats more frequently used rights-of-way, pasture edges, savannah-like woods, and other openings rather than large, continuous tracts of closed canopy forests. These findings are consistent with the interpretation of telemetry data in similar studies.

For roosting ecology the study found a total of 26 roost trees for 8 of 17 bats fitted with transmitters. Of the 26 roost trees, 39% were shagbark hickories (*Carya ovata*) and 12 % northern red oak (*Quercus rubra*), for a total of 51%. Other tree species used as roosts included white oak (*Quercus alba*), red maple (*Acer rubrum*), sugar maple (*Acer saccharum*), black oak (*Quercus velutina*), bitternut hickory (*Carya cordiformis*), American basswood (*Tilia americana*), and yellow birch (*Betula alleghaniensis*). Five (19%) of the roost trees were dead snags. All roost trees were located in close proximity to the cave entrance ranging from 0.16 to 0.86 miles, with an average distance of 3,280 feet (0.6 miles). All roost trees were located near forest canopy openings such as open woodlands of pastures, scattered trees of recently logged areas, old logging roads, utility line corridors, and natural drainages. Five of the eight bats used the same roost tree for two to three consecutive days. Roosts were located in all types of deciduous forests, but exhibited a disproportionately small use of mixed evergreen and deciduous forests. Roosts trees were very exposed with little or no canopy. It is likely that in doing so the bats were taking advantage of exposure to solar radiation in order to better regulate body temperature. Many open-canopy areas existed due to recent logging activity that left scattered trees within the

harvested areas. Roosts in closed canopy deciduous forests were often in small openings near open corridor flyways.

While much of the activity observed during the study was close to the cave (within approximately 0.6 mile) bats also left the 2-mile study area all together. Males more so than females tended to range further from the cave. Perhaps they would leave to forage where there was less competition for prey (the caves in the area serve as hibernacula for over 8,000 individual bats of at least five different species) and return to the cave area periodically to mate. It's therefore likely roosting and foraging activity also occurred outside this 2-mile area but all documented roost trees and foraging behavior observed were within two miles of the Newberry-Bane cave. Work in Missouri (Romme et al. 2002) and Kentucky (Kiser and Elliott 1996; and Gumbert 1996) have found that Indiana bats range up to 5 miles from hibernacula during autumn and spring swarming activity periods. Based on terrain and landscape characteristics of these areas (generally rolling without great vertical relief) when compared to the Ridge and Valley terrain of Virginia (mountainous with vertical relief 1,300 to 2,500 feet) it is likely Indiana bat activity in this portion of the Appalachians is confined to the valley in which the hibernaculum occurs and may extend into adjacent valleys via gaps in the surrounding ridges or mountains. It is unlikely many bats will fly up more than a 1,000 vertical feet and over a mountain to forage in an adjacent valley, especially when these mountains are densely forested without many open corridors to serve as flyways.

The timing of spring and autumn migration has been generally inferred as the time between when bats leave the hibernacula and when they are found in maternity areas (spring), and vice-versa (autumn). In most portions of the range, this is generally considered to be from 15 April to 15 May in spring, and 15 August to 15 November in autumn, although these dates are sometimes adjusted regionally to accommodate latitudinal differences in season. Essentially all acres within the George Washington National Forest could serve as potential migratory habitat for the Indiana bat.

Additional recent threats include White Nose Syndrome (WNS) and commercial scale wind power development. WNS is a fungus caused disease that was first seen in New York caves during the winter of 2006-2007. The newly discovered, cold-loving fungus (*Geomyces destructans*) has spread south during the past several years and was first confirmed in Virginia and West Virginia during the winter of 2008-2009 with additional spread and caves contaminated in 2009-2010. To date well over 1-million bats have been killed by this fungus which irritates bats during hibernation causing them to wake and use precious fat reserves. The bats then starve and or freeze when they attempt to fly and leave the cave in search of food during the midst of winter conditions.

Commercial wind power development has rapidly expanded across the Appalachians. Multiple sites have been developed in West Virginia and one site is being constructed in Virginia west of Monterey in Highland County. Bats are often killed during wind tower operations when they fly into the lower pressure area surrounding the trailing edge of spinning blades and suffer extreme barotrauma where decompression causes capillaries in the lungs to explode. Bats are most affected during periods of fall migration when they often follow ridgetops and come into contact with wind towers built along those same ridgetops.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

Effects to the federally endangered Indiana bat (*Myotis sodalis*) were considered because it is assumed the entire Forest is potential habitat for this species. See USDI Fish and Wildlife Service's Biological Opinion (BO) of September 16, 1997 and the Forest's Environmental Assessment/Decision Notice of March 12, 1998 for the "Proposed Forest Plan Amendment for Management of the Federally Endangered Indiana Bat." Potential habitat (mature forests with trees having exfoliating bark) exists across the entire Forest and contains tree species of the size and type known to be used by the Indiana bat. The retention of some snags, shagbark hickory, and hollow trees (as available) will allow for potential Indiana bat roost sites. Decreasing canopy closure as occurs with timbering and prescribed fire activities will increase the degree of exposure of some potential maternity roost trees to solar radiation, providing improved thermal conditions for raising young during a wide range of weather conditions. Pond/waterhole construction will increase the number of upland water sources available for Indiana bats. Persistence of early successional habitats and forests with an open understory and patchy overstory would create insect-rich foraging areas and flight corridors leading to any potential roost trees. Harvesting would produce a mosaic of regeneration areas intermixed with mature and late successional forests. Likewise prescribed fire would also create a mosaic of forest successional stages

from early to late resulting from varying fire intensities associated with topographic features, vegetative types, and fuel accumulations. This will indirectly provide feeding areas since bats are known to forage within the canopy openings of upland forests, over clearings with early successional vegetation, and even along the borders of croplands, or wooded strips (fencerows), and over ponds. In contrast, negative impacts to the Indiana bat will be: (a) the slight chance that individuals or small groups of roosting bats (including summer maternity colonies) could be unintentionally killed by the intentional felling of trees harboring undetected roosts (e.g. dead limbs with loose bark, or small cavities in the boles), or by the accidental felling of occupied snags, or damaged or hollow trees during timber harvest or other activities; and (b) a short-term reduction in the total amount of foraging habitat available to individual Indiana bats which would be incurred on regeneration cuts. Although the likelihood is very low, tree cutting activities could result in the inadvertent loss of individual Indiana bats or small groups of Indiana bats via removal of some large-diameter hardwood trees occupied by bats during the period from approximately April 1 to October 15. Occupied and potential roost trees could be directly affected by vegetation management, firewood and salvage sales, routine maintenance/permitting of small clearings including easements, rights-of-way and access to privately-owned lands, and road construction. Plan implementation will result in vegetation disturbance and possible impact to currently occupied and potentially occupied roost trees. There is potential for adverse effects to a maternity roost tree if one occurs on the Forest and in an area where trees are being felled. However, forest-wide standards would minimize, if not eliminate, the chance of adverse effects under all alternatives. Any Indiana bat roosts that are discovered would be protected from cutting and modification until they were no longer suitable (unless treatments were needed for public or employee safety) under all alternatives.

The National Forest fuelwood program allows the public to purchase and collect wood, often recently downed or standing/leaning dead trees, for personal use. The program is regulated by issuance of an area-specific permit and collection occurs primarily along roadsides and other specified sites with easy access. Vehicles must remain on open roads are not allowed to travel through the forest in order to find, cut, and load firewood. This therefore restricts the distance at which most people are willing to cut and haul firewood and results in firewood being cut within 150 feet (about two tree lengths) of an open road, and limited almost exclusively to level terrain or the uphill side. Volume of firewood cut on the GWNF during 2008 was 4,488 CCF (hundred cubic feet) and during 2009 5,256 CCF, for an average of 4,872 CCF over the two-year period. A 14” DBH tree contains approximately 0.5 CCF of firewood; therefore approximately 9,744 dead trees were cut for firewood each year. The number of standing dead trees on the GW can be calculated based on analysis of data collected during the 2002-2007 Forest Inventory and Analysis conducted by the Southern Forest Research Station, Asheville, NC and published in 2009. The number of dead standing trees at that time was 14.9 per acre for all trees larger than 5” DBH and 6.1 per acre for trees larger than 9” DBH. Given that the Forest is approximately 1,065,389 acres, this equates to at least 6,498,873 dead standing trees >9” DBH. All portions of the Forest continue to be infested with gypsy moths and infestations are forest-wide with cycles of defoliation and mortality resulting from population fluctuations of gypsy moths. The result of these infestations is extensive areas of hardwood (especially oak) mortality in the overstory. Therefore, if 9,744 standing dead trees are cut each year for firewood, this equals to 0.15% of the total available standing dead trees. Since most of these dead trees are not close to roads or are in Management Prescriptions where firewood cutting is not allowed, the possibility of harming an Indiana bat is extremely remote. Also it is not just standing dead trees or snags that Indiana bats roost in, but also live trees. Brack and Brown (2002) reported 81% of roost sites used by radio-tagged Indiana bats were live trees and 19% were snags. The odds of encountering a roosting bat are even further reduced since only dead trees are available for cutting as firewood and these dead trees represent perhaps 20% of the trees where they roost. Assuming this trend represented Indiana bat roost selection throughout the GWNF, personal use firewood collection could affect 0.0003% of the potential Indiana bat roost sites. Although risk of “take” resulting from firewood cutting cannot be completely eliminated, the risk of direct effects to roosts in the vicinity of hibernacula is further minimized since the collection of firewood in primary and secondary cave protection areas is not allowed by prescription standard. Some minimal risk of taking a bat roosting in a standing dead tree cut for firewood elsewhere on the Forest would continue to exist. However, given the relatively low number of Indiana bats on the Forest when compared to the number of acres, plus standing trees and snags, and that the use of any individual dead tree as a roost is very brief, the likelihood of take from firewood cutting is extremely small, if not non-existent under all alternatives. Most types of timber harvest (salvage, even-aged, uneven-aged, etc.) activities would require some snag and potential roost tree retention plus specific retention of leave trees such as shagbark hickories. Forestwide standards in all alternatives require stand regeneration treatments greater than ten acres in size, a minimum average basal area of 15 square feet per acre of live trees is retained throughout the rotation, and

priority is given to retaining the largest available trees that exhibit characteristics favored by roosting Indiana bats (sloughing bark, cracks and crevices).

Over the past several years the Forest has steadily increased its prescribed burn program. Alternative E would have the highest acres with 20,000 acres estimated to be prescribed burned each year. Most of these burns will occur during the spring and early summer with some during the late winter and early fall. Control lines will consist of existing roads, trails, and streams wherever possible. In areas where control lines will need to be constructed they will be done with handtools and/or bulldozer. Lines will consist of a two to five foot wide strip dug to mineral soil. Some trees will need to be felled during line construction but in most cases larger trees will be avoided with the line going around and between the largest trees. Some standing trees and snags near the line will be felled which pose a hazard to personnel or may burn and fall across the line thereby spreading fire across the line and into areas not scheduled for burning. Purposes for the use of prescribed fire include ecosystem restoration, wildlife and rare species management, site preparation, and oak/pine regeneration. The 1997 Biological Opinion stated as a Conservation Recommendation that the Forest increase prescribed burning on lands unsuitable for timber harvest to maintain flight and foraging corridors in upland and riparian areas.

Two Indiana bats were found to have WNS during an April 21, 2010 cave survey conducted by Rick Reynolds (VDGIF) and Wil Orndorff (VDCR) in Starr Chapel Cave. This represents the first time Indiana bats have been documented with WNS on the Forest. They are also known to occur in other caves which are infested with WNS and where other bat species have been found that are infected but individual Indiana bats in those caves have not shown signs of WNS infection. Time will tell the extent to which WNS will affect the Indiana bat. Caves with significant bat populations on Forest land will continue to be gated and locked. Currently a Regional Forester closure order is in effect that closes all caves and mines on National Forest lands to human intrusion. If and when access is needed WNS protocols will be followed that eliminate contamination from caving activity.

Plan Alternatives A, C, and E do not allow for commercial wind power development. Alternatives B, D, F and G allow for consideration of wind power development. Alternatives B, F and G assume one development site and assume 15 towers per site, while Alternative D assumes three sites and assumes 45 towers. Currently, there are no proposals for wind power development on the GWNF. Any such proposal will be evaluated with an environmental analysis and impacts to bats will be disclosed at that time.

Cumulatively, with implementation of any alternative, the Forest will maintain a supply of snags, live potential roost trees, upland water sources, and other habitat features across the landscape to allow for the maintenance, and promote the recovery, of Indiana bat populations. At the same time, activities can still continue to meet other multiple-use objectives. For example, timber harvesting can still occur to accomplish sufficient forest regeneration to provide diverse insect productions and provide for the continuation of diverse forest conditions across the GWNF. Overall, there will be both benefits and impacts to the Indiana bat from management activities on the Forest. From a beneficial standpoint, the retention of some snags, shagbark hickory, and hollow trees in sale areas would allow potential Indiana bat roost sites to be conserved; the opening up of the canopy in sale areas and their margins would increase the degree of exposure of some potential maternity roost trees to solar radiation, providing improved thermal conditions for raising young; pond construction would increase the number of upland water sources available for Indiana bat. Slightly positive benefits for Indiana bat would result as harvested units create insect-rich foraging areas and flight corridors leading to any tree roosts that might be present there. Positive benefits would result from prescribed burning by decreasing understory vegetation density. Positive benefits will also be realized from the application of prescriptions and associated standards focused on protecting caves and managing vegetation structure and condition within 2-miles of hibernacula.

Contrastingly, negative impacts to the Indiana bat would be: (a) the slight chance that individuals or small groups of roosting bats (including summer maternity colonies) could be unintentionally killed by the intentional felling of trees harboring undetected roosts (e.g. dead limbs with loose bark, or small cavities in the boles), or by the accidental felling of occupied snags, or damaged or hollow trees during timber harvest or other activities; and (b) a short-term reduction in the total amount of foraging habitat available to individual Indiana bat which would be incurred on regeneration cuts. Although these bats will use small forest openings and edges as foraging habitat, they would be unlikely to utilize the central portions of harvested units during the

early years of regeneration unless the residual basal area were unusually high. It is possible that the increased rate of insect production in the regeneration areas would make up for any loss of foraging habitat acreage, but such a determination would be difficult to make without extensive long-term research on the subject. The level of estimated timber harvest ranges from 1,000 to 5,000 acres depending on Alternative. Specific acreage by type of silvicultural system for each alternative is discussed in the Social/Economic Environment, Timber Management section of the EIS. See specifically Table C6.13.

Although the likelihood is very low, implementation of any alternative may result in the inadvertent loss of individual Indiana bats or small groups of Indiana bats, via removal of some large-diameter hardwood trees occupied by bats during the period April 1 through October 15. This risk would be greatest in those alternatives with the highest acres of timber harvest. Alternative D has the highest acres estimated, followed by Alternatives A, B, E, G and F in order. Alternative C has no timber harvest allowed.

Under all alternatives, Forestwide and management prescription standards will provide adequate protection for summering and transitory Indiana bat individuals. These standards and prescriptions provide for maintenance of extensive forest areas that would remain undisturbed by most human processes that result from tree cutting. These areas are characterized by disturbance events where net losses and gains of potential roost trees would be dependent on ecological processes including tree mortality due to aging, insect and disease, lightning caused fires, and weather events.

In addition, all alternatives allocate areas surrounding known Indiana bat hibernacula to Management Prescription 8E4a and 8E4b. In the future, newly discovered hibernacula will be added through the Forest Plan amendment process. In the 1997 Biological Opinion for the GWNF, and the 2004 BO for the Jefferson NF, the Service determined that the level of anticipated take (4,500 acres not including prescribed burning on the GW and 16,800 acres including prescribed burning on the JNF) is not likely to result in jeopardy to the Indiana bat or destruction or adverse modification of any critical habitat. Finally, this agency feels that there will be overall cumulative positive benefits for the Indiana bat. The agency believes that some level of harvesting on the GWNF is necessary in order to manage, retain and perpetuate the existing forest types. It is within this diversity of these forest types that the Indiana bat has been able to survive over long periods of time, and has been able to maintain its numbers on the Forest in recent years. Although the loss of a few individuals from time to time during timber harvest is remotely possible, the overall large amount of improving roosting and foraging habitat for the Indiana bat, coupled with management activities taking bat life requirements into account, coupled with an increasing number of upland drinking water sources, and gating of hibernacula, suggests that these potential losses would be offset by overall future net gains in the population under all alternatives.

Effects of WNS are unknown at this time. It's likely that Indiana bats will be further affected by WNS and those cumulative effects will exceed any action Forest Plan implementation will cause under any alternative.

Cumulative effects of wind power development will be addressed in project level analysis if and when the Forest receives a proposal for construction.

VIRGINIA BIG-EARED BAT

AFFECTED ENVIRONMENT

Formerly included in the genus *Plecotus*, the Virginia big-eared bat is a subspecies of the more common and widespread Western (or Townsend's) big-eared bat that occurs throughout the western U.S., southwest Canada, and most of Mexico. The subspecies, *virginianus*, occupies a very limited geographic range in the Central Appalachians. The species was listed under provisions of the Endangered Species Act as Endangered in December 1979. The Recovery Plan was issued in May 1984 and a draft revised recovery plan was submitted for review in 1996, but was never completed. The first substantive 5-year review of the species was released by the USFWS, Elkins Office in Summer 2008. Generally, population numbers have shown moderate to strong increases range-wide over the past 15 years. In the late 1980's it was estimated the total population of the subspecies in West Virginia, Virginia, Kentucky, and North Carolina to be approximately 10,000 bats

(Dalton 1987). By 1997 the range-wide population of *C.t. virginianus* was estimated to have almost doubled at less than 20,000 individuals (Pupek 1997). In West Virginia some cave populations grew as much as 350% from 1983 to 1995 (Pupek 1997). Survey data from 2006-2007 indicate a population of 10,900 hibernating bats and 7,169 maternity colony bats. These surveys did not include bachelor colonies or several caves with significant bat use due to access or safety concerns. In Virginia this bat is known from eight caves in five counties in two separate geographic areas. One is in the upper headwaters of the James River (Cowpasture River) and the other is in the New River watershed. According to the Virginia Fish and Wildlife Information Service, it is known from three caves in Tazewell County and one in Highland County during the summer and five caves during the winter in Tazewell, Bland, and Highland Counties. Previous observations of single or a few individuals in caves found in Rockingham, Bath, and Pulaski Counties have not been seen in recent years. The Virginia big-eared bat occupies caves year-round. These bats are not migratory and their longest recorded movement is only 64 kilometers (almost 40 miles) (Dalton & Handley 1991). Males and females hibernate singly or in mixed clusters in a few caves then move in the spring to other cave(s) with females forming smaller summer maternity / nursery colonies and males being solitary or in bachelor groups during that season. Mating begins in late summer/early autumn and continues into early winter. Ovulation and fertilization are delayed until late winter/early spring. Maternity colonies form as early as March or as late as June depending on when the roost site reaches a suitably warm temperature. Gestation lasts 2-3.5 months. A litter of one is born in late spring/early summer. Young can fly at about 2.5-3 weeks of age, weaned by 6-8 weeks, and leave the cave to forage on their own by the end of July or August. Most individuals leave the nursery cave by mid to late September. Females are sexually mature their first summer. Males may not be sexually active until their second year. Nearly all adult females breed every year (NatureServe 2010).

The Virginia big-eared bat is primarily a feeder on moths. Food habits of the maternity colony in Tazewell County, Virginia found that moths formed over 90% of the diet with beetles a distant second followed by lesser quantities of other flying insects. Foraging activity typically occurs within 4-6 miles of summer roost caves. Bats have been observed foraging over corn and alfalfa fields as well as mature upland forests, wherever moths occur in abundance (Dalton et al. 1986). Limiting factors for the Virginia big-eared bat include caves with suitable temperature regimes (cold in winter and warm in summer). This bat tolerates lower cave temperatures during hibernation than other bats and often occupies areas in caves that receive cold-air flow near entrances. Maternity colonies are typically warmer than those used for hibernation.

Declines appear to be primarily related to human disturbance and loss of cave habitat quality. The Virginia big-eared bat is extremely intolerant of any human disturbance. The growing popularity of spelunking is a tremendous threat to these bats. Former decline is likely attributable to human intrusion into caves, which depletes energy reserves of aroused bats and may lead to cave abandonment if disturbance is frequent, (NatureServe 2010). The recovery plan (USDI Fish and Wildlife Service 1984) recommends recovery actions focused on cave acquisition and gating of entrances to control human access. On the George Washington National Forest there are no caves occupied by the Virginia big-eared bat at any time of the year. All occupied caves in Virginia, during both summer and winter, are on private land. Cave occurrences of the Virginia big-eared bat closest to the Forest are located in Highland County, Virginia and Pendleton County, West Virginia where the distance from occupied caves to Forest managed land is approximately 9-miles. It's therefore possible, but unlikely, that the species may forage over some portions of the North River Ranger District from the Brandywine area of Pendleton County, WV south to the McDowell area of Highland County, VA.

Additional recent threats include White Nose Syndrome (WNS) and commercial scale wind power development. WNS is a fungus caused disease that was first seen in New York caves during the winter of 2006-2007. The newly discovered, cold-loving fungus (*Geomyces destructans*) has spread south during the past several years and was first confirmed in Virginia and West Virginia during the winter of 2008-2009 with additional spread and caves contaminated in 2009-2010. To date well over 1-million bats have been killed by this fungus which irritates bats during hibernation causing them to wake and use precious fat reserves. The bats then starve and or freeze when they attempt to fly and leave the cave in search of food during the midst of winter conditions.

Commercial wind power development has rapidly expanded across the Appalachians. Multiple sites have been developed in West Virginia and one site is being constructed in Virginia west of Monterey in Highland County. Bats are often killed during wind tower operations when they fly into the lower pressure area surrounding the trailing edge of spinning blades and suffer extreme barotrauma where decompression causes

capillaries in the lungs to explode. Bats are most affected during periods of fall migration when they often follow ridgetops and come into contact with wind towers built along those same ridgetops.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

Under all alternatives, Forestwide standards relevant to the Virginia big-eared bat and associated cave habitat would protect all caves that are potentially discovered or purchased which support Virginia big-eared bats. Although no hibernacula or summer roost caves have been identified on the Forest, Forest-wide standards maintain vegetation and require installation of gates or other protective structures at entrances of all caves occupied by populations of any threatened or endangered bats. Until a newly discovered cave has been surveyed for bats, it is assumed that federally listed bats are present and the cave and surrounding habitat are maintained for them until surveyed. Potential foraging habitat will be maintained as vegetated and any changes will result from forest succession and limited management activities such as timber sales and prescribed burning.

Currently no VBEB have been found with WNS. They are known to occur in caves which are infected with WNS and where other bat species have been found that are infected. Time will tell if WNS will affect the VBEB. Caves with significant bat populations on Forest land will continue to be gated and locked. Currently a Regional Forester closure order is in effect that closes all caves and mines on National Forest lands to human intrusion. If and when access is needed WNS protocols will be followed that eliminate contamination from caving activity.

Alternatives A, C, and E do not allow for commercial wind power development. Alternatives B, D, F and G allow for consideration of wind power development. Alternatives B, F and G assume one development site and assume 15 towers per site, while Alternative D assumes three sites and assumes 45 towers. Currently there are no proposals for wind power development on the GWNF. Any such proposal will be evaluated with an environmental analysis and impacts to bats will be disclosed at that time.

There are expected to be no cumulative effects to the Virginia big-eared bat resulting from implementation of any alternative. As stated above, the caves where this species occurs are on private land near the Forest. Landowners of these caves are aware of the bats presence and the caves are either gated or protected to limit human entrance and disturbance. Individual Virginia big-eared bats may occasionally forage or fly over National Forest land, but vegetated conditions will be maintained based on standards associated with prescription allocations under all alternatives. Insect populations (especially moths) will continue and be maintained so foraging will not be effected. In the northern portion of the Virginia big-eared bats range there have been concerns about the effect gypsy moth (*Lymantria dispar*) defoliation and suppression efforts may have on Virginia big-eared bats. Defoliation and the subsequent short-term loss of forest cover may suppress insect populations and thus food sources for the bats. Likewise the use of certain pesticides suppresses or eliminates insect populations to varying degrees and lengths of time depending on the type of insecticide used (USDA 1995). Gypsy moths are well established across the GWNF. Suppression of gypsy moth outbreaks have not been done on the GW since Spring of 2003 when 1,311 acres in six areas were treated with Btk and none of those areas were within 50-miles of known Virginia big-eared bat occurrences. If and when necessary, decisions on gypsy moth management will be made at that time and further analysis handled at a project level.

Effects of WNS are unknown at this time. It's likely that VBEB will be affected by WNS and those cumulative effects will exceed any action Forest Plan implementation will cause under any alternative.

Cumulative effects of wind power development will be addressed in project level analysis if and when the Forest receives a proposal for construction.

SHALE BARREN ROCK CRESS

AFFECTED ENVIRONMENT

Unless otherwise noted, the information used in this analysis comes from NatureServe (accessed in 2010).

Shale barren rockcress was listed as endangered under the Endangered Species Act on August 8, 1989.

A narrow endemic known only from shale barren regions of Virginia and West Virginia; one of the most restricted shale barren endemics. According to NatureServe, approximately 56 occurrences are believed extant, 34 in Virginia and 22 in West Virginia, of these most are made up of fewer than 50 individuals; there are, perhaps, fewer than 4,000 plants altogether. Most occurrences are on public lands, predominantly National Forests. Depending on the definition of an occurrence, there appear to be more occurrences than indicated in NatureServe. The following is from the Forest's Monitoring and Evaluation Report 2004:

> *"In 1993 there were 17 known occurrences of shale barren rockcress on the Forest. The Forest's focus since this species was listed has been to attempt to locate additional populations and further define its range on the Forest. From 1994 to 1998 agency personnel worked cooperatively with the Virginia Division of Natural Heritage and the USFWS to inventory shale barrens on the Forest (Belden, Ludwig, and Van Alstine 1999). The Virginia Division of Natural Heritage identified 809 potential shale barrens from aerial photographs. Of these, 188 were examined for rare species. The inventory resulted in 27 new occurrences of shale barren rockcress, bringing the total known sites on the Forest (in Virginia) to 37. This number does not include two sites where shale barren rockcress was known to occur recently, but could not be found in 1994. In 2004 the West Virginia Department of Natural Resources discovered a new population of shale barren rockcress at the Little Fork North Shale Barren bringing the total occurrences on the Forest from the 77 reported by the West Virginia Natural Heritage Program in 2000 to 78. This includes both Virginia and West Virginia information. Of the 78 occurrences, 17 were known in 1993 when the GWNF Plan took effect, so there has been an increase of 61 occurrences."*

Because of the highly stressful nature of shale barrens environments, this species is not believed to be capable of tolerating much additional disturbance. Threats include road/trail construction and maintenance, erosion, inundation resulting from flood control measures, deer browsing, competition from exotic plants, and declines of its pollinators due to the spraying of Dimilin and BT insecticides for gypsy moth control.

An endemic of shale deposits, this species occurs only on sparsely-vegetated xeric, south or west-facing shale slopes (barrens) at elevations from 400 to 600 meters. Populations are known from both the shale openings and shale woodlands adjacent to the shale openings. All extant occurrences are on shales of Devonian age (Ludwig pers. comm.); a single occurrence was known from the Martinsburg shale of Ordovician age, but it is no longer extant.

The term "shale barren" is a general reference to certain mid-Appalachian slopes that possess the following features: 1) southern exposures, 2) slopes of 20-70 degrees and 3) a covering of lithologically hard and weather-resistant shale or siltstone fragments (Dix 1990). These barrens support sparse, scrubby growth; frequently-observed species include *Quercus ilicifolia, Q. prinus, Q. rubra, Pinus virginiana, Juniperus virginiana, Prunus alleghaniensis, Rhus aromatica, Celtis tenuifolia, Kalmia latifolia, Bouteloua curtipendula, Andropogon scoparius, Phlox subulata var. brittonii, Silene caroliniana ssp. pensylvanica, Sedum telephoides, Antennaria spp., Aster spp*., and *Solidago spp.* (Dix 1990). Local variations in associated flora may be considerable (Braunschweig et al 1999, Jarrett et al. 1996, Keener 1970, Keener 1983, Wieboldt 1987).

Although adequate moisture is available for most plants within the substrata of the shale layers, adverse surface conditions act to restrict germination and establishment success of plants (Platt 1951). It is primarily the effect of high surface temperatures that limits plant reproductive success in these habitats. Surface soil temperatures are often well above the physiological tolerance of most plant species, reaching maximum temperatures of 63 degrees Celsius (Dix 1990). Such temperatures are high enough to cause direct damage to seedlings. For additional detailed information pertaining to the shale-barren community, see Dix (1990).

Recovery tasks for the Forest identified in the shale barren rockcress Recovery Plan include:

- Implement and evaluate the monitoring program.

Threats include:

- Construction of roads, railroads, and hiking trails has impacted occurrences in the past; several occurrences are now located adjacent to these corridors where they may be impacted by erosion or maintenance activities.
- Flood control measures are a potential threat at some locations (e.g. South Fork Valley of West Virginia) (Bartgis in litt.); one barren has already been destroyed by a stream dam (Dix 1990).
- Most extant occurrences are moderately to severely browsed by deer, which is considered by some to be a prime threat to the species (USFWS 1989); quantifying the impact of deer browsing is an area of active research (Ludwig pers. comm.).
- Moderately xeric sites may be subject to encroachment of exotic plant species such as *Centauria biebersteinii* and numerous grasses (Dix 1990). Such encroachment is a particular concern for *Arabis serotina* since it does not tolerate competition well; it is generally restricted to the more open portions shale barren communities.
- A significant threat to the insect pollinators of A. serotina is presented by the spraying of Dimilin and BT insecticides for gypsy moth control. Because of the open habitat, shale barren insects are maximally exposed to pesticides (Dix 1990). Dimilin is a broad-spectrum biocide that persists until leaf fall and up to a few years in the duff and would have a long-term impact of shale-barren slopes. All insect occurrences on shale-barrens sprayed with Dimilin should be considered extirpated (Schweitzer in litt). BT is lepidopteran-specific and only persists for roughly one week (Dix 1990). Application during larval development may have devastating impacts on the fauna.
- Finally, the very small number of individuals within many occurrences suggests that the long-term persistence of these occurrences is uncertain, especially considering that populations tend to fluctuate dramatically.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

All known locations of shale barren rockcress on the Forest in WV and VA are on land allocated to management prescription 4D, Special Biological Area. Habitat for this species is stable on the Forest. There are possible threats to shale barren communities from invasive native and exotic species. Populations appear stable, but since they naturally tend to fluctuate greatly from year to year, this is uncertain. Potential habitat is being inventoried and continues to reveal new populations that will be protected. Management activities are having no effect on the habitat that contains the shale barren rockcress and thus are having no effect on the rockcress.

Overall, viability is being maintained through identification and protection of occurrences, however, viability is still of concern due to the naturally limited distribution of this species. Shale barren rockcress populations are expected to remain relatively stable in the near future.

The Forest encompasses several populations of the endemic shale barren rockcress that are in the core of its limited distribution in the Northern Ridge and Valley Section of the mid-Appalachians. This species is inherently rare and not well distributed across the Forest. Current management provides for ecological conditions capable to maintain the shale barren rockcress populations considering its limited distribution and abundance. Overall, ecological conditions are sufficient on the Forest to maintain viability (persistence over time) of populations on national forest land.

SMOOTH CONE FLOWER

AFFECTED ENVIRONMENT

Unless otherwise noted, the information used in this analysis comes from NatureServe (accessed in 2010).

Smooth coneflower was listed as endangered under the Endangered Species Act on September 8, 1992.

This species is known from about 100 occurrences, a majority of which are of fair to poor viability in several southeastern states. Most historically known populations were destroyed by development and habitat alteration, especially the suppression of fire, and a number of remaining populations are primarily in marginal locations, where they are vulnerable to urbanization, the use of herbicides, repeated mowing, and potentially, collection for the medicinal trade. Small remote populations may suffer from loss of habitat due to succession.

The Recovery Plan for smooth coneflower does not have any recovery tasks specific to the Forest.

Habitat loss and degradation due to habitat alteration affected 19 of 21 populations known in 1992 (USFWS 1992). Conversion of habitat to agriculture and/or silviculture, residential and industrial development, and highway maintenance (e.g., herbicides) has threatened this species in the past and may continue. Habitat loss and degradation as a result of prolonged fire suppression is also considered a major threat to the species' habitat. Commercial digging was not thought to be a problem as this practice is generally confined to Echinacea populations west of the Mississippi River. However, the Southern Appalachian Species Viability Project (2002) reported that this showy species with medicinal uses is occasionally harvested. Remaining populations appear to be small in numbers which may result in low genetic diversity.

Formerly, a plant of prairie-like habitats or oak-savannas maintained by natural or Native American-set fires as well as large herbivores (such as bison), it now, primarily occurs in openings in woods, such as cedar barrens and clear cuts, along roadsides and utility line rights-of-way, and on dry limestone bluffs. Usually found in areas with magnesium and calcium-rich soils. It requires full or partial sun. Associated species include: *Juniperus virginiana* and *Eryngium yuccifolium*. Fire or some other suitable form of disturbance, such as well-timed mowing or the careful clearing of trees, is essential to maintaining the glade remnants upon which this species depends. Without such periodic disturbance, the habitat is overtaken by shrubs and trees [Endangered Spp. Tech. Bull. 17(1-2): 9-10].

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

All known locations of smooth coneflower on the Forest are on lands allocated to management prescription 4D, Special Biological Area. There are currently two known populations of this species on the Forest. Both are in Alleghany County. One is a roadside occurrence that continues to be difficult to manage due to the steepness of the site and encroaching woody vegetation. This population is very small and may not be viable over the long term. The second population is more robust and occurs in an open woodland area. The site needs prescribed fire to maintain the open conditions this species requires, however, no prescribed fires have occurred or are planned.

VIRGINIA SNEEZEWEED

AFFECTED ENVIRONMENT

Unless otherwise noted, the information used in this analysis comes from NatureServe (accessed in 2010).

Virginia sneezeweed was listed as threatened under the Endangered Species Act on November 3, 1998.

A limited amount of habitat in two Virginia counties and six Missouri counties make up this species' entire global range. There are currently 61 documented occurrences, although 4 or fewer may not be extant, with the

majority in Missouri as of 2006. The Virginia occurrences are restricted to small, discrete areas around sinkholes, and occupying, in total, less than 20 acres (8 ha). Missouri occurrences occupy ca. 11 acres within both discrete and less discrete wetland habitat. Six Virginia occurrences are currently protected by being on National Forest land or within state preserves. Only 9 Missouri occurrences have some protection although not complete. Sites in both states are threatened by drainage and residential development.

The number of Virginia documented occurrences has been revised downward to 17 by using a 1 km separation distance between occurrences (J. Townsend, VA Dept. of Conservation and Recreation 2006 pers. comm.) These 17 occurrences had previously been recognized as 30 occurrences, with an occurrence at that time being equal to the plants within a discrete pond or wet meadow. It is expected that additional survey work will find more occurrences within the 21-80 range; some of these may be within the more disturbed farm pond type of habitat. As most of the sites in Virginia have not been visited since 1995, it is not known how many are currently extant. Based on what was known at the time the draft Recovery Plan was written in 2000 there were 4 sites where plants had not been seen over several years of surveys (U.S. Fish and Wildlife Service 2000). The Virginia occurrences were located during extensive survey work from 1985 to 1995 in over 100 limestone sinkhole ponds along the western edge of the Blue Ridge Mountains in the Shenandoah Valley of Virginia (FWS 1998).

The Draft Recovery Plan includes the Forest in the following recovery tasks:

- Seek permanent protection for known populations.
- Identify essential habitat.
- Identify sinkhole habitat adjacent to the National Forest lands, but within the proclamation boundary, to target for future acquisitions by the GWJNF.
- Conduct studies to characterize environmental parameters of the sinkhole ponds.
- Conduct studies to characterize the hydrologic regime at selected sinkhole ponds.
- Alleviate site specific threats as the need and opportunity arise.
- Develop a monitoring plan including standard monitoring methodologies.
- Implement the monitoring plan.
- Conduct surveys for additional populations in Virginia.
- Develop guidelines as to what constitutes a self-sustaining population.
- Maintain seed sources for the species.

On the Forest all known populations of Virginia sneezeweed are located in Augusta County except for a very small population that was located in 2009 between Glasgow and Buena Vista in Rockbridge County.

In Virginia the long-term viability of existing populations is primarily threatened by human-induced disruptions of hydrologic regimes, particularly by encroaching agriculture, residential land development, and logging (Van Alstine 1991; J. Knox, C. Williams pers. obs.). In addition, a private site and adjacent sites on the George Washington National Forest are sporadically impacted by off road vehicles (e.g., during summer 1991 on the private land; J. Knox, C. Williams, pers. obs.).

Exotic organisms may pose threats to H. virginicum populations in the near future. Purple loosestrife, *Lythrum salicaria*, is slowly spreading through Virginia and may eventually invade some *H. virginicum* sites, especially following disturbances to hydrologic regime and/or substrate. The gypsy moth, *Lymantria dispar*, is currently defoliating large areas of the George Washington National Forest and adjacent lands but it is unclear whether the gypsy moth will negatively impact *H. virginicum* populations. For example, as *H. virginicum* is shade-intolerant, defoliation of trees and shrubs that grow on the periphery of sinkholes may increase light availability and allow *H. virginicum* to expand into areas from which it was formerly excluded.

The following paragraphs are taken, with modifications, from U.S. Fish and Wildlife Service (2000): The most serious threat to *H. virginicum* appears to be habitat loss, most often arising from changes in the natural hydrological regime of the sinkhole pond habitat. Four of the sites, three of which are grazed by cattle, have had a portion of the wetland deepened to create a permanent pond; prior to being excavated, much of this section once undoubtedly supported *H. virginicum* and so loss of some habitat has occurred. In contrast, actions have been taken at some of the Virginia sites to stop or lessen the periodic inundation. Significant ditches have been dug at two sites, with smaller ditching at three sites. Ditching and plowing occurred at one site in the past, and some evidence of the ditch remains, but does not significantly affect the hydrologic regime. Portions of the sites at 2 sites have been filled in. It is safe to assume that the pressure to control seasonal flooding will only increase, as the area of the Shenandoah Valley where the Virginia populations of *H. virginicum* are found is experiencing rapid growth, particularly in the building and expansion of residential subdivisions.

In addition to obvious hydrological alterations made directly to the sinkhole ponds, off-site actions may affect the hydrology of the ponds. Input from groundwater sources may be decreased by withdrawals for wells for adjacent developments such as subdivisions. Overland surface water flow may be altered by activities such as timber harvesting or road building in upslope areas. Little is known about the relative importance of groundwater vs. surface flow to the hydrological regime of the sinkhole ponds, but preliminary research suggests that the relative importance of these water sources is unique for each pond (E. Knapp, Washington and Lee University pers. comm.).

A variety of site-specific threats to *H. virginicum* from habitat loss have appeared over the last ten years. The Virginia Department of Transportation (VDOT) has proposed to widen to four lanes Route 340, a currently two lane north-south corridor on the east side of the Shenandoah Valley. A portion of one site in Augusta County is immediately east of Route 340. The Virginia Department of Conservation and Recreation's Division of Natural Heritage reviewed the proposal for this project in 1991 and recommended against any road widening to the east in the area of the pond and further recommended that VDOT consult with the U.S. Fish and Wildlife Service before any construction began. While the long range plans still include widening Rt. 340 to 4 lanes in this section, this project is not active; VDOT will coordinate with USFWS whenever the project becomes active (S. Stannard, VDOT pers. comm.)

Another *H. virginicum* population is near the site of silos built in the early 1990's that are used to store septic waste. This waste is eventually dumped on the ground elsewhere on this landowners' ridge-top property and not near the *H. virginicum* site. However, in a 1995 site visit by DCR-DNH a large pile of soil was present on the north side of the shallow basin that supports the *H. virginicum* population. The landowner was considering pushing the soil into the seasonally wet basin to level it out, but was agreeable to not do that. In a 1997 site visit the pile was still present and was larger than in 1995. In 1995 and 1997, it was noted that sediment from the pile had washed into the edge of the pond site, creating different soil conditions in that area and making it more favorable for weedy species (DCR-DNH database).

Mowing occurs in at least 3 of the Virginia sites. Continued mowing may provide beneficial effects to the species; a site that is one of the largest if not the largest and densest population, has been periodically mowed and bush-hogged by the landowner for an extended period of time. Repeated mowing before seed is set and the seed bank is replenished, may lead to local extinction as vegetative plants die out and the seed bank ultimately becomes depleted.

Herbivory does not appear to be a problem; however, the threat to *H. virginicum* from cattle grazing needs evaluation. Large populations of *H. virginicum* co-exist in three sites with cattle grazing. This suggests that the species may respond favorably to limited amounts of disturbance. Knox et al. (1999) tested the hypothesis that H. virginicum is unpalatable to generalist herbivores in a common garden study; none of the H. virginicum plants were grazed by either vertebrate or invertebrate herbivores. Knox notes that this is consistent with reports of toxicity in other *Helenium* species associated with the presence of sesquiterpene lactones (Hesker 1982, Anderson et al. 1983, Anderson et al. 1986, Arnason et al 1987). *Helenium virginicum* has been shown to contain a sesquiterpene lactone, virginolide (Herz and Santhanam 1967). According to J.S. Knox (pers. comm.), the leaves of *H. virginicum* are bitter-tasting; selective grazing by cattle of more palatable associated species therefore may eliminate plant competitors. However, other effects on *H. virginicum* from cattle grazing

such as the increased nutrient loads, soil compaction, and trampling of plants are unknown. As the soils of the *H. virginicum* sites have been found to be nutrient-limiting (Knox 1997), long-term nutrient enrichment from cattle could ultimately create more favorable habitat for other plant species.

With federally listed wetland species, the federal permitting process carried out by the US Army Corps of Engineers (USACOE) under authority of the Clean Water Act of 1977, is often the point at which proposed actions can be reviewed in light of their effect on a federally listed species and protection actions can be recommended. The isolated and often small seasonally wet habitat of *Helenium virginicum*, however, does not currently have direct federal protection. United States vs. Wilson 133 F. 3d 251(4th Cir. 1997) ruled that the USACOE has no jurisdiction over isolated water bodies that have no surface connection with any tributary stream that flows into traditional navigable waters or interstate waters. Nationwide Permit 26, under federal wetlands regulations (56 CFR 59134-59147, Part 330-Nationwide Permit Program), which has applied to headwater areas and isolated wetlands, is currently being revised including a lower minimum acreage (1/10 acre); the Norfolk District of the USACOE is proposing a regional minimum threshold of 1/4 acre (E. Gilinsky, DEQ, pers. comm.). These lower minimum acreages, however, will not apply to the *Helenium virginicum* habitat if the ruling in U.S. vs. Wilson stands.

Currently, so-called Tulloch ditching, draining by ditching in which excavation occurs by mechanical means that do not require placing excavated material into a wetland and in which the material is lifted and hauled to an upland disposal site, does not require that USACOE be notified or a permit obtained. Major ditching has been used at three of the *H. virginicum* sites to control the seasonal flooding with more minor ditching used at another three sites.

As most of the populations of *H. virginicum* are on private lands, the current legal protections in place for this species will not be adequate to insure the long-term survival of *H. virginicum*. The effects of future regulation changes are not known.

Extremes in the fluctuating hydroperiod of the sinkhole ponds could, when preceded by low investment in the seed bank, result in the local extinction of populations. Extended drought at a site could make a site more favorable for colonization by other plants previously hampered by the periodic inundation of the site. This would include tree species, which could result in increased shading within the site and so reduce the areas favorable for *H. virginicum*. An extended period of inundation, coupled with development of a floating vegetation mat, such as occurred at one site (Knox 1997), could lead to local extinction if an insufficient seed bank existed to recover from the death of the vegetative plants. Either of these extremes in hydroperiod could result from normal variability in weather patterns or from larger scale climate changes, of either natural or human origin.

If found to hold true for other populations of *H. virginicum*, the self-incompatible breeding system of *H. virginicum* found in one of the populations may eventually lead to local extinction at sites with low population numbers as the chance of successful pollination decreases (Messmore and Knox 1997).

In Missouri threats include grazing and/or trampling of plants in the pasture sites and haying of the plants during the growing season. Herbicide or plant growth hormones used on roadside pose a threat to the roadside populations.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

All known locations of Virginia sneezeweed on the Forest are on land allocated to 4D Special Biological Area. These Special Biological Areas are managed specifically to restore and maintain conditions to benefit the community and/or rare species for which the area was established. There are still threats from illegal ATV use on this species.

SWAMP PINK

AFFECTED ENVIRONMENT

Unless otherwise noted, the information used in this analysis comes from NatureServe (accessed in 2010).

Swamp pink was listed as a threatened species under the Endangered Species Act on September 9, 1988. *Helonias bullata* is known from the Coastal Plain of New Jersey, Delaware, Maryland, and Virginia (formerly also Staten Island, NY, where now extirpated), as well as from higher elevations in northern New Jersey, Virginia, North Carolina, South Carolina, and Georgia. Restricted to forested wetlands that are perennially water-saturated with a low frequency of inundation, habitat specificity appears to be a critical factor in this species' rarity. Approximately 225 occurrences are believed extant, over half of which are in New Jersey; 80 additional occurrences are considered historical and 15 are extirpated. The species is locally abundant at several sites in New Jersey, Delaware, Virginia, and North Carolina; some have 10,000+ clumps of plants. In addition to sites known to have been extirpated, significant habitat has been lost throughout the range due to factors such as drainage for agriculture. A number of local population declines have also been documented in the past 20 years. Degradation of this species' sensitive habitat via changes to the hydrologic regime is the primary threat. Such changes can be direct (ditching, damming, draining) or indirect (from development in the watershed); indirect impacts are particularly difficult to address. Other threats include poor water quality, invasive species, trash, all terrain vehicles, deer herbivory, trampling, and collection. Given this species' very specific hydrological requirements, climate change could also be an issue. *H. bullata* has limited ability to colonize new sites (low incidence of flowering, limited seed dispersal, and poor seedling establishment) and low genetic variation, limiting its ability to adapt to changing conditions and recover when sites are destroyed.

Overall trends of local population declines and extirpations are beginning to emerge (USFWS 2007). The number of occurrences considered historic has increased from 79 to 97 since 1991, a loss of 18 sites (8 in NJ, 8 in DE, and 2 in NC) (USFWS 2007). More than 20 occurrences in New Jersey and Delaware alone have documented declines in population size or condition since the early 1990s (USFWS 2007). In New Jersey, the number of occurrences ranked A or B has decreased by 7 since 1991; comparing occurrence ranks from 1997 and 2004, 6 occurrences were upgraded while 20 were downgraded (USFWS 2007). Of the 27 occurrences discovered in Delaware between 1983 and 1999, 16 showed substantial declines in plant numbers during the most recent site visits (USFWS 2007).

Habitat specificity appears to be the critical factor in defining *H. bullata* as a rare species (USFWS 2007). Adapted to stable habitats with a number of specialized conditions (e.g., low light, limited nutrients, and saturated soils), this species appears to compete poorly when change in one or more habitat parameters creates an opportunity for the establishment of other species (USFWS 2007). Habitat availability may be a limiting factor across much of the range; Coastal Plain forested headwater wetlands have been significantly reduced by development, and mountain bogs are both historically uncommon and impacted by agricultural conversion (USFWS 2007). Nevertheless, the New Jersey Pine Barrens contain some apparently suitable but unoccupied sites, suggesting that this species' habitat requirements are not fully understood and/or that low dispersal limits colonization of these areas (USFWS 2007). Efforts to create or restore *H. bullata* habitat have had limited success (USFWS 2007).

Recovery tasks for Federal agencies in the swamp pink Recovery Plan include:

- Monitor threats to extant sites.
- Develop and maintain site-specific conservation plans.
- Enforce regulations protecting the species and its wetland habitat.
- Investigate population dynamics, using a standard method.
- Identify and, as needed, implement management techniques.

Habitat degradation is the primary range wide threat. This degradation is difficult to address through either land protection or regulatory mechanisms because it is often brought about by off-site land uses, particularly

development. Evidence of detrimental effects of development on *H. bullata* habitat and population quality continues to accumulate; such impacts are anticipated to worsen as development continues (USFWS 2007). A major component of habitat degradation is changes to the hydrologic regime. Such changes can be direct (e.g., ditching, damming, draining) or indirect (i.e., from development in the watershed). Indirect impacts often result from increased impervious surface in the watershed, which reduces infiltration and increases overland flow of stormwater, leading to increased stream erosion, wetland sedimentation, flood volumes and velocities, water level fluctuations, and hydrologic drought (USFWS 2007). Other components of degradation associated with adjacent development include poor water quality, invasive exotic species, trash, all terrain vehicles, herbivory by overabundant deer populations, trampling, and collection (USFWS 2007). Direct habitat losses have slowed, but historical losses were substantial (USFWS 2007). Because this species requires a very specific hydrology in order to thrive, climate change, which has the potential to either increase or decrease water levels at established sites, is an anticipated threat. For example, increased drought in southern Appalachians mountain bogs may already be having detrimental impacts. Also, about 10% of known occurrences are in areas with increased vulnerability to coastal flooding due to sea level rise (USFWS 2007).
The specific wetland habitat required by this species is easily degraded through both direct and secondary disturbances; among the wetland types it inhabits, some such as sphagnum bogs and Atlantic white cedar swamps are particularly fragile. A low incidence of flowering, limited seed dispersal, and poor seedling establishment combine to make colonization of new sites via reproduction from seed rare for this species (Godt et al. 1995, USFWS 2007). Finally, Godt et al. (1995) found low overall genetic diversity both within the species and within populations, even relative to the means found for other endemic and narrowly distributed species. This suggests that *H. bullata* may have limited capacity to adapt to future environmental change.

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At one site in St. Mary's Wilderness trail maintenance by a volunteer group altered swamp pink habitat and a log footbridge was placed on 6 swamp pink plants. Fortuitous and prompt action by the Forest Botanist resulted in the removal of the logs and monitoring a year later indicated the plants had survived and were doing well. The Mills Creek Dam restoration project has the potential to affect swamp pink, however, the US Fish and Wildlife Service has described mitigation measures that would reduce or eliminate the impact of this project.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

All known occurrences of swamp pink are on land that will be allocated to 4D, Special Biological Area, and/or 1A Designated Wilderness. These Special Biological Areas are managed specifically to restore and maintain conditions to benefit the community and/or rare species for which the area was established. Herbivory and shading may continue to be threats. Use of prescribed fire or wildland fire may be a tool to reduce shading in some areas.

NORTHEASTERN BULRUSH

AFFECTED ENVIRONMENT

Unless otherwise noted, the information used in this analysis comes from NatureServe (accessed in 2010).

Northeastern bulrush was listed as endangered under the Endangered Species Act in 1991. Populations are known from MA, MD, NH, NY (presumed extirpated), PA, VA, VT, and WV. The habitat seems to vary geographically, although there are not enough sites to allow generalizations to be made. However, one does observe that in the south, sinkhole ponds are the most common habitat for the plant, and in the north, other kinds of wetlands, including beaver-influenced wetlands, provide suitable habitat. When this species was listed as endangered there were 33 known populations. As of 2007, there were about 113 extant occurrences known in the Appalachians from southern Vermont and New Hampshire to western Virginia, with most occurrences in Pennsylvania.

Most populations are in Pennsylvania (70) and Vermont (22) (USFWS 2008). The other populations are in Massachusetts (1), Maryland (1), New Hampshire (9), Virginia (7), and West Virginia (3) (USFWS 2008). There are about ten historical occurrences: New York (1), Pennsylvania (7), Virginia (1), Quebec (1). The plants are restricted to fairly specific wetland habitats that are infrequent, especially in the southern part of the range. Various threats are associated with the habitat, including drainage and development, agricultural runoff, and any developments that could alter the local hydrology. Additional, unsurveyed habitat does exist, and more populations of this species may be found in the future if the potential habitats remain intact.

Long-term monitoring of known sites is needed before any conclusions can be drawn about the habitat needs of the plant, or about the stability of its populations in changing environments.

The implementation schedule for the northeastern bulrush recovery plan (USDI Fish and Wildlife Service 1993) includes five items that directly relate to Forest Service management:

- Secure permanent protection for known populations;
- Resurvey sites thought to have suitable habitat;
- Verify, monitor, and protect any additional populations;
- Identify potentially suitable habitat for additional surveys; and
- Survey potential sites.

Throughout its range, northeastern bulrush is found in open, tall herb-dominated wetlands. Often it grows at the water's edge, or in a few centimeters of water, but it may also be in fairly deep water (0.3-0.9 m) or away from standing water. In the southern part of its range, the most common habitat is sinkhole ponds, usually in sandstone. Water levels in these ponds tend to vary both with the season and from year to year. At least one site (in Massachusetts) is in a sand plain, where water level fluctuates as well. Two sites in Vermont are influenced to some extent by beaver activity as well as other hydrological factors.

With the information available it is difficult to compare sites throughout the plant's range. For example, lists of associated species may represent an entire wetland or the immediate vicinity of the plant, but this is not always possible to determine from available information. Nevertheless, examination of field reports indicates that there is considerable variety in associated species. A few species, however, are common to several of the sites. These are *Dulichium arundinaceum, Scirpus cyperinus sens. lat., Glyceria canadensis*, and *Triadenum virginicum*.

Virginia. There are seven extant northeastern bulrush sites in Virginia, with two ranked as A/AB, two ranked B/BC, and one ranked E. The status of most of these sites is unknown because they have not been surveyed since the 1980s or 1990s. Habitat includes emergent ridgetop shallow ponds, shallow sinkhole depressions and mountainside bench ponds. Four sites are located on private land, three are on public land, and ownership of one site is undetermined. In Virginia, the northeastern bulrush is listed as State endangered; however, no additional protection (e.g., buffers) is afforded to wetlands supporting the species. No upland buffers are regulated or protected around any wetlands in the State. The northeastern bulrush is protected under the Endangered Plant and Insect Species Act of 1979, which prohibits take without a permit, but individual landowners are exempt from these permitting requirements.

West Virginia. There are three northeastern bulrush populations in West Virginia, two of which are ranked B, and one of which is ranked D. These occurrences were surveyed and last observed in 2005. Habitat includes sinkhole ponds atop a low, flat sandstone ridge, and small seasonal ponds. Two of these sites are located on private lands, and one is located on National Forest land managed by the U.S. Forest Service (USFWS 2008).

The northeastern bulrush has no official status in West Virginia, and this State does not have an endangered species law. No upland buffers are regulated or protected around any wetlands in the State.

Among the potential human threats are agricultural runoff, construction of logging and fire roads, development, all-terrain vehicle use, collection, and dredging. In addition to human activity, there may be natural threats to the species as well, although more information about the biology and ecology of the species is needed before these influences can be clearly implicated in the decline of the species. Among possible natural threats are deer, beaver (one Vermont population has suffered alarming fluctuations, apparently as a result of beaver activity), natural water level fluctuations, fire (this may have damaged a population in Pennsylvania), and succession (it has been suggested that this may adversely affect populations in West Virginia and Maryland). Fluctuations in population size have been observed at several localities for the species. It is very likely that botanists visiting the known sites for the species do not identify vegetative plants, and it is postulated that the fluctuations are in number of flowering/ fruiting culms rather than actual number of plants.

The 5-year review of northeastern bulrush by the US Fish and Wildlife Service stated that new information indicates that shading may be a threat, "Therefore, in some cases, it may be helpful to manage the habitat surrounding these sites by selectively removing larger trees to reduce canopy cover increase light exposure" (USFWS 2008). The 5-year review also noted that alterations of the hydrology of wetlands supporting northeastern bulrush could have negative effects.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

The known occurrences of this species on the Forest are protected under all alternatives, except A (the 1993 Revised Forest Plan), as management prescription 4D, Special Biological Area. These Special Biological Areas are managed specifically to restore and maintain conditions to benefit the community and/or rare species for which the area was established. The cumulative impacts of the OHV trail that passes near the pond on Potts Mountain have the potential to negatively affect the pond and the northeastern bulrush through illegal OHV use (driving through the pond or creating deep ruts that affect hydrology) or through maintenance of the OHV road affecting the hydrology of the area. Standards in management prescription 4D allow OHV use to be managed to protect this plant. The Pond Run Pond site is very near the intersection of two trails that are used by hikers and horses. In the past there has been evidence of hoof prints in the pond basin. A wire fence has been constructed to discourage watering horses in the pond. Shading has also been a concern at this site and over the past several years a slow process of girdling trees has been occurring.

SUMMARY

Table B2.8 T&E species, Associated Ecological Systems, and Management Strategies

Species	Ecosystem	Management Strategies
Indiana bat	Caves and Karstlands	Management Prescription Areas: designation of the primary and secondary Indiana bat cave areas Standards/Guidelines: standards for activities within the primary and secondary Indiana bat cave areas; standards for activities throughout the Forest in regard to leave trees during timber harvest activities Objectives: improvement of habitat through increased open woodlands
Virginia Big-Eared Bat	Caves and Karstlands	Standards: Cave standards
James Spinymussel	Floodplains, Wetlands and Riparian Areas	Standards: Riparian standards
Shale Barrens Rock Cress	Appalachian Shale Barrens	Management Prescription Areas: All known locations are in Special Biologic Areas
Smooth Cone Flower		Management Prescription Areas: All known locations are in Special Biologic Areas
Virginia Sneezeweed	Floodplains, Wetlands and Riparian Areas	Management Prescription Areas: All known locations are in Special Biologic Areas Standards: Riparian standards
Swamp Pink	Floodplains, Wetlands and Riparian Areas	Management Prescription Areas: All known locations are in Special Biologic Areas Standards: Riparian standards
Northeastern Bulrush	Floodplains, Wetlands and Riparian Areas	Management Prescription Areas All known locations are in Special Biologic Areas Standards: Riparian standards

B2C– DEMAND SPECIES

The discussions of changes in habitat by alternative in the following sections are based on information from previous sections. The effects of each alternative on key habitat features across ecological forest types are discussed in detail in the Ecosystem Diversity Report (Appendix E) and Species Diversity Report (Appendix F). Tables B1.1, B1.2, B2.2, and B2.3 display Ecosystem and Species Group Indicators that quantify current conditions and desired conditions of these major habitat components, by ecosystem and alternative, over a ten and fifty year period. Unless otherwise noted, figures from these tables are used in the analysis of future trends.

In comparing alternatives, it is important to remember that Alternative A is defined as the management direction for the current plan. The actual accomplishments achieved under current management are closer in scope to Alternative D for prescribed fire and Alternative F for timber harvest.

WHITE-TAILED DEER

AFFECTED ENVIRONMENT

White-tailed deer (*Odocoileus virginianus*) use a wide variety of forest types and successional stages to meet their year-round needs. In the central Appalachians, deer are found in all forest types and use various successional stages during their annual life cycle (Johnson et al. 1995, VDGIF 2007). Older forests are important in the fall and winter, when acorns become a dominant fall and winter food item (Wentworth et al. 1990a). Deer nutrition, reproduction, weights, and antler characteristics can be influenced by the availability of acorns (Harlow et al. 1975, Feldhammer et al. 1989, Wentworth et al. 1990a, 1992). Year-round use of vegetation in the form of woody browse, soft mast, forbs and grasses is extremely important and found most abundantly in early successional woody habitat, open woodland, grasslands, and shrublands of varying sizes (Wentworth et al. 1990b, Ford et al. 1993, VDGIF 2007). High quality deer habitat is characterized by the interspersion of mature forested and other habitats that provide not only food sources, but escape cover (VDGIF 2007). In eastern hardwood forests, Barber (1984) recommended that at least 50% of the landscape should consist of mature mast trees, with the remainder containing an interspersion of evergreens, shrubs and vines, and openings with herbaceous and early successional woody vegetation. Based on utilization data, current deer densities in the Southern Appalachians can be maintained by providing approximately 5% of the landscape in regenerating forest vegetation (Wentworth et al. 1990b). Wentworth et al. (1989) concluded that approximately 2% of the area in high quality grasslands and shrublands would be necessary to adequately buffer the effects of a poor acorn year.

White-tailed deer are present throughout the Region. Population densities generally are medium to high in the Northern Ridge and Valley, Allegheny Mountains, Northern Cumberland Mountains, and Southern Appalachian Piedmont Sections, and low to medium in the remainder of the Southern Appalachian Assessment area (SAMAB 1996). High population densities are associated with greater amounts of cropland and lesser amounts of developed and coniferous forestland. Current deer densities are generally higher on private lands than on national forest and state lands in Virginia (VDGIF 2007).

Forest Trends

The GWNF is comprised of approximately 960,000 acres (90%) in thirteen Virginia counties and 105,000 acres (10%) in four West Virginia counties, for a total of 1,065,000 total acres, of which 1,035,000 is forested. There are approximately 240,000 hunters in Virginia that hunt deer (VDGIF 2007). Recreation generated primarily by deer hunting produced approximately $221 million in 2001 in the state (USFWS 2001). Approximately 323,000 people hunt deer in West Virginia, with the sport generating approximately $247.5 million annually to the states' overall economy (USFWS 2001). Current population reconstruction models indicate that Virginia's statewide deer population has been relatively stable over the past decade, fluctuating between 850,000 and 1,050,000 animals (VDGIF 2007). Ninety-two percent of the deer habitat in Virginia exists on private land, whereas eight percent is found on public land. Most public lands in Virginia are located along and west of the Blue Ridge Mountains.

In Virginia, deer population trends were evaluated by examining the annual rate of change in the population index (i.e., antlered buck harvest per unit area) over the 10-year period from 1996-2005. An exponential regression (y = aert; where, y = population index, a = intercept, e = 2.718, r = instantaneous rate of change, and t = year) was used to determine trends in population. The annual rate of change (R) = er – 1. The status of the deer population in each county was considered to be increasing or decreasing if the annual rate of change in the population index was >2.26% (either positive or negative) and the statistical significance level of the exponential regression model was p < 0.10 (r2 Value > 0.301). Annual rates of change that exceeded 2.26% represent a change of at least 25% in the population index over the decade (1.022610 = 1.25). Counties that displayed a rate of change between 0 and +2.26 were deemed to be stable. Overall on the GWNF in Virginia, 9 counties, representing 660,476 acres (69% of the 960,000 of total acres in Virginia) demonstrated stable population trends, and 4 counties, representing 295,788 acres (31%) demonstrated decreasing trends. Since 2000, VDGIF harvest data has suggested a more substantial decline across much of the GWNF. In contrast, private land in the same counties ranges from stable to increasing trends (VDGIF 2007)

A similar population index for GWNF public land in West Virginia counties (105,000 acres) is not available at this time. The agency's assumption is that the overall trend would be similar due to similarity of forest age structure and management activities on George Washington in the two states.

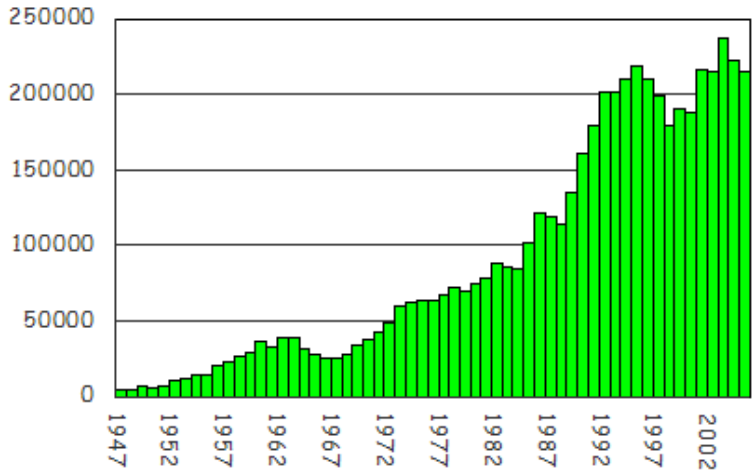
Table B2.9 White-tailed Deer Population Index Trend across the GWNF, 1996 to 2005 (Source: VDGIF)

County	Percent GWNF in County	Number of GWNF Acres in County	Ranger Districts Included	*R*[1]	p[2] Value	Status
Allegheny	56	159,359	James River, Warm Springs	-3.23%	0.180	Stable
Amherst	19	57,600	Pedlar	-6.90%	0.762	Decreasing
Augusta	30	186,239	North River, Pedlar	-1.80%	0.168	Stable
Bath	50	170,239	North River, Warm Springs	-4.70%	0.299	Stable
Botetourt	2	5870	James River,	-3.04	0.325	Decreasing
Frederick	2	5,120	Lee	-4.58	0.297	Stable
Highland	5	13,440	North River, Warm Springs	-4.80%	0.269	Stable
Nelson	6	17,920	Pedlar	-4.39%	0.254	Stable
Page	13	25,600	Lee	-0.12%	0.002	Stable
Rockbridge	17	95,999	North River, James River, Pedlar	-3.85%	0.374	Decreasing
Rockingham	25	136,319	North River, Lee,	-5.15%	0.545	Decreasing
Shenandoah	23	75,519	Lee	-1.98%	0.284	Stable
Warren	5	7,040	Lee	2.95%	0.150	Stable

[1] *R* = Percent annual change in population index. Values less than -2.26% and values greater than 2.26% are considered significant (1.0226^{10} = 1.25 or a 25% increase or decrease over the 10-year period).
[2] *p* = Statistical significance level of exponential regression model. Values (*p* < 0.10) are considered significant.

Statewide, VDGIF reports a 3% decrease in total number of deer harvested in 2005 compared to 2004, but the total number harvested was still 4% greater than the 10-year average.

Virginia Deer Harvest, 1947 to 2005



Source: http://www.dgif.state.va.us/wildlife/deer/harvestsummary.asp

In 2000, VDGIF and WVDNR estimated deer populations at 49,418 individuals on the GWNF. Based on evidence of declines in recent years, deer populations for 2005 are estimated to be lower on the GWNF than in 2000. Virginia's newly revised Deer Management Plan has an objective to stabilize deer populations on public land in counties that contain GWJNF lands (Virginia Deer Management Plan: 2006-2015). The revised Deer Management Plan recommends supporting habitat management objectives on public lands that manipulate vegetation for early successional wildlife and promote restoration, regeneration, and productivity of plant species important to wildlife, particularly those that provide diverse hard and soft mast (e.g., American chestnuts, acorns, grapes, and berries). Deer densities are normally greater in areas of high quality browse, hard mast production of both red and white oaks, and well distributed, high quality grassland/shrublands. These conditions are most influenced by soil fertility and are more common where there is an intermingled ownership of private and National Forest System lands. Many deer populations, especially on private land, have experienced steady increases over the past decades (VDGIF 2007). Deer densities are managed in part by controlling the number of antlerless deer hunting days. Liberalized hunting regulations over several years appear to have stabilized the herd growth for most areas in Virginia, especially on private land.

The deer management objective for the Virginia Department of Game and Inland Fisheries is based on the Cultural Carrying Capacity (CCC) and is intended to stabilize the deer population on public lands on all thirteen counties of the GWNF (VDGIF 2007). The quality of deer habitat has declined in recent years on National Forest System lands in many western Virginia counties because of maturing forest habitat conditions, with little replacement of early successional woody habitat for browse and cover. The Virginia Department of Game & Inland Fisheries (VDGIF) and West Virginia Department of Natural Resources recommends implementation of habitat management improvements that are beneficial to deer on over 1% of the total National Forest acreage annually (VDGIF 2007, WVDNR 2009). This includes an increase in timber harvest, as well as prescribed fire that creates open woodlands and early successional woody habitat, and restoration and maintenance of grasslands and shrublands. Such habitat creation should be well dispersed across the otherwise mature forested landscape of the GWNF.

DIRECT AND INDIRECT EFFECTS

Deer habitat quality and numbers are directly associated with soil quality, habitat type, successional stage, and the amount of habitat interspersion or edge (VDGIF 2007). The Forest Service recognizes that deer numbers are generally higher and increase from the implementation of projects that increase available food and cover,

such as timber management, prescribed burning and the development and management of grasslands and shrublands. Conversely, deer populations are usually lower and decline over time from actions that limit the development of successional habitat, such as the designation of areas with preservation management strategies. The importance of a diversity of hard mast producers, successional habitat for browse, and grasslands/shrublands, each being well distributed across the landscape to meet the year-round needs of deer, has been previously discussed. The effects of each alternative on key habitat features across ecological forest types are discussed in detail in the Ecosystem Diversity Report (Appendix E) and Species Diversity Report (Appendix F). Tables B1.1, B1.2, B2.2, and B2.3 quantify current condition and desired conditions of these major habitat components, by ecosystem and alternative, over a ten and fifty year period.

Table B2.10 depicts the acres of active management activities planned annually under each alternative. The four activities that have the greatest influence on deer habitat quality is early successional forest created by timber management, open woodland habitat restored and maintained through prescribed fire, grassland/shrubland restoration and maintenance, and mid- to late- successional hard mast producing forest.

Table B2.10 Planned Annual Activities in acres, by Alternative

Active management activities	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Timber harvest	3,000	1,800-3,000	0	3,000-5,000	1,800-3,000	1,800-3,000	1,800-3,000
Prescribed fire	3,000	12,000-20,000	0	5,000-12,000	20,000	12,000-20,000	12,000-20,000
Grassland/shrubland restoration and maintenance	407	622	292	722	652	622	652
Temporary wildlife openings	120	250	0	250	250	250	250

Early successional forest. The GWNF currently has about 30,000 acres of early successional forest in a landscape of 1,035,000 forested acres. The highest projected acreage of early successional forest created by timber management is 40,000 – 50,000 acres (4-5%) at 10 years under Alternative D. The lowest is 16,888 acres at 10 years under Alternative C, which assumes no timber harvesting and only natural disturbances creating early successional forest, modeled at 1-2% (Table B2.11). Alternatives A, B, E, and G have similar timber management objectives [18,000 – 30,000 acres (2-3%) at 10 years], with Alternative F the lowest outside of C [10,000 – 18,000 acres (1-2%) at 10 years].

Open woodland restoration. The highest acreage of prescribed fire is 200,000 acres at 10 years under alternative E. The lowest is 0 acres under Alternative C. Alternatives B, F, and G have similar fire management objectives (120,000 – 200,000 acres at 10 years). Alternatives D and A have lower fire management objectives (50,000 – 120,000 and 30,000 acres at 10 years, respectively). The success of prescribed fire in improving deer habitat depends on many factors, including site quality, stand conditions, and fire prescriptions (VDGIF 2007). Prescribed fire that restores open woodland structural conditions (in appropriate forest types) in an otherwise closed canopy forested landscape, can provide high quality year-round food and cover for deer. Open woodland conditions allows the development of woody browse, grasses, forbs, and soft and hard mast producing shrubs in the understory, while maintaining an overstory of hard- and soft- mast producing trees species for deer and many other high priority species . While early successional forest is ephemeral, changing locations over time across the GWNF, open woodlands, when maintained by fire, creates permanent habitat for deer. In addition, open woodland habitat is restored at a larger scale than early successional forest habitat Dense grassy/shrubby escape cover for fawns vulnerable to predators such as coyotes and black bears is

more effective when it is in a 500 to 1,000 acre patch of open woodlands (average prescribed burn block) than a 25-40 acre patch of early successional forest habitat (average timber treatment unit) or a 1-5 acre grassland/shrubland patch (average size of wildlife opening). Table B2.11 shows the amount of projected open woodland restoration by forest type and alternative at 10 years, restored and maintained through prescribed fire. The highest projected open woodland acres are 117,270 acres at 10 years under Alternatives B, E, F, and G. The lowest is 18,241 acres at 10 years under Alternative C. Alternatives A and D have 52,026 and 87,740 acres at 10 years, respectively.

Grassland/shrubland restoration and maintenance. The GWNF currently has about 5,000 acres in maintained grasslands/shrublands (Table B2.11). Alternatives B, E, F, and G have the highest objectives for grassland/shrubland restoration and maintenance of 7,000 acres at 10 years. Alternative C has the lowest objective at 2,500 at 10 years. Alternatives A and D have objectives at 5,500 and 6,000 acres at 10 years.

Mid- to late – successional hard mast producing forest. The GWNF currently has about 940,286 acres (90%) of mid- to late-successional forest containing hard mast producing trees. Forest types include Cove Forest, Oak Forests and Woodlands, and Pine Forests and Woodlands. The alternative with the highest projections for mid-to late successional hard mast producing forest is C with 953,762 acres (92%) at 10 years. Alternative D has the lowest objective with 911,742 acres (88%) at 10 years. Alternatives F, E, G, A, and B have 943,833 (91%), 935,772 (90%), 924,757 (89%), and 923,810 (89%) respectively. All alternatives have projected mid- to late successional forest of at least 88% or greater on the GWNF, with the difference between the lowest and highest acreage only four percentage points. All alternatives have an abundance of mature hard mast producing forest to provide hard mast and seasonal cover for white-tailed deer (VDGIF 2007).

The alternatives with the highest combination of projected early successional forest habitat, open woodlands, and grassland/shrublands are B, E, and G with 142,000 to 154,000 acres (14-15%) at 10 years. The alternative with the lowest combination early forest, open woodlands, and grassland/shrublands is Alternative C with 37,629 acres (3%) at 10 years. Alternatives F and A have a projected combination of 134,270 – 142,270 (13-14%) and 87,526 (8%) acres at 10 years, respectively.

Under Alternatives A and D, most early successional woody habitat created by timber management would be developed in the 8A1, 8B, 8C, and 10B management prescription areas, comprising 43% and 54% of the total forested acreage of the GWNF, respectively. Under Alternatives B, E, F, and G, most early successional woody habitat created by timber management would be developed in the 13 management prescription area, comprising 53%, 46%, 33%, and 48% of the total forested acreage, respectively. Prescribed burning and grassland/shrubland restoration and maintenance is a suitable use not only in the aforementioned management prescription areas, but in all other prescription areas except 1A Designated Wilderness, representing 96% of the total forested acreage. Therefore open woodland and grassland/shrubland restoration/maintenance can be accomplished, where appropriate, over most of the GWNF landscape. Active management prescription areas and suitable active management activities are well distributed over the GWNF landscape, with the exception of wilderness areas. Ownership patterns and adjacent private lands can offset or compound deer population distribution problems in at least two ways: (1) Early successional habitat may be provided on adjacent private lands that will meet browse needs for deer within localized areas; or (2) The deer may move off NF lands where browse is insufficient and cause damage to crops and pastures, thus becoming a nuisance to private landowners. Such movements may result in private landowner requests for kill permits, restitution from hunters through county damage stamps, or the filing of insurance claims for deer damages to their property. In either case, the opportunity for hunting recreation is diminished because hunting by the general public is restricted on most private lands and the overall numbers of available deer are decreased on NF lands.

Hard mast producing species are generally well distributed across the GWNF, although their success is heavily dependent on weather conditions during spring flowering and drought cycles. Adequate mast crops occur about every 3 to 5 years with heavy crops occurring about every 5 to 8 years (VDGIF 2007). The availability of hard mast producing species is not considered to be a problem with any plan alternative as shown in Tables B2.11 and B2.12.

The Forest Service also recognizes that both plant and animal populations can be adversely affected from the overpopulation of deer within an area. Some plants of the families Liliaceae and Orchidaceae are preferred as browse for deer. Deer populations can increase to the point of exceeding the biological carrying capacity (overpopulation) of the area, where development of early successional habitat for food and hunting are not allowed (VDGIF 2007). The goal of both VDGIF and WVDNR is to manage each state's deer population through hunting and other regulations to moderate populations below the biological carrying capacity (VDGIF 2007, WVDNR 2009). National Forest System lands receive annual hunting to control deer densities, with the goal of preventing over-population of these areas and thus reduce negative effects of browse pressure on plant diversity and protect the viability of herbaceous ground flora in these areas.

In summary, the combination of habitat components important for white-tailed deer habitat are projected to steadily increase (combination of early forest, open woodlands, and grasslands/shrublands) or stay relatively stable (mid- to late-successional mast producing forest) over the next 10 years under Alternatives B, D, E, F, and G. White-tailed deer populations should stabilize and/or increase under these alternatives over the next decade. The combination of early forest, open woodlands, and grasslands/shrublands under Alternative A are projected to increase only slightly above current conditions and decrease under Alternative C. Mid- to late successional mast producing forest should stay relatively stable for both alternatives. Under these two alternatives, white-tailed deer populations should stabilize and/or decrease over the next decade, due to lack of available habitat components other than mid- to late successional mast producing forest.

CUMULATIVE EFFECTS

Table B2.12 displays the projected habitat components at year fifty, by alternative, that have the greatest influence on habitat quality for white-tailed deer. The amount of early successional forest, grassland/shrublands, and mid- to late successional hard mast producing forest acres stay relatively constant from 10 year to 50 years under each alternative. The largest difference is the increase in open woodland habitat for some alternatives, increasing to about 190,000 acres (18%) at year 50 under Alternatives B,E,F, and G, 127,921 acres (12%) under Alternative D, and 61,969 acres (6%) under Alternative A. Open woodland habitat stays the same between years 10 to 50 under Alternative C [19,249 acres (2%)]. Open woodland structural conditions do not affect the age of the overstory trees, therefore preserving the mid- to late successional age structure of the forest. The largest difference is in the understory, because the overstory trees are spaced far enough apart to allow sunlight to reach the forest floor. Many high priority species need both mature overstory trees and a dense grassy/shrubby/herbaceous understory, including white-tailed deer. When combining early successional forest, grassland/shrubland, and open woodland restoration, Alternatives B,E,F, and G project a cumulative increase in the acreage of habitat important for white-tailed deer at year 50 to 216,711 – 228,711 acres (21-22%.) Alternatives D and A also projects a cumulative increase, but at a lower rate [165,340-185,340 acres (16-17%) and 114,898 acres (11%), respectively]. Alternative C projects no increase in these habitat components [38,952 acres (3%)]. Long-term deer populations should be expected to stabilize and possibly increase under Alternatives B, E, F, G, and D. Long-term deer populations should be expected to decrease due to lack of available high quality habitat under Alternatives A and C.

Table B2.11 Projected Habitat components in acres and percentage of forested landscape at 10 years by alternative.

Habitat Component	Current Condi-tions	%	Alt A	%	Alt B	%	Alt C	%	Alt D	%	Alt E	%	Alt F	%	Alt G	%
Early Successional Forest	30,539	3	46,829	4	18,000-30,000	2 -3	16,888	2	30,000 - 50,000	3 - 5	18,000-30,000	2 -3	18,000-30,000	2 - 3	18,000-30,000	2 -3
Open Woodlands	20,202	2	52,026	5	117,000	11	18,241	2	87,740	8	117,000	11	117,000	11	117,000	11
Grassland/ shrublands	5,000	.05	5,500	.05	7,000	.06	2,500	.02	6,000	.05	7,000	.06	7,000	.06	7,000	.06
Total acres of combined active management habitat components	55,741	5	87526	8	142,000–154,000	14 - 15	37,629	3	133,740-143,740	13-14	142,000 – 154,000	13-14	134,270 – 142,270	13 - 14	142,000-154,000	13-14
Mid- to late successional Hard Mast Producing Forest	940,286	90	923,810	89	928,810	89	953,762	92	911,742	88	935,772	90	943,833	91	924,757	89

Table B2.12 Projected Habitat components in acres and percentage of forested landscape at 50 years by alternative.

Habitat Component	Current Condi-tions	%	Alt A	%	Alt B	%	Alt C	%	Alt D	%	Alt E	%	Alt F	%	Alt G	%
Early Successional Forest	30,539	3	46,829	4	18,000-30,000	2 -3	16888	2	30,000 - 50,000	3 - 5	18,000-30,000	2 -3	18,000-30,000	2 - 3	18,000-30,000	2 -3
Open Woodlands	20,202	2	61,969	6	190,049	18	19,249	2	127,921	12	190,049	18	190,057	18	190,049	18
Grassland/ shrublands	5,000	.05	6,100	.05	8,662	.08	2,815	.02	7,419	.07	8,662	.08	8,662	.08	8,662	.08
Total acres of combined active management habitat components	55,741	5	114,898	11	216,711–228,711	21-22	38,952	3	165,340 185,340	16-17	216,711–228,711	21-22	2167,19 – 228,719	21 - 22	216,711–228,711	21-22
Mid- to late successional Hard Mast Producing Forest	940,286	90	924,220	89	924,220	89	953,762	92	904,509	87	935,762	90	943,786	91	924,220	89

EASTERN WILD TURKEY

AFFECTED ENVIRONMENT

Eastern wild turkey (*Meleagris gallopavo*) occupies a wide range of habitats, with diversified habitats providing optimum conditions (Schroeder 1985). This includes mature mast-producing stands during fall and winter, shrub dominated stands for nesting, and herb dominated communities, including grasslands, for brood rearing. Habitat conditions for wild turkey can be enhanced by management activities such as prescribed burning and thinning (Hurst 1978; Pack et al. 1988), and the development of herbaceous openings (Nenno and Lindzey 1979, Healy and Nenno 1983).

For the eastern hardwood region, Wunz and Pack (1992) recommended maintaining 50 to 75% of the area in mast producing condition and approximately 10% in well distributed permanent grassland/shrublands and/or open woodlands, in addition to the early successional woody habitats that result from timber harvest and other activities. They suggest that timber treatments should be 30 acres in size or less. Forest thinning (removing less than 20% of basal area) is recommended to enhance the herbaceous component of the stands. Heavier thinnings that increase the quantity of woody species is less desirable. Prescribed burning to create and maintain open woodland structural conditions is important for brood and year-round foraging habitat. Other important habitat components include spring seeps, especially in areas with regular snow cover, and a diversity of soft mast producing plants (e.g. dogwood, black gum, grape, blueberries, etc).

Eastern wild turkeys are present throughout the Region. Population densities generally are medium to high in the Northern Ridge and Valley, Allegheny Mountains, Northern Cumberland Mountains, and Southern Appalachian Piedmont Sections, and low to medium in the remainder of the SAA area (SAMAB 1996). High population densities are associated with greater amounts of oak forest and cropland, and lesser amounts of developed and coniferous forestland. Wild turkey populations have expanded in range and density in the last 25 years. As with deer, this increase likely is related to both nonhabitat factors such as extensive restoration efforts, protection, and conservative harvest strategies as well as increased acorn capability resulting from the increase in mid-to late successional oak forests.

Forest Trends

Wild turkey population trends are monitored by the Virginia Department of Game and Inland Fisheries (VDGIF) and West Virginia Department of Natural Resources (WVDNR). Population trends, in terms of harvest/square mile, vary over the years, but indicate an overall stable to increasing population trend.

Table B2.13 Spring Wild Turkey Harvest Information on GWNF, 1997 To 2006 (Source: http://www.dgif.state.va.us/wildlife/turkey/nationalforestspringturkeyharvest2006.pdf)

County	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Harvest /square mile
Allegheny	102	45	87	74	148	117	112	83	88	88	0.34
Amherst	34	26	30	30	37	43	51	32	40	35	0.39
Augusta	158	93	95	139	158	157	122	86	56	114	0.37
Bath	134	91	153	133	221	164	106	99	66	119	0.44
Botetourt	99	45	41	52	93	84	91	65	58	66	0.54
Frederick	4	6	4		3	3	6	5	6	8	1.04
Highland	26	26	41	47	61	38	32	17	22	36	0.40

County	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Harvest /square mile
Nelson	6	3	6	4	2	12	3	3	2	6	0.20
Page	10	6	6	7	13	5	8	6	9	20	0.47
Rockbridge	43	31	26	24	45	63	35	38	41	50	0.48
Rockingham	125	63	68	57	91	93	92	76	53	92	0.42
Shenandoah	57	41	31	20	48	48	47	60	44	70	0.59
Warren	3	4	3	3	9	5	9	6	3	3	0.31

DIRECT AND INDIRECT EFFECTS

Wild turkeys require a mixture of various successional stage habitats to meet their year-round habitat needs, as previously mentioned. Key requirements include the interspersion of mature mast producing forest during fall and winter, early successional woody habitat, grassland/shrublands and open woodlands for nesting (early successional habitat), and grasslands and open woodlands for brood range and year-round foraging (Norman, et al. 2001).

The four activities that have the greatest influence on wild turkey habitat quality is early successional forest created by timber management, open woodland habitat restored and maintained through prescribed fire, grassland/shrubland restoration and maintenance, and mid- to late- successional hard mast producing forest.

Early successional forest. The GWNF currently has about 30,000 acres of early successional forest in a landscape of 1,035,000 forested acres. The highest projected acreage of early successional forest created by timber management is 40,000 – 50,000 acres (4-5%) at 10 years under Alternative D. The lowest is 16,888 acres at 10 years under Alternative C, which assumes no timber harvesting and only natural disturbances creating early successional forest, modeled at 1% (Table B2.11). Alternatives A, B, E, and G have similar timber management objectives [18,000 – 30,000 acres (2-3%) at 10 years], with Alternative F the lowest outside of C [10,000 – 18,000 acres (1-2%) at 10 years].

Open woodland restoration. The highest acreage of prescribed fire is 200,000 acres at 10 years under Alternative E. The lowest is 0 acres under Alternative C. Alternatives B, F, and G have similar fire management objectives (120,000 – 200,000 acres at 10 years). Alternatives D and A have lower fire management objectives (50,000 – 120,000 and 30,000 acres at 10 years, respectively). The success of prescribed fire in improving wild turkey habitat depends on many factors, including site quality, stand conditions, and fire prescriptions (VDGIF 2010). Prescribed fire that restores open woodland structural conditions (in appropriate forest types) in an otherwise closed canopy forested landscape can provide high quality year-round food, nesting, brood-rearing habitat, and seasonal cover for wild turkeys. Open woodland conditions allows the development of woody browse, grasses, forbs, and soft and hard mast producing shrubs in the understory, while maintaining an overstory of hard- and soft- mast producing trees species for wild turkeys and many other high priority species. While early successional forest is ephemeral, changing locations over time across the GWNF, open woodlands, when maintained by fire, creates permanent habitat for turkeys. Table B2.11 shows the amount of projected open woodland restoration by forest type and alternative at 10 years, restored and maintained through prescribed fire. The highest projected open woodland acres are 117,270 acres at 10 years under Alternatives B, E, F, and G. The lowest is 18,241 acres at 10 years under Alternative C. Alternatives A and D have 52,026 and 87,740 acres at 10 years, respectively.

Grassland/shrubland restoration and maintenance. The GWNF currently has about 5,000 acres in maintained grasslands/shrublands. (Table B2.11). Alternatives B, E, F, and G have the highest objectives for grassland/shrubland restoration and maintenance of 7,000 acres at 10 years (Alternative C has the lowest objective at 2,500 at 10 years. Alternatives A and D have objectives at 5,500 and 6,000 acres at 10 years.

Mid- to late – successional hard mast producing forest. The GWNF currently has about 940,286 acres (90%) of mid- to late-successional forest containing hard mast producing trees. Forest types include Cove Forest, Oak Forests and Woodlands, and Pine Forests and Woodlands (Table B2.11). The alternative with the highest projections for mid- to late successional hard mast producing forest is C with 953,762 acres (92%) at 10 years. Alternative D has the lowest objective with 911,742 acres (88%) at 10 years. Alternatives F, E, G, A, and B have 943,833 (91%), 935,772 (90%), 924,757 (89%), and 923,810 (89%) respectively. All alternatives have projected mid- to late successional forest of at least 88% or greater on the GWNF, with the difference between the lowest and highest acreage only four percentage points. All alternatives have an abundance of mature hard mast producing forest to provide hard mast and seasonal cover for wild turkeys.

The alternatives with the highest combination of projected early successional forest habitat, open woodlands, and grassland/shrublands are B, E, and G with 142,000 to 154,000 acres (14-15%) at 10 years. The alternative with the lowest combination early forest, open woodlands, and grassland/shrublands is alternative C with 37,629 acres (3%) at 10 years. Alternatives F and A have a projected combination of 134,270 – 142,270 (13-14%) and 87,526 (8%) acres at 10 years, respectively.

Under Alternatives A and D, most early successional woody habitat created by timber management would be developed in the 8A1, 8B, 8C, and 10B management prescription areas, comprising 43% and 54% of the total forested acreage of the GWNF, respectively. Under Alternatives B, E, F, and G, most early successional woody habitat created by timber management would be developed in the 13 management prescription area, comprising 53%, 46%, 33%, and 48% of the total forested acreage, respectively. Prescribed burning and grassland/shrubland restoration and maintenance is a suitable use not only in the aforementioned management prescription areas, but in all other prescription areas except 1A Designated Wilderness, representing 96% of the total forested acreage. Therefore open woodland and grassland/shrubland restoration/maintenance can be accomplished, where appropriate, over most of the GWNF landscape. Active management prescription areas and suitable active management activities are well distributed over the GWNF landscape, with the exception of wilderness areas.

Hard mast producing species are generally well distributed across the GWNF, although their success is heavily dependent on weather conditions during spring flowering and drought cycles. Adequate mast crops occur about every 3 to 5 years with heavy crops occurring about every 5 to 8 years (VDGIF 2007). The availability of hard mast producing species is not considered to be a problem with any plan alternative as shown in Tables B2.10 and B2.11.

The availability of grasslands/shrublands, open woodlands, and early successional woody habitat for nesting, brood range, and year-round forage is the most limiting factor to wild turkey populations on the GWNF. The combination of habitat components important for wild turkeys are projected to steadily increase (combination of early forest, open woodlands, and grasslands/shrublands) or stay relatively stable (mid- to late-successional mast producing forest) over the next 10 years under Alternatives B, D, E, F, and G. Wild turkey populations should stabilize and/or increase under these alternatives over the next decade. The combination of early forest, open woodlands, and grasslands/shrublands under Alternative A are projected to increase only slightly above current conditions and decrease under Alternative C. Mid- to late successional mast producing forest should stay relatively stable for both alternatives. Under these two alternatives, wild turkey populations should stabilize and/or decrease over the next decade, due to lack of available habitat components other than mid- to late successional mast producing forest.

CUMULATIVE EFFECTS

Table B2.12 displays the projected habitat components at year fifty, by alternative, that have the greatest influence on habitat quality for wild turkey. The amount of early successional forest, grassland/shrublands, and mid- to late successional hard mast producing forest acres stay relatively constant from 10 year to 50

years under each alternative. The largest difference is the increase in open woodland habitat for some alternatives, increasing to about 190,000 acres (18%) at year 50 under Alternatives B, E, F, and G, 127,921 acres (12%) under Alternative D, and 61,969 acres (6%) under Alternative A. Open woodland habitat stays the same between years 10 to 50 under Alternative C [19,249 acres (2%)]. Open woodland structural conditions do not affect the age of the overstory trees, therefore preserving the mid- to late successional age structure of the forest. The largest difference is in the understory, because the overstory trees are spaced far enough apart to allow sunlight to reach the forest floor. Many high priority species need both mature overstory trees and a dense grassy/shrubby/herbaceous understory, including wild turkeys. When combining early successional forest, grassland/shrubland, and open woodland restoration, Alternatives B, E, F, and G project a cumulative increase in the acreage of habitat important for wild turkeys at year 50 to 216,711 – 228,711 acres (21-22%.) Alternatives D and A also projects a cumulative increase, but at a lower rate [165,340-185,340 acres (16-17%) and 114,898 acres (11%), respectively]. Alternative C projects no increase in these habitat components [38,952 acres (3%)]. Long-term wild turkey populations should be expected to stabilize and/or increase under Alternatives B, D, E, F, and G. Long-term wild turkey populations should be expected to stabilize and/or decrease due to lack of available high quality habitat other than mid- to late successional mast producing forest under Alternatives A and C.

RUFFED GROUSE

AFFECTED ENVIRONMENT

Ruffed grouse (*Bonasa umbellus*) utilize a variety of forest habitats and successional stages. Appalachian ruffed grouse require a variety of forested habitats, as well as openings within the forested landscape (ACGRP 2004 and Harper et al. 2005). Each season brings changes in biological activities of ruffed grouse and the environment in which they live. In the Appalachians, grouse adjust by using forest stands with seasonal foods in or near adequate cover. Ruffed grouse reproduction, recruitment, and survival determine year-to-year grouse abundance. Lack of nutritious food and suitable cover are often cited as limiting factors for Appalachian grouse populations. The location, proximity, and design of active forest management, with respect to seasonal habitat requirements, in large part determine the success of ruffed grouse populations. Important components of grouse habitat include an interspersion of mesic forests with herbaceous ground cover, young hardwoods 3-20 years old with high stem densities, mature stands with mast producing trees, and grassland/shrublands, open woodlands, and gated forest roads with abundant legumes and other forbs.

Nesting cover generally is located in poletimber or larger hardwood stands (Harris 1981, Thompson and Dessecker 1997). Haney (1996) also reported use of mature cove hardwood forests in the Southern Appalachians for nesting and brood rearing. While nesting habitat does not appear to be limiting, close interspersion with secure adult cover and brood habitat is important (Thompson and Dessecker 1997). Some key features of brood cover are security and an abundant high protein food source. Insects are most abundant in habitats characterized by lush herbaceous vegetation (Dimmick et al. 1996).

Some key features of brood cover are security and an abundant high protein food source. Insects are most abundant in habitats characterized by lush herbaceous vegetation (Dimmick et al. 1996). Thompson and Dessecker (1997) describe brood cover as 3-7 year-old regenerating stands containing significant herbaceous component through shrub dominated old fields and herbaceous openings such as grasslands, open woodlands, and sides of roads. In Georgia, broods preferred upland hardwood sapling (>10 year-old) and poletimber habitats, but also used sawtimber stands, although not in proportion to availability (Harris 1981). Regeneration areas (<6 years-old) and evergreen shrub thickets were avoided. Brood habitats were characterized by dense and diverse, herbaceous vegetation which provided low overhead cover with freedom of movement beneath. Dimmick et al. (1996) suggest that the lack of interspersion of areas with a well developed herb layer and areas of high stem density for protective cover may be one of the limiting factors in southeastern grouse populations. They suggest that brood habitat could be enhanced by the conversion of logging roads and log landings to linear food plots by planting clover/grass mixtures, which would provide bugging areas in close proximity to secure cover.

Adult cover, including drumming habitat, usually consists of young regenerating forest (6-15 year-old) or shrub cover (Thompson and Dessecker 1997). The dense cover provides protection from both avian and mammalian

predators. Secure cover is provided in habitats with good vertical structure (8,000+ stems/acre) of 15-20 foot saplings (Kubisiak 1989). Dimmick et al. (1996) reported that males began to orient their drumming sites around or in clearcuts within 3 years post harvest. In Georgia, drumming habitat was associated with the presence of a relatively dense understory of heath shrubs; primarily flame azalea and mountain laurel (Hale et al. 1982). No strong preference for timber types or stand condition classes was evident. Harris (1981) found that males preferred upland hardwood sawtimber, generally associated with evergreen shrub thickets during the breeding and post breeding seasons.

Dimmick and others (1996) found that breeding male density (based on drumming counts) increased significantly in response to clearcutting in Tennessee. A similar response to timber harvest was reported from oak-dominated forests in Missouri (Wiggers et al. 1992). Highest grouse densities occurred where 7-to-15 year-old hardwood regeneration comprised greater than 14% of the area.

In oak forests of the Central Hardwood region, Thompson and Dessecker (1997) recommended managing on an 80-year rotation that would maintain approximately 15% of the forest in brood or adult cover (3-15 years old). Appropriate regeneration methods include clearcut, seedtree, and shelterwood. Residual basal areas should not exceed 20 square feet per acre. Cutting units should be > 5 acres, and preferably 10-40 acres in size. Group selection is not recommended since the regeneration patches are too small to provide large enough patches of contiguous habitat. In oak-hickory forests, hard mast (acorns and beechnuts) is a critical winter food for grouse. Therefore, it is important to juxtapose mature oak stands adjacent to timber treatments so foraging opportunities for acorns and other mast are not limited (ACGRP 2004 and Harper et al. 2005). Positioning timber treatments mid-slope can provide important escape cover for grouse traveling between ridge-top drumming sites, roost sites, and bottomland foraging sites. Another important consideration is to regenerate or, at least, to thin stands along riparian zones, which are preferred habitats for ruffed grouse during winter and summer when a dense stem density is present. Thinning forest stands can improve ruffed grouse habitat if those species that do not produce preferred food resources (e.g. maples, yellow poplar, ashes, and sourwood) are targeted for removal, while more desirable species (e.g. oaks, black cherry, serviceberry, birches, American beech) are retained. Thinning allows increased sunlight into the forest stand, stimulating understory vegetation. Typically, mesic sites will produce more herbaceous vegetation, while xeric sites will produce more woody cover. Regardless of site, soft-mast production by species such as blueberry, huckleberry, blackberry, and raspberry can be expected to increase 2-5 years post treatment. Where riparian issues do not allow removal of timber, 'wildlife' cuts, in which selected trees are cut and left on site, or girdled to become snags, is an alternative method to regenerate or thin along riparian zones (ACGRP 2004 and Harper et al. 2005).

Although once commonly used, fire has been suppressed in the Appalachian region for at least 80 years, altering many of the associated forest types and wildlife communities (ACGRP 2004 and Harper et al. 2005). Prescribed fire has proven beneficial for ruffed grouse, particularly in oak-hickory forests where burning can enhance brooding habitat. Grouse broods in the Appalachians select areas with abundant herbaceous vegetation, especially forb and fern cover, but also low-growing woody cover, such as blueberries and huckleberries. Prescribed fire in the Appalachians is restricted primarily to oak-hickory forests and other forest types associated with southern and western exposures and ridgetops. This offers numerous opportunities for habitat enhancement, especially where oak-hickory forests comprise 50 percent or more of the available forest cover. When burning oak-hickory stands, fire often feathers into coves and more mesic forest types, but intensity is much less and will often will be too moist to burn. In fact, when burning relatively large areas (200 or more acres, which is usually necessary on National Forests where there is a lack of roads or firebreaks), coves, creeks, and northern/eastern exposures are commonly used as natural firebreaks. This provides an exceptional mosaic of conditions across the burned area, which is quite favorable for ruffed grouse for both winter foraging and brooding habitat. Following prescribed fire, areas supporting a diverse herbaceous community can by utilized almost exclusively by grouse broods during the critical summer months. Utilizing prescribed fire after silvicultural treatments (e.g. clearcuts and shelterwood with reserves) to enhance oak regeneration, also improves grouse habitat by increasing invertebrate abundance and soft mast-producing plants. Basal area will fluctuate among sites, but reducing the canopy closure to 60-80 percent normally allows sufficient sunlight into the forest floor to develop the desired structure for brood habitat and will also promote additional soft mast production. The natural mosaic pattern of fire intensity created by prescribe fire across a forested landscape (especially in larger fire areas) often creates small patches of young forest on southern and

western facing slopes, which further enhances ruffed grouse habitat. In areas where silvicultural treatments are not economical, or restricted for other reasons, prescribed fire is a critical tool for creating and maintaining ruffed grouse habitat (ACGRP 2004 and Harper et al. 2005).

Forest roads (access routes) and grassy/herbaceous openings can provide critical habitat for ruffed grouse in the central and southern Appalachians (ACGRP 2004 and Harper et al. 2005). Forest roads and openings can be an important foraging habitat, especially within oak-hickory dominated forests during years with little mast. Ruffed grouse hens will utilize forest roads in the fall and winter and during the breeding season. Grouse forage on herbaceous material dominated by clover, cinquefoil, birdsfoot trefoil, coltsfoot, and wild strawberry. In most areas where grouse are found in the Appalachians, forest roads and openings comprise less than 1 percent of the land cover. Because they are such a critical habitat, managing roads and openings is paramount to ruffed grouse habitat.

Dominant fall and winter foods in the Southern Appalachians include leaves and fruits of greenbrier (*Smilax* spp.), the leaves of mountain laurel (*Kalmia latifolia*), fruits of grapes (*Vitis* spp.) and oaks (*Quercus* spp.), and Christmas fern (*Polystichum acrostichoides*) (Seehorn and others 1981). Similarly, Stafford and Dimmick (1978) reported that greenbrier, mountain laurel, and Christmas fern were the dominant fall and winter food items in the Southern Appalachian region of Tennessee and North Carolina. When available, acorns comprise a significant proportion of the diet (Seehorn et al. 1981, Servello and Kirkpatrick 1987, Kirkpatrick 1989, Thompson and Dessecker 1997). They provide a high energy food source during the critical winter period when forage quality is limited (Servello and Kirkpatrick 1987, Kirkpatrick 1989). However, lack of secure cover in open oak stands may limit their use by grouse (Stafford 1989, Thompson and Dessecker 1997). Kubisiak (1985) suggested that 40-60% of a compartment be maintained in stands of mast-bearing age.

Ruffed grouse are found primarily in the Northern Ridge and Valley, Allegheny Mountains, Northern Cumberland Mountains, Blue Ridge Mountains, Northern Cumberland Plateau, and Southern Cumberland Mountains (SAA Terrestrial Report, pgs. 66-67). Low density populations also extend into the adjacent portions of the Central Ridge and Valley, Southern Cumberland Plateau, Southern Ridge and Valley, and Southern Appalachian Piedmont. Population densities generally are moderate in the Blue Ridge Mountains and low to moderate elsewhere. Current grouse densities generally are higher on national forest system lands, national parks, and the Cherokee Indian Reservation than on other ownerships. However, grouse population densities have declined over the last 25 years. The declining trend likely is largely due to the reduction of forest cover in the sapling-pole successional class, which is important to this species.

Areas of quality grouse hunting are in very short supply today and do not meet hunter demands because of very limited habitats where they exist. Ruffed grouse populations on the GWNF appear to have declined over the last two decades as they have throughout the Southern Appalachians. Much of this decline is attributable to reduced availability of hardwood shrub-sapling habitat due to reductions in timber harvest levels. Recent habitat trends have moved more toward mid to late successional forests with more than 87% of the forest exceeding 60 years of age and only 3% less than 20 years of age. Optimum habitat conditions consist of a variety of habitats and successional stages including 40-60% in mid-late successional forest for mast production and nesting, approximately 15% in (6-15 year old) early successional deciduous forest patches capable of producing 20-25,000 woody stems per hectare (Gullion 1984a; Kubisiak 1985; Stoll et al. 1999; Dimmick et al. 1998, Dessecker 2001) and shrub dominated old field habitats. Permanent openings are normally either too large, too open, or do not have thick escape cover nearby to be considered optimum for grouse use. Mortality from avian and mammalian predators is a significant factor limiting grouse populations in the Southern Appalachians (Reynolds et al. 2000).

DIRECT AND INDIRECT EFFECTS

The four activities that have the greatest influence on ruffed grouse habitat quality is early successional forest created by timber management, brood habitat created and maintained through prescribed fire, grassland/shrubland and open woodland restoration and maintenance, and mid- to late- successional hard mast producing forest.

Early successional forest. The GWNF currently has about 30,000 acres of early successional forest in a landscape of 1,035,000 forested acres. The highest projected acreage of early successional forest created by timber management is 40,000 – 50,000 acres (4-5%) at 10 years under Alternative D. The lowest is 16,888 acres at 10 years under Alternative C, which assumes no timber harvesting and only natural disturbances creating early successional forest, modeled at 1% (Table B2.11). Alternatives A, B, E, and G have similar timber management objectives [18,000 – 30,000 acres (2-3%) at 10 years], with Alternative F the lowest outside of C [10,000 – 18,000 acres (1-2%) at 10 years].

Prescribed fire and open woodland restoration. The highest acreage of prescribed fire is 200,000 acres at 10 years under alternative E. The lowest is 0 acres under Alternative C. Alternatives B, F, and G have similar fire management objectives (120,000 – 200,000 acres at 10 years). Alternatives D and A have lower fire management objectives (50,000 – 120,000 and 30,000 acres at 10 years, respectively). The success of prescribed fire in improving ruffed grouse habitat depends on many factors, including site quality, stand conditions, and fire prescriptions (ACGRP 2004 and Harper et al. 2005). Prescribed fire often feathers into coves and more mesic forest types, but intensity is much less and will often be too moist to burn. In fact, when burning relatively large areas (200 or more acres, which is usually necessary on National Forests where there is a lack of roads or firebreaks), coves, creeks, and northern/eastern exposures are commonly used as natural firebreaks. This provides an exceptional mosaic of conditions across the burned area, which is quite favorable for ruffed grouse for both winter foraging and brooding habitat. Following prescribed fire, areas supporting a diverse herbaceous community can by utilized almost exclusively by grouse broods during the critical summer months. Prescribed fire that restores open woodland structural conditions (in appropriate forest types) in an otherwise closed canopy forested landscape, allows the development of woody browse, grasses, forbs, and soft and hard mast producing shrubs in the understory, while maintaining an overstory of hard- and soft- mast producing trees species for ruffed grouse and many other high priority species. While early successional forest is ephemeral, changing locations over time across the GWNF, open woodlands, when maintained by fire, creates permanent habitat for ruffed grouse. Table B2.11 shows the amount of projected open woodland restoration by forest type and alternative at 10 years, restored and maintained through prescribed fire. The highest projected open woodland acres are 117,270 acres at 10 years under Alternatives B, E, F, and G. The lowest is 18,241 acres at 10 years under Alternative C. Alternatives A and D have 52,026 and 87,740 acres at 10 years, respectively.

Grassland/shrubland restoration and maintenance. The GWNF currently has about 5,000 acres in maintained grasslands/shrublands. (Table B2.11). Alternatives B, E, F, and G have the highest objectives for grassland/shrubland restoration and maintenance of 7,000 acres at 10 years. Alternative C has the lowest objective at 2,500 at 10 years. Alternatives A and D have objectives at 5,500 and 6,000 acres at 10 years.

Mid- to late – successional hard mast producing forest. The GWNF currently has about 940,286 acres (90%) of mid- to late-successional forest containing hard mast producing trees. Forest types include Cove Forest, Oak Forests and Woodlands, and Pine Forests and Woodlands (Table B2.11). The alternative with the highest projections for mid- to late successional hard mast producing forest is C with 953,762 acres (92%) at 10 years. Alternative D has the lowest objective with 911,742 acres (88%) at 10 years. Alternatives F, E, G, A, and B have 943,833 (91%), 935,772 (90%), 924,757 (89%), and 923,810 (89%) respectively. All alternatives have projected mid- to late successional forest of at least 88% or greater on the GWNF, with the difference between the lowest and highest acreage only four percentage points. All alternatives have an abundance of mature hard mast producing forest to provide hard mast and seasonal cover for ruffed grouse.

The alternatives with the highest combination of projected early successional forest habitat, open woodlands, and grassland/shrublands are B, E, and G with 142,000 to 154,000 acres (14-15%) at 10 years. The alternative with the lowest combination early forest, open woodlands, and grassland/shrublands is Alternative C with 37,629 acres (3%) at 10 years. Alternatives F and A have a projected combination of 134,270 – 142,270 (13-14%) and 87,526 (8%) acres at 10 years, respectively.

Under Alternatives A and D, most early successional woody habitat created by timber management would be developed in the 8A1, 8B, 8C, and 10B management prescription areas, comprising 43% and 54% of the total forested acreage of the GWNF, respectively. Under Alternatives B, E, F, and G, most early successional woody habitat created by timber management would be developed in the 13 management prescription area,

comprising 53%, 46%, 33%, and 48% of the total forested acreage, respectively. Prescribed burning and grassland/shrubland restoration and maintenance is a suitable use not only in the aforementioned management prescription areas, but in all other prescription areas except 1A Designated Wilderness, representing 96% of the total forested acreage. Therefore open woodland and grassland/shrubland restoration/maintenance can be accomplished, where appropriate, over most of the GWNF landscape. Active management prescription areas and suitable active management activities are well distributed over the GWNF landscape, with the exception of wilderness areas.

Hard mast producing species are generally well distributed across the George Washington NF, although their success is heavily dependent on weather conditions during spring flowering and drought cycles. Adequate mast crops occur about every 3 to 5 years with heavy crops occurring about every 5 to 8 years (VDGIF 2007). The availability of hard mast producing species is not considered to be a problem with any plan alternative as shown in Table B2.11 and B2.12.

The availability of early successional woody habitat, grasslands/shrublands, and open woodlands for nesting, brood range, and year-round forage is the most limiting factor to ruffed grouse populations on the GWNF. The combination of habitat components important for ruffed grouse are projected to steadily increase (combination of early forest, open woodlands, and grasslands/shrublands) or stay relatively stable (mid- to late-successional mast producing forest) over the next 10 years under Alternatives B, D, E, F, and G. Ruffed grouse populations should stabilize and/or increase under these alternatives over the next decade. The combination of early forest, open woodlands, and grasslands/shrublands under Alternative A are projected to increase only slightly above current conditions and decrease under Alternative C. Mid- to late successional mast producing forest should stay relatively stable for both alternatives. Under these two alternatives, ruffed grouse populations should stabilize and/or decrease over the next decade, due to lack of available habitat components other than mid- to late successional mast producing forest.

CUMULATIVE EFFECTS

Table B2.12 displays the projected habitat components at year fifty, by alternative, that have the greatest influence on habitat quality for ruffed grouse. The amount of early successional forest, grassland/shrublands, and mid- to late successional hard mast producing forest acres stay relatively constant from 10 year to 50 years under each alternative. The largest difference is the increase in open woodland habitat for some alternatives, increasing to about 190,000 acres (18%) at year 50 under Alternatives B, E, F, and G, 127,921 acres (12%) under Alternative D, and 61,969 acres (6%) under Alternative A. Open woodland habitat stays the same between years 10 to 50 under Alternative C [19,249 acres (2%)]. Open woodland structural conditions do not affect the age of the overstory trees, therefore preserving the mid- to late successional age structure of the forest. The largest difference is in the understory, because the overstory trees are spaced far enough apart to allow sunlight to reach the forest floor. Many high priority species need both mature overstory trees and a dense grassy/shrubby/herbaceous understory, including ruffed grouse. When combining early successional forest, grassland/shrubland, and open woodland restoration, Alternatives B, E, F, and G project a cumulative increase in the acreage of habitat important for ruffed grouse at year 50 to 216,711 – 228,711 acres (21-22%.) Alternatives D and A also projects a cumulative increase, but at a lower rate [165,340-185,340 acres (16-17%) and 114,898 acres (11%), respectively]. Alternative C projects no increase in these habitat components [38,952 acres (3%)]. Long-term ruffed grouse populations should be expected to stabilize and/or increase under Alternatives B, D, E, F, and G. Long-term ruffed grouse populations should be expected to stabilize and/or decrease due to lack of available high quality habitat other than mid- to late successional mast producing forest under Alternatives A and C.

BLACK BEAR

AFFECTED ENVIRONMENT

The black bear (*Ursus americanus*) uses a wide variety of habitats in the southern Appalachians, occurring primarily on National Forests and National Parks of the Southern Blue Ridge, Northern Cumberland, and Allegheny Mountains and the Northern Ridge and Valley. These public lands in Virginia, West Virginia, North

Carolina, Tennessee, and Georgia connect to form a forested landscape of over 6 million acres where bears are generally distributed at low to medium densities. The increase of older oak forests in this large block of habitat, along with increased protection and conservative hunter harvest, has allowed bear populations throughout the southeastern mountain region to moderately increase over the past 30 years. Bears generally are absent from the Cumberland Plateau, Southern Cumberland Mountains, and Piedmont (SAMAB 1995:61).

In the Central and Southern Appalachians, including the GWNF, important habitat elements are habitat remoteness, habitat diversity, den site availability, and availability of hard mast.

Black bears are opportunistic omnivores and consume a variety of seasonal plant and animal foods including flowering plants, grasses, various roots and tubers, and especially soft mast (grapes, berries, apples, etc.). However, availability of hard mast (acorns and hickory nuts) is critical throughout the winter, and reproductive success is closely related to this habitat factor (Eiler 1981; Wathen 1983; Eiler et al. 1989). Total production of hard mast and production by individual trees can fluctuate from year to year due to climatic and other factors (Downs and McQuilkin 1944; Fowells 1965). Since bears utilize nearly any abundant plant or animal food, they are likely to thrive when a diversity of forest age classes and food sources are available. Vegetation management can provide much of this diversity (Reagan 1990). Naturally occurring events such as ice storms, wildland fires, and hurricanes provide habitat diversity, but at random intervals and locations, making benefits sometimes limited and unreliable.

Bears den in a wide variety of sites including road culverts, abandoned buildings, and in vegetation (Carlock et al. 1983). Traditional dens are found on the ground in caves, rockfalls, or under the root mass of uprooted trees, and in hollow trees. Carlock et al. (1983) and M. Vaughan (pers. comm.) found that hollow trees are preferred dens. Brody (1984) found that ground dens are preferred in the North Carolina mountains. Preference may be related to availability and may be a learned behavior (Brody 1984).

Levels of human access within bear habitat determine the degree of negative effects on bears (Beringer 1986; Brody and Pelton 1989). Generally, high bear population densities are associated with areas of low open road density (SAMAB 1995:87). Low-traffic roads and trails are used by bears as travel ways and provide the benefit of additional edge and associated soft mast, whereas high traffic volumes have a negative impact (B. Fletcher, pers. comm.). Effects vary based the duration and time of year the road or trail is open for use and the number and type of recreation users present.

Forest Trends

The state agencies of Virginia and West Virginia use a combination of indices derived from harvest, nuisance activity, age structure, and miscellaneous mortalities to monitor status of black bear population. VDGIF uses the Downing method to perform black bear population reconstruction and determine population trends (D. Martin, VDGIF Black Bear Biologist, Pers. Communication, 5/21/2004). Five years of harvest data is required to reconstruct one year of population estimates, as such the reconstructed population data is for the years 1989-1998. Both male and female populations exhibited an increasing trend.

Table B2.14 Virginia's Black Bear Population Trend, 1989 to 1998
Downing Method

Sex	Population Growth Trend (%) per year	R-Square	Significance
Male	+ 7.4	0.97	P<0.97
Female	+ 4.2	0.91	P<0.91

In addition, the trend in annual bear hunter harvests reflects the trend in population growth; this can be verified by comparisons of past harvest trends to trends in population reconstruction analyses. During the last

10 years (1995-2005), Virginia's bear harvest has been significantly increasing at an average annual rate of 7.8% per year (95% confidence interval is 4.0% - 11.8%) (VDGIF 2009).

DIRECT AND INDIRECT EFFECTS

The four activities that have the greatest influence on black bear habitat quality is early successional forest created by timber management, open woodland habitat restored and maintained through prescribed fire, grassland/shrubland restoration and maintenance, and mid- to late- successional hard mast producing forest with an abundance of cavities and den trees.

Early successional forest. The GWNF currently has about 30,000 acres of early successional forest in a landscape of 1,035,000 forested acres. The highest projected acreage of early successional forest created by timber management is 40,000 – 50,000 acres (4-5%) at 10 years under Alternative D. The lowest is 16,888 acres at 10 years under Alternative C, which assumes no timber harvesting and only natural disturbances creating early successional forest, modeled at 1% (Table B2.11). Alternatives A, B, E, and G have similar timber management objectives [18,000 – 30,000 acres (2-3%) at 10 years], with Alternative F the lowest outside of C [10,000 – 18,000 acres (1-2%) at 10 years].

Open woodland restoration. The highest acreage of prescribed fire is 200,000 acres at 10 years under alternative E. The lowest is 0 acres under Alternative C. Alternatives B, F, and G have similar fire management objectives (120,000 – 200,000 acres at 10 years). Alternatives D and A have lower fire management objectives (50,000 – 120,000 and 30,000 acres at 10 years, respectively). Prescribed fire that restores open woodland structural conditions (in appropriate forest types) in an otherwise closed canopy forested landscape, can provide high quality year-round food and cover for black bear. Open woodland conditions allows the development of woody browse, grasses, forbs, and soft and hard mast producing shrubs in the understory, while maintaining an overstory of hard- and soft- mast producing trees species for black bear and many other high priority species. While early successional forest is ephemeral, changing locations over time across the GWNF, open woodlands, when maintained by fire, creates permanent habitat for black bear. In addition, open woodland habitat is restored at a larger scale than early successional forest habitat. Table B2.11 shows the amount of projected open woodland restoration by forest type and alternative at 10 years, restored and maintained through prescribed fire. The highest projected open woodland acres are 117,270 acres at 10 years under Alternatives B, E, F, and G. The lowest is 18,241 acres at 10 years under Alternative C. Alternatives A and D have 52,026 and 87,740 acres at 10 years, respectively.

Grassland/shrubland restoration and maintenance. The GWNF currently has about 5,000 acres in maintained grasslands/shrublands. (Table B2.11). Alternatives B, E, F, and G have the highest objectives for grassland/shrubland restoration and maintenance of 7,000 acres at 10 years. Alternative C has the lowest objective at 2,500 at 10 years. Alternatives A and D have objectives at 5,500 and 6,000 acres at 10 years.

Mid- to late – successional hard mast producing forest. The GWNF currently has about 940,286 acres (90%) of mid- to late-successional forest containing hard mast producing trees. Forest types include Cove Forest, Oak Forests and Woodlands, and Pine Forests and Woodlands. The alternative with the highest projections for mid-to late successional hard mast producing forest is C with 953,762 acres (92%) at 10 years. Alternative D has the lowest objective with 911,742 acres (88%) at 10 years. Alternatives F, E, G, A, and B have 943,833 (91%), 935,772 (90%), 924,757 (89%), and 923,810 (89%) respectively. All alternatives have projected mid- to late successional forest of at least 88% or greater on the GWNF, with the difference between the lowest and highest acreage only four percentage points. All alternatives have an abundance of mature hard mast producing forest to provide hard mast and cavities and den trees for black bears (VDGIF 2009).

The alternatives with the highest combination of projected early successional forest habitat, open woodlands, and grassland/shrublands are B, E, and G with 142,000 to 154,000 acres (14-15%) at 10 years. The alternative with the lowest combination early forest, open woodlands, and grassland/shrublands is alternative C with 37,629 acres (3%) at 10 years. Alternatives F and A have a projected combination of 134,270 – 142,270 (13-14%) and 87,526 (8%) acres at 10 years, respectively.

Under Alternatives A and D, most early successional woody habitat created by timber management would be developed in the 8A1, 8B, 8C, and 10B management prescription areas, comprising 43% and 54% of the total forested acreage of the GWNF, respectively. Under Alternatives B, E, F, and G, most early successional woody habitat created by timber management would be developed in the 13 management prescription area, comprising 53%, 46%, 33%, and 48% of the total forested acreage, respectively. Prescribed burning and grassland/shrubland restoration and maintenance is a suitable use not only in the aforementioned management prescription areas, but in all other prescription areas except 1A Designated Wilderness, representing 96% of the total forested acreage. Therefore open woodland and grassland/shrubland restoration/maintenance can be accomplished, where appropriate, over most of the GWNF landscape. Active management prescription areas and suitable active management activities are well distributed over the GWNF landscape, with the exception of wilderness areas. Hard mast producing species are generally well distributed across the Forest, although their success is heavily dependent on weather conditions during spring flowering and drought cycles. Adequate mast crops occur about every 3 to 5 years with heavy crops occurring about every 5 to 8 years (VDGIF 2007). The availability of hard mast producing species is not considered to be a problem with any plan alternative as shown in Table B2.11 and B2.12.

Remote habitat free from the regular presence of humans is an important component of bear habitat quality. Prescriptions with remoteness as a desired condition are found in Wilderness and recommended wilderness study areas (1A, 1B), Special Biological Areas (4D), Mt. Pleasant National Scenic Area (4F), Recommended National Scenic Area (4FA), Shenandoah Mtn Crest – Cow Knob Salamander (8E7), Black Bear/Remote Habitats (8C), and Remote Backcountry (12D), and Mosaics of Habitat – Unsuitable (13U). Currently, 43% of the GWNF is in prescriptions with remoteness as a desired condition. The alternative with the highest percentage of the forest in remote conditions is C (838,698 acres, 79%), followed by Alternatives F, D, A, E, and G [601,645 (56%), 494,291 (46%), 454,194 (43%), 443,771 (42%), and 421,586 (40%) acres, respectively]. The alternative with the lowest percentage of forest in remote conditions is B (361,267 acres, 33%). All alternatives except B have 40% or greater of the GWNF in prescriptions with remoteness as a desired condition.

In summary, the combination of habitat components important for black bear habitat are projected to steadily increase (combination of early forest, open woodlands, and grasslands/shrublands) under Alternatives B, D, E, F, and G, increase only slightly above current conditions under alternative A, and decrease under Alternative C. Mid- to late successional mast producing forest is projected to be stable over the next 10 years under all alternatives. Percentage of forest with remote conditions as a desired condition is 40% or greater in all alternatives except B. Given the current increasing population trend for black bears on the GWNF, black bear populations should continue to increase under all alternatives over the next decade.

CUMULATIVE EFFECTS

Table B2.12 displays the projected habitat components at year fifty, by alternative, that have the greatest influence on habitat quality for black bear. The amount of early successional forest, grassland/shrublands, and mid- to late successional hard mast producing forest acres stay relatively constant from 10 year to 50 years under each alternative. The largest difference is the increase in open woodland habitat for some alternatives, increasing to about 190,000 acres (18%) at year 50 under Alternatives B, E, F, and G, 127,921 acres (12%) under alternative D, and 61,969 acres (6%) under Alternative A. Open woodland habitat stays the same between years 10 to 50 under Alternative C [19,249 acres (2%)]. Open woodland structural conditions do not affect the age of the overstory trees, therefore preserving the mid- to late successional age structure of the forest. The largest difference is in the understory, because the overstory trees are spaced far enough apart to allow sunlight to reach the forest floor. Many high priority species need both mature overstory trees and a dense grassy/shrubby/herbaceous understory, including black. When combining early successional forest, grassland/shrubland, and open woodland restoration, Alternatives B, E, F, and G project a cumulative increase in the acreage of habitat important for black bear at year 50 to 216,711 – 228,711 acres (21-22%.) Alternatives D and A also projects a cumulative increase, but at a lower rate [165,340-185,340 acres (16-17%) and 114,898 acres (11%), respectively]. Alternative C projects no increase in these habitat components [38,952 acres (3%)]. Percentage of forest with remote conditions as a desired condition is 40% or greater in all alternatives except B and not expected to change between year 10 and 50. Long-term black bear populations

are projected to continue to increase or stabilize due to factors other than habitat availability (territoriality and/or other population density pressures), under all alternatives.

NORTHERN BOBWHITE

AFFECTED ENVIRONMENT

Northern bobwhite (*Colinus virginianus*) numbers have declined steadily throughout their range for over 40 years and quite likely for much longer. From 1980 to 1999, fall bobwhite populations declined 66% and projected trends indicate a further decline of approximately 54% over the next two decades (Dimmick et al. 2002).

A lack of nesting and brood-rearing cover is considered the major limiting factor over much of the range of the northern bobwhite (Dimmick et al. 2002 and VDGIF 2008). The loss of native warm season plant communities by planting non-native invasive grasses, planting dense pine forests, and intensive production of row crops is principally responsible for limiting bobwhite populations as well as those of other species such as loggerhead shrike, dickcissel, bobolink, Henslow's sparrow, Bachman's sparrow, and field sparrow. Managed warm season grasses with an adequate component of forbs provide good to excellent nesting and brood-rearing habitat. Hardwood forests provide important winter habitats for bobwhite throughout much of its range. Open woodland restoration and management provides habitat conditions that promote bobwhite productivity and survival.

Northern bobwhite has specific seasonal needs that vary throughout the year. This species favors old fields and brushy areas such as wood margins, hedgerows, thickets and open woodlands (Hamel 1992). Summer nesting cover and summer brood habitat consisting of grassy areas (preferably bunch grasses) and weedy patches with exposed bare ground are needed to provide for the recruitment within a population. Winter food and winter cover of seed producing plants and shrublands are needed to carry populations through the dormant season (Rosene 1985). Habitat conditions for bobwhite quail require disturbances from prescribed burning and/or mowing or discing on 2 to 3 year intervals. Northern bobwhite are considered area sensitive in their habitat needs, requiring a landscape patch of 500 acres or greater of interspersed suitable habitat in order to persist over time (Dimmick et al. 2002 and VDGIF 2008)

The recovery of bobwhite quail may be difficult with an accelerating loss of available land to create and maintain quail habitat throughout its range. Restoring bobwhite populations range-wide will depend upon: 1) the amount of agricultural lands that are enhanced to provide nesting, brood rearing, and roosting habitats for quail and other grassland species; 2) the amount of pine dominated and mixed pine hardwood lands that are managed to provide open grass- and forb-dominated ground cover through thinning, harvesting, and periodic burning; and 3) the amount of rangeland that is managed to improve native plant communities and provide quail food and cover.

Forest Trends

Populations of bobwhite quail on the GWNF and surrounding landscape are very low, with small and widely scattered areas of occupied range. The population level is presently considered unhuntable, given their low numbers (Puckett VDGIF, personal communication).

DIRECT AND INDIRECT EFFECTS

Habitat needs for northern bobwhite were considered by reviewing and incorporating elements of the Northern Bobwhite Conservation Initiative (Dimmick et al. 2002) and the Quail Action Plan for Virginia (VDGIF 2008). Habitat conditions recommended to improved conditions for quail include restoration of open woodlands, grasslands/shrublands, and creation of early successional forests.

The three activities that have the greatest influence on bobwhite quail habitat quality is early successional forest created by timber management, open woodland habitat restored and maintained through prescribed fire, and grassland/shrubland restoration and maintenance.

Early successional forest. The GWNF currently has about 30,000 acres of early successional forest in a landscape of 1,035,000 forested acres. The highest projected acreage of early successional forest created by timber management is 40,000 – 50,000 acres (4-5%) at 10 years under Alternative D. The lowest is 16,888 acres at 10 years under Alternative C, which assumes no timber harvesting and only natural disturbances creating early successional forest, modeled at 1%-2% (Table B2.11). Alternatives A, B, E, and G have similar timber management objectives [18,000 – 30,000 acres (2-3%) at 10 years], with Alternative F the lowest outside of C [10,000 – 18,000 acres (1-2%) at 10 years].

Open woodland restoration. The highest acreage of prescribed fire is 200,000 acres at 10 years under alternative E. The lowest is 0 acres under Alternative C. Alternatives B, F, and G have similar fire management objectives (120,000 – 200,000 acres at 10 years). Alternatives D and A have lower fire management objectives (50,000 – 120,000 and 30,000 acres at 10 years, respectively). The success of prescribed fire in improving bobwhite quail habitat depends on many factors, including site quality, stand conditions, and fire prescriptions (VDGIF 2008). Prescribed fire that restores open woodland structural conditions (in appropriate forest types) in an otherwise closed canopy forested landscape, can provide high quality year-round food and cover for bobwhite quail. Open woodland conditions allows the development of woody browse, grasses, forbs, and soft and hard mast producing shrubs in the understory, while maintaining an overstory of hard- and soft-mast producing trees species for bobwhite quail and many other high priority species. While early successional forest is ephemeral, changing locations over time across the GWNF, open woodlands, when maintained by fire, creates permanent habitat for bobwhite quail. In addition, open woodland habitat is restored at a larger scale than early successional forest habitat, usually 500 to 1,000 acres in size (average prescribed burn block). Table B2.11 shows the amount of projected open woodland restoration by forest type and alternative at 10 years, restored and maintained through prescribed fire. The highest projected open woodland acres are 117,270 acres at 10 years under Alternatives B, E, F, and G. The lowest is 18,241 acres at 10 years under Alternative C. Alternatives A and D have 52,026 and 87,740 acres at 10 years, respectively.

Grassland/shrubland restoration and maintenance. The GWNF currently has about 5,000 acres in maintained grasslands/shrublands. (Table B2.11). Alternatives B, E, F, and G have the highest objectives for grassland/shrubland restoration and maintenance of 7,000 acres at 10 years. Alternative C has the lowest objective at 2,500 at 10 years. Alternatives A and D have objectives at 5,500 and 6,000 acres at 10 years.

The alternatives with the highest combination of projected early successional forest habitat, open woodlands, and grassland/shrublands are B, E, and G with 142,000 to 154,000 acres (14-15%) at 10 years. The alternative with the lowest combination early forest, open woodlands, and grassland/shrublands is alternative C with 37,629 acres (3%) at 10 years. Alternatives F and A have a projected combination of 134,270 – 142,270 (13-14%) and 87,526 (8%) acres at 10 years, respectively.

Under Alternatives A and D, most early successional woody habitat created by timber management would be developed in the 8A1, 8B, 8C, and 10B management prescription areas, comprising 43% and 54% of the total forested acreage of the GWNF, respectively. Under Alternatives B, E, F, and G, most early successional woody habitat created by timber management would be developed in the 13 management prescription area, comprising 53%, 46%, 33%, and 48% of the total forested acreage, respectively. Prescribed burning and grassland/shrubland restoration and maintenance is a suitable use not only in the aforementioned management prescription areas, but in all other prescription areas except 1A Designated Wilderness, representing 96% of the total forested acreage. Therefore open woodland and grassland/shrubland restoration/maintenance can be accomplished, where appropriate, over most of the GWNF landscape. Active management prescription areas and suitable active management activities are well distributed over the GWNF landscape, with the exception of wilderness areas.

In summary, the combination of habitat components important for bobwhite quail habitat are projected to steadily increase above current conditions (combination of early forest, open woodlands, and grasslands/shrublands) over the next 10 years under Alternatives B, D, E, F, and G. The combination of early forest, open woodlands, and grasslands/shrublands under Alternative A are projected to increase only slightly above current conditions and decrease under Alternative C. The greatest hope for reversing the declining trends of bobwhite quail is open woodland restoration at a scale of 500 acres or greater, in combination with early successional forest and grassland/shrubland management. Wild bobwhite quail coveys were recently

found in a 1,000 acre open woodland patch created and maintained by prescribed fire called Second Mountain (Croy, personal comm. 2010). This is the first documented case of bobwhite quail colonizing open woodland habitat created by prescribed fire on the GWNF. Under all alternatives except A and C, increasing suitable habitat will provide greater opportunity for the northern bobwhite population to increase in the next decade.

CUMULATIVE EFFECTS

Table B2.12 displays the projected habitat components at year fifty, by alternative, that have the greatest influence on habitat quality for northern bobwhite quail. The amount of early successional forest and grassland/shrublands acres stay relatively constant from 10 year to 50 years under each alternative. The largest difference is the increase in open woodland habitat for some alternatives, increasing to about 190,000 acres (18%) at year 50 under Alternatives B, E, F, and G, 127,921 acres (12%) under Alternative D, and 61,969 acres (6%) under Alternative A. Projected open woodland acres stay the same between years 10 to 50 under alternative C [19,249 acres (2%)]. When combining early successional forest, grassland/shrubland, and open woodland restoration, Alternatives B, E, F, and G project a cumulative increase in the acreage of habitat important for bobwhite quail at year 50 to 216,711 – 228,711 acres (21-22%.) Alternatives D and A also project a cumulative increase, but at a lower rate [165,340-185,340 acres (16-17%) and 114,898 acres (11%), respectively]. Alternative C projects no increase in these habitat components [38,952 acres (3%)]. Long-term bobwhite quail populations have the greatest chance to increase under Alternatives B, E, F, G, and D. Long-term quail populations have very little chance of increasing due to low availability of suitable habitat, under Alternatives A and C.

AMERICAN WOODCOCK

AFFECTED ENVIRONMENT

Although classed as a game bird, populations of American woodcock (*Scolopax minor)* have shown large declines in the eastern U.S. since surveys began in 1968 (Krementz and Jackson 1999). In the Appalachians, breeding populations are highly variable in density and spotty in distribution (WMI 2008). Wintering population densities vary from year to year, but the species is much more common and widely distributed in winter than in summer in the South. According to conservation status rankings, the woodcock is listed as a priority species under the Forest Service's southern national forest migratory and resident landbird conservation strategy (Gaines and Morris 1996).

The American woodcock is closely associated with young, second-growth hardwoods and other early successional habitats that are a result of periodic forest disturbance (Straw et al. 1994, WMI 2008). Ideal habitat consists of young forests and grasslands/shrublands mixed with forested land (Keppie and Whiting 1994). These include forest openings, grasslands, or open woodlands for singing displays in spring, shrubby thickets or other young hardwoods on moist soils for feeding and daytime cover, early successional hardwoods for nesting, and grasslands/open woodlands for night-time roosts (Mendall and Aldous 1943, Andrle and Carroll 1988, Boothe and Parker 2000, WMI 2008). American woodcock are considered area sensitive, needing a landscape patch of 500 acres or greater of suitable interspersion of habitat mosaics in order to persist over time (WMI 2008).

Roosting and display habitat is typically open fields or regenerating forests. Maintenance of old fields for roosting and display habitat can be accomplished through disking, mowing, use of herbicides, and prescribed burns, although maintaining some small trees and shrubs is desirable. The goal is to create open habitats that are "patchy," rather than uniform in structure (Krementz and Jackson 1999).

Natural disturbances historically responsible for creation of early successional habitat also improve woodcock habitat. Beavers created extensive habitat, as did fire and possibly windstorms. In general, maintaining integrity of wetter sites such as springs, streams and creeks is beneficial to these species. Allowing thickets to grow in riparian areas will greatly improve habitat quality for woodcock, (Krementz and Jackson 1999). Grassy

areas near water provide prime nesting and display grounds. Restoration of beavers on the GWNF would increase suitable foraging habitat.

Non-breeding or wintering habitat is similar to breeding habitat but typically includes more open conditions such as sedge meadows, beaver pond margins, rice fields, upper reaches of estuaries and occasionally coastal meadows (del Hoyo et al. 1996). Winter habitats range from bottomland hardwoods to upland pine forests, young pine plantations, and mature pine-hardwood forests, though in some pine habitats the birds tend to focus their activities in lowlands dominated by hardwoods (Roberts 1993). Unlike during breeding, mature pine-hardwood and bottomland hardwoods are often preferred (Krementz and Pendleton 1994, Horton and Causey 1979). During the non-breeding season, woodcock generally occupy moist thickets in daytime, and shift to more open habitats such as pastures, fields (including agricultural), and young clearcuts at night. A diversity of habitat types and age classes may be especially important to survival when severe weather forces woodcock from preferred sites (Krementz and Pendleton 1994). The use of prescribed burns is a common forest management practice and can be used to set back plant succession. A light, controlled fire can maintain habitat patchiness as well. Burns may also remove pine needle cover, opening the ground to woodcock foraging. Mowing can also be used to improve foraging habitat, but appropriate habitat should be maintained for nesting birds (Roberts 1993).

Forest Trends

Most woodcock use on the GWNF during migration periods, but breeding woodcock have been confirmed on the GWNF. Populations of woodcock appear very low and scattered on the forest.

DIRECT AND INDIRECT EFFECTS

The three activities that have the greatest influence on American woodcock habitat quality is early successional forest created by timber management for nesting and foraging if near riparian areas, open woodlands created and maintained through prescribed fire for singing grounds and evening roost areas, and grassland/shrubland restoration and maintenance for singing/roosting grounds, and nesting/foraging if near riparian areas.

Early successional forest. The GWNF currently has about 30,000 acres of early successional forest in a landscape of 1,035,000 forested acres. The highest projected acreage of early successional forest created by timber management is 40,000 – 50,000 acres (4-5%) at 10 years under Alternative D. The lowest is 16,888 acres at 10 years under Alternative C, which assumes no timber harvesting and only natural disturbances creating early successional forest, modeled at 1% (Table B2.11). Alternatives A, B, E, and G have similar timber management objectives [18,000 – 30,000 acres (2-3%) at 10 years], with Alternative F the lowest outside of C [10,000 – 18,000 acres (1-2%) at 10 years].

Prescribed fire and open woodland restoration. The highest acreage of prescribed fire is 200,000 acres at 10 years under alternative E. The lowest is 0 acres under Alternative C. Alternatives B, F, and G have similar fire management objectives (120,000 – 200,000 acres at 10 years). Alternatives D and A have lower fire management objectives (50,000 – 120,000 and 30,000 acres at 10 years, respectively). The success of prescribed fire in improving American woodcock habitat depends on many factors, including site quality, stand conditions, and fire prescriptions (ACGRP 2004 and Harper et al. 2005). Prescribed fire that restores open woodland structural conditions (in appropriate forest types) in an otherwise closed canopy forested landscape, allows the development of woody browse, grasses, forbs, and soft and hard mast producing shrubs in the understory, while maintaining an overstory of hard- and soft- mast producing trees. Such habitat is favorable for singing grounds and evening roost areas for American woodcock. While early successional forest is ephemeral, changing locations over time across the GWNF, open woodlands, when maintained by fire, creates permanent habitat for ruffed grouse. Prescribed fire, especially when applied over large areas, feathers into more mesic sites. The lighter fire effects can create shrubby conditions in moist soil areas, creating suitable foraging areas for woodcock (WMI 2008). Table B2.11 shows the amount of projected open woodland restoration by forest type and alternative at 10 years, restored and maintained through prescribed fire. The highest projected open woodland acres are 117,270 acres at 10 years under Alternatives B, E, F, and G. The

lowest is 18,241 acres at 10 years under Alternative C. Alternatives A and D have 52,026 and 87,740 acres at 10 years, respectively.

Grassland/shrubland restoration and maintenance. The GWNF currently has about 5,000 acres in maintained grasslands/shrublands. (Table B2.11). Alternatives B, E, F, and G have the highest objectives for grassland/shrubland restoration and maintenance of 7,000 acres at 10 years. Alternative C has the lowest objective at 2,500 at 10 years. Alternatives A and D have objectives at 5,500 and 6,000 acres at 10 years.

The alternatives with the highest combination of projected early successional forest habitat, open woodlands, and grassland/shrublands are B, E, and G with 142,000 to 154,000 acres (14-15%) at 10 years. The alternative with the lowest combination early forest, open woodlands, and grassland/shrublands is Alternative C with 37,629 acres (3%) at 10 years. Alternatives F and A have a projected combination of 134,270 – 142,270 (13-14%) and 87,526 (8%) acres at 10 years, respectively.

Under Alternatives A and D, most early successional woody habitat created by timber management would be developed in the 8A1, 8B, 8C, and 10B management prescription areas, comprising 43% and 54% of the total forested acreage of the GWNF, respectively. Under Alternatives B, E, F, and G, most early successional woody habitat created by timber management would be developed in the 13 management prescription area, comprising 53%, 46%, 33%, and 48% of the total forested acreage, respectively. Prescribed burning and grassland/shrubland restoration and maintenance is a suitable use not only in the aforementioned management prescription areas, but in all other prescription areas except 1A Designated Wilderness, representing 96% of the total forested acreage. Therefore open woodland and grassland/shrubland restoration/maintenance can be accomplished, where appropriate, over most of the GWNF landscape. Active management prescription areas and suitable active management activities are well distributed over the GWNF landscape, with the exception of wilderness areas.

The availability of early successional woody habitat, grasslands/shrublands, and open woodlands (especially near riparian areas) for nesting, singing grounds, diurnal feeding, and evening roosting, is the most limiting factor to American woodcock populations on the GWNF. The combination of habitat components important for woodcock are projected to steadily increase above current conditions (combination of early forest, open woodlands, and grasslands/shrublands) under Alternatives B, D, E, F, and G increase only slightly under Alternative A, and decrease under Alternative C over the next 10 years. American woodcock populations have the greatest chance to increase under Alternatives B, D, E, F, and G. Woodcock populations are projected to stabilize or decrease under Alternatives A and C, due to low availability of suitable habitat components.

CUMULATIVE EFFECTS

Table B2.12 displays projected habitat components at year fifty, by alternative, that have the greatest influence on habitat quality for American woodcock. The amount of early successional forest and grassland/shrublands stay relatively constant from 10 year to 50 years under each alternative. The largest difference is the increase in open woodland habitat for some alternatives, increasing to about 190,000 acres (18%) at year 50 under Alternatives B, E, F, and G, 127,921 acres (12%) under Alternative D, and 61,969 acres (6%) under Alternative A. When combining early successional forest, grassland/shrubland, and open woodland restoration, alternatives B,E,F, and G project a cumulative increase in the acreage of habitat important for woodcock at year 50 to 216,711 – 228,711 acres (21-22%.) Alternatives D and A also projects a cumulative increase, but at a lower rate [165,340-185,340 acres (16-17%) and 114,898 acres (11%), respectively]. Alternative C projects no increase in these habitat components [38,952 acres (3%)]. Long-term American woodcock populations have the greatest chance to stabilize and/or increase under Alternatives B, D, E, F, and G. Long-term ruffed grouse populations should be expected to stabilize and/or decrease due to low availability of suitable habitat under alternatives A and C.

B2D– MIGRATORY SPECIES

AFFECTED ENVIRONMENT

Migratory birds have become a focus of conservation concern due to evidence of declining population trends for many species. To ensure that forest plan revision alternatives include provisions for migratory bird habitat, planning efforts included coordination with the Migratory Bird Office of the U.S. Fish and Wildlife Service and others under the umbrella of Partners in Flight (PIF) and the Appalachian Joint Venture (AJV). Both PIF and AJV are cooperative efforts involving partnerships among federal, state, and local government agencies, foundations, professional organizations, conservation groups, industry, the academic community and private individuals. They were launched in response to growing concerns about declines in populations of all bird species and to emphasize conservation of birds not covered by existing conservation initiatives.

PIF and AJV have developed Bird Conservation Plans for each physiographic area relevant to the national forest planning area. These plans are science-based, long-term, proactive strategies for bird conservation across all land ownerships and are designed to ensure long-term maintenance of healthy populations of native land birds. Forest Service biologists work with PIF and AJV coordinators to identify key management issues and opportunities for high priority species on National Forest System lands, and developed related goals, objectives, and standards for incorporation into the Revised Forest Plan. In addition, *The Southern National Forest's Migratory and Resident Landbird Conservation Strategy* (Gaines and Morris 1996) was also reviewed and incorporated into planning efforts. This strategy identifies priority species and provides a framework for monitoring populations. The monitoring program described in this document is currently being implemented, and would continue under all alternatives.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

Because migratory and resident landbirds are so ubiquitous and diverse, they are relevant to the majority of ecological communities and habitat elements considered during forest planning. As a result, provisions for these species are integrated into numerous plan objectives and standards focused on achieving desired habitat conditions. Effects of these provisions on ecological communities, associated species, and all relevant conservation priority species (as identified by the U.S. Fish and Wildlife Service) are addressed through the Ecological Diversity Analysis in the EIS (See Ecosystem Diversity Report (Appendix E) and Species Diversity Report (Appendix F)). Effects to specific species of birds are addressed under appropriate sections for those chosen as Management Indicator Species (MIS).

The majority of the George Washington National Forest is contained within the Ridge and Valley Ecological Section, but there are also sections contained within the Blue Ridge and Allegheny Mountain Ecological Sections. The PIF plans and associated management issues for each of these areas will be addressed at some level in the Forest Plan Revision.

National Forests play an important role in conservation of bird species within the Ridge and Valley Section. Key landbird conservation issues within this Section are summarized below.

- Creation and maintenance of early succession shrub habitat is desirable in order to provide habitat for the Appalachian Bewick's Wren, golden-winged warbler, prairie warbler and whip-poor-will. Intensive surveys to determine the current use of the Forest by these species are needed. There are several management prescriptions that identify the need to provide large enough patches of early successional habitat for area-sensitive early successional species.
- Creation of structural diversity in mature stands to enhance conditions desirable for species such as the cerulean warbler, worm-eating warbler, and wood thrush. Mesic oak and mixed mesophytic stands can be evaluated for addition of canopy gaps and vertical structure through group selection and commercial thinning harvest programs.

- Protection and maintenance of northern hardwood/spruce-fir forests is a priority. The potential for restoration needs to be evaluated. This type is protected where it occurs and the potential for restoration of additional acres needs to be evaluated.

The Pedlar Ranger District falls within the Blue Ridge Section, and therefore are covered by the PIF Bird Conservation Plan for the Southern Blue Ridge. Despite habitat protection on federal lands within the Southern Blue Ridge Area, 30% of breeding species have declined sharply in the last 30 years and an additional 18% have shown possible declines (Hunter et al. 1999). Key landbird conservation issues within this Section are summarized below.

- Conservation and restoration of spruce-fir and northern hardwood forest communities are important for associated boreal bird species. Spruce-fir forests are treated as rare communities in the George Washington National Forest Plan and they will be maintained and restored across all alternatives. Standards protect the spruce-fir type from conversion to other forest types and from silvicultural practices except those designed to maintain or restore the type in all alternatives [Refer to Ecological Systems and Terrestrial Species Diversity Sections].
- Large patches of mature hemlock-white pine, northern hardwoods and mixed mesophytic (mesic hardwood) forests are uncommon due to past land management. Older stands of northern hardwood and mixed mesophytic hardwood forests cover only about 1% of the Southern Blue Ridge land base. There is a need to increase and maintain late successional acreage for these types. In addition, some low elevation forests, especially riparian forests, are fragmented on private lands. Regardless of Alternative, between 79 and 90% of the mixed mesophytic forest will be in a mid-late successional condition at the end of the next ten years, and after 50 years the range is expected to be between 61 and 98%. Alternative G results in less of this type being disturbed and Alternative F the most. Forests dominated by eastern hemlock will not be subject to regeneration harvest. Hemlock will be retained as patches during all silvicultural treatments [Refer to Ecological Systems and Terrestrial Species Diversity Sections].
- Many early successional species at mid- to high elevations have declined due to forest maturation, fire suppression, elimination of grazing, and decline in active forest management on federal lands. The George Washington National Forest established an objective to create or maintain at least 285 acres of high elevation early successional habitat through forest regeneration and/or maintenance of balds, utility rights of way, old fields, and open woodlands [Refer to Ecological Systems and Terrestrial Species Diversity Sections].
- A predominance of forest stands in the 40-80 year age class on national forest system lands has resulted in a closed canopy condition with poorly developed understory and subcanopy. There is an overall lack of forest with "old growth" characteristics, including a multi-layered canopy, snags and downed woody debris. The George Washington National Forest will be implementing canopy gap creation to enhance the understory for a variety of bird species (Refer to Ecological Systems and Terrestrial Species Diversity Sections).
- Development of private land to resort, urban and suburban uses is creating increased fragmentation effects at a landscape level. See Refer to Ecological Systems and Terrestrial Species Diversity Sections.

In addition to providing a diversity of habitats for migratory birds on the landscape, collision of migratory birds with communications towers was considered during plan revision. The U.S. Fish and Wildlife Service (2000) has identified this as an issue needing attention:

> "Construction of these towers (including radio, television, cellular, and microwave) increases at an estimated 6 to 8 percent annually in the United States. According to the Federal Communication Commission's *2000 Antenna Structure Registry*, the number of lighted towers greater than 199 feet above ground level (AGL) currently number over 45,000 and the total number of towers over 74,000. Non-compliance with the registry program is estimated at 24 to 38 percent, bringing the total to 92,000 to 102,000. By 2003, all television stations must be digital, adding potentially 1,000 new towers exceeding 1,000 feet AGL."…."The construction of new towers creates a potentially significant impact on

migratory birds, especially some 350 species of night-migrating birds. Communications towers are estimated to kill 4-5 million birds per year."

Two mechanisms for bird mortality occur at communications towers (World Wide Web 2002). The first occurs when birds flying in poor visibility conditions do not see the structure (i.e., blind collision). Towers that are lighted at night for aviation safety may help reduce blind collisions, but they bring about a second mechanism for mortality. When there is a low cloud ceiling or foggy conditions, refracted light creates an illuminated area around the tower. Migrating birds lose their stellar cues for nocturnal migration and a broad orienting perspective on the landscape in these weather conditions. The lighted area may be the strongest cue for navigation, and birds remain in the lighted space by the tower. Mortality occurs when they collide with the structure and guy wires, or even other migrating birds, as more and more passing birds cram into the relatively small, lighted space. The lights apparently do not attract birds from afar, but hold birds that pass within the vicinity.

The GWNF adopted forest-wide standards requiring removal of obsolete communications towers, location of new communication equipment on existing towers where possible, and coordination of new tower planning and construction with U.S. Fish and Wildlife Service in an effort to reduce tower collision mortality and to comply with the Migratory Bird Treaty Act, the Endangered Species Act, and the Bald and Golden Eagle Act.

B2E– MANAGEMENT INDICATOR SPECIES

National Forest Management Act regulations, adopted in 1982, require selection of management indicator species (MIS) during development of forest plans (36 CFR 219.19(a)). Reasons for their selection must be stated. This section describes the MIS selected for the revised Land and Resource Management Plan and the conditions they are to represent. A more complete documentation of the process is contained in the MIS Process Selection white paper.

Management indicator species (MIS) are to be selected "because their population changes are believed to indicate the effects of management activities" (36 CFR 219 (a)(1)). They are to be used during planning to help compare effects of alternatives (36 CFR 219.19(a)(2)), and as a focus for monitoring (36 CFR 219.19(a)(6)). Where appropriate, MIS shall represent the following groups of species (36 CFR 219 (a)(1)):

- Threatened and endangered species on State and Federal lists;
- Species with special habitat needs;
- Species commonly hunted, fished, or trapped;
- Non-game species of special interest; and
- Species selected to indicate effects on other species of selected major biological communities.

Since adoption of these regulations, the management indicator species concept has been reviewed and critiqued by the scientific community (Caro and O'Doherty 1999, Simberloff 1998, Noss 1990, Landres et al. 1988, and Weaver 1995). These reviews identify proper uses and limitations of the indicator species concept. They generally caution against overreaching in use of indicator species, especially when making inferences about ecological conditions or status of other species within a community. Caution is needed because many different factors may affect populations of each species within a community, and each species' ecological niche within a community is unique.

To reflect this current scientific understanding while meeting the letter and spirit of regulations, we have made great effort to clearly define the legitimate uses and limitations of each selected MIS. The MIS process is but one tool used to develop management strategies and monitoring programs designed to meet NFMA requirements related to diversity of plant and animal communities. Other elements used for comprehensive planning for plant and animal diversity include: objectives and standards for maintenance and restoration of desired ecological conditions based on knowledge of overall ecosystem structure and function; biological evaluations and assessments at both the forest plan and site-specific project levels; and evaluation of risk to species of viability concern at the forest plan level. Other elements important to monitoring effects of plan

implementation on plant and animal diversity include, where appropriate, monitoring of key ecological conditions, levels of management activities important to restoration and maintenance of community diversity, species assemblages (birds, bats, fish, etc.), harvest levels of game and other demand species, and populations of threatened, endangered, and sensitive species.

AFFECTED ENVIRONMENT

Table B2.15 MIS for the GWNF

Species Common Name	Category (s)
Cow Knob Salamander	T/E/S Indicator, Special Interest Species Indicator
Pileated Woodpecker	Special Habitat Indicator
Ovenbird	Special Habitat Indicator
Chestnut-sided Warbler	Special Habitat Indicator
Acadian Flycatcher	Special Habitat Indicator
Hooded Warbler	Biological Community Indicator
Scarlet Tanager	Biological Community Indicator
Pine Warbler	Biological Community Indicator
Eastern Towhee	Biological Community Indicator
Wild Brook Trout	Biological Community Indicator, Demand Species Indicator
Eastern Wild Turkey	Demand Species Indicator
Black Bear	Demand Species Indicator
Deer	Demand Species Indicator
Beaver	Riparian Ecological System Indicator

COW KNOB SALAMANDER (*PLETHODON PUNCTATUS*)

This salamander is a species with a restricted range. It is endemic to the higher elevations of Shenandoah Mountain along the VA/WV border. It is a terrestrial salamander that occurs primarily above 2500 feet in elevation and mainly occurs in rocky talus areas on north to northeast aspects. It forages openly on cool to warm, dark, humid/rainy nights consuming small insects and other invertebrates. The Cow Knob salamander is an MIS because it is a Sensitive species and a narrow endemic that occurs almost entirely on the George Washington National Forest (North River Ranger District). The 1993 GW Forest Plan created the Shenandoah Crest Special Management Zone (SC-SMZ) to protect the habitat of this salamander.

Forest Trends

The Plan created the Shenandoah Mountain Crest Special Interest Area in part to protect the known range of the Cow Knob salamander. As documented in Appendix G of the annual Monitoring and Evaluation reports the

habitat trend is one of an aging forest that benefits Cow Knob salamanders and should lead to a stable or increasing population. Recent field surveys (2002-2003) discovered the Cow Knob salamander outside the current range south along Shenandoah Mountain to Hardscrabble Knob.

Table B2.16 Cow Knob Salamander Population Surveys

Location	Year of Survey	# of Adults	# of Juveniles	Total #
Sugar Grove, VA	2005	14	20	34
Sugar Grove, VA	2006	17	27	44
Sugar Grove, VA	2007	27	27	54
Tomahawk, WV	2004	1	9	10
Tomahawk, WV	2006	1	2	3

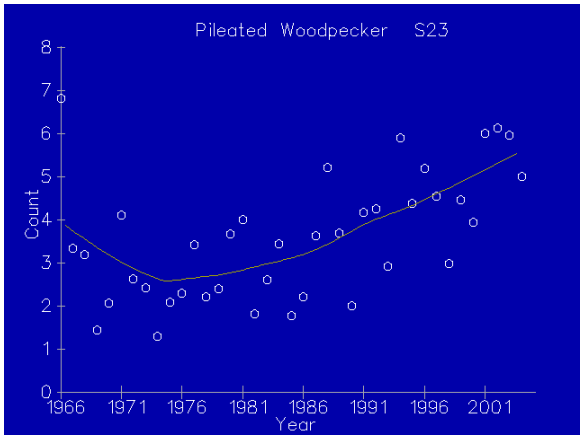
PILEATED WOODPECKER (*DRYOCOPUS PILEATUS*)

The pileated woodpecker was selected as an MIS because it requires large snags for nesting and feeding. The occurrence of this species may be correlated with forested habitats containing abundant large dead trees and fallen logs (Hamel 1992), which also are used by other woodpeckers, owls, and numerous other birds, mammals, and amphibians. This species is selected to help indicate the effects of management activities on the availability of forests with desired abundance of snags. Its use as an indicator is limited by its wide-ranging habits, which causes it to be documented in forest types that are not particularly suitable. It also occurs at relatively low densities, reducing the number of data points available for trend estimates. Local analysis would therefore be limited; analysis in regional trends across national forests would provide more analytical power. Population monitoring would be combined with information on forest age-class distribution and snag densities to provide a full picture of management effects on this species and other snag-dependent wildlife.

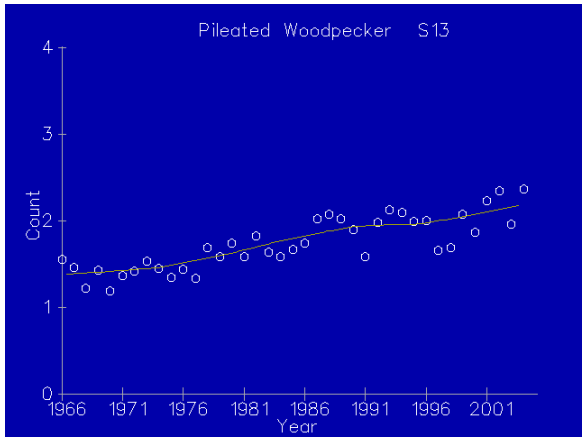
Forest Trends

USGS BBS data indicates an increasing population trend of pileated woodpeckers in the Blue Ridge Mountain and Northern Ridge and Valley regions. Data from the GWJNF Point Counts indicated an overall stable population trend for pileated woodpeckers on the GWJNF.

Trend in BBS Data of Pileated Woodpeckers across the Blue Ridge and Ridge and Valley regions, 1966 To 2005. Source: http://www.mbr-pwrc.usgs.gov/bbs/bbs.html

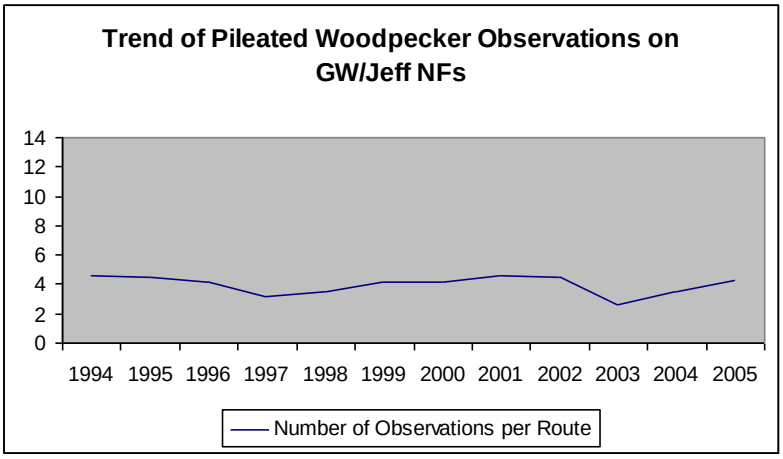


Blue Ridge Physiographic Region



Ridge and Valley Physiographic Region

Trend in GWJNF Data of Pileated Woodpeckers across GWJNF, 1994 to 2005



Pileated woodpeckers generally prefer mature forests near riparian areas. This species is a primary cavity nester/excavator, requiring large snags for nesting cavities and large dead trees for feeding. Generally, this species requires trees greater than 15 inches DBH for cavities, but prefers trees greater than 20 inches DBH. Based on the results of monitoring data and habitat evaluation, this species is showing stable population trends on the GWJNF's and increasing trends both statewide and across the Blue Ridge Mountain and Ridge and Valley Regions. Pileated woodpeckers have the abundance and distribution across the Forest that will provide for its persistence into the foreseeable future.

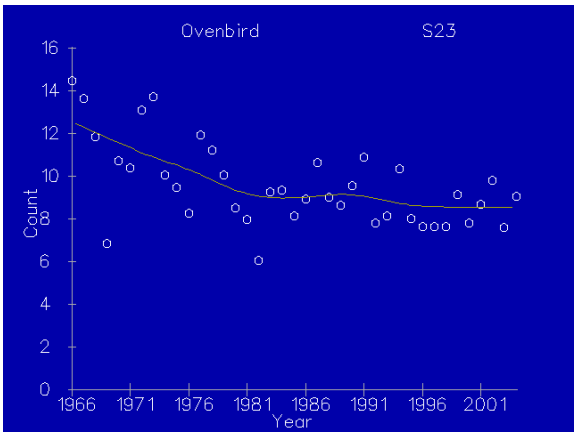
OVENBIRD (*SEIURUS AUROCAPILLUS*)

The ovenbird was selected as a MIS because it is associated with forest interior conditions. It is strongly associated with mid-successional to mature forest interior habitats (Hamel 1992, Crawford et al. 1981), and it is also common enough to be feasibly monitored for trends. Long-term monitoring of this species has resulted in some of the most robust data sets of any of the interior bird species surveyed on the forest. This species is selected to help indicate the effects of management on the availability of suitable mature forest interior habitats. Other elements, such as landscape analysis of forest fragmentation using remote sensing data, would supplement information received from monitoring this species.

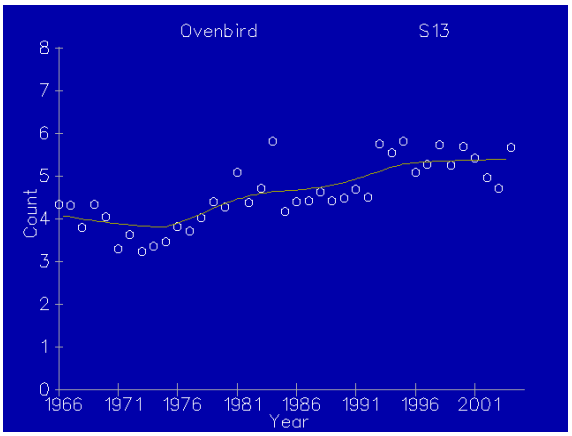
Forest Trends

USGS Breeding Bird Survey data indicates stable to increasing trends in the Blue Ridge Mountain and Northern Ridge and Valley regions. Avian point count data from the GWJNF's for ovenbird also indicates an overall stable to increasing population trend.

Trend in BBS Data of Ovenbirds across the Blue Ridge and Ridge and Valley regions, 1966 To 2005. Source: http://www.mbr-pwrc.usgs.gov/bbs/bbs.html

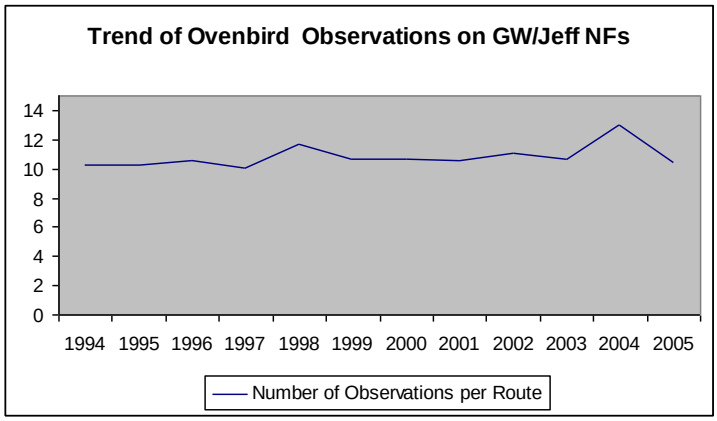


Blue Ridge Physiographic Region



Ridge and Valley Physiographic Region

Trend in GWJNF Point Count Data of Ovenbirds across GWJNF, 1994 To 2005



Ovenbirds breed in upland deciduous or mixed deciduous/pine forests with a moderately dense understory. They nest on the ground and build a covered nest from leaf litter. They require large patches of mature forest for nesting. While the need for large patches of mature forested habitat has been well documented for many migratory bird species, including ovenbirds, evidence is mounting that early successional woody habitats are also important during the critical time period just after breeding and during migration (Bulluck and Buehler 2006). These areas provide 'safe havens' for adult and fledgling ovenbirds for the following needs: molting, abundant food for the buildup of fat reserves for migration, and protection from predators. Studies strongly recommend conservation strategies that maintain large tracts of mature forest, within which there is a mosaic of different forest types and ages (early and mid-successional forest stands), to provide the habitat requirements needed by migratory birds such as ovenbirds during all of their life stages here in North America. Based on the results of monitoring data and habitat evaluation, this species exhibits stable to increasing population trends on the GW, as well as state-wide and region-wide, and have the abundance and distribution across the Forest that will provide for their persistence into the foreseeable future.

CHESTNUT-SIDED WARBLER (*DENDROICA PENSYLVANICA*)

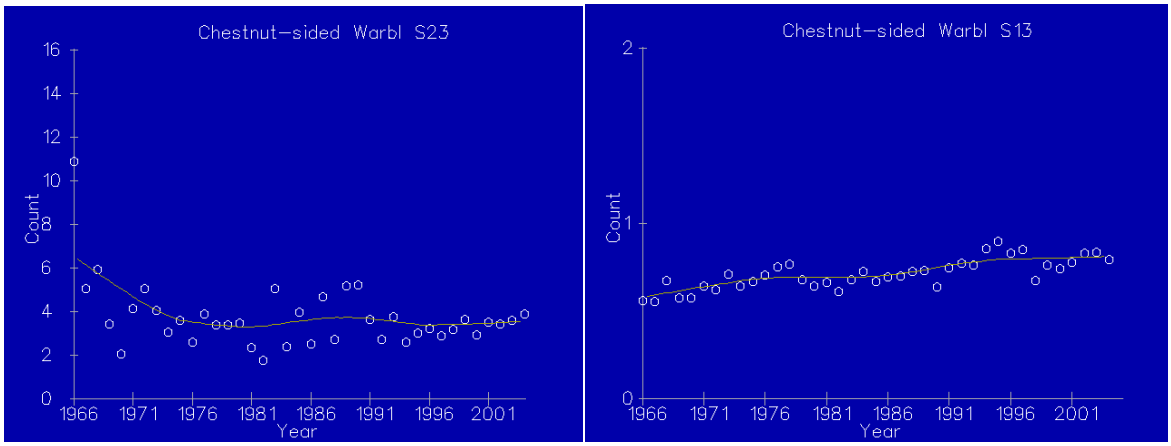
The chestnut-sided warbler was selected as the most appropriate MIS for high-elevation early-successional habitats because of its strong association with these habitats, and because its populations should be

responsive to forest management efforts to create and sustain such habitats. Also, the chestnut-sided warbler is effectively monitored using established protocols.

Forest Trends

USGS Breeding Bird Survey data indicates decreasing trends in populations of chestnut-sided warblers in the Ridge and Valley regions, and relatively stable trends in the Blue Ridge region. Avian point count data from the GWJNF's for ovenbird also indicates an overall stable to slightly increasing population trend.

Trend in BBS Data of Chestnut-sided warblers across the Blue Ridge and Ridge and Valley regions, 1966 To 2005.
Source: http://www.mbr-pwrc.usgs.gov/bbs/bbs.html



Blue Ridge Physiographic Region

Ridge and Valley Physiographic Region

Chestnut-sided warblers are associated with larger patches (e.g. greater than 12 acres) of early successional woodlands, mountain laurel thickets, and forest edge habitat above 2,000 feet (Hamel 1992, Hunter et al. 2001). Chestnut-sided warblers have exhibited significant continental population declines in the last couple of decades, mirroring an overall trend of decline of disturbance-dependent bird species associated with open habitats in eastern North America (Vickery 1992, Askins 2000, Hunter et al. 2001). A significantly greater proportion of bird species exhibiting steep population declines are associated with disturbance-mediated habitats than in forested or generalist habitat types (Brawn et al. 2001). Forty percent of all North American species associated with some type of disturbance-mediated habitat (grassland, shrub-scrub, open woodlands) have been significantly decreasing in population since 1966 (Brawn et al. 2001). Combined with recent research highlighting the importance of early successional woody habitat for post-breeding and migratory stop-over needs of forest-interior migratory bird species in a larger landscape of mature forest (see sections on ovenbirds, worm-eating warblers, and hooded warblers), the role of early successional habitat in largely mature, forested landscapes and the need to restore/maintain disturbance regimes creating such habitats is of vital importance in conservation planning (Brawn et al. 2001, Hunter et al. 2001). Based on the results of monitoring data and habitat evaluation (see Species Diversity Report, Appendix F), chestnut-sided warblers show a stable population trend on the GWNF, and in the Blue Ridge region, with an abundance and distribution across the Forests that will provide for their persistence into the foreseeable future, though the steadily declining trends in the Ridge and Valley region and statewide are cause for concern.

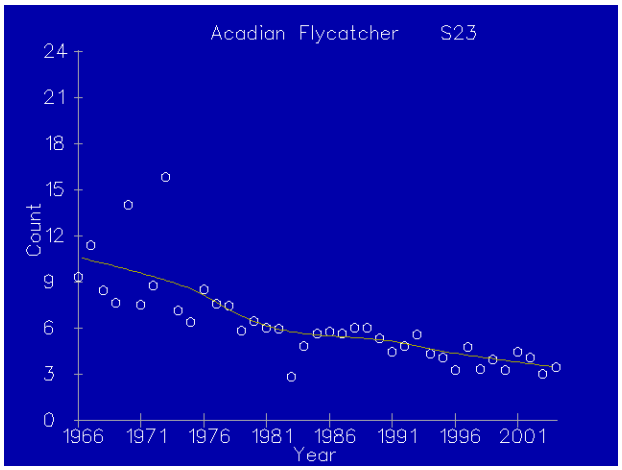
ACADIAN FLYCATCHER (EMPIDONAX VIRESCENS)

The Acadian flycatcher was selected as the most appropriate species to indicate management-induced changes to mature riparian forests. It is highly associated with mature deciduous forests along streams and bottomland hardwoods, which it uses for feeding and reproduction (Hamel 1992). It is also effectively monitored using proven, consistent protocols. It is relatively common in these habitats, providing enough data for evaluation.

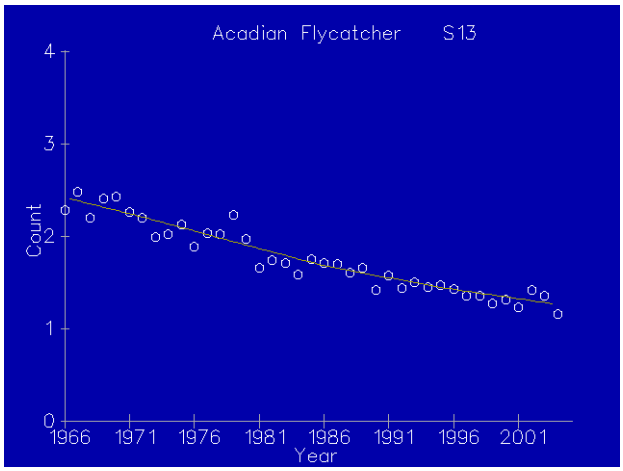
Forest Trends

USGS Breeding Bird Survey data indicates declining trends in the Blue Ridge Mountain and Ridge and Valley regions. Data from the GWJNF point count data for the Acadian flycatcher indicate an overall stable trend on the GWJNF's.

Trend in BBS Data of Acadian flycatchers across the Blue Ridge and Ridge and Valley regions, 1966 To 2005. Source: http://www.mbr-pwrc.usgs.gov/bbs/bbs.html



Blue Ridge Physiographic Region



Ridge and Valley Physiographic Region

Acadian flycatchers occur in deciduous, mixed deciduous/coniferous forest types, in riparian areas (Hamel 1992). Acadian flycatchers are often associated with closed overstory canopies and open understories. After breeding, Acadian flycatchers utilize open scrub and early successional woody habitat during migration. With overall stable population trends of Acadian flycatcher on the GWJNF's, Acadian flycatchers have the abundance and distribution across the Forests that will provide for their persistence into the foreseeable future. Though such trends are not apparent on the GWJNF's, of concern are declining trends shown by USGS BBS data in populations of Acadian flycatcher throughout the larger regions of the Blue Ridge Mountains and Ridge and Valley Regions.

BLACK BEAR (*URSUS AMERICANUS*), WILD TURKEY (*MELEAGRIS GALLOPAVO*), AND WHITE-TAILED DEER (*ODOCOILEUS VIRGINIANUS*)

These species were retained as MIS because they are species of high demand in Virginia. The National Forest provides key habitat attributes for bear in Virginia including remoteness and the availability of den trees and mast. Many Virginia hunters must utilize public lands to pursue deer and turkey, thus management activities will influence their success and experience. The Virginia Department of Game and Inland Fisheries tracks annual harvest for these species; harvest data is identified by county and land ownership status (public versus private). These MIS are discussed under the Demand Species section of this Chapter.

HOODED WARBLER (*WILSONIA CITRINA*)

The hooded warbler was selected as an MIS for mid- to late-successional mesic deciduous forests. The hooded warbler is heavily associated with moist deciduous forests with fairly dense understories, where it breeds and feeds (Hamel 1992, Crawford et al. 1981). Management opportunities exist to increase the structural diversity of closed canopied habitats in this type to favor species, such as the hooded warbler, that optimize their life history in forests with canopy gaps and patches of dense understory. This species is expected to respond positively to management actions (including thinning and moderate frequency burning) that are designed to stimulate advanced oak regeneration and perpetuation of the forest type on these mesic sites. This species is

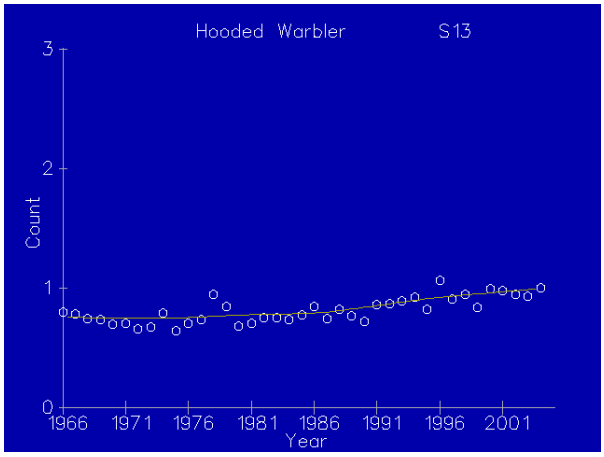
deemed appropriate for helping to indicate the availability of mid- and late-successional mesic deciduous habitats and the efficiency of management intended to favor its habitat.

Forest Trends

USGS Breeding Bird Survey data indicates stable to slightly increasing population trends for Hooded warbler in the Blue Ridge Mountain and Ridge and Valley regions. Data from the GWJNF point count data for Hooded warbler indicate an overall stable trend on the GWJNF's.

Trend in BBS Data of Hooded warblers across the Blue Ridge and Ridge and Valley regions, 1966 To 2005. Source: http://www.mbr-pwrc.usgs.gov/bbs/bbs.html

Blue Ridge Physiographic Region



Ridge and Valley Physiographic Region

Hooded warblers occur in deciduous, mixed deciduous/coniferous forest types, near or in riparian areas (Hamel 1992, Robbins et al. 1989). Hooded warblers are associated with canopy gaps and other small patches of dense woody vegetation in an otherwise mature forest (Robbins et al. 1989, Hunter et al. 2001). After breeding, both fledglings and adults move to areas characterized by dense, woody vegetation, abundant insect availability, and the presence of ripe fruits (Morton 1990, Evans Odgden and Stutchbury 1997, Anders et al. 1998, Vega Rivera et al. 1998, 1999). These areas provide 'safe havens' for molting, abundant food for the buildup of fat reserves for migration, and protection from predators. Habitats supporting this kind of vegetation include open oak, oak/pine, and pine woodlands, patches of early successional habitat resulting from insect infestation and natural disturbance such as ice storms, patches of early successional habitat where the overstory had been thinned or harvested in some way (modified shelterwood, clear cut, high-grading), areas of second growth scrub/deciduous saplings located along forest borders and old fields, and mature riparian forests with a dense understory (Anders et al 1998, Vega Rivera et al. 1998, 1999). Recent studies strongly recommend conservation strategies that maintain large tracts of mature forest, within which there is a mosaic of different forest types and ages (early and mid-successional forest stands), as well as mature riparian forest, to provide the habitat requirements needed by migratory birds during all of their life stages here in North America, including the hooded warbler (Kilgo et al. 1999, Suthers et al. 2000, Hunter et al. 2001). With overall stable population trends of hooded warbler on the GWJNF's and stable to increasing trends at the regional level, hooded warblers have the abundance and distribution across the Forests that will provide for their persistence into the foreseeable future.

SCARLET TANAGER (*PIRANGA OLIVACEA*)

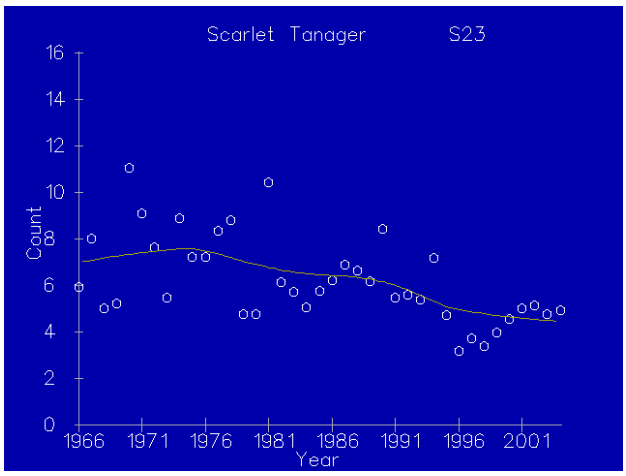
Drier oak forests support a slightly different mix of species due to their more open woodland condition. To represent this upland oak community, the scarlet tanager is selected as an MIS. This species is most abundant in upland mature forest (Hamel 1992). Trends for these species will be evaluated along with trends in total

acres, age-class distribution, and level of restoration and maintenance activities in this forest type to provide a more complete picture of effects of management on this community.

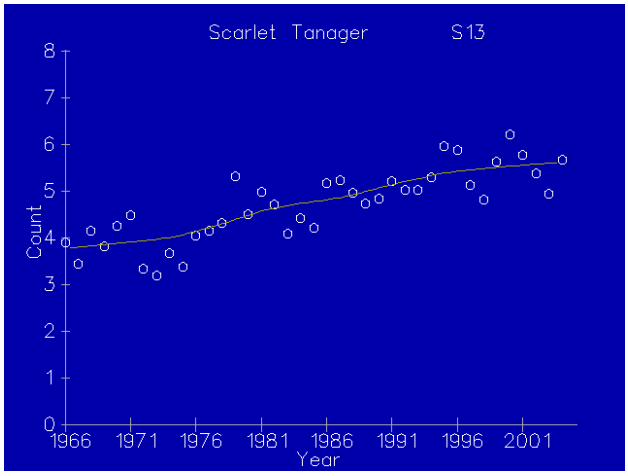
Forest Trends

USGS Breeding Bird Survey data indicates stable to slightly increasing population trends of scarlet tanagers for the Blue Ridge Mountain and increasing population trends in the Ridge and Valley regions. Data from the GWJNF point count data for Scarlet tanager indicate an overall stable trend on the GWJNF's.

Trend in BBS Data of Scarlet tanagers across the Blue Ridge and Ridge and Valley regions, 1966 To 2005. Source: http://www.mbr-pwrc.usgs.gov/bbs/bbs.html



Blue Ridge Physiographic Region



Ridge and Valley Physiographic Region

Scarlet tanagers occur in deciduous, mixed deciduous/coniferous and coniferous forest types in the Appalachian region (Rosenburg et al. 1999). In the Appalachian region, research has indicated that scarlet tanagers do not show area sensitivity in moderately or heavily forested landscapes (Rosenburg et al. 1999). With overall stable to increasing population trends of scarlet tanagers on the GWJNF's and at the regional level, scarlet tanagers have the abundance and distribution across the Forests that will provide for their persistence into the foreseeable future.

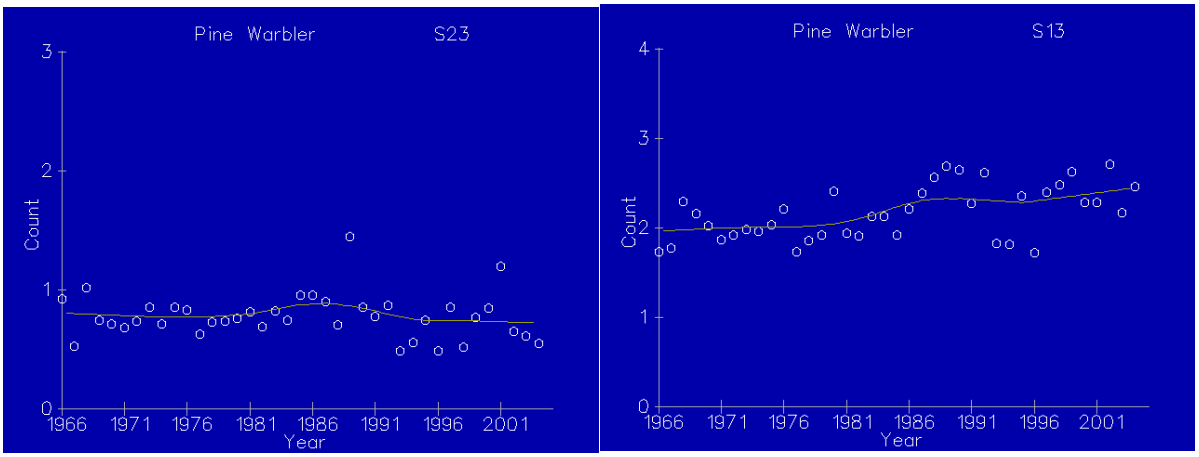
PINE WARBLER (*DENDROICA PINUS*)

Pine forests have been in serious recent decline on the national forest as a result of southern pine beetle epidemics and lack of fire needed to maintain their dominance. Therefore, they will be the focus of ecological restoration and maintenance on some portions of the national forest. The pine warbler is closely associated with pine and pine-oak forests, generally occurring only where some pine component is present. It therefore is an appropriate indicator of the effects of management in restoring and maintaining pine forests. It should be noted, however, that this species does not discriminate as to the condition of pine stands relative to mid and understory, and so would indicate little more than the presence of pine. Other bird species that may be associated with desired fire-maintained conditions were not deemed sufficiently likely to be present to be appropriate MIS. Understory plant species also were considered and found to be too universal in association to be appropriate MIS. Therefore, pine warbler and various habitat-based elements, such as amount and effectiveness of prescribed burning, will be used to indicate effects of management on species associated with this community.

Forest Trends

USGS Breeding Bird Survey data indicates stable population trends of pine warblers for the Blue Ridge Mountain and stable to slightly increasing trends in the Ridge and Valley regions. Data from the GWJNF point count data for pine warbler indicate an overall stable trend on the GWJNF's.

Trend in BBS Data of Pine warblers across the Blue Ridge and Ridge and Valley regions, 1966 To 2005. Source: http://www.mbr-pwrc.usgs.gov/bbs/bbs.html



Blue Ridge Physiographic Region

Ridge and Valley Physiographic Region

Pine warblers occur in mid- to late-successional pine and pine/oak forest types throughout its range (Hamel 1992). It is rarely found in pure hardwood forest types. Pine warblers are temperate migrants in the Appalachians, shifting to the Piedmont and Coastal Plain during the winter months. They are mainly insectivorous during the breeding season, but shift to insects, berries, and small seeds the rest of the year. With overall stable population trends of pine warbler on the GWJNF's and stable to increasing trends in the Blue Ridge and Ridge and Valley regions, pine warblers have the abundance and distribution across the Forests that will provide for their persistence into the foreseeable future.

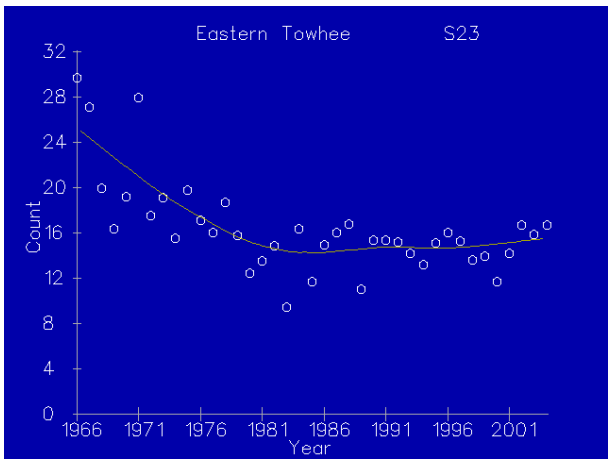
EASTERN TOWHEE (*PIPILO ERYTHROPHTHALMUS*)

The eastern towhee was selected as the most appropriate MIS to represent early-successional forests. Eastern towhees are shrubland nesting birds that require thickets or brushy places on the ground or in shrubs or saplings to 5 feet high for nesting. Providing early successional and open woodland forest is necessary to support populations of this species.

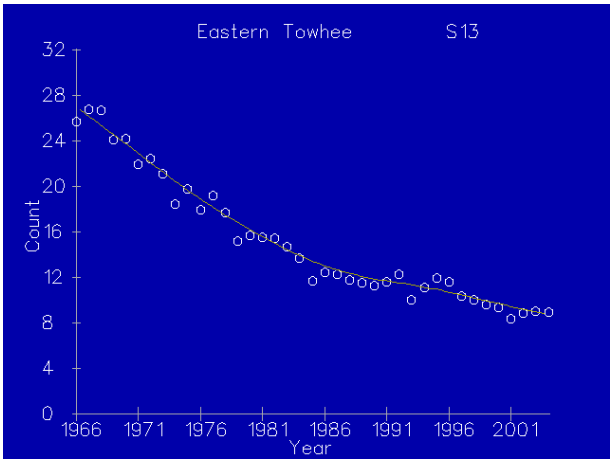
Forest Trends

USGS Breeding Bird Survey data indicates decreasing to stable population trends of eastern towhees for the Blue Ridge Mountain and decreasing trends in the Ridge and Valley regions. Data from the GWJNF point count data for eastern towhee indicate an overall stable trend on the GWJNF's.

Trend in BBS Data of Eastern towhees across the Blue Ridge and Ridge and Valley regions, 1966 To 2005. Source: http://www.mbr-pwrc.usgs.gov/bbs/bbs.html



Blue Ridge Physiographic Region



Ridge and Valley Physiographic Region

Eastern Towhees inhabit early successional habitat associated with dense second growth, dense vegetation associated with open woodlands, and forest edge habitat (Hamel 1992) (Hunter et al. 2001). Eastern towhees have exhibited significant continental population declines in the last couple of decades, mirroring an overall trend of decline of disturbance-dependent bird species associated with open habitats in eastern North America (Vickery 1992, Askins 2000, Hunter et al. 2001). A significantly greater proportion of bird species exhibiting steep population declines are associated with disturbance-mediated habitats than in forested or generalist habitat types (Brawn et al. 2001). Forty percent of all North American species associated with some type of disturbance-mediated habitat (grassland, shrub-scrub, open woodlands) have been significantly decreasing in population since 1966 (Brawn et al. 2001). Combined with recent research highlighting the importance of early successional woody habitat for post-breeding and migratory stop-over needs of forest-interior migratory bird species in a larger landscape of mature forest (see sections on ovenbirds and worm-eating warblers and hooded warblers), the role of early successional habitat in largely mature, forested landscapes and the need to restore/maintain disturbance regimes creating such habitats is of vital importance in conservation planning (Brawn et al. 2001, Hunter et al. 2001). With overall stable population trends of eastern towhees on the GWNF, and in the Blue Ridge region, eastern towhees have an abundance and distribution across the Forests that will provide for their persistence into the foreseeable future, though the steadily declining trends in the Ridge and Valley region are cause for concern.

WILD BROOK TROUT (*SALVELINUS FONTINALUS*)

Wild brook trout were chosen as a MIS because many of the trout streams on the GW National Forest support wild native brook trout. Wild trout are indicative of cold water streams, good water quality and sedimentation rates that are in equilibrium with the watershed. In addition, trout are commonly fished and are a demand species. Furthermore, some management activities, such as stream liming and habitat restoration, are specifically designed to improve brook trout habitat and increase their populations. MIS population trends and changes are analyzed for wild trout, rather than hatchery reared fish, since many stocked streams are not suitable for year-round survival or recruitment of a self-sustaining population. VDGIF tracks wild brook trout populations on selected Forest streams. This MIS is discussed under the Fisheries and Aquatic Habitat section of this Chapter.

BEAVER (CASTOR CANADENSIS)

Beavers were selected as an MIS because they are a keystone species that create wetland habitat with many physical and biological benefits. Beavers alter ecosystem hydrology, biogeochemistry, vegetation, and productivity with consequent positive effects on the plant, vertebrate, and invertebrate populations that occupy

beaver-modified landscapes. Their impoundments trap fine textured sediments that act as water storage reservoirs, resulting in slow, sustained discharge that maintains streamflows during dry periods; afford protection from flooding of downstream areas; and produce a raised water table that enhances riparian zones. Additionally, beaver habitat modifications can reduce pollution and improve water quality in aquatic ecosystems, by trapping sediment and nutrients; reducing downstream turbidity; and purifying water from acidification and other non-point source pollutants. The capability of beavers to store water, trap sediment, reduce erosion, and enhance riparian vegetation can be used as a management tool to restore degraded aquatic and riparian ecosystems. Beavers are a habitat-modifying species and play a pivotal role in influencing community structure in many riparian and wetland systems. Restoring beaver populations to their maximum viability on public lands is desirable because of the beaver's capability to restore and maintain healthy riparian ecosystems. Key conservation elements for the beaver on National Forest System lands are, therefore, protection and enhancement of aquatic and riparian habitats by management of water resources and riparian vegetation, beaver population enhancement by natural recolonization and transplants where necessary, and proactive management of beaver damage issues.

Forest Trends

The primary conservation concerns are to ensure that existing beaver populations remain viable and to restore beaver populations to unoccupied habitat where appropriate to take advantage of their capability to restore and strengthen the ecological integrity of aquatic and riparian ecosystems. Beaver management plans must take into account landscape-scale habitat management. To maintain viable populations, managers should ensure that land uses maintain connectivity between watersheds to facilitate long-range dispersal and gene flow. This scale of management maintains metapopulation dynamics and allows natural dispersal to repopulate watersheds where beavers have been reduced or extirpated by natural or human causes. At project-level scales, management practices that potentially affect riparian vegetation and stream hydrology or morphology should mitigate adverse impacts to beaver habitat, and enhance beaver habitat where possible.

Beavers are vulnerable to overharvest because of the relative ease of capture, their dependence on aquatic habitat, delayed sexual maturity, and a slow reproductive rate. Since beavers are regulated by the state wildlife agencies as a furbearer species, maintaining viable beaver populations will require cooperative management plans that account for overharvest vulnerability, to ensure that local or regional populations are not decimated by excessive exploitation and that National Forest wetland habitat conditions are being met. Ensuring a sustainable harvest may include designating some areas as off limits to trapping.

The following areas have been identified as important beaver habitat sites because of the quality and quantity of long term wetland habitat that beavers have created. Since beavers are a new MIS there is no existing trend analysis. In the future, these areas will be monitored for beaver activity.

Table B2.17 Key Beaver Habitat Sites on the GWNF

Ranger District	Important Beaver Habitat Site	Current Beaver Activity
Warm Springs	Laurel Fork	Low
Pedlar	Maple Flats	Moderate
North River	Tillman Road	Low
Lee	Paddy and Cove Runs	High

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

Future trends in MIS are discussed in various sections of this document. These are identified in Table B2.18. Table B2.19 displays the objectives for habitat management for each Management Indicator Species by alternative.

In summary, 14 species have been selected as management indicator species for the revised forest plan. They will be used to assess effects of alternatives and to help monitor effects of implementing the selected alternative.

Within specific major forest communities and terrestrial habitats there is discussion of individual MIS and their expected response to each alternative. Viable populations of management indicator species are expected within all alternatives, but the mix of habitat components, by Alternative, will influence the degree to which increases or decreases are expected for each MIS.

Table B2.18 Location of Discussion of Management Indicator Species Effects

MIS Common Name	Location of Discussion of Future Trends by Alternative
Cow Knob Salamander	Habitat management is directed through establishment of the Shenandoah Mountain Crest-Cow Knob Salamander Management Prescription Area. The direction was prepared as part of the Conservation Agreement and is expected to maintain or improve current populations.
Pileated Woodpecker	This MIS is part of the Cavity Trees, Den trees and Snags group of species and is discussed in the Ecological Sustainability Assessment (Species Diversity Report), as well as the Terrestrial Diversity Section of this Chapter. Population trends of the species in this group by alternative are found in Table B2.3.
Ovenbird	This MIS is part of the Area Sensitive Mature Coniferous, Deciduous, and/or Mixed Forest Associates and is discussed in the Ecological Sustainability Assessment (Species Diversity Report), as well as the Terrestrial Diversity Section of this Chapter. Population trends of the species in this group by alternative are found in Table B2.3.
Chestnut-sided Warbler	This MIS is part of the High Elevation Openings, grassy or shrubby or open woodlands Associates and is discussed in the Ecological Sustainability Assessment (Species Diversity Report), as well as the Terrestrial Diversity Section of this Chapter. Population trends of the species in this group by alternative are found in Table B2.3.
Acadian Flycatcher	This MIS is part of the Riparian Area Associates and is discussed in the Ecological Sustainability Assessment (Species Diversity Report), as well as the Terrestrial Diversity Section of this Chapter. Population trends of the species in this group by alternative are found in Table B2.3.
Hooded Warbler	This MIS is part of the Late Successional Hardwood Associates and is discussed in the Ecological Sustainability Assessment (Species Diversity Report), as well as the Terrestrial Diversity Section of this Chapter. Population trends of the species in this group by alternative are found in Table B2.3.
Scarlet Tanager	This MIS is part of the Open woodlands Associates and is discussed in the Ecological Sustainability Assessment (Species Diversity Report), as well as the Terrestrial Diversity Section of this Chapter under Oak Forests and Woodlands. Population trends of the species in this group by alternative are found in Table B2.3.
Pine Warbler	This MIS is part of the Fire Dependent and Fire Enhanced Associates and is discussed in the Ecological Sustainability Assessment (Species Diversity Report), as well as the Terrestrial Diversity Section of this Chapter under Pine Forests and Woodlands. Population trends of the species in this group by alternative are found in Table B2.3.
Eastern Towhee	This MIS is part of the Regenerating Forests Associates and is discussed in the Ecological Sustainability Assessment (Species Diversity Report), as well as the Terrestrial Diversity Section of this Chapter. Population trends of the species in this group by alternative are found in Table B2.3.
Wild Brook Trout	This MIS is discussed under the Fisheries and Aquatic Habitat section of this Chapter.
Eastern Wild Turkey	This MIS is discussed under the Demand Species section of this Chapter.
Black Bear	This MIS is discussed under the Demand Species section of this Chapter.
Deer	This MIS is discussed under the Demand Species section of this Chapter.
Beaver	With emphasis on beaver, it is expected that populations will increase under all alternatives

Table B2.19 Management Indicator Species Habitat Management by Alternative

MIS Common Name	Objectives for Habitat Management by Alternative
Cow Knob Salamander	All alternatives utilize the Shenandoah Mountain Crest-Cow Knob Salamander Management Prescription Area to implement the Conservation Agreement for the salamander.
Pileated Woodpecker	All alternatives incorporate the suite of standards to address the needs of the cavity trees, den trees and snags groups of species. All alternatives also result in a large proportion of the forest in late successional stages.
Ovenbird	The ecological systems objectives all include a substantial portion of the systems meeting the needs of the area sensitive mature forest associate species group. This need will be met in all alternatives.
Chestnut-sided Warbler	All alternatives will meet some of the objectives for the high elevation openings species group. However, Alternative C relies on natural processes, so does not actively increase the amount of regeneration at high elevations. The amount of regeneration at high elevation varies by alternative.
Acadian Flycatcher	All alternatives have objectives for riparian areas. Alternatives B, C, E, F, and G (D to a lesser extent) all expand the width of riparian area corridors.
Hooded Warbler	All alternatives have objectives to maintain large amounts of late successional habitat with Alternative C having the largest.
Scarlet Tanager	All alternatives utilize fire to some extent to create open woodland habitat. Alternative C relies wildfire and Alternative A has a small amount of prescribed fire. The other alternatives all increase the level of prescribed fire to create this condition.
Pine Warbler	Pine habitat is also dependent upon wildland fire. See description for scarlet tanager.
Eastern Towhee	All alternatives will meet some of the objectives for the regenerating forest species group. However, Alternative C relies on natural processes, so does not actively increase the amount of regeneration. The amount of regeneration varies in each of the other alternative.
Wild Brook Trout	All alternatives address the objectives of maintaining and restoring the aquatic systems.
Eastern Wild Turkey	The objectives for this species are largely a combination of the open woodland and regenerating forest species groups.
Black Bear	The objectives for this species are largely a combination of the open woodland and regenerating forest species groups.
Deer	The objectives for this species are largely a combination of the open woodland and regenerating forest species groups.
Beaver	All alternatives address the objectives of maintaining and restoring the aquatic systems. Alternatives B, C, E, F, and G (D to a lesser extent) all expand the width of riparian area corridors. Restoration of beaver habitat is an emphasis in Alternatives E and G.

B3 – OLD GROWTH

SUMMARY OF OLD GROWTH GUIDANCE

In 1989 then-Chief Dale Robertson issued a national position statement on old growth. This included a national generic definition and description of old growth forests that is still applicable today:

> Old growth forests are ecosystems distinguished by old trees and related structural attributes. Old growth encompasses the later stages of stand development that typically differ from earlier stages in a variety of characteristics that may include tree size, accumulation of large dead woody material, number of canopy layers, species composition, and ecosystem function.
>
> The age at which old growth develops and the specific structural attributes that characterize old growth will vary widely according to forest type with climate, site conditions, and disturbance regime. For example, old growth in fire-dependent forest types may not differ greatly from younger forests in the number of canopy layers or accumulation of downed woody material.
>
> Old growth is typically distinguished from younger growth by the following structural attributes and characteristics:
>
> 1. Large trees for that species and site.
> 2. Uneven age structure with tree species in several size classes resulting in multiple canopy layers.
> 3. Accumulations of large-size dead standing and fallen trees that are high relative to earlier stages and in all stages of decay.
> 4. Broken or deformed tops or bole and root decay primarily resulting from weather phenomena such as ice or wind storms.
> 5. Single or multiple tree-fall gaps usually resulting from windthrow and resulting in understory patchiness and increased micro-topography relief.
> 6. Undisturbed soils and soil macropores usually with a well developed surface organic layer (O horizon).
> 7. On mesic sites a well developed fungal component.

Beginning in 1990, the Southern and Eastern Regions of the Forest Service; the Forest Service Southern, Northeastern, and North Central research stations; and The Nature Conservancy began efforts to develop science-based old growth definitions for the east. The effort proved to be problematic in large part because so few representatives of old growth conditions exist and their history for their entire life so poorly known that quantifying the range of natural variability was imprecise. But after five years of effort, in December of 1995, the Southern Regional Forester chartered the Region 8 Old Growth Team to make the draft scientific old growth definitions 'operational and useful'. In June of 1997 the Team completed a report entitled *Guidance for Conserving and Restoring Old-Growth Forest Communities on National Forests in the Southern Region*, hereafter called the 'old growth report' (Forest Service, 1997). It is this report that continues to guide management of old growth on the Southern Region Forests.

The old growth report recognized old growth forests as a valuable natural resource worthy of protection, restoration, and management that provides a variety of ecological, social, and spiritual values. Old growth communities are rare or largely absent in the southeastern forests from Virginia south to Florida. Existing old growth areas (referred to as 'primary forests') may represent around 0.5% (approx. 482,000 acres) of the total forested acreage of 88,079,000 acres (Davis 1996). For these reasons the Southern Region's National Forests are making efforts to restore more of this portion of forest ecosystems.

The old growth report gave operational definitions for sixteen old growth community types that encompassed nearly all of the forest cover types in the Southeast. Factors used to define old growth forest type (OGFT) groups are those that most strongly influence the structural and functional characteristics of old growth forests. These include site factors that directly or indirectly affect productivity and spacing of trees, disturbance regimes, physiognomy, dominant tree species, and geography (in that geography is related to climate, which

controls productivity, in part). A few forest cover types were not included such as those considered rare communities plus the tropical forests of the Caribbean.

For each old growth forest type, minimum ages were determined at which a stand will begin to develop attributes characteristic of old growth conditions. Several accepted definitions used to describe old growth state that a given old growth forest type will begin to develop old growth characteristics at an age approximately one-half the maximum longevity (lifespan) of the dominate tree(s) found in that type (Cogbill 1983, Leverett 1996, Loehle 1988). The nine old growth forest type groups that occur on the Forest have five different ages at which they begin to develop old growth characteristics ranging from 100 to 140 years. These groups not only reflect the longevity of dominate trees, but natural disturbance regimes (fire, ice storms, gap formation, etc.) and edaphic conditions (rainfall, slope, aspect, etc.) where they're found.

The operational definitions established four criteria which had to be met before a stand would be considered 'existing' old growth: (1) AGE - minimum age in the oldest age class; (2) PAST DISTURBANCE - no obvious human-caused disturbance that conflicts with old growth characteristics for that type; (3) BASAL AREA - minimum basal areas of stems 5" d.b.h. and larger; and (4) TREE SIZE - a minimum diameter at breast height (d.b.h.) of the largest trees. Except for number two, the values for these criteria vary by old growth type. The report also generally charged each Forest to provide: (1) a distribution of large (more than 2,500 acres), medium (100 thru 2,500 acres), and small (1 thru 99 acres) possible old growth patches; and (2) representation of all possible and applicable old growth forest types for each ecological section unit (e.g. physiographic region). An exception to the large block requirement was made for forests in the Northern and Southern Cumberland Plateau and the Appalachian Piedmont ecological sections because of land ownership patterns. The distribution guidance did not specify an amount, such as acres or percent of area, to be in each patch size. In addition, old growth patches were assumed to be occurring on National Forests in a matrix of mid- to late successional forest conditions, providing connectivity without old growth allocations being physically contiguous. Representation was limited to ensuring that old growth community types were present, not a total amount nor an amount per each type. Amounts (i.e. acres) were to be based on public issues and ecological capabilities of the land.

THE BIOLOGICAL SIGNIFICANCE OF OLD GROWTH

To date no species of plant or animal had been identified in the Southeastern United States that is considered an old growth obligate; that is, requiring old growth for some portion or all of their life cycle. Therefore, the provision of existing or future old growth is not directly linked in a cause and effect relationship to the viability of any species.

However, old growth and associated late successional forests & woodlands are a condition that is particularly rich in habitat attributes for a variety of species and these attributes occur in close association (intra-stand) with one another as opposed to a landscape scale (inter-stand) distribution. A wider variety of habitat niches are available than in earlier life stages of the same community. The long development period is conducive to the formation of complex vertical structure that may include 'emergent' trees, dominant and co-dominant trees, suppressed trees, and a forest floor shrub layer and/or an herb/forb/grass layer. Canopy gaps of various sizes caused by: (a) the death in-place of a single tree; or (b) the deaths in-place of small groups of trees; or (c) the falling of a group of trees, in comparison with their immediate surroundings provide micro-sites with higher light regimes, higher stem counts, and an 'edge effect' both around the edge of the gap and back into the surrounding stand. Standing dead trees provide large and small diameter snags for foraging, perching, and cavity excavation. Down logs and limbs provide a substrate for wood decomposing fungi and insects; cover for small mammals, amphibians, and insects; and in later stages a 'nurse log' for the establishment of new tree seedlings. Large-diameter living trees, with a long-term exposure to natural damaging agents, have the potential through wood-rotting fungi activity for the formation of large cavities suitable for bear, raccoon, squirrel, bats, or other cavity users. The heavy limb structure that develops in some tree species as they age provides sturdy nest platforms for species such as bald or golden eagles.

THE SOCIAL SIGNIFICANCE OF OLD GROWTH

Whether biologically necessary to species or not, old growth is of value. There seems to be a general sense that it is intelligent to be sure to have this habitat condition on the landscape. In Aldo Leopold's words, '*The first rule of intelligent tinkering is to keep all the parts.'* As with Wilderness, there also appears to be a desire for places almost completely unmodified by humans whether or not those holding such a value ever visit them; that is, an 'existence' value. There can be, and often is, a historical, cultural or spiritual value associated with old growth whether it's a few acres, hundreds of acres, or even thousands of acres. There also is value in providing old growth of different types on a variety of landscapes that each person holding that value can readily relate to. That is, it is not enough to say something valued is being provided simply 'somewhere'.

In more pragmatic terms, old growth has other recognized social values. It is a desirable recreation setting, both for its biological variety and for the associated state of mind from knowing one is in an 'old growth' setting perhaps surrounded by an open forest of big trees. It serves as a 'biological time machine' in that it is a reference area for what ecologically-comparable areas may have been previously and can be restored to given a similar amount of time and disturbance history. They are a valuable part of showing a comprehensive whole of ecological dynamics in conservation education. They are also a source of scientific information for research such as dendrochronology (tree ring analysis) used in studies of disturbance regimes and climate fluctuations.

IMPLEMENTATION OF OLD GROWTH GUIDANCE IN FOREST PLAN

The GWNF has used the 1997 Regional Guidance to help address this component of biodiversity and in the delineation of old growth, both possible and existing. Small, medium, and large sized patches have been identified using stand ages contained in FSVeg and analyzed their spatial arrangement using GIS. Existing Wilderness, recommended Wilderness study areas, Remote Backcountry, and other prescriptions with large acreages, such as Special Biological Areas and Shenandoah Mountain Crest, provide for the large blocks both now and in the future.

AFFECTED ENVIRONMENT

Existing old growth was defined in the old growth report as '…forest stands that meet all four criteria (age, disturbance, basal area, and tree size) described in the operational definitions.' for that applicable old growth forest type. Possible old growth is defined as Forest stands which meet one or more of the preliminary inventory criteria from the Old Growth Guidance. Polygons were identified from a query of the FSVeg 'Stands' layer in GIS. FSVeg forest types were aggregated into the appropriate Old Growth Forest Type (OGFT) as described in the Regional Guidance Report and those stands meeting the minimum age were then tagged as the initial inventory of possible old growth. Ages had been determined for each stand on the Forest during the prescription process for all compartments and stands on the Forest. Most of the polygons identified through this process have not been visited to verify the existence of old growth per the four elements of the criteria. The current inventory is an initial screen and inventory. During project implementation those stands in the project area identified as possible old growth will be examined to determine if they meet the four criteria and are therefore considered existing old growth. Table B3.1 displays the current acres of possible old growth by type and compares that with the acreage of that type regardless of age. This table also projects the future amount of possible old growth at +10 and +50 years as the forest continues to get older.

Table B3.1 Amount of Possible Old Growth by Old Growth Forest Type as of 2010

OGF Type #	Old Growth Forest Type Name	Min. Age	Current Total Acres On GW All Ages	Current Acres & % Possible Old Growth	Current Acres +10 yrs & % Possible Old Growth	Current Acres +50 yrs & % Possible Old Growth
1	Northern Hardwood Forest	100	9,644	1,264 (13%)	4,491 (47%)	8,457 (88%)
2	Conifer-Northern Hardwood Forest					
2a	Hemlock-Northern Hardwood	140	6,574	2,498 (38%)	3,010 (46%)	5,194 (79%)
2b	White Pine-Northern Hardwood	140	37,711	684 (2%)	1,741 (5%)	9,888 (26%)
2c	Red Spruce-Northern Hardwood	120	524	118 (23%)	118 (23%)	255 (49%)
5	Mixed Mesophytic Forest	140	57,515	5,064 (9%)	7,936 (14%)	32,905 (57%)
10	Hardwood Wetland Forest	120	111	0 (0%)	0 (0%)	0 (0%)
21	Dry- Mesic Oak	130	678,932	151,268 (22%)	207,224 (31%)	598,663 (88%)
22	Dry and Xeric Oak	110	492	331 (67%)	467 (95%)	467 (95%)
24	Xeric Pine and Pine Oak	100	124,374	66,455 (53%)	101,758 (82%)	118,709 (95%)
25	Dry and Dry Mesic Oak-Pine	120	122,525	16,849 (14%)	36,224 (30%)	113,658 (93%)
28	Eastern Riverfront Forest	100	194	6 (3%)	25 (13%)	76 (39%)
TOTAL Acreage and % of Current			1,038,596	244,537 (24%)	362,996 (35%)	888,271 (86%)

The network, or spatial distribution, of old growth by patch size is of importance as described in the Regional Guidance report. Currently (2010) the inventory of possible old growth identified 1,749 small patches (1-99 acres) totaling 58,773 acres, and 450 medium sized patches (100-2,499 acres) totaling 152,657 acres, and 7 large patches (>2,499 acres) totaling 33,107 acres across the GWNF. The average size of small patches is 34 acres, 339 acres for medium sized patches, and 4,730 acres for large patches. Table B3.2 shows the current condition of patches and their condition projected to be in 10 and 50 years from now.

Table B3.2 Number and acreage of small, medium, and large patches

Patch Size	Current (2010)		Current +10 years		Current +50 years	
	# of Patches	Acres	# of Patches	Acres	# of Patches	Acres
1 (1-99 acres)	1,749	58,773	1,846	60,534	234	7,476
2 (100-2,499 acres	450	152,657	522	202,909	108	56,050
3 (>2,499 acres)	7	33,107	19	99,553	32	824,745
Total # and acres	2,206	244,537	2,387	362,996	374	888,271

DIRECT AND INDIRECT EFFECTS

Each alternative evaluated in detail includes management prescriptions that either have the intent of protecting possible old growth and expanding it, or of providing old growth indirectly as the result of management focused on other values, such as primitive recreation. But, as noted in the old growth report, the primary focus of old growth management in the near and medium term is restoring it on the landscape. And the primary (not the only) component of restoration is simply time; time for existing stands to age through the gradual development of old growth conditions. For that reason, alternatives are compared by how old growth forest types will be managed and the sum of the acreage they allocate to old growth compatible prescriptions.

Future old growth is defined as forest stands or patches allocated to old growth through land management decisions, but which do not currently meet the operational definition for existing old growth. Table B3.3 shows

that Alternative C provides for the greatest level of future old growth being found in larger blocks. This alternative contains the greatest acreage within future old growth since over one-third of the total Forest acreage is in Wilderness. It also would contain the largest potential block. This is followed by Alternatives F, A, E, and G respectfully. Alternatives B and D provides the least amount of future old growth.

Table B3.3. Acreage in Key Management Prescriptions that will Provide for Most Large Blocks (>= 2,500 acres) of Future Old Growth, by Alternative

Management Prescription		Alternative						
		A	B	C	D	E	F	G
1A	Designated Wilderness	42,954	43,049	42,992	42,992	42,992	42,992	42,992
1B	Recommended Wilderness Study	1,413	20,422	386,786	14,627	24,325	112,144	20,314
4B1	Research Natural Area	2,808	1,980	1,979	1,979	1,979	1,979	1,979
4D	Special Biological Area	24,454	51,427	21,303	51,574	51,574	30,438	51,565
4D1	Key Natural Heritage Community Area	0	0	0	0	3,308	0	3,308
4F	Mt Pleasant National Scenic Area	7,753	7,742	7,744	7,744	7,744	7,744	7,744
4FA	Recommended National Scenic Area	0	0	0	8,241	0	127,940	0
8A1U	Mix of Successional Habitats – Unsuitable	69,736	0	0	0	0	0	0
8CU	Black Bear / Remote Habitats - Unsuitable	61,204	0	0	0	0	0	0
8E7	Shenandoah Mtn Crest – Cow Knob Salamander	43,137	46,692	20,343	53,855	49,644	23,382	46,812
12D	Remote Backcountry	198,858	191,935	113,852	190,423	264,184	147,622	252,159
13U	Mosaics of Habitat - Unsuitable	0	0	245,678	0	0	109,380	0
Total Acres		452,317	363,247	840,677	371,435	445,750	603,621	426,873

Possible old growth identified by type and minimum age plus areas identified in the field as old growth according to the 4-part Regional criteria in types #1, 2a, 2b, 2c, 5, 10, 22, 24, and 28 will be considered unsuitable for timber production in all alternatives. In Alternatives C, E, and F OGFTs 21 and 25 are added to the list as unsuitable for timber production. In Alternative A and B possible and existing old growth type 21 stands on suitable ground remain suitable. In Alternative D and G possible and existing old growth in both types 21 and 25 stands on suitable ground remain suitable.

In Alternatives A and B it is estimated that the amount of timber harvested from stands in OGF type 21 that meet the definition of old growth would be less than 3,000 acres during the next ten years. In Alternative D it is estimated that the amount of timber harvested from stands in OGF types 21 and 25 that meet the definition of old growth would be less than 5,000 acres during the next ten years, with about 4,000 in OGF type 21. In Alternative G it is estimated that the amount of timber harvested from stands in OGF types 21 and 25 that meet the definition of old growth would be less than 3,000 acres during the next ten years, with about 2,400 in OGF type 21.

Therefore, prior to scheduling any silvicultural practices on lands classified as suitable for timber production in OGFT #21 (dry-mesic oak forests) and/or OGFT #25 (dry and dry-mesic oak-pine forests), stands are inventoried using the Southern Region's Guidance (Forestry Report R8-FR 62) depending on Alternative.

Silvicultural practices could proceed after site-specific analysis and disclosure which included a discussion on the old growth characteristics found in the stand(s) of the project area, the effect of the action on these characteristics, and the effect the action would have on the contribution of the area to the Forest's "old growth" inventory.

Currently the GWNF Forest Plan states that timber harvesting can only occur within the Dry Mesic Oak Type (OGFT #21), as all other stands meeting the minimum age in other groups were classified during the Forest Plan revision process as unsuitable for timber production. While some individual old age stands of the Dry Mesic Oak type were cut for timber during the past 18 years (<1,000 acres), the total acreage of stands meeting the minimum age within the that group continues to increase. From 1993 to 2010 there was an increase of 63,379 acres (72%) from 87,889 to 151,268 acres in OGFT 21. Thus, timber harvesting is not significantly limiting the old growth forest conditions on the GWNF, and in particular OGFT #21 since it is the most common and widespread group on the GW.

Fire is a natural disturbance process common to most OGFTs (but is very infrequent in northern hardwoods, spruce/fir, and riverfront forests) (USDA 1997, Trombulak 1996). Thus, the increased use of prescribed fire is not affecting the overall amount of old growth across the Forest, but instead is restoring and maintaining vegetation in species composition and structure more typical of the fire regime these forests experienced prior to active fire suppression (~1930's). In the absence of fire as a major landscape scale disturbance (which it once was) the structure and composition of forests, regardless of age, will not meet historic old growth conditions (NatureServe, Landfire, Native Tree Society). These forests will be much more closed canopy and closed understory as opposed to the open canopy and very open understory that historically existed. We will meet the age requirements for an old growth forest but will lack much of the associated structure. Thus, the acreage of all old growth forest types meeting minimum necessary ages is steadily increasing as the forest continues to increase in age, but stand structure in most types is not being met due to lack of fire related disturbances.

CUMULATIVE EFFECTS

Beyond the expected and naturally occurring disturbances like wind, ice, fire, native insects and disease the biggest impact upon existing and future old growth will be alterations in disturbance regimes and effects of non-native insect and disease events. Hemlock woolly adelgid is likely to have as large of an impact on eastern and Carolina Hemlocks as chestnut blight had on American chestnuts. Other major impacts will result from naturalized non-native pests like gypsy moths, European boars, beech-bark disease, and butternut blight and their induced mortality is expected to severely impact certain old growth types. The greatest effect of alteration in natural disturbance regimes is the decrease in with fire across most OGFTs. Fire is discussed elsewhere in this EIS and Plan but the overall effect of an altered fire regime has been to alter many old growth characteristics related to species composition and structure with current conditions much more closed canopy and species tolerant to shade such as red maple and white pine increasing while fire tolerant species decrease. But, regardless of alternative, the maturation of the Forest will continue and an increase in old growth as a function of age is expected into the future. Tables B3.1 and B3.2 show how the acreages increase and shift in 10 and 50 years for the types and the patches. Continued inventory for old growth will occur at the project level, and this is expected to result in an increase in old growth acreage.

B4 – AQUATIC SPECIES DIVERSITY

B4A FISHERIES AND AQUATIC HABITAT

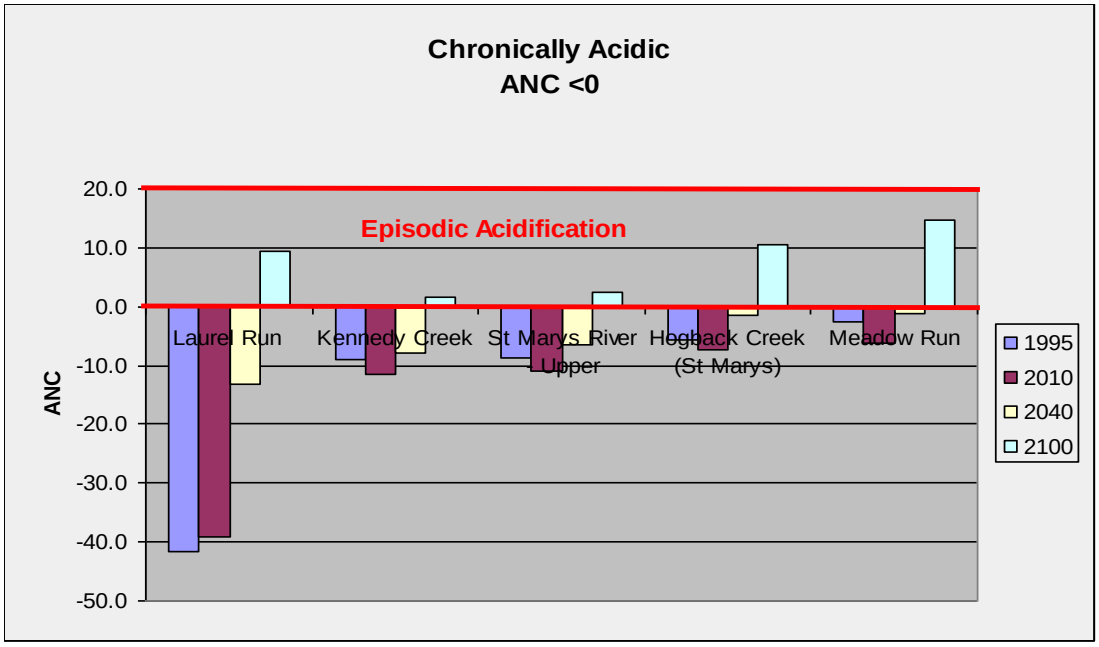
AFFECTED ENVIRONMENT

The Forest has approximately 1,171 miles of perennial streams and 2,348 miles of intermittent streams. Of the perennial streams, about 702 miles are classified as supporting a cold water (less than 70 degree water temperatures) fishery, and 469 miles are classified as supporting cool or warm water fisheries (temperatures greater than 70 degrees during summer months). In addition, the Forest has 3,229 acres of lakes, ponds, wetlands and reservoirs greater than 1 acre.

Habitats

Water Quality

Water quality has been systematically monitored on Forest streams since 1988. As expected, the general water quality of any given stream is strongly tied to the underlying geology coupled with prevailing air quality. The collected data has been used to determine trends and changes in stream water composition, and to project the future chemical status of native trout streams. Water quality in the cold water stream habitat is generally described as infertile with total alkalinity less than 20 parts per million (ppm), and slightly to very acidic with pH as low as 4.8. A 1998 report (Bulger et al. 1998) found that of the study streams in non-limestone geology, 50 percent are "non-acidic." An estimated 20 percent are extremely sensitive to further acidification. Another 24 percent experience regular episodic acidification at levels harmful to brook trout and other aquatic species. The remaining 6 percent of streams are "chronically acidic" and cannot host populations of brook trout or any other fish species. Modeling conducted by the Southern Appalachian Mountain Initiative (SAMI), showed that even with sulfate deposition declining considerably, as new air regulations are implemented, stream recovery will be slow or non-existent over the next 100 years (Sullivan et al 2004). Chronically acidic streams on the Forest may improve slightly and be only episodically acidic by 2100, but they will still be marginal for brook trout.

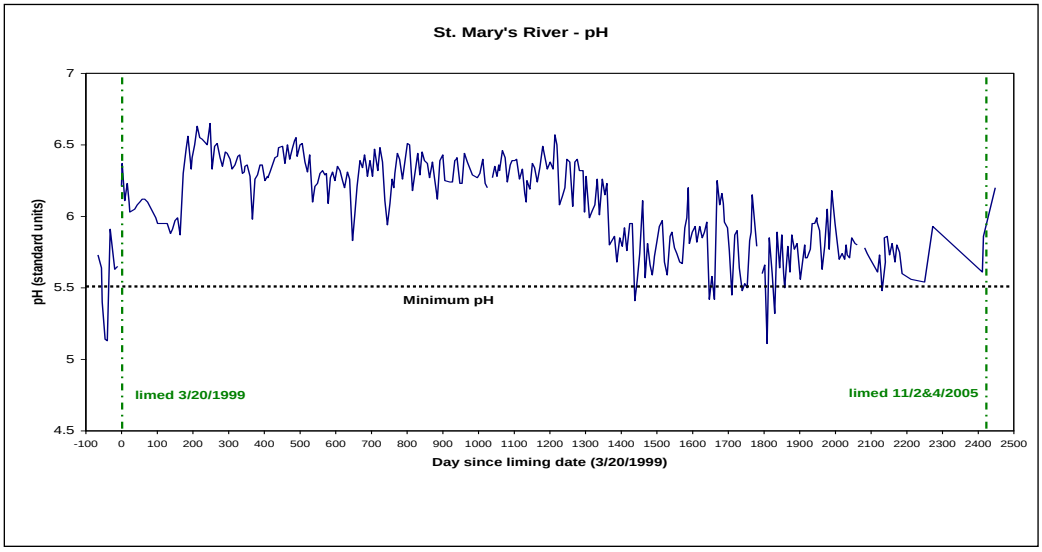


Due to the lengthy recovery time anticipated for acidified streams on the Forest, selective liming to improve water has been considered. The following streams have been limed on the GW Forest since 1989:

Table B4.1 George Washington National Forest Stream and Lake Liming

Date	Stream	County
1990, 1997	Cedar Creek	Shenandoah
1993, 1994, 1997	Laurel Run	Shenandoah
1997, 2000, 2003, 2006, 2009	Little Passage Creek	Shenandoah
1989, 1990,1991, 1998, 2001, 2004, 2007, 2010	Little Stony Creek	Shenandoah
1990, 1998, 2001, 2007	Mill Creek	Shenandoah
1993,1997, 1999, 2002, 2005, 2008	Mountain Run	Rockingham
1999	St. Mary's River & 5 tribs	Augusta
2005	St. Mary's River & 6 tribs	Augusta
1995, 1996, 1997, 1998, 1999	Trout Pond Run	Hampshire, WV

Trend in pH for one of the limed streams is shown below.



Water quality in the warm water stream habitat is generally higher in alkalinity and hardness, and not as susceptible to impacts from acid deposition because of more carbonate geology in the valley bottoms. Impacts to warm water streams often come from non-point source pollutants that enter the streams as they flow through private land.

For additional discussion on water quality, impaired waters, drinking water, and outstanding natural resource waters see the Water Resource section of EIS.

Physical Stream Condition

Large woody debris within a stream is ecologically important for instream habitat and productivity. Within the stream system, downed wood from riparian trees and shrubs greatly influence channel morphology and aquatic ecology. By altering stream flow, large woody debris stores and distributes sediment, and creates channel features, such as pools, riffles, and waterfalls. Wood also traps organic matter, which allows this material to be processed by instream organisms. Fish and insects occupy the pools and riffles created by the large woody debris, and riparian forest regeneration occurs on deposited sediment (Lassettre and Harris 2001).

Forest personnel surveyed stream habitat to measure DFC parameters identified in the 1993 Revised GWNF Forest Plan. Surveys were conducted on portions of the Pedlar Ranger District in 1995 and 2005, Lee District in 2001, Dry River District in 2002, 2003, 2004 and 2005, and the Warm Springs in 2005. Overall, 631 km (392 miles) of streams were surveyed using a modified Basinwide Visual Estimation Technique (BVET [Dolloff et al. 1993]) to estimate woody debris loading, percentage of pool and riffle area, and the width of the riparian area of streams. The distribution of woody debris was also mapped. See Table B4.2 for a summary of LWD and % pool area.

Table B4.2 Miles of Stream Habitat Surveyed In 1995-2005 on GWNF

Year Surveyed	# of Stream Miles Surveyed	% of Streams Below Minimum Pool Area DFC	% of Streams Below Minimum LWD DFC
1995	113	48	44
2001	75	75	35
2002	57	62	33
2003	55	70	19
2004	35	71	78
2005	57	96	83

A comparison of individual streams surveyed in 1995 and again in 2005 on the Pedlar District showed a decrease in the median number of pools, number of riffles, and total LWD per km, while the median pool and riffle surface area increased. This report suggests that in 1995 only 25% of streams met the DFC for stream area in pools and less than half of streams met the DFC for total LWD. By 2005 no streams met the DFC for pool area and 75% of streams did not meet the DFC for total LWD. The changes in pool/riffle ratio, number of pools and riffles per km, and pool and riffle surface area are all consistent with decrease in total LWD. The largest decrease of LWD was in the smallest size class. These pieces most often form pool habitat by combining with other small woody debris to form debris jams. In general the smallest size classes are the most easily dislodged and transported downstream or out of the active stream channel during high flows (Hilderbrand et al. 1998, Montgomery et al. 2003). Loss of debris accumulations from long riffle areas following flood events could result in the changes in stream habitat observed. The median amount of the largest size classes of LWD either remained the same or increased in the reaches between 1995 and 2005.

Following 1993 Plan approval, across all Ranger Districts, large woody debris was deliberately added to many streams that did not meet the DFC. In addition, efforts were made in the North River to return a highly modified stream channel to a more natural condition. Past hydrological modifications of the North River include bank armoring with rock gabions and channelization to protect the road from frequent floods. These modifications resulted in a wide, shallow channel that lacks fisheries habitat complexity. Under a recent project, rock veins and weirs, and other structures made of natural materials were placed in the stream channel to consolidate streamflow and increase sinuosity. Non-functional rock gabions blocking the natural floodplain were removed.

Physical Reservoir and pond Condition

There are approximately 34 large man-made reservoirs on the GWNF; they were constructed by various agencies for the purposes of flood control, drinking water, hydro-electric and/or recreation between 30 and 80 years ago. The dams have affected the dammed streams in three ways: alteration of downstream flux of water and sediment, changed water temperatures, and barriers for upstream-downstream movement of organisms and nutrients. The resultant lake habitat has often been managed for fisheries (see next section). Many of these dams are aging; they were built to accommodate an estimated fifty year filling of the sediment pool and these life expectancies are being met or exceeded. In a new flood storage dam, the sediment pool is entirely occupied by water. Over time, the water is gradually replaced by sediment as the feeder stream transports material into the reservoir. An aged dam may thus have a recreational pool that is shallow and of limited habitat for fish, thus reducing recreation, while creating an area with greater likelihood for warming surface waters. In addition, the accumulated sediment may serve as a trap for airborne toxins such as mercury. Furthermore, the underwater structural habitat diversity (generally, trees and shrubs) that may have been present at time of lake development is decaying and needs to be replaced in order to maintain a healthy, self-sustaining warm water fish population within the reservoir.

Aside from the loss of recreation that accompanies the filling of the sediment pool, structural deterioration in primary spillways, degradation of secondary spillways, under-dam seepage and other problems are developing that can lead to dam failure. Many of these dams are under special use permits and owned by local political entities such as Soil and Water Conservation Districts or municipalities, but the land on which they sit is National Forest. As these dams come up for refurbishment, the National Forest will review the purpose and need in light of its obligation to maintain integrity of the forest both for the use of humans and flora and fauna.

In contrast, small, natural impoundments such as beaver dams can be ecologically beneficial to an area. Beavers alter ecosystem hydrology, biogeochemistry, vegetation, and productivity with consequent effects on the plant, vertebrate, and invertebrate populations that occupy beaver-modified landscapes. Their impoundments trap fine textured sediments that act as water storage reservoirs, resulting in slow, sustained discharge that maintains streamflows during dry periods; afford protection from flooding of downstream areas; and produce a raised water table that enhances riparian zones. Additionally, beaver habitat modifications can reduce pollution and improve water quality in aquatic ecosystems, by trapping sediment and nutrients; reducing downstream turbidity; and purifying water from acidification and other non-point source pollutants. They create open, early successional habitat near riparian areas favored by species like woodcock.

The capability of beavers to store water, trap sediment, reduce erosion, and enhance riparian vegetation can be used as a management tool to restore degraded aquatic and riparian ecosystems. Beavers are a habitat-modifying species and play a pivotal role in influencing community structure in many riparian and wetland systems. Because they are porous and often have multiple channels through the dam, beaver dams generally do not restrict upstream or downstream movement of aquatic organisms. Beavers have disappeared, probably trapped out, from areas where they have previous played an integral habitat-maintaining role for many rare species (for example, the headwaters of Laurel Fork). Maintenance and restoration of beaver habitat across the Forest is necessary. Because of their role as a keystone species that create wetland habitat with many physical and biological benefits, beavers were chosen as Management Indicator Species (MIS).

BIOTA

The Southeastern United States supports the greatest diversity of freshwater mussel species in the world (Parmalee and Bogan 1998), and the richest freshwater fish fauna in North America north of Mexico (Warren et al. 2000). Looking at those species that are on or near the George Washington National Forest, 22 species of fish, aquatic invertebrates, and aquatic plants and mammals are listed as threatened, endangered, or sensitive (see Table B4.3). Because these species are associated with aquatic habitats, the effects to these and aquatic locally rare (LR) species are included in the general direct, indirect, and cumulative effects analyses below, and also addressed in the next section.

Table B4.3 Federally Threatened (T) or Endangered (E), and Forest Service Sensitive (S) Aquatic/Riparian Species On or Near the George Washington National Forest.

SCIENTIFIC NAME	COMMON NAME	Status
Alasmidonta varicosa	Brook floater	S
Boltonia montana	Doll's daisy	S
Cicindela ancocisconensis	Appalachian tiger beetle	S
Elliptio lanceolata	Yellow lance	S
Fusconaia masoni	Atlantic pigtoe	S
Helenium virginicum	Virginia sneezeweed	FT
Helonias bullata	swamp pink	FT
Hydraena maureenae	Maureen's shale stream beetle	S
Iliamna remota	Kankakee globe-mallow	S
Isoetes virginica	Virginia quillwort	S
Lasmigona subviridis	Green floater	S
Notropis semperasper	Roughhead shiner	S
Noturus gilberti	Orangefin madtom	S
Peltigera hydrothyria	waterfan	S
Pleurobema collina	James spinymussel	FE
Poa paludigena	bog bluegrass	S
Potamogeton hillii	Hill's pondweed	S
Potamogeton tennesseensis	Tennessee pondweed	S
Scirpus ancistrochaetus	northeastern bulrush	FE
Sida hermaphrodita	Virginia mallow	S
Sorex palustris punctulatus	southern water shrew	S
Vitis rupestris	sand grape	S

Common native fish species in the cold water stream environments include brook trout, mottled sculpin, fantail darter, blacknose dace, longnose dace, and torrent suckers. Introduced species such as rainbow trout and brown trout are routinely stocked for sport fishing. In some Forest streams, these species have developed into naturalized populations. An effort has been made to eliminate introduced species from some native brook trout watersheds.

Wild trout (brook, rainbow, and brown) are indicative of cold water streams, good water quality and sedimentation rates that are in equilibrium with the watershed. In addition, trout are commonly fished and are a demand species. Wild brook trout were chosen as a MIS because many of the trout streams on the GW National Forest support wild native brook trout. MIS population trends and changes are analyzed for wild trout, rather than hatchery reared fish, since many stocked streams are not suitable for year-round survival or recruitment of a self-sustaining population.

Virginia has one of the strongest native brook trout resources in the Southeast. Wild brook trout populations are generally limited to higher elevations in the western mountains of the state. However, brook trout were

once found throughout the limestone spring creeks in the Great Valley region located between the Blue Ridge and Allegheny mountain ranges and along some of the smaller tributaries of the Potomac at least as far east as Fairfax County. Most of the valley limestone stream populations were likely extirpated a century or more ago with the agricultural development of the valley but some persisted as late as the mid-1960s. The populations within Potomac River tributaries were known to be strong through the 1950s and still persisted as late as the early 1980s. These populations were eliminated with residential development of the region. Recent research supports the relationship between forested watersheds and presence of brook trout; conversely, watersheds with extensive development (with as little as 4% impervious cover) were unable to support brook trout in their streams (Stranko et al. 2008). It is estimated that at least 38% of the original brook trout populations have been extirpated from Virginia.

Most of the remaining populations are well protected from land use changes due to public ownership. Land management agencies include the George Washington and Jefferson National Forest, the Shenandoah National Park and scattered holdings of the Virginia Department of Game and Inland Fisheries. The GWNF has 1,120 miles potential brook trout habitat in Virginia and West Virginia (see Aquatic Ecological Sustainability Analysis). The threats to this habitat that are not within the control of the National Forest include acid deposition and altered streamflow and temperature from climate change (see Climate Change section). However, impacts to trout and other cold-water species can hopefully be reduced by implementing the management strategies within the Forest Plan designed to maintain and protect healthy watersheds, and support watershed resilience.

The Eastern Brook Trout Joint Venture (EBTJV) is a unique partnership between state and federal agencies, regional and local governments, businesses, conservation organizations, academia, scientific societies, and private citizens that is a geographically focused, locally driven, and scientifically based effort to protect, restore and enhance aquatic habitat throughout the range of the Eastern brook trout. Many of the watersheds identified as having “in-tact” brook trout populations by the EBTJV are on the GWNF; they have been identified as priority watersheds.

Cool/warm water streams across the Forest vary greatly in water quality and productivity. Common game fish species found in cool/warm water stream environments on the Forest include smallmouth bass, largemouth bass, redbreast sunfish, channel catfish, and rock bass. Typical non-game species include white sucker, carp, redhorse sucker, yellow bullhead, and a large variety of minnow and darter species. Chronic spring-time fish mortality and disease events have occurred in the Shenandoah River 2004-2009, and in the upper James River 2007-2010. These episodes have not been uniform in location or severity over these time periods. Adult smallmouth bass, redbreast sunfish and rock bass have been the primary fish affected. However, several additional species have also been inflicted. Affected fish typically exhibit open sores or "lesions" on the sides of their bodies. Some dead and dying fish have no visibly external abnormalities. Other external symptoms include: dark patches of skin, raised bumps, loss of scales, split or eroded fins, and discolored/eroded gills. Determining the cause of these mortality and morbidity events has proven to be extremely difficult. Scientists have conducted in-depth studies on fish health, pathogens, water quality, and contaminant exposure. The fact that these events have occurred in two separate watersheds that differ in many ways has added to the complexity of understanding the cause. In the initial years of these events there was higher mortality observed and biologists estimated that fish losses were quite high. Fish biologists stressed that these were estimates and that the severity of the mortality and disease was not uniform throughout the rivers that were affected. However, several factors have allowed these fish populations to recover faster than anticipated; the most significant of these being excellent smallmouth reproduction between 2004 and 2007. The years 2004 and 2007 were two of the best spawning years in the past decade in the Shenandoah River. Virginia biologists have documented that river flow in the spring/early summer is what determines the success of the smallmouth bass spawn. It also only takes a small number of successful spawning fish to keep the population viable.

Most of the lake habitats on the Forest are small in size and relatively infertile with limited productivity. They routinely contain introduced largemouth bass, bluegill, and channel catfish. Trout species are stocked in lakes that have significant cold water environments. The largest reservoir on the Forest is Lake Moomaw, which was completed by the U. S. Army Corps of Engineers in 1981, and is the second largest impoundment in western Virginia. It covers 2,530 surface acres and the average depth of the reservoir is 80 feet, with the maximum depth at 150 feet near the dam. The impoundment is "drawn down" between 10-15 feet annually, beginning

slowly in June and reaching its lowest level usually by September. There are 43 miles of undeveloped, wooded shoreline.

Lake Moomaw's geographic location and its operational procedure lend itself to thermal stratification in the summer. As much as 60,000 acre-feet of coldwater fisheries habitat is available in later summer for species such as brown and rainbow trout. Coldwater habitat varies annually depending on flow into the lake and downstream release loads. In summer 1993, the Corps of Engineers changed the way they released water out of the impoundment during summer/early fall. The Corps is required to provide 210C.water at Covington, 30 km downstream of Gathright Dam, throughout this period. Currently, water from the epilimnion is mixed with cold, anoxic water from the hypolimnion, meeting downstream temperature requirements and preserving summer trout habitat in the lake. Alewives, the primary forage base, also thrive in the lake's two-story environment. Trout are the only sport fish that are stocked annually.

Changes in Moomaw's physical habitat have focused primarily on black bass populations. Warmwater fish species such as black bass, black crappie, rock bass, sunfish, chain pickerel, channel catfish, and yellow perch reproduce and grow in the flats, drop-offs, brush, and standing timber afforded to them along the lake's shoreline. Common carp found their way into the reservoir through bait introductions in the late 1990's. Artificial habitat such as tire reefs, artificial grass, cedar tree shelters, crappie stakes, pallet structures, log cribs, hinge trees, brush/tree piles, concrete structures, and PVC attractors have been deployed at various times in Lake Moomaw since 1981. Prior to impoundment, the Corps of Engineers left 40 hectares of standing timber in several coves and a few boulder piles in deep sections of the lower lake. Hundreds of stumps were also left along the shoreline, providing exceptional cover/nesting habitat for channel catfish. Addition of physical habitat has been accomplished jointly by DGIF, USFS, and local angling clubs. An inventory of past projects is maintained by USFS at the Warm Springs Ranger District office. A lake management plan was also jointly developed by DGIF and USFS in 1993.

Aquatic macroinvertebrates integrate the physical, chemical, and biological components of the riparian ecosystem and have been successfully used as biological indicators of change and impacts (Environmental Protection Agency 1989). Aquatic insects make up the largest group of invertebrates that live in streams and other water bodies. Because of their usefulness as biological indicators, aquatic macroinvertebrates will be used in monitoring the Forest Plan. Analysis of 925 sites on the George Washington and Jefferson National Forests established the current range of conditions for aquatic macroinvertebrate communities across the four ecological units found on the Forests. In order to evaluate the current condition of a stream relative to others within the same ecological unit, a compilation of nine ecological aspects, or metrics, of these communities were developed based on the EPA's Rapid Bioassessment Protocol II. The nine metrics, called the Macroinvertebrate Aggregated Index for Streams or MAIS result in scores ranging from 0 to 18 (Smith and Voshell 1997). MAIS scores of 17-18 are "very good", 13-16 are "good", 7-12 are "poor/fair", and 1-6 are "very poor". The majority of the streams inventoried on the Forests (79%) fall into the "good" or "very good" category. These metric scores will be used as a tool for monitoring the effectiveness of the Forest Plan.

Macroinvertebrate Monitoring Objective: Streams are managed in a manner that results in sedimentation rates that stabilize or improve the biological condition category of the stream as monitored using aquatic macroinvertebrates. Aquatic macroinvertebrates will be measured using EPA's Rapid Bioassessment Protocol II (EPA 1989), with modifications by Smith and Voshell (1997).

DIRECT AND INDIRECT EFFECTS

Currently, the biggest concerns for aquatic habitats on the Forest are sedimentation, future sources of large woody debris for self-maintaining diverse habitat components, canopy cover to maintain water temperature regimes, impacts from roads, and acid rain. Ground disturbing management activities in watersheds, particularly in the riparian areas, have the most potential for effects on fisheries and aquatic habitat resources on the Forest. Other threats include the removal of large trees that are located close to aquatic systems. These large trees provide shade, which aids in the regulation of stream temperatures. In addition, they are essential components in the continuous replacement of large woody debris to stream channels. Large logs and stumps create diverse habitat niches in streams vital to aquatic organisms.

Timber harvesting can directly affect sediment transport in streams if it increases (or decreases) the supply of sediment, if it alters the peak flow or the frequency of high flows, and if it changes the structure of the channel by removing the supply of large woody debris that forms sediment storage sites. Bank erosion and lateral channel migration also contribute sediments if protective vegetation and living root systems are removed.

If a forested riparian corridor were not left along the streams in a project area, reduction of streamside canopy could affect the physical characteristics of the stream channel and can also affect food quality and quantity for macroinvertebrates and other stream organisms directly and indirectly. Direct effects occur by changing the input of particulate food (leaf litter). Indirect effects come from alteration of the structure and productivity of the microbial food web through increased sunlight and modifying the levels of dissolved organic carbon and nutrients. Indirect effects of canopy removal may include increases in stream temperature. A 2-5° C warming of small streams can affect life history characteristics of macroinvertebrates and developmental time of fish eggs (Sweeney 1993).

Roads affect the timing and volume of stream discharges by: intercepting and concentrating surface and subsurface flows; expanding or decreasing the channel networks; and reducing infiltration. The historic hydrological patterns within a watershed may be altered affecting the functions and processes to which the riparian and its inclusive aquatic communities have adapted. Roads located within the riparian corridor that either parallel or cross a stream present the greatest potential for allowing pollutants into surface waters. The use and construction of roads, log landings, trails, and other ground disturbing activities (including those associated with the development of wind energy that can increase erosion and sedimentation and concentrate runoff) could increase the amount of erosion during periods of high flow. Sediment loading in streams affects the aquatic fauna directly and indirectly. Direct effects include damage to gills and body surface by abrasion by suspended particles. Indirect effects come from a reduction in available dissolved oxygen, a reduction in suitable habitat due to substrate being covered with sediment, a reduction in pool volume, and the filling of interstitial spaces. These all affect habitat quality and complexity.

Large, human-built impoundments can alter flow regimes by changing the timing and quantity of instream flow below the reservoir. A decrease in water volume can lead to changes in channel morphology, and an increase in water temperature. Increased flow below an impoundment can lead to channel scour and flow levels that disrupt the reproductive cycle of aquatic organisms. For example, high flows could wash away glochidia or juvenile mussels. Impoundments also affect dissolved and particulate organic matter in the water column, and can change the natural temperature regime of a downstream river reach. These changes can affect the available food for aquatic organisms and create unsuitable thermal habitat. River habitat above an impoundment ultimately changes from a lotic to a lentic system.

Large, anthropogenic impoundments, as well as poorly designed road and trail stream crossings, can block fish passage thereby isolating upstream populations. Migration and movement of aquatic species are primarily restricted at road crossings by hanging culverts, high water velocity, inadequate swimming depth, or any combination of these three factors. Migration and movement barriers may be desirable (in rare cases) to protect a native species (brook trout) from a non-native competitor (rainbow trout). During watershed level analysis, the aquatic communities should be sampled above and below any culverts that could be barriers. Where the aquatic community above a culvert appears to have lost components, a decision should be made to either restock the unoccupied habitat through seining or electro-fishing or replace the culvert to facilitate natural movement back into the area.

The limiting factor for meeting the chemical desired future condition is atmospheric deposition, something the Forest Service cannot control. This effect will not vary by alternative. The only way to change the chemical condition of the streams is to mitigate acidification directly through addition of limestone, or indirectly through participation in the development of air pollution emission regulations.

Management activities in watersheds, particularly in riparian areas, have the most potential for effects on aquatic and riparian habitat resources on the Forest. As previously stated, the biggest concerns for aquatic habitat are sedimentation, future sources of large woody debris for self-maintaining diverse habitat components, canopy cover to maintain water temperature regimes, acid rain, and aquatic organism passage. Prescription areas and riparian management activities vary by alternative. Table B4.4 shows by alternative the

general riparian approach for species sensitivity factors. An additional sensitivity factor of "riparian integrity" was added to display the differences in approach between alternatives.

Table B4.4 General Riparian Direction by Forest Plan Alternative

Species Sensitivity Factor	Forest Plan Alternative Measure	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F	Alt. G
Riparian Integrity	riparian corridor width-perennial	66'+	100'	100'	66'+	100'	100'	100'
	riparian corridor width-intermittent	33'+	50'	50'	33'+	50'	50'	50'
	riparian corridor width-ephemeral		25'	25'		25'	25'	25'
Sediment	acres of soil disturbance	254 acres	292-384 acres	79 acres	635-785 acres	189-275 acres	260-323 acres	315-407 acres
	filter strip zone-perennial	66-200'	100-150'	100-150'	66-200'	100-150'	100-150'	100-150'
	filter strip zone-intermittent	33-100'	50-100'	50-100'	33-100'	50-100'	50-100'	50-100'
	filter strip zone-ephemeral		25'	25'		25'	25'	25'
Habitat Complexity	LWD DFC -cold water	125-300	200+	200+	125-300	200+	200+	200+
	LWD DFC -cool water	75-200	200+	200+	75-200	200+	200+	200+
Temperature	shade strip width-perennial	66'	100'	100'	66'	100'	100'	100'
	shade strip width-intermittent	33'	50'	50'	33'	50'	50'	50'
	shade strip width-ephemeral		25'	25'		25'	25'	25'
Acid dep	Treatment of acid streams with lime a priority?	yes	yes	no	yes	yes	yes	yes
Passage	Net road system at end of 10 years	1,842 miles	1,692 miles	1,539 miles	1,776 miles	1,679 miles	1,656 miles	1,679 miles

Riparian integrity, sedimentation, large woody debris, canopy cover, acid rain, and aquatic organism passage are addressed differently by alternative. They are addressed either by mitigation, a resource approach (active management to meet desired future conditions), or a natural processes approach (limited active management).

Alternatives A and D use an approach that resembles current management. The riparian areas are managed as a separate prescription area based on ecological parameters (width determined by true riparian characteristics defined by soils, vegetation, and biota). The desired future condition for fisheries and aquatic habitats are defined and buffered from other management activities through defined shade strips, filter strips, and vehicle exclusion zones. Aquatic habitats and fisheries are sustained in a healthy condition. Timber harvesting occurs in the riparian area outside the 66' buffer. There are no standards for channeled ephemeral streams. Current fisheries management practices may be suitable such as stocking, lake fertilization, streambank stabilization, use of habitat improvement structures, and use of mitigation measures for stream acidification. Wetland areas maintained by beavers and identified as important beaver habitat will be protected and enhanced. Alternative D implements the Federally Listed Mussel and Fish Conservation Plan in those 6th level HUC watersheds that contain the James Spinymussel.

Alternatives B, E, F, and G also use a resource approach where riparian areas are managed as a separate prescription area, but defined widths are based on maintaining the desired ecological conditions of the entire riparian area, not just aquatic habitat. Riparian and aquatic habitats are sustained in a healthy condition. Timber harvesting occurs in the core riparian area only when needed to protect or enhance riparian-dependent resources. It can occur in the extended riparian corridor, as long as 50% basal area is maintained and vehicles are excluded. There are Forest-wide standards for channeled ephemeral streams. Current fisheries management practices may be suitable such as stocking, lake fertilization, streambank stabilization, use of habitat improvement structures, and use of mitigation measures for stream acidification. Wetland areas maintained by beavers and identified as important beaver habitat will be protected and enhanced. The desired condition and standards are consistent with the Federally Listed Mussel and Fish Conservation Plan, forest-wide. The riparian corridor will be managed to retain, restore, and/or enhance the inherent ecological processes and functions of the aquatic, riparian, and upland components within the corridor in these alternatives. These standards should have a beneficial effect on the communities and their associated species.

Alternative C uses a natural processes approach, identifying riparian areas as a separate prescription area as in B, E, F and G; but excluding most management activities to attain desired future condition in riparian areas. The desired condition and standards are consistent with the Federally Listed Mussel and Fish Conservation Plan, forest-wide; however, many fish management activities such as stocking, habitat improvement, and mitigation for acid deposition are restricted or prohibited. Wetland areas maintained by beavers and identified as important beaver habitat will be protected and enhanced. Species that require management to maintain suitable habitat (such as brook trout in acidified streams) would decline.

Overall, aquatic habitats are included in the riparian management prescription (11). Under this management prescription, riparian areas and aquatic resources are managed to encourage the processes that maintain or lead to a desired future condition for fisheries and aquatic habitats. Riparian habitats and fisheries are sustained in a healthy condition. In most riparian areas, a slow progression toward a mature forest of more shade tolerant species occurs. More large woody debris is deposited into streams. When projects are implemented with full consideration of the riparian management prescription and channeled ephemeral stream standards, no direct or indirect adverse effects to aquatic organisms or to the aquatic habitat that sustain them should occur. In order to verify that these standards are adequate, some ground disturbing projects will be monitored for: filter strip widths (implementation monitoring); off-site sediment movement and aquatic invertebrate community composition (effectiveness monitoring).

CUMULATIVE EFFECTS

The area considered for cumulative effects includes the fifth-level watersheds within the Forest proclamation boundary, and the analysis includes the potential effects of Forest, state and private activities on the waters within and leaving the Forest. Cumulative effects address the environmental consequences from activities

implemented or projected within the watersheds in the past, present and reasonably foreseeable future. The combination of activities on NFS, state and private lands can create an effect at a watershed scale that otherwise would not be perceived as a problem at the project or subwatershed scale. In addition to their natural variability, watersheds differ by their management history, ownership patterns, and the types and levels of contemporary management activity. The combination of natural variables, ownership patterns and management activities contribute to the cumulative effects that shape the current conditions of the aquatic ecosystems within the analysis area. Given the variability in watershed conditions, both natural and management related, the discussion of cumulative effects will be general in nature (Reid 1998).

The current watershed and aquatic resource conditions in the analysis area are a reflection of the cumulative effects of past and present actions. Streams are deficient in LWD largely due to historic logging activities, sediment levels are elevated due to past and present management activities, and the hydrology of the watersheds is altered due to past and present land uses. Future activities can contribute to these effects or alleviate some of the problems. On NFS lands, the reasonably foreseeable future actions are considered to be the continuation of existing programs such as timber management, roads, developed and dispersed recreation, gas and mineral development, grazing allotments, special uses, fish and wildlife management, and other activities. On a broad scale, the effects of future management on NFS lands may result in some localized effects, but overall should not contribute to any measurable downstream impacts. This is due in part to Forest Plan direction for the protection of soil, water, and riparian resources, the continued natural recovery of watershed conditions across the Forest, and the implementation of watershed, riparian, and aquatic restoration projects. The level of potential harvest, and its distribution across watersheds, should not result in any hydrologic effects at the fifth-level watershed scale. With the exception of areas where roads, trails, or other facilities cross channels, riparian standards and guidelines should maintain the current level of stream shading and LWD recruitment. Opportunities also exist to revegetate and restore areas of degraded riparian conditions.

One concern is that future ground-disturbing activities have the potential to contribute to existing sediment sources, primarily associated with the Forest-wide transportation system. Roads continue to be a chronic source of sediment and additional inputs may be detrimental to the health of aquatic ecosystems depending on the existing site-specific conditions. The recovery of disturbed soils can be relatively quick, which reduces the erosion potential following the disturbance. But sediment that enters a channel can remain in the system for years, even decades, depending on the level of inputs and channel characteristics. Potential new sources could be off-set, in part or wholly, by correcting existing problems and reducing current inputs.

The influence of NFS land on cumulative effects for waters draining the analysis area largely depends on the level of ownership. NFS lands average 24 percent of the fifth-level watersheds within the proclamation boundary, ranging from .75 percent in the Craig Creek watershed to 59 percent in Dry River-North River watershed. NFS lands are typically located in the higher elevations and headwaters, and the influence of state and private lands increases going downstream. In watersheds where NFS lands are limited, the influence of state and private activities is greater.

Assuming the activities on state and private lands remain relatively constant, existing watershed and stream conditions within those areas should persist in the foreseeable future. Watershed, riparian, and aquatic conditions are modified by roads, rural and agricultural developments, logging, mining, housing developments, and other activities. Direct impacts to aquatic habitats occur through road crossings and flood control efforts. Reduced riparian vegetation effects stream shading, bank stability, LWD recruitment, and channel stability. A wide range of ground disturbing activities result in soil erosion and sedimentation in streams.

Implementation of Forest-wide standards and guidelines would minimize the potential effects of land management activities on NFS lands and the Forest's potential contribution to cumulative effects. The existing transportation system continues to affect aquatic resources and water quality, and foreseeable actions that improve road-related problems can reduce the potential effects and the contribution to cumulative effects. Foreseeable harvest activities have the potential to contribute to sedimentation and cumulative effects associated with conventional logging and road-related impacts. Future harvest activities also provide an opportunity to correct or reduce existing road-related problems and sediment source. Alternative C has the lowest potential for ground-disturbing activities associated with management activities, followed by

Alternatives E, A, F, B, G and D. However, Alternative C also has the highest potential for un-mitigated impacts from acid deposition or other anthropogenic activities, because of the natural processes approach. Alternative A has the highest projected mileage of system roads at the end of 10 years, followed by D, B, G, E, F and C.

B4B - AQUATIC SPECIES VIABILITY EVALUATION

National Forest Management Act (NFMA) regulations, adopted in 1982, require that habitat be managed to support viable populations of native and desirable non-native vertebrates within the planning area (36 CFR 219.19). For planning purposes, a viable population is one that has numbers and distribution of reproductive individuals to insure its continued existence and is well distributed in the planning area. USDA regulation 9500-004, adopted in 1983, reinforces the NFMA viability regulation by requiring that habitats on national forests be managed to support viable populations of native and desired non-native plants, fish, and wildlife. These regulations focus on the role of habitat management in providing for species viability. Supporting viable populations involves providing habitat in amounts and distributions that can support interacting populations at levels that result in persistence of the species over time.

Aquatic habitats are unique in that they are found in and adjacent to streams and lakes. The mobility of aquatic species is usually limited to these habitats. Habitat alteration is probably the major cause of decline of aquatic diversity in the South. Channelization, impoundment, sedimentation, and flow alterations are the most common physical habitat alterations associated with the decline of aquatic species (Walsh et al. 1995; Etnier 1997; Burkhead et al. 1997). Other human-induced impacts to aquatic species include pollution, introduced species, and over-harvesting (Miller 1989).

Species are tied to specific habitat; when this relationship is known, the amount of suitable habitat can be estimated. Plan revision direction was designed to address the key factors that maintain the physical, chemical, and biological aspects of suitable habitat on the Forest. Aquatic habitats on the Forest are protected, restored, or enhanced to maintain the ecological integrity of the system. However, habitat quality within a freshwater ecosystem is determined by activities within the watershed (Abell et al. 2000; Scott and Helfman 2001), both on and off National Forest land. For administrative purposes these watersheds are described as 5th level hydrologic units (HUCs). The planning areas for aquatic species are 5th level hydrologic units or watersheds at the Forest Plan level.

AFFECTED ENVIRONMENT

There are hundreds of aquatic species found in the 29 5th level HUCs associated with this plan revision. It is impossible to determine viability for each of these individual species. As a surrogate, the viability of proposed, endangered, threatened, sensitive, and locally rare (TESLR) aquatic species are assessed and threat to their viability determined; as well as Management Indicator Species and Species of Management Concern. Other species with wide ranges are generally not at risk.

To determine effects to habitat of these species, the condition of individual watersheds was determined. Watershed condition is determined from the physical and anthropogenic interactions within the watershed. Ideally, watershed condition would be determined from stream surveys. However, the extent and detail required to address all watersheds, including private land, with stream surveys is not available. To address habitat condition at the watershed level it is necessary to determine values from geographic data. These values were compared among the watersheds and a condition or set of conditions was determined.

VIABILITY EVALUATION PROCESS

Species Lists and Stressors

A comprehensive list of aquatic and riparian species with potential viability concern was compiled for the George Washington National Forest; the species list and associated documentation is found in Section 3,

Species Diversity in the Aquatic Ecological Sustainability Analysis. The list included those species found both on and downstream (within the 5th level HUC) from National Forest in the following categories:

- Species listed as proposed, threatened, or endangered under the federal Endangered Species Act,
- Species listed on the Regional Forester's Sensitive Species list,
- Species identified as locally rare on the National Forest by Forest Service biologists,
- Management Indicator Species and Species of Management Concern

There are a number of physical, biological and chemical factors that influence populations; a thorough discussion of the key habitat factors that maintain aquatic ecological integrity, along with current condition and trend, is found in Section 2, Ecosystem Diversity in the Aquatic Ecological Sustainability Analysis. The stressors addressed here relate to these key habitat factors and the anthropogenic change processes discussed in Section 2.4a, Disturbance Processes. They are specific to forest management activities and our potential to affect population viability. The primary concerns associated with land management activities are 1) increased sedimentation due to ground disturbing activities, 2) decreased habitat conditions and channel stability due to reduced recruitment of large woody debris, 3) increased stream temperatures due to reduced riparian vegetation and stream shading, and 4) fragmentation of habitat and isolation of populations due to passage barriers associated with road crossings. In addition to these land management factors, much of the planning area is underlain by geologic formations that are sensitive to acid deposition and streams in watersheds with poorly buffered geologic types are susceptible to acidic conditions.

The threat analysis evaluated the sensitivity of species to the different stressors (sediment, habitat complexity, temperature, acidic conditions, and passage). Sensitivity to the stressors was assigned for each species, based on the published literature and personal communications; where there was a lack of detailed life history information, the following assumptions are used to evaluate species sensitivity:

Sedimentation: Benthic organisms, or life stages, are susceptible to sedimentation and the filling of interstitial spaces that affect habitat and food supplies.

Habitat Complexity: Species that prefer pool habitat are more sensitive to a loss of channel structure and habitat complexity than riffle and run dwelling species. Large woody debris plays a greater role in forming habitat in smaller headwater streams than in larger main stem systems, so species occupying headwater streams are more sensitive to losses of LWD.

Water temperature: Cold water species are more sensitive to changes in stream temperature than the cool and warm water species that are more tolerant.

Acid deposition: At times, the literature referred specifically to a species' sensitivity to acidic conditions. These species have been identified as being acid sensitive, when in actuality all species are susceptible to low pH levels. We also assumed that species in headwater streams are generally more susceptible to acidic conditions than species inhabiting main stem rivers with broad drainage areas, along with those that occur in watersheds highly sensitive to acidification (see Section 3.4, Species Groups in the Aquatic Ecological Sustainability Analysis).

Passage barriers: Road crossings on small streams are more likely to create passage barriers and reduce the habitat available to headwater species than crossings on larger main stem streams.

The list of species, potential habitat on national forest, ranks, and sensitivity factors are found in Table H.4 (in Appendix H).

Overall, the potential of the Forest to influence population viability either positively or negatively is greater in the headwaters than the larger main stem rivers. Headwater streams are usually in closer proximity to Forest management activities and the relative influence of management on NFS lands typically decreases as the drainage area increases downstream.

Watershed Condition

Species sensitivity to the five stressors was compared with the condition of their respective watersheds to determine the threats to their persistence in the planning area. The watershed condition was assessed using metrics representing each of the identified stressors. The metrics were a compilation from geographic information layers. These layers include ownership, streams, roads, geology, and landuse. The metrics and combinations of data used to determine the metrics are outlined in the following list of watershed measures; an expanded discussion and data sources are found in Appendix E, Watershed Analysis for GW Plan Revision in the Aquatic Ecological Sustainability Analysis, and EWAP (2002).

Stressor	Watershed Measure
Sedimentation	Percent High Erosion Potential
Habitat Complexity	Percent Forested Riparian
Temperature	Percent Forested Riparian
Acid Deposition	Percent High Acid Sensitivity
Passage barriers	Road Density

Aquatic Viability Determinations

Separate viability determinations were made for each watershed where a species occurs, because in many cases watersheds support separate populations, and because factors affecting viability can vary considerably from watershed to watershed. Viability outcomes from each species by watershed were determined by incorporating elements of species distribution, abundance, and sensitivities to environmental factors; watershed condition relative to the species' environmental sensitivities; and the national forest role in the watershed. Viability outcomes are:

Outcome A. Species is well distributed and abundant within watershed. Forest Service may influence conditions in the watershed to keep it well distributed. Likelihood of maintaining viability is high.

Outcome B. Species is potentially at risk in the watershed; however, the extent and location of NFS lands with respect to the species is conducive to positively influence the sustainability of the species within this watershed. Therefore, likelihood of maintaining viability is moderate.

Outcome C. Species is potentially at risk within the watershed; however, the extent and location of NFS lands with respect to the species is NOT conducive to positively influence the sustainability of the species within this watershed. Therefore, species viability in the watershed may be at risk.

Outcome D. The species is so rare within the watershed (population is at very low density and/or at only a few local sites) that stochastic events (accidents, weather events, etc.) may place persistence of the species within the watershed at risk; however, the extent and location of NFS lands with respect to the species is conducive to positively influence the sustainability of the species within this watershed. Therefore, likelihood of maintaining viability is moderate.

Outcome E. The species is so rare within the watershed (population is at very low density and/or at only a few local sites) that stochastic events (accidents, weather events, etc.) may place persistence of the species within the watershed at risk. Forest Service ability to influence the species is limited. Therefore species viability in the watershed may be at risk.

An assumption inherent in the determination of population viability outcomes is that a viable population currently exists. Often, this could not be confirmed using the available information. If a species was reported

within a watershed, the assumption was other individuals exist and habitat conditions occur within that watershed to support a viable population.

VIABILITY EVALUATION RESULTS

Viability by Watershed

A summary of stressors and viability outcomes by watershed for each species is found in Table H.3 (Appendix H).

For the species that are in watersheds with a viability outcome B and D, the species are potentially at risk in the watershed because of one or more stressors; however, the species are actually on the Forest, and through riparian management prescription direction the Forest Service may positively influence conditions at those localized sites. Therefore, through proactive management where the species occur on National Forest land, the likelihood of maintaining viability in that watershed is moderate.

Watershed stressor and species viability associations are primarily a result of historical influences that have reduced distribution and abundance of some habitat elements and species populations. This viability analysis was based on the assumption that the riparian corridor width is that found in Section 2.6 Plan Components for Ecosystem Diversity, in the Aquatic Ecological Sustainability Analysis. In general, effects of proposed management strategies are small relative to historical impacts and future external threats. Risks to species viability are minimized by thorough riparian management prescription direction and standards, as well as applicable common standards.

ALTERNATIVE COMPARISON

Viability outcomes by watershed were then evaluated in light of species sensitivities and Forest Plan Alternatives (see Table B4.4. General Riparian Direction by Forest Plan Alternative in the Fisheries and Aquatic Habitat Section), and assigned a rating of:

+, increased protection for aquatic and riparian habitat from current plan

-, decreased protection for aquatic and riparian habitat from current plan

o, no change in protection for aquatic and riparian habitat from current plan

Although ratings could vary between stressors in the same alternative, only one rating was given for each species and watershed based on the overall potential for change.

The changes to viability outcome by species, watershed, and Forest Plan Alternative are found in Table H.5 (Appendix H). A summary of the changes by alternative is below.

Table B4.5 Number of Species/Watershed Combinations with Increased (+), Decreased (-) or No Change (o) in Protection for Aquatic and Riparian Habitat from Current Plan

Change in Viability Rating	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Increased Protection (+)		150	131	9	150	150	150
Decreased Protection (-)			19				
No change (o)	150			141			

Riparian integrity, sedimentation, large woody debris, canopy cover, acid rain, and aquatic organism passage are addressed differently by alternative. They are addressed either by mitigation (protect from other management activities), a resource approach (active management to meet desired future conditions), or a natural processes approach (limited active management).

Alternatives A and D use an approach that resembles current management. The riparian areas are managed as a separate prescription area based on ecological parameters (width determined by true riparian characteristics defined by soils, vegetation, and biota). The desired future condition for fisheries and aquatic habitats are defined and buffered from other management activities through defined shade strips, filter strips, and vehicle exclusion zones. Aquatic habitats and fisheries are sustained in a healthy condition. Timber harvesting occurs in the riparian area outside the 66' buffer. There are no standards for channeled ephemeral streams. Current fisheries management practices may be suitable such as stocking, lake fertilization, streambank stabilization, use of habitat improvement structures, and use of mitigation measures for stream acidification. Alternative D implements the Federally Listed Mussel and Fish Conservation Plan in those 6th level HUC watersheds that contain the James Spinymussel.

Alternatives B, E, F, and G also use a resource approach where riparian areas are managed as a separate prescription area, but defined widths are based on maintaining the desired ecological conditions of the entire riparian area, not just aquatic habitat. Riparian and aquatic habitats are sustained in a healthy condition. Timber harvesting occurs in the core riparian area only when needed to protect or enhance riparian-dependent resources. It can occur in the extended riparian corridor, as long as 50% basal area is maintained and vehicles are excluded. There are Forest-wide standards for channeled ephemeral streams. Current fisheries management practices may be suitable such as stocking, lake fertilization, streambank stabilization, use of habitat improvement structures, and use of mitigation measures for stream acidification. The desired condition and standards are consistent with the Federally Listed Mussel and Fish Conservation Plan, forest-wide.

Alternative C uses a natural processes approach, identifying riparian areas as a separate prescription area as in B, E, F and G; but excluding most management activities to attain desired future condition in riparian areas. The desired condition and standards are consistent with the Federally Listed Mussel and Fish Conservation Plan, forest-wide; however, many fish management activities such as stocking, habitat improvement, and mitigation for acid deposition are restricted or prohibited. Species that require management to maintain suitable habitat (such as brook trout in acidified streams) would decline.

B4C – FEDERALLY LISTED THREATENED AND ENDANGERED SPECIES

JAMES SPINYMUSSEL

AFFECTED ENVIRONMENT

The James spinymussel was federally listed as endangered in 1988 (USDI Fish and Wildlife Service 1990). Historically, this species was apparently throughout the James River above Richmond, in the Rivanna River, and in ecologically suitable areas in all the major upstream tributaries (Clarke and Neves 1984). The species remained widespread through the mid-1960's, but now appears extirpated from 90% of the historic range. Since 1990, James spinymussel populations have been found in three tributaries to the Dan River in Virginia and North Carolina, which is outside of the species range known at the time of listing.

This species is found in slow to moderate currents over stable sand and cobble substrates with or without boulders, pebbles, or silt (Clarke and Neves 1984). Hove and Neves (1994) found James spinymussels in 1.5 to 20 m wide second and third order streams at water depths of 0.3 to 2 m. Seven fish hosts, all in the family Cyprinidae, have been identified (Hove 1990): bluehead chub, rosyside dace, blacknose dace, mountain redbelly dace, rosefin shiner, satinfin shiner, and stoneroller. Freshwater mussels are filter feeders taking

organic detritus, diatoms, phytoplankton, and zooplankton from the water column. The following excerpt from Hove and Neves (1994) states the current thinking on threats:

"There are several anthropogenic and natural threats to the James spinymussel's continued existence. Nearly all the riparian lands bordering streams with the James spinymussel are privately owned. With more intensive use of the land, it is probable that water quality and habitat suitability will deteriorate. At present, the most detrimental activities include road construction, cattle grazing, and feed lots that often introduce excessive silt and nutrients into the stream."

The introduced Asian clam is also considered to be a threat to the James spinymussel and is beginning to invade several sites (Hove and Neves 1994).

Occurrences of the James spinymussel near the Forest include Potts Creek, Craig Creek, Pedlar River, Cowpasture River, Bullpasture River, Mill Creek, and there are historic records from the James and Calfpasture Rivers. In the Craig Creek watershed, the species is stable due to population(s) in Johns, Dicks, and Little Oregon creeks (near the Jefferson National Forest). The species appears to be extirpated in Potts Creek or at low numbers that detection is extremely difficult. In the Cowpasture River watershed, population status in the Cowpasture and Bullpasture is uncertain with the population in Mill Creek stable (see Table B4.6, Watson 2010).

Table B4.6 Location and Status of James Spinymussel Populations in the James River Watershed.

Watershed	Tributary	County/State	Status
James River	Bullpasture River	Highland/VA	Unknown
James River	Calfpasture River	Rockbridge/VA	Extirpated?
James River	Catawba Creek	Botetourt/VA	Extirpated?
James River	Cowpasture River	Bath & Alleghany/VA	Stable?
James River	Mill Creek	Bath/VA	Stable
James River	Craig Creek	Craig/VA	Declining
James River	Dicks Creek	Craig/VA	Stable to increasing
James River	James River mainstem	Various	Extirpated
James River	Johns Creek	Craig/VA	Stable
James River	Little Oregon Creek	Craig/VA	Stable to increasing
James River	Patterson Creek	Botetourt/VA	Extirpated?
James River	Pedlar River	Amherst/VA	Stable
James River	Potts Creek	Monroe/WV	Stable
James River	Potts Creek	Craig & Alleghany/VA	Extirpated?
James River	Upper Potts Creek	Monroe/WV	Stable?

Despite extensive searches, no occurrences of the spinymussel have been located on the GWNF (Watson 2010). The 14 miles of potential habitat modeled for this species in the Ecological Sustainability Analysis assumes all of the river mileage is suitable substrate, which is not probable; in all of the watersheds with spinymussels near the GWNF, the occurrences are all on private land. The James spinymussel does occur both upstream and downstream from the Forest. Current Forest management provides for water quantity and quality that contributes to the persistence of mussel populations. The main avenues for the Forest to aid in this species recovery are through land acquisition, assisting in augmentation efforts, and working with landowners to protect streams and streamside habitat. Several isolated reaches of habitat on the Forest could provide

sites for augmentation if the substrate were suitable. Working cooperatively with State biologists, university experts, and the US Fish and Wildlife Service, the Forest developed a pro-active conservation plan for federally listed fish and mussels in 2004. The standards and guidelines in the plan are implemented in 6th level HUC watersheds that contain listed fish or mussel species. The following watersheds on the GWNF are covered by the Federally Listed Mussel and Fish Conservation Plan.

Table B4.7 Sixth Level HUC Watersheds on the George Washington National Forest Included in the Federally Listed Mussel and Fish Conservation Plan

6th Level HUC	Watershed Name
020802010403	Mill Branch-Potts Creek
020802010404	Cast Steel Run-Potts Creek
020802010405	Hays Creek-Potts Creek
020802010601	Wolfe Draft-Cowpasture River*
020802010602	Shaws Fork*
020802010603	Benson Run-Cowpasture River*
020802010701	Scotchtown Draft-Cowpasture River
020802010702	Dry Run*
020802010703	Thompson Creek-Cowpasture River*
020802010801	Mill Creek-Cowpasture River*
020802010803	Simpson Creek-Cowpasture River
020802011201	Rolands Run Branch-Craig Creek
020802011202	Barbours Creek*
020802011205	Roaring Run-Craig Creek
020802011302	Town Branch-Catawba Creek
020802020104	Hamilton Branch*
020802020105	Fridley Branch-Calfpasture River*
020802020106	Cabin Creek-Mill Creek
020802020108	Guys Run-Calfpasture River*
020802020506	Poague Run-Maury River*
020802030201	Lynchburg Reservoir-Pedlar River
020802030202	Browns Creek-Pedlar River
020802030203	Horsley Creek-Pedlar River

* No spinymussel occurrence in this watershed, but is found in downstream HUC(s)

The decline and extirpation of most populations of the James spinymussel may be attributed to habitat modification, sedimentation, eutrophication, and other forms of water quality degradation. Restricted movement of host fish may also be a factor in the decline of this species. For populations of the James spinymussel on or near the Forest potential management influences include: sedimentation, altered flow, and blockage of host fish passage associated with roads and crossings. Forest-wide and riparian standards will protect the James spinymussel and its habitat from sediment released during management activities. Instream flow needs will be quantified and maintained to protect aquatic organisms when new water use authorizations are proposed. Prior to the stocking of any non-native species, the national forest coordinates with the appropriate State agencies to ensure populations and habitats of native species are maintained.

The Forest will manage and protect extant populations and historical habitats of the James spinymussel. Protection and active management will be implemented where the species is physically on or historically occurred on Forest lands. Protection, monitoring, and augmentation will be the primary recovery objectives. Actions will be taken in order to identify additional suitable habitat and restore fish hosts and mussels to areas on Forest lands.

Recovery objectives will include annual or bi-annual monitoring within Virginia of representative populations by qualified biologists for populations trend and habitat quality. Monitoring will include either search indices or transects depending on local conditions and mussel densities. Inventories of additional potential habitat will also be conducted.

B5 – FOREST HEALTH AND PROTECTION

Beginning about 18,000 years ago during the peak of the last major glacial period, the forest communities of the GWNF that we know today began to be shaped by global climate changes, indigenous human cultures, lightning, windstorms, beavers, large ungulates, and native insects and diseases. In the more recent past, European settlement and modern society have disrupted some of these natural processes (fire, beavers, and large ungulates) and introduced new disturbances like air pollution, gypsy moth, and hemlock woolly adelgid. The Southern Forest Resource Assessment (USDA Forest Service 2002) and the Southern Appalachian Assessment (SAMAB 1996) provide a vast amount of information regarding the history of native plant communities in the southeast. This section of Chapter 3 will focus on non-native invasive species, insects and diseases, wildland fire suppression, wildland fire use, and prescribed fire.

NON-NATIVE INVASIVE SPECIES

A multitude of non-native invasive species including non-native plants, insects, and pathogens threaten the integrity of native ecosystems in the southern Appalachian area. The Chief of the U.S. Forest Service (USFS) has identified non-native invasive species as one of the four critical threats to USFS ecosystems. In the United States, invasive species are reported to be the second-most critical threat to conservation of biodiversity (Wilcove et al. 1998). The Southern Appalachian Assessment (SAMAB 1996: 109) discusses a number of non-native invasive forest pathogen and pest organisms that have or are currently affecting the GWNF. Insects and diseases of most concern for the purposes of this analysis include European gypsy moth, hemlock woolly adelgid, and southern pine beetle. Emerging pests of concern, but for which the potential to impact the GWNF is yet unknown, include the emerald ash borer, ramorum blight, and Thousand Cankers Disease. A new non-native invasive aquatic species found on the Forest since the last planning cycle is the diatom, *Didymosphenia geminata* (didymo).

NON-NATIVE INVASIVE PLANTS

AFFECTED ENVIRONMENT

Non-native plants are known to occur across Southern and Central Appalachian forests, often accounting for 25% or more of the documented flora. While not all non-native species are known to disrupt native ecosystems, of particular concern are those that are successful at invading and rapidly spreading through natural habitats. As defined in Executive Order 13112 issued February 3, 1999, an invasive species is one that meets the following two criteria: "1) it is non-native to the ecosystem under consideration and, 2) its introduction causes or is likely to cause economic or environmental harm or harm to human health."
The Plan objective is to protect native populations of plants and animals through the timely treatment of non-native invasive plant (NNIP) infestations and to prevent or reduce the spread of NNIP infestations to high quality natural habitats. In selecting treatment methods, minimizing effects to native species and natural communities is a priority.

One of the goals of both the George Washington and Jefferson National Forest Land and Resource Management Plans is to maintain and enhance the diversity of plant and animal communities of the Central Appalachians, favoring plant and animal communities that warrant special attention. Given the current distribution of NNIP infestation sites on the Forest, there is a need to implement a comprehensive and integrated program of NNIP control to protect the integrity of natural plant communities. The integrity of natural communities on the Forest will be compromised if NNIP infestations are allowed to continue to spread and invade previously unaffected areas. In addition, management of NNIP infestations sites will help slow the spread of NNIPs in the Southern and Central Appalachians by minimizing the degree to which the Forest is a source of infestations for surrounding lands, both public and private.

To fulfill the goals of Executive Order 13112, NNIP treatments are intended to be adaptive in nature and allow the use of integrated methods for the future treatment of invasive plant infestations.

The Forest recognizes that prevention is critical in NNIP management. Prevention includes educational efforts as well as Forest Plan standards and guidelines that reduce the probability of NNIP being spread by Forest management activities.

A list of the high priority invasive plant species across the Forests has been developed both from botanical surveys completed during the past 18 years and by consulting NNIP information provided by the Virginia Division of Natural Heritage, the Virginia Native Plant Society, and the West Virginia Department of Natural Resources. The exact infested acreage within the Forest is unknown and changes annually. Most of the 26 species identified in Table 1.3.1 are prevalent across the region and are continuing to spread, actively impacting biodiversity. A review of Forest field survey data from 2001 to 2010 indicated that 60% of the sites had one or more NNIP species present (Fred Huber pers comm.). These species were assigned a relative priority for treatment based on their known impacts on rare species and communities, their ability to rapidly spread, and their ability to persist in the forest. These species have been identified as the highest priority species on the Forest at the present time but the list will be updated as needed, based on new information regarding species' spread, invasion by new species, and infestation characteristics.

Table B5.1 Priority Species for NNIP Control

SCIENTIFIC NAME	COMMON NAME	INVASIVENESS*	RANKING**	PRIORITY‡
Ailanthus altissima	tree of heaven	1	77	1
Alliaria petiolata	garlic mustard	1	62	3
Buddleja davidii	butterfly bush	L	50	2
Berberis thunbergii	Japanese barberry	L	44	1
Carduus nutans	musk thistle	2	47	2
Celastrus orbiculatus	oriental bittersweet	1	71	1
Centaurea biebersteinii	spotted knapweed	1	67	3
Cirsium vulgare	bull thistle	2	49	2
Elaeagnus umbellata	autumn olive	1	73	2
Lespedeza cuneata	sericea lespedeza	1	46	2
Ligustrum spp.	Privet	1	50	2
Lolium arundinaceum	tall fescue	2	57	1
Lonicera japonica	Japanese honeysuckle	1	80	3
Lonicera maackii	Amur honeysuckle	2	65	1
Lonicera morrowii	Morrow's honeysuckle	1	65	1
Lonicera tatarica	Tartarian honeysuckle	2	65	1
Lythrum salicaria	purple loosestrife	1	73	1
Microstegium vimineum	Japanese stiltgrass	1	69	3
Paulownia tomentosa	princess tree	2	50	2
Perilla frutescens	beefsteak plant	3	40	1
Persicaria perfoliatum	mile-a minute	1	73	1
Polygonum cuspidatum	Japanese knotweed	1	55	1
Pueraria montana var. lobata	kudzu	1	52	2

SCIENTIFIC NAME	COMMON NAME	INVASIVENESS*	RANKING**	PRIORITY‡
Rosa multiflora	multiflora rose	1	78	2
Spiraea japonica	Japanese spiraea	2	44	2
Tussilago farfara	coltsfoot	L	60	3

* **Invasiveness** based on Virginia Department of Conservation and Recreation: 1=Highly Invasive; 2=Moderately invasive; 3=Occasionally invasive; L=Locally invasive
****Ranking** based on Hiebert and Stubbendieck 1993
‡ **Priority:** 1=high, eradicate wherever found
2=medium, control source populations and eradicate outliers
3=low, prevent invasion of last areas not invaded; eradicate high priority areas

Of the non-native invasive plant species found on the Forest, 26 species are particularly troublesome and are anticipated to make up the largest percentage (by acreage) of actual treatments implemented. Of these 26 species, 15 are listed as Highly Invasive by the Virginia Department of Conservation and Recreation, 7 are listed as Moderately Invasive, one is listed as Occasionally Invasive, and three are locally invasive on the Forest.

DIRECT AND INDIRECT EFFECTS

While not all non-native species are known to disrupt native ecosystems, of particular concern are those that are successful at invading and rapidly spreading through natural habitats. Invasive plants create a host of harmful environmental effects to native ecosystems including: displacement of native plants; degradation or elimination of habitat and forage for wildlife; extirpating rare species; impacting recreation; affecting fire frequency; altering soil properties; and decreasing native biodiversity. Invasive plants spread across landscapes, unimpeded by ownership boundaries. Infested areas represent potential seed sources for continuation of the invasion on neighboring lands. Alternative A follows the current Plan which is not as aggressive in controlling NNIP as Alternatives D, E, F, and G. Alternative B only includes integrated pest management and is less aggressive at controlling NNIP than D, E, F, and G. Alternative C would result in the least amount of ground disturbance which could reduce the potential for NNIP infestations; however, the decrease in accessibility could result in less aggressive treatment of NNIP infestations. Alternatives D, E F, and G all have similar language regarding pre-treatment of areas that will be disturbed. Therefore, the potential for NNIP infestations from ground disturbing activities could be offset by aggressive NNIP treatments.

CUMULATIVE EFFECTS

Left unmanaged, NNIP infestations will continue to spread. Even without active management NNIP infestations will occur across the Forest. Insect and disease outbreaks, wildfires, storm events (including wind thrown trees, flooding, landslides, and ice damage) encourage NNIP establishment. More areas of the Forest will be affected and the areas that are affected now will grow in size. Native species diversity and the integrity of natural communities will decline. Some threatened, endangered, sensitive or locally rare species may become extirpated from the Forest. Wildlife species will lose food sources and habitat structure will be modified. Plan alternatives that emphasize wilderness and limit accessibility will reduce somewhat the likelihood of NNIP infestations, but they will also reduce the ability to actively restore and maintain habitat using fire and timber management. Private land, state and federal roads, and streams adjacent to the Forest are all potential sources for NNIP to affect the Forest. It can be expected during the life of the Plan that development will occur near the Forest that will facilitate the spread of NNIP onto the Forest.

DIDYMO

AFFECTED ENVIRONMENT

Didymo (*Didymosphenia geminata*) is a freshwater diatom (type of alga) that historically was only found in pristine lakes and streams of northern latitudes. Its range is now expanding in North America to include lower elevation clear, cool streams. It can form massive blooms on the bottoms of streams and rivers where it attaches itself to the streambed by stalks. These stalks can form a thick brown mat that smothers rocks, submerged plants and other materials. Established mats form flowing streamers that can turn white at their ends and look similar to tissue paper. Although the alga appears slimy, it feels like wet cotton wool. Didymo was found in the Jackson River (GWNF) and Smith River tailwaters in Virginia in spring of 2006, the Pound River tailwater (JNF) in 2007, and Dan River in 2008. Information sheets were posted at Forest Service angler access points along the Jackson River to inform anglers and instruct them on how to prevent the spread of this invasive species. The Smith and Dan Rivers are not on or near National Forest land.

DIRECT AND INDIRECT EFFECTS

Didymo colonization was monitored monthly over a 24 month period at a single transect in the Jackson River downstream of Gathright Dam to observe its growth over time. In 2008-2009, didymo density steadily increased from February – April, peaked in May - June, then rapidly declined in the period from July – October. Transect scores were plotted against discharge, water temperature, and depth to evaluate relationships between alga density and non-biological factors. Positive, but weak, relationships were determined with all three criteria, but the strongest was between transect score and discharge. Biological response to didymo infestation was also examined by electrofishing and benthic macroinvertebrate monitoring before and after 2006. Post-infestation catch rates for wild rainbow trout (*Onchorhynchus mykiss*) in the Gathright Dam area were not significantly different than historic values (t0.05, 5 = 0.949). Stream metrics calculated for macroinvertebrates from the Gathright Dam area in 2007-08 showed a decline in ecological health from 1992-93 samples. Results from this preliminary investigation indicated that didymo infestation has had a variable impact on aquatic fauna in one reach of the Jackson River Tailwater.

CUMULATIVE EFFECTS

Directly below Gathright Dam, the density of didymo varies by season from thick mats covering the stream bed during May-June, to a few scattered “buds” during the winter. Didymo has been observed at FS access points further downstream, but at much lower density, and has not developed into thick mats, even during the summer months. It is assumed that the water temperature is too warm and/or other factors keep the algae from surviving in the river past Covington. Didymo is currently unknown from other streams on the GWNF.

EUROPEAN GYPSY MOTH

AFFECTED ENVIRONMENT

The European gypsy moth, *Lymantria dispar* (L.), is a major defoliator of deciduous hardwood forests. This non-native pest was first introduced from Europe into Massachusetts in 1869, and because one of the favored hosts (oak) is widespread in the eastern deciduous forests, it thrived and continues to expand its range west and south each year. By the 1980’s, the gypsy moth was established throughout the Northeast (SAMAB, 1996). The generally infested, or quarantine area, extends from New England, south into Virginia, west to Ohio, and includes all of Michigan. The entire GWNF is considered generally infested by the gypsy moth and is wholly within the quarantine area. Meanwhile the gypsy moth continues to move southward.

The gypsy moth completes a single generation each year. First instar larvae (caterpillars) emerge from egg masses in April or early May. As temperatures increase, the caterpillars leave the egg masses during daylight hours and climb into the forest canopy. Upon reaching the tips of branches, larvae may spin down on silken

threads and disperse on the wind. Most larvae are dispersed within the local area, but some may be carried for distances greater than twelve miles (Taylor and Reling 1986). Larvae may repeat this dispersal process several times before settling down to feed. Male caterpillars usually pass through five larval instars (or, growth stages) and females pass through six. Larvae usually complete their development by early to mid-June and seek a sheltered location for pupation. The pupal stage lasts about 2 weeks at which time the adult emerges. The male adult moth is dark brown and bears several black bands across the front wings and are capable fliers. The female moth is nearly white, with black bands across the front wings.

Females cannot fly but they can travel short distances from their site of pupation. This fact results in a relatively slow rate of natural spread of this pest. Females release a potent sex attractant (pheromone) to allure male moths for mating. Once mated, the female deposits her brood in a single mass of eggs and dies. The egg mass may contain from 75 to 1,000 eggs. Within four to six weeks, embryos develop into larvae within the eggs, overwinter, and hatch the following spring.

The gypsy moth's primary natural mode of spread over relatively short distances is by ballooning of first instar caterpillars on wind currents. The insect also may spread over much greater distances via human transport. Long distance spread occurs by two mechanisms, the transport of caterpillars or the transport of egg masses. People may pick up larvae in infested areas and carry them on their vehicles, belongings, or clothing to uninfested forested areas. The transport of the gypsy moth via egg masses occurs when vehicles, equipment, or household belongings infested with egg masses are brought into an uninfested area.

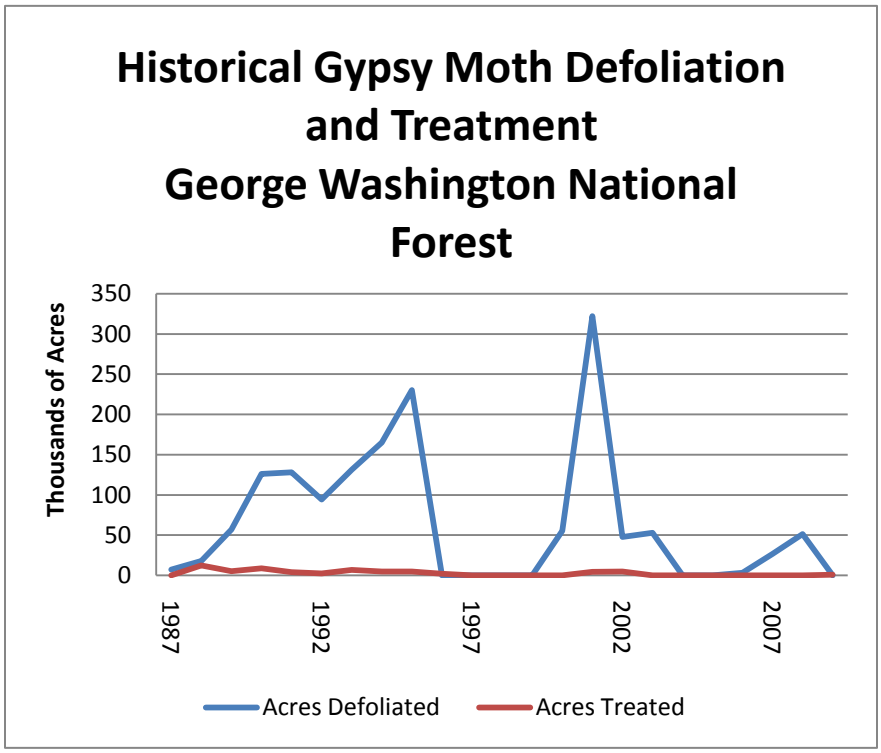
Gypsy moth larvae feed on more than 500 species of trees, shrubs, and vines. Favored hosts include oak, apple, birch, basswood, witch hazel, and willow. Hosts moderately favored by gypsy moth include maple, hickory, beech, black cherry, elm, and sassafras. Least favored hosts include ash, yellow poplar, American sycamore, hemlock, pine, spruce, black gum, and black locust. Late instar larvae can feed upon tree species that younger larvae avoid, such as hemlock, maple, pine, and spruce. 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. An individual gypsy moth caterpillar consumes the equivalent of approximately one square meter (10.75 square feet) of foliage during its development. A typical upland oak forest has 2.5 - 4.5 square meters of foliage per square meter of ground surface area. Thus, the feeding of a relatively few, healthy caterpillars can result in severe defoliation of oak in a stand.

Defoliation by the gypsy moth may induce oak decline in healthy trees, resulting in reduced growth of shoots and stem, dieback of the crown, a failure in hard mast production, and a sufficiently weakened tree such that it is attacked and killed by woodboring insects and root disease fungi. Oaks in vigorous condition often can tolerate a year or two of defoliation before oak decline becomes pronounced. However, oaks that are stressed by pre-existing oak decline, drought, or some other factor tolerate defoliation less well. Tree mortality can be widespread and severe after a single defoliation under severe or compounding stress conditions. 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 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.

Gypsy moth populations are cyclic. Generally populations build to epidemic proportions for a few years and then crash to low levels for a few more years. The entire cycle may range from three to ten years. 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 (gmNPV) and the gypsy moth fungus (*Entomophaga maimaiga*) lead to the collapse of outbreak populations of gypsy moth. Generally speaking, the

period between outbreaks may range from 2 to 5 years and the actual outbreak period may range from 1 to 3 years. On a region-wide basis, gypsy moth populations develop to outbreak levels across wide areas of the northeast, mid-Atlantic, and 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.

The first record of Gypsy moth defoliation on the GWNF occurred in 1987. Since that time the forest has experienced 3 to 4 outbreak cycles with a total of about 1.5 million acres defoliated. Many areas have been defoliated several times resulting in severe mortality (Figure X). However, no good estimate of acres within various levels of mortality has been attempted. In response to these outbreaks, the GWNF has participated in suppression efforts treating approximately 61,000 acres through aerial application of insecticides, primarily the biological insecticide *Bacillus thuringiensis var. kurstaki (Btk).*



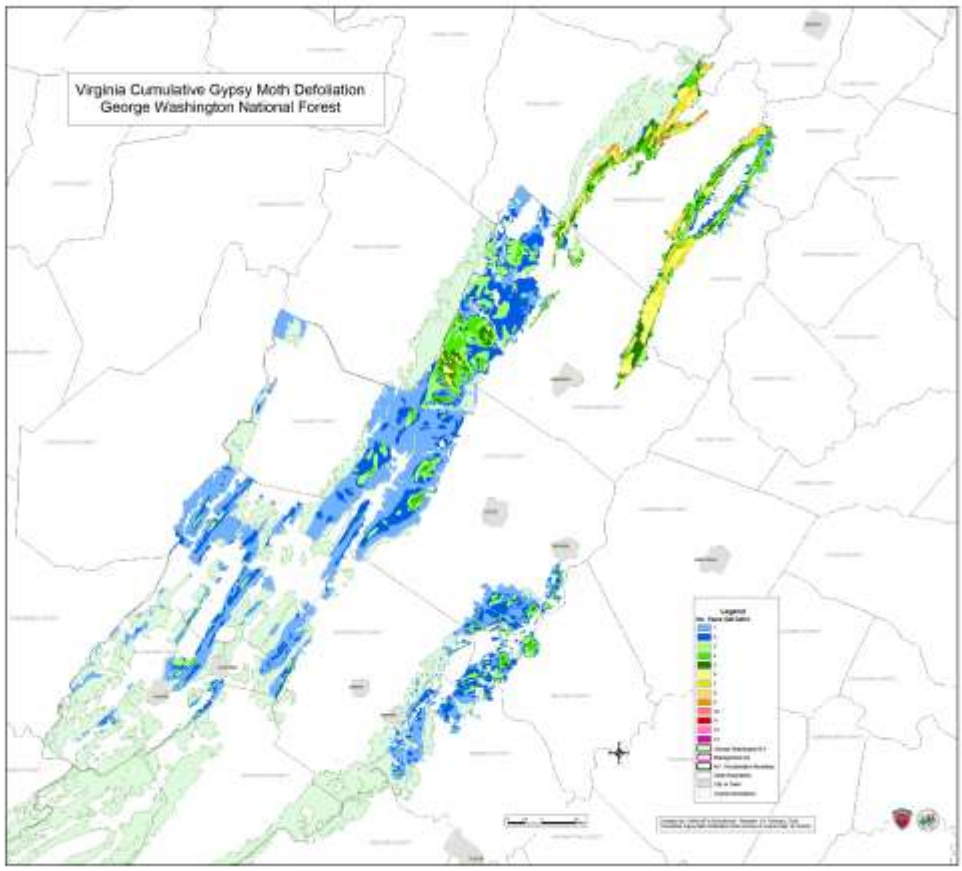


Figure B5.1 Cumulative Gypsy Moth Defoliation, George Washington National Forest

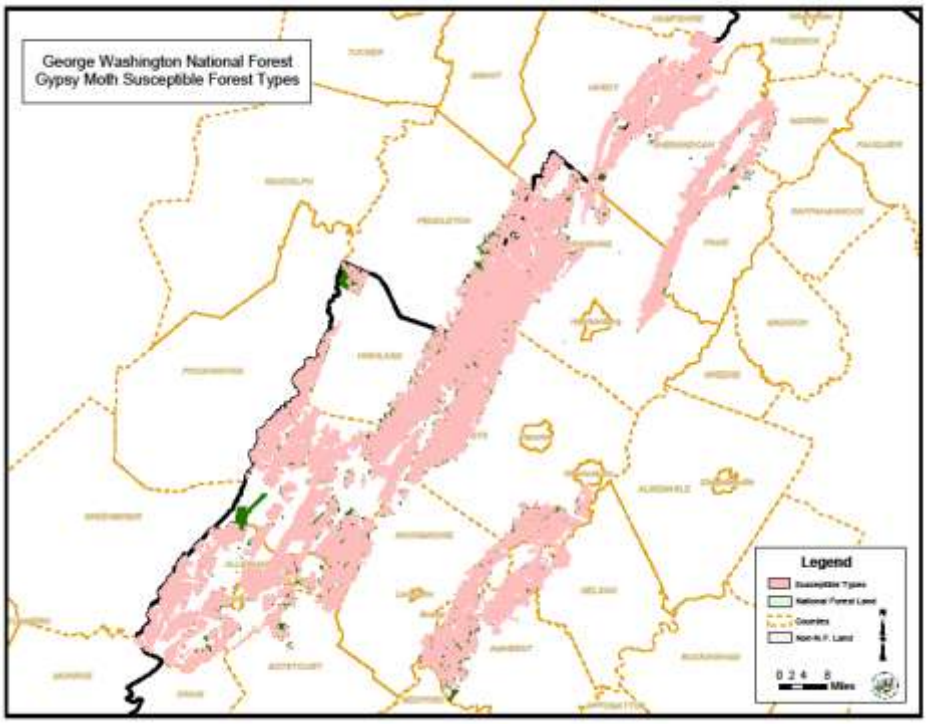


Figure B5.2 Gypsy Moth Susceptible Host Types.

Approximately 867,000 acres of the GWNF is comprised of forest types susceptible to gypsy moth infestation (types where oak either dominates or is a significant portion of the stand). This represents approximately 72% of the forest in a moderate or severely susceptible host type. Figure B5.2 displays the distribution of these stands. As one would expect, the susceptible forest types are found evenly distributed across the entire GWNF.

A gypsy moth risk rating system has been developed for use with Forest Service Vegetation database (FSVeg) maintained by the GWNF. Entomologists at the Forest Health Protection field office in Asheville, NC developed this risk rating system. The model utilizes variables such as forest type, condition class, site index (a measure of site productivity) and age to assign a risk to each stand. Risks are categorized as Unaffected, Low, Moderate, High, or Extreme. This model was applied to the GWNF FSVeg information. Table B5.2 displays the existing condition pertaining to these gypsy moth risks.

Table B5.2 Number of Acres and Percent of the GWNF within 5 Gypsy Moth Risk Categories.

Risk Category	Acres	Percent
Unaffected	302,000	28%
Low	78,000	7%
Moderate	65,000	6%
High	398,000	37%
Extreme	216,000	20%
Insufficient Data	28,000	3%

Thus, while almost one-third of the GWNF is currently considered to be at no risk (unaffected) from gypsy moth impacts, primarily by virtue of ineligible forest types (that is, they contain a predominance of tree species immune or not preferred by the insect), almost two-thirds of the Forest has a moderate to extreme risk of experiencing gypsy moth-related impacts.

DIRECT AND INDIRECT EFFECTS

While suppression of gypsy moth populations would be permissible under all Alternatives, the economic cost and concern for environmental impacts of widespread use of current treatment tactics, primarily the aerial application of insecticides, would result in only a very small amount of the Forest receiving such management actions. Generally, gypsy moth outbreaks on most Forest lands will not be managed actively and population outbreaks will be brought to an end through the action of natural control agents (primarily by disease epidemics caused by fungal and viral pathogens). However, where high value resources, such as developed recreation areas, are threatened with defoliation and damage, treatment with insecticides may be considered to manage gypsy moth populations and limit damage. The impacts associated with such treatments are well documented in the Final Environmental Impact Statement (FEIS) for Gypsy Moth Management in the United States: A Cooperative Approach. This document and associated Record of Decision (ROD) analyzes the impacts of various aerially applied pesticides on control of the gypsy moth, impacts to non-target organisms, as well as impacts to human health. The FEIS and ROD indicate that the use of suppression, eradication, and slow the spread treatments fully meet the USDA goal of reducing the adverse effects of the gypsy moth, addresses the major issues associated with gypsy moth and their treatment, and provides the greatest amount of flexibility in managing ecosystems affected by the gypsy moth. Means to avoid or minimize adverse non-target impacts due to gypsy moth treatment are discussed in Chapter 2 of that FEIS and have been adopted. The findings from this FEIS are hereby incorporated by reference. It should be noted that such treatments do nothing to alter the risk associated with a vegetative condition; they merely control the pest.

Oaks are a favored host species and their density is a primary indicator of the susceptibility of a stand to gypsy moth defoliation (Gansner and Herrick, 1985). Oak and mixed oak-pine forest types contain oaks at a high density and are therefore most susceptible to defoliation. Gypsy moth outbreaks may tend to be more frequent and the damage most severe where these stands occur in low-rainfall areas of the Forest. Hardwoods that are stressed by drought, oak decline, or some other factor tolerate defoliation less well (Witcosky, 2000). Furthermore, outbreaks occurring simultaneously with severe spring droughts often lead to relatively high levels of mortality (>15% mortality following a single year of severe drought and defoliation; 30% mortality following 2-3 years of severe drought and defoliation). Long-term detrimental changes in forest composition and structure following gypsy moth outbreaks will be most frequent under conditions corresponding to high oak decline risk; stands with a large red oak component (especially black and scarlet oak) of advanced age growing on soils with low moisture availability. Outbreaks that cause defoliation for 2-3 years in a row will lead to more severe levels of damage to affected stands and outbreaks that recur in the same stand after very short intervening time intervals will lead to greater levels of damage. Mast production may be reduced or fail in affected oak stands during and following gypsy moth outbreaks (Gottschalk, 1988).

As stated previously, factors that determine gypsy moth risk include forest type (oak density), site productivity (site index), age, and stand condition (condition class). Managers have no control over site productivity. Thus, species composition (forest type), stand condition, and age are the factors that managers can manipulate to alter the risk of gypsy moth impacts. Thinning and/or regeneration harvests can alter species composition and stand condition while only regeneration harvests can alter age of a given stand. Thus, our best tool in reducing the risk of receiving gypsy moth-related defoliation and/or mortality is vegetation manipulation through various types of timber harvesting.

By modeling oak and oak-pine community types on the George Washington National Forest, we can obtain indications of how gypsy moth risk and active forest management actions interact. In the absence of management we can expect approximately 1% of the GWNF to move from a moderate to a high risk by the end of the first decade. The acres in a high or extreme risk category would increase by 27% to 84% of the Forest.

Harvesting of these stands in a timely fashion improves the risk of the stands in experiencing gypsy moth-related impacts. Harvesting can accomplish this goal through reducing the percentage of susceptible host

types (primarily oak trees) and/or altering the stand condition (removing weakened or decadent trees) during a thinning or other partial harvest. Regeneration harvests also have this affect while reducing stand age, thereby increasing stand vigor and ultimately reducing the vulnerability of the stand to gypsy moth-related mortality in the event of a defoliation event (adapted after Gottschalk, 1993.) In theory, managed fire may have similar results with stand replacing fires acting as regeneration harvests and less severe burning perhaps acting as a thinning. The logical conclusion is that those alternatives that harvest and/or utilize prescribed fire on more acres in upland oak and mixed oak-pine stands will have a more positive impact on reducing gypsy moth risk. Table B5.3 displays the acres estimated to be regenerated in these forest types by alternative. Because fire is a less precise tool and it is difficult to predict acres regenerated or "thinned" through the use of fire, the effect of fire on gypsy moth risk is not quantified in this analysis.

Table B5.3 Estimated Acres Harvested within Gypsy Moth Susceptible Forest Types in the Next Decade and Acres of Moderate-High Gypsy Moth Risk at the End of the Next Decade

Activity in Susceptible Types	Alternative (acres)						
	A	B	C	D	E	F	G
Acres Regenerated	17,000	11,000	0	23,000	11,000	8,000	11,000
Acres Thinned	6,000	4,000	0	8,000	4,000	2,000	4,000
Total Acres Harvested	23,000	15,000	0	31,000	15,000	10,000	15,000
Total Acres Moderate – High Risk	599,000	607,000	622,000	591,000	607,000	617,000	607,000

Based in part on the Desired Condition of the Alternative, an estimate of the above management activities' effects on the number of acres and percent of susceptible forest types within each risk category is presented. The focus of each alternative was used to estimate the percent of acres regenerated that would occur in each gypsy moth risk category. The base assumption is that the acres regenerated under each alternative would be equally distributed across all four gypsy moth risk categories. This assumption was then altered only for those alternatives where the focus would clearly change this distribution. For example, the focus of Alternative D is commodity driven and strives toward a balanced age class distribution and includes active control of insects. In this case, the total acres regenerated under Alternative D where allocated to acres of high and extreme gypsy moth risk. Conversely, Alternative F focuses on a variety of recreation opportunities and, in terms of forest health, emphasizes the maintenance of recreational experiences (e.g. user safety and visual quality). In this case the total acres regenerated were equally distributed across all risk categories.

Upon examining the results of Table B5.2 above, it is apparent that there is very little difference between the alternatives in altering gypsy moth risk after the first decade. The percentage of the oak and oak-pine community types in a high or extreme risk category range from 56% to 59% of the forest under all alternatives. Ten years is simply not enough time to seriously alter age class or species composition under any alternative.

Upon examining Table B5.4 below, we begin to see how the alternatives vary in their effect on gypsy moth risk at the end of 50 years of management. Alternative D would have the greatest impact with approximately 45% of the GWNF in a high or extreme gypsy moth risk. This is consistent with Table B5.3 above as Alternative D would regenerate the most acres of these susceptible community types. Alternative D would reduce gypsy moth risk better than any other alternative.

Table B5.4 Gypsy Moth Risk

Risk	Alt A		Alt B		Alt C		Alt D		Alt E		Alt F		Alt G	
	10 yr	50 yr	10 yr	50 yr	10 yr	50 yr	10 yr	50 yr	10 yr	50 yr	10 yr	50 yr	10 yr	50 yr
Low	7%	7%	7%	6%	7%	7%	7%	7%	7%	7%	7%	6%	7%	7%
Moderate	5%	5%	5%	3%	5%	5%	5%	5%	5%	5%	5%	3%	5%	5%
High	37%	34%	38%	37%	38%	39%	37%	32%	38%	36%	38%	38%	38%	36%
Extreme	19%	15%	20%	19%	20%	21%	19%	13%	20%	17%	20%	19%	20%	17%

Alternatives A, E, and G have a more moderate effect; approximately 49% and 52%, respectively, of the GWNF would be in a high or extreme gypsy moth risk. This is also consistent with the acres managed shown in Table B5.3 as these alternatives have a relatively high number of acres managed. Alternatives F, B, and C have less effect on gypsy moth risk; these alternatives range from 57% to 60% of the GWNF in a high or extreme risk category.

CUMULATIVE IMPACTS

When considering actions on private and other agency lands within or directly adjacent to the GWNF, cumulative impacts regarding gypsy moth risk are somewhat mixed. Lands administered by the National Park Service (Shenandoah National Park and Blue Ridge Parkway) and the Virginia Department of Conservation and Recreation (Douthat State Park) are unlikely to be altered through vegetation management actions to any great degree. Thus, gypsy moth risk can be expected to increase slightly (similar to that modeled for the Forest without action) on these acres, where the proper forest type exists, for all of the reasons described previously. However, since these areas focus so heavily on recreation, they are likely to suppress gypsy moth populations on relatively more acres. Since lands administered by these agencies comprise a very small percentage of the area as a whole, such suppression is unlikely to have any effect on population dynamics of the general area. But, they may experience less gypsy moth-related impacts regardless of their vegetative condition simply due to repeated suppression activities on their lands.

Conversely, the State Wildlife Management Areas (Highland, T.M. Gathright, Little North Mountain, and Goshen) do receive a degree of vegetation manipulation and is unlikely to receive a large amount of suppression efforts. Presumably, this area would be similar to the GWNF National Forest Alternatives B, E, F, and G with respect to the ability to reduce the risk of gypsy moth.

Management actions on privately held lands vary quite a bit depending upon the objectives and beliefs of individual landowners. Certainly those forested acres held by private industry are likely to be intensively managed and gypsy moth populations may be suppressed. However, as noted in the Timber Demand Analysis, very little industrial private forest remains in this area. Non-Industrial Private Forests (NIPF) account for almost 80% of the lands in the general area. The Timber Demand Analysis also found that perhaps as much as 55% of this land would not be available for vegetation management due to landowner attitudes and/or economic return. Perhaps increased gypsy moth activity may result in increased gypsy moth suppression activities and pre-salvage efforts ahead of defoliation as has been observed on some privately held acres. However, many acres of privately held lands would remain unmanaged and likely increase the risk of gypsy moth-related impacts.

OAK DECLINE

AFFECTED ENVIRONMENT

Oak decline is a complex native disease involving interactions between environmental and biological stresses and subsequent attacks by insects and pathogens of opportunity. The disease generally progresses slowly over several years. It begins with a long-term predisposing stress such as prolonged drought or advanced age. These stressed or older trees are often subsequently damaged by short-term inciting factors such as insect defoliation (e.g. gypsy moth), spring frosts, or acute drought. In their weakened condition, the trees may be attacked by insects and diseases that normally do not invade healthy trees. At this point, classic decline symptoms appear, beginning as dieback from branch tips inward and ultimately resulting in the death of the tree. The most important underlying factor when resource damage is severe may be a tree population dominated by senescent overstory oaks lacking vigor (Oak et al. 1991).

Oak decline is a serious forest health concern on upland hardwood forests in the Southern Appalachian National Forests. Stand and site factors that determine oak decline risk in the Southern Appalachians include forest type (oak density), site productivity (site index), age, and stress factors such as spring defoliation and drought or combinations of these stresses (Oak and Croll 1995). The highest risk conditions are stands with a large oak component (especially red oak of advanced age), growing on sites of average or lower productivity, with a recent defoliation history and prolonged growing season drought. Risk may be reduced by reducing stand age through regeneration harvests, altering species composition through thinning (reduce or eliminate oak component), and/or preventing stress factors (treating spring defoliating insects with insecticides is the only feasible option but is often not economically justifiable).

Oak decline is so pervasive in the Southern Appalachians that no reasonable alternative can adequately address risk at the landscape scale in the short-term. Management actions can lower risk locally and sustained effort over the long-term can gradually lower risk on more area. Based on SAA analyses, the GWNF (along with the neighboring Jefferson National Forest) has the highest incidence of oak decline vulnerability and damage of all the Southern Appalachian Forests (SAMAB 1996). Indeed, Oak et al. (1991) found that approximately 30% of the oak forest types in the Northern Mountain Survey Unit of Forest Inventory and Analysis (FIA) data, which includes the GWNF, had oak decline symptoms. This area also had the highest losses due to oak decline ranging from 14 to 25 cubic feet per year. Vulnerability to oak decline refers to the probability that oak decline is expected to occur in a given stand. Approximately 288,000 acres of the GWNF is highly vulnerable to oak decline (chestnut oak stands), representing about 24%. Another 452,000 acres, or 33% of the GWNF, is moderately vulnerable to oak decline (oak-hickory stands). The remaining 475 of the GWNF is in forest types of low vulnerability. (Adapted after Oak et al. 1991)

DIRECT AND INDIRECT EFFECTS

There are a number of parallels between oak decline and gypsy moth impacts and our ability to manage them. For this reason, many of the conclusions and affects presented for gypsy moth above also apply to this discussion regarding oak decline. Like the gypsy moth, oak decline risk factors include forest type (oak density), site productivity (site index), age, and stress factors such as spring defoliation and drought or combinations of these stresses. Of these, managers have no control over site productivity and/or drought and little control over defoliating insects. Attempts to suppress insect pests over the entire, or even a significant part, of the landscape cannot be justified economically or environmentally. Thus, species composition (forest type) and age are the factors that managers can manipulate to alter the risk of oak decline. Thinning and regeneration harvests can alter species composition and only regeneration harvests can alter the age of a given stand. Thus, similar to gypsy moth, our best tool in combating oak decline is vegetation manipulation through various types of timber harvesting.

The ratio of site index (SI) to age can be used to estimate the vulnerability of an oak stand to oak decline. A SI/age ratio of less than 1.0 indicates a highly vulnerable stand and a SI/age ratio between 1.0 and 1.3 indicates a moderately vulnerable stand (Oak, et al. 1991). Oak found that 60% of oak decline affected stands in western Virginia had SI/age ratios less than 1.0 and an additional 24% of the affected acres had SI/age

ratios less than 1.4. However, the risk of mortality once a stand becomes oak decline affected appears to be higher in oak stands with an SI/age ratio less than 1.4. For the purpose of this analysis, we will consider stands with a SI/age ratio less than 1.4 to be vulnerable to oak decline and at a high risk for mortality if oak decline affected.

Regenerating these stands to a younger age class in a timely fashion reduces the risk of oak decline. This means that those alternatives that regenerate more acres in Northeastern Interior Dry-Mesic Oak Forest and Central and Southern Appalachian Montane Oak Forest Ecological Systems, especially in, black oak and scarlet oak stands, will have a more positive impact on oak decline risk and the preservation of related forest values such as wildlife habitat, recreation, and wood products. Table B5.5 displays the acres estimated to be regenerated in the vulnerable ecological systems and the acres at risk from oak decline effect at the end of the next decade by alternative.

Table B5.5 Acres in Northeastern Interior Dry-Mesic Oak Forest and Central and Southern Appalachian Montane Oak Forest Ecological Systems regenerated and at risk from oak decline effects at the end of the next decade by alternative

Activity in Susceptible Types	Alternative (acres)						
	A	B	C	D	E	F	G
Acres Regenerated	89,000	27,000	0	116,000	58,000	39,000	58,000
Total Acres Vulnerable/High Risk	668,000	730,000	757,000	641,000	699,000	718,000	699,000

Alternatives B, E, F, and G have a more moderate effect on reducing oak decline vulnerability and risk; approximately 67% to 69% of the forest would be in a vulnerable and high risk of mortality to oak decline effects.

Alternatives D and A have the greatest effect on reducing oak decline vulnerability and risk; these alternatives range from 61% to 64%, respectively, of the forest in a vulnerable and high risk category. Alternative C would be expected to have the least impact as compared to all other alternatives on reduction of oak decline effects

CUMULATIVE IMPACTS

In the description of the oak decline disease complex above, the role of both the long-term predisposing stress agent(s) and a short-term inciting agent was discussed. The entire GWNF experienced droughty conditions from 1999 through 2002 and most recently in the summer of 2010. This, coupled with the advancing age of our oak forests, results in an existing condition that is ripe for serious oak decline incidence. The potential consequences of this condition have been illustrated in recent catastrophic decline episodes in the Ozark-Ouachita Highlands of Arkansas and Missouri during the past five years (Starkey and others 2004). The gypsy moth, an insect defoliator, has repeatedly defoliated several portions of the GWNF. More discussion on the gypsy moth and its impacts are disclosed elsewhere in this document, however it deserves discussion here as well. The gypsy moth is likely to be a short-term inciting agent that has and will continue to trigger oak decline events as populations of this insect continually cycle up and down. The combined effect of older aged oaks, past drought, and gypsy moth defoliation is likely to result in serious and widespread oak decline-related mortality of oaks.

When considering actions on private and other agency lands within or directly adjacent to the GWNF, cumulative impacts regarding oak decline risk are somewhat mixed. Lands administered by the National Park Service (Shenandoah National Park and Blue Ridge Parkway and the Virginia Department of Conservation and Recreation (Douthat State Park) are unlikely to be regenerated through management actions. Thus, oak decline risk can be expected to increase dramatically where the proper forest types exist as stands age without regeneration, for all of the reasons described previously. Conversely, the State Wildlife Management Areas

(Highland, T.M. Gathright, Little North Mountain, and Goshen) do receive a degree of vegetation manipulation. Presumably, these areas would be similar to the GWNF Alternatives B, E, F, and G with respect to the ability to reduce the risk of oak decline.

Management actions on privately held lands vary quite a bit depending upon the objectives and beliefs of individual landowners. Certainly those forested acres held by private industry are likely to be intensively managed and gypsy moth populations may be suppressed. However, as noted in the Timber Demand Analysis, very little industrial private forest remains in this area. Non-Industrial Private Forests (NIPF) account for almost 80% of the lands in the general area. The Timber Demand Analysis also found that perhaps as much as 55% of this land would not be available for vegetation management due to landowner attitudes and/or economic return. Perhaps increased gypsy moth activity may result in increased gypsy moth suppression activities and pre-salvage efforts ahead of defoliation as has been observed on some privately held acres. Both of these activities would result in a reduction of the risk of oak decline effects. However, many acres of privately held lands would remain unmanaged and likely increase the risk of gypsy moth-related impacts. Furthermore, the encroachment of residences in the urban/wildland interface results in a desire to keep older oak trees intact for aesthetic reasons. Unfortunately, construction of house foundations in proximity to such trees often creates another stress through disturbance of the root zone. Often, such trees ultimately die unless care is taken in protecting them during construction. Therefore, the increase in residences encroaching on the GWNF is likely to result in more oak decline incidence in the general area.

HEMLOCK WOOLLY ADELGID

AFFECTED ENVIRONMENT

The hemlock woolly adelgid (HWA), *Adelges tsugae*, an insect species native to Asia, was first identified in the eastern United States in 1951 in Richmond, VA, but it has recently expanded into the Southern Appalachians and threatens to spread throughout the ranges of eastern and Carolina hemlock. This non-native pest is currently established along the mountainous regions of western Virginia throughout the entire GWNF. The adelgid may be spread by wind, birds, or mammals (McClure 1990). Long-range movement of the adelgid by migrating songbirds in the spring could explain why northward spread has been faster than southward spread. Although individual stands of hemlock may not yet be infested by this insect pest, for all intents and purposes, the entire GWNF is has been impacted by the HWA. A vast majority of hemlocks in the GWNF are in advanced stages of damage and widespread mortality is evident, although the number of acres of mortality and/or damage has not been estimated at this time.

There are two species of hemlock in the SAA area, eastern hemlock (*Tsuga canadensis*) and Carolina hemlock (*Tsuga caroliniana*). Both species are included in the hemlock and northern hardwood forest community type. The former is an important component of riparian ecosystems, providing cooling shade for streams, contributing nutrients for streams through litterfall, and providing winter shelter for wildlife. It may also be important as a feeding and nesting niche for neotropical migratory birds (Rhea and Watson 1994). Carolina hemlock, on the other hand, is less understood ecologically and much less common on the GWNF. It generally occupies more xeric sites on ridges and rock outcrops, but it also probably provides cover and nesting sites for birds and small mammals. Both eastern hemlock and Carolina hemlock are threatened by the adelgid.

Approximately 8,000 acres of the GWNF is classified as containing a hemlock component, comprising less than 1% of the Forest. The highest concentration of the host type is located along the Blue Ridge and in the central portion of the forest on the North River Ranger District. The GWNF has been treating HWA infestation associated with a few recreation sites that still contained relatively healthy hemlocks in the late 1990's. These efforts focused on Brandywine campground in West Virginia and Hone Quarry and Todd Lake in Virginia. Originally an insecticidal soap was applied to the foliage annually. This treatment was abandoned in favor of the more effective soil injection of imidacloprid. These treatments have been effective in maintaining the health of these isolated hemlock stands. Meanwhile, a vast majority of hemlocks on the GWNF have experienced sever mortality.

DIRECT AND INDIRECT EFFECTS

Once infested by the adelgid, hemlocks are weakened, gradually lose their foliage, and are unable to refoliate or produce cones. Mortality occurs after complete defoliation, generally within 5 years of initial infestation (McClure 1987). There is no known genetic resistance to adelgids in either of the native Appalachian hemlock species, but resistance is known to occur in hemlocks native to Asia and in the two species native to the Western United States. Individual hemlock trees can be protected by spraying or soil treatments, but due to the advanced stages of decline and mortality found in a vast majority of hemlock stands on the GWNF, these treatments will not protect the trees. Except for those areas that have been protected in the past, it is simply too late to save most if not all of the hemlock on the GWNF. It appears that all untreated hemlocks, with the possible exception of small geographically isolated populations, could eventually be killed by the adelgid. Loss of hemlock will negatively impact riparian ecosystems and may result in a substantial reduction in habitat quality for birds and other wildlife (Rhea 1996).

On the GWNF, both horticultural oil and imidacloprid (a soil injected insecticide) has been used to reduce adelgid populations and impacts on about 30 acres in three developed recreation areas. This treatment is likely to continue under all alternatives. Any healthy hemlock populations that may be found in the future may also be treated under all alternatives. Therefore, no substantial difference between the alternatives regarding treatment of or impacts from, HWA are identified in this analysis. The impact of any treatment under any alternative is inconsequential to the landscape scale of this analysis. The extremely small areas treated have negligible influence on the impacts of the adelgid or hemlock forests on the GWNF.

Indirect effects may result in a loss of thermal insulation (summer cooling and winter insulation) along streams and riparian areas. In some areas, white pine may be able to fill this ecological niche, but it will take time for white pine to fully occupy the sites formerly held by hemlock. Loss of cover is likely to also adversely affect a myriad of bird and wildlife species on the GWNF.

CUMULATIVE EFFECTS

The situation described above can also be applied to surrounding lands held by private interests and other agencies. The adelgid infests hemlock regardless of ownership and active management or the lack thereof has no influence on the pest or its impacts on the host. The very sad fact is that hemlocks throughout the Appalachian mountains of Virginia will continue to deteriorate and die and there is very little anyone can do about it at this time.

SOUTHERN PINE BEETLE

AFFECTED ENVIRONMENT

Southern pine beetle (SPB) (*Dendroctonus frontalis*) infestations have occurred cyclically throughout recorded history in the South. This is a native pest. SPB outbreaks move from low levels of infestation to high levels over several years. The cycles may be localized or regional and depend upon weather and other stress factors as well as the interrelationship between the populations of SPB and its predators.

The female SPB kills pines and occasionally other conifers by boring under the bark and destroying the cambium layer of the tree. They construct winding galleries while feeding and laying eggs. During outbreaks, trees are usually mass-attacked by thousands of beetles. The crowns of trees attacked by SPB during warm, dry weather may fade in color within weeks. Once a tree is successfully attacked, the tree usually turns light greenish-yellow, then yellow, and finally reddish-brown. This color change pattern can vary depending on the tree and environmental conditions.

SPB outbreaks in the SAA area are generally less dramatic than those on the Piedmont and Coastal Plain of the south because yellow pine forests types are less common in the Appalachian Mountains. However, in rare instances, as occurred in the mid 1990's on the GWNF, SPB populations can build to such high levels that they

attack and kill white pine. On the rare occasions when they do occur in the Appalachians, SPB outbreaks have significant ecological implications, not only because of the loss of relatively scarce habitat, but because at least one yellow pine species, table mountain pine, is largely fire dependent. Table mountain pine stands killed by SPB rarely regenerate, and are permanently lost.

Factors that determine SPB hazard include the proportion of the stand in susceptibility host trees (primarily the southern yellow pine species, although white pine can rarely be a susceptible species as well) and the radial growth of those trees over the past five years. Trees with a relatively high radial growth are less susceptible to SPB-related mortality. While we do not have individual tree radial growth data to estimate susceptibility, we can use the Culmination of Mean Annual Increment (CMAI) as a proxy for radial growth. Trees within stands that have passed beyond CMAI are growing relatively slower and radial growth should be slower. Previous modeling using the Forest Vegetation Simulator indicates that CMAI for the Yellow Pine working group ranges from 35 to 50 years old depending upon site productivity. For the purpose of this analysis we will consider stands equal to or older than 60 years old to be of a higher susceptibility to SPB. While thinning of these stands can increase radial growth and reduce SPB susceptibility, little or no thinning of yellow pine is implemented on the GWNF since most of these types occur on less productive lands.

Currently there are approximately 124,000 acres, or 12% of the GWNF, in the Southern Appalachian Montane Pine Forest and Woodland and Central Appalachian Pine-Oak Rocky Woodland ecological systems, without the white pine forest types. These ecological systems correspond to the host types susceptible to SPB. Of this acreage, approximately 118,000 acres, or 95% of the ecological system (without white pine types), are greater than 60 years old. Approximately 61,000 of these acres, or 49% of the ecological system (without white pine types), are greater than 100 years old. We conclude that for all intents and purposes, all of the Southern Appalachian Montane Pine Forest and Woodland and Central Appalachian Pine-Oak Rocky Woodland ecological systems on the GWNF are susceptible to SPB and roughly half of these systems are highly susceptible to SPB.

DIRECT AND INDIRECT EFFECTS

Managers can control both the proportion of susceptible species and the radial growth of trees through vegetation manipulation activities. Thinning and/or regeneration harvests can alter both species composition and radial growth of the trees within a stand. However, thinning in these stands that often occur on relatively poor sites is rarely economically, or even logistically, viable. Many of these stands occur on lands unsuitable for timber production. The use of prescribed fire can reduce stand density, much as a thinning would, and ultimately increase radial growth on the residual stems. Fire can also regenerate some forest types, especially table mountain and to a lesser extent pitch pine. Thus, while timber harvest can help to lower SPB risk, the use of prescribed fire can treat the most acres and represents our best tool in lowering SPB risk.

Table B5.6 Acres in Southern Appalachian Montane Pine Forest and Woodland and Central Appalachian Pine-Oak Rocky Woodland Ecological Systems burned, regenerated, and thinned and at risk from Southern Pine Beetle effects at the end of the next decade by alternative

Activity in Susceptible Types	Alternative (acres)						
	A	B	C	D	E	F	G
Acres Managed by Fire	3,000	16,000	10,000	12,000	70,000	16,000	70,000
Acres Regenerated by Harvest	2,000	700	0	3,000	1,500	1,000	1,500
Acres Thinned by Harvest	0	0	0	0	200	102,000	200
Total Acres Vulnerable/High Risk	114,000	102,000	109,000	104,000	48,000	102,000	48,000

Between 40% and 92% of the ecological systems of concern would be in a SPB susceptible condition under the various alternatives analyzed given the objectives for prescribed fire and timber harvesting under each alternative. Alternatives E and G would reduce SPB risk the most as it is projected to utilize the most prescribed fire and any timber harvesting would be focused on ecological restoration and maintenance objectives. Alternatives B and F are ranked next highest in the number of susceptible acres due to a somewhat lower prescribed fire objective. Alternative D is not much different than B and F; in this case the greater timber harvest objective compensates somewhat for a lower prescribed fire objective. Conversely, because Alternative C allows for an expanded use of wildfire, it is projected to result in slightly less SPB susceptible acres as compared to Alternative A, which improves SPB susceptibility the least of all alternatives.

CUMULATIVE IMPACTS

When considering actions on private and other agency lands within or directly adjacent to the GWNF, cumulative impacts regarding SPB hazard is somewhat mixed. Lands administered by the National Park Service (Shenandoah National Park and Blue Ridge Parkway) and the Virginia Department of Conservation and Recreation (Douthat State Park) are unlikely to receive significant vegetation management actions. Thus, SPB susceptibility can be expected to increase dramatically where the proper forest types for all of the reasons described previously. Conversely, the State Wildlife Management Areas (Highland, T.M. Gathright, Little North Mountain, and Goshen) do receive a degree of vegetation manipulation. Presumably, these areas would be similar to the GWNF Alternatives B, F, and G with respect to the ability to reduce the susceptibility to SPB.

Conversely, management actions on privately held lands vary quite a bit depending upon the objectives and beliefs of individual landowners. However, one commonality on privately held lands would be the very low use of prescribed fire and aggressive attack of wildfire. The role of fire in lowering susceptibility to SPB on these lands is expected to be negligible. Certainly those forested acres held by private industry are likely to be intensively managed and SPB outbreaks aggressively fought using timber harvest. However, many acres of privately held lands would remain unmanaged and likely increase in hazard of SPB outbreaks.

EMERALD ASH BORER

AFFECTED ENVIRONMENT

The Emerald Ash Borer (EAB) (*Agrilus planipennis*) is an insect pest of recent concern for the GWNF. 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 in Maryland, West Virginia, and Virginia. As of this writing, the nearest known infestations of EAB are located in Morgan County, WV and Fairfax County, VA. EAB trapping has occurred in and around the GWNF since 2009; however no EAB have been detected as yet. Like the SPB, the EAB also 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. Unlike SPB, 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 our forested stands with only about 100 acres of the GWNF being classified in a Forest Type containing ash species. However, ash species are often found as a minor component throughout the entire GWNF in the more mesic sites. 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 our Forest, it certainly could lead to severe decline and impact of ash species throughout the GWNF.

DIRECT AND INDIRECT EFFECTS

As there are few management actions or treatments identified that can prevent EAB susceptibility or risk, it is difficult to display differences in impacts amongst the alternatives. At this time the most effective activities in

combating EAB on the GWNF 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. We expect all these activities would continue under all alternatives.

In the event that an infestation is discovered on the Forest, removing the infested trees is about the only tactic that would prevent further spread. It is expected that all alternatives would utilize this approach. Perhaps the only difference between alternatives that can be expected is that this activity could be a commercial activity under all alternatives except Alternative C. For that reason, this activity may cost less to implement under all alternatives as compared to Alternative C.

CUMULATIVE IMPACTS

Unfortunately, we cannot be optimistic regarding this insect pest. The activities described above on the GWNF are likely to occur on all lands in the area regardless of ownership. However, despite these efforts in the past, new infestations of this pest continue to be found. It is very likely that this pest will continue to expand its range and mortality of ash trees in and around the GWNF is likely to increase despite any individual or agency action.

RAMORUM BLIGHT

AFFECTED ENVIRONMENT

Ramorum blight, also known as Sudden Oath Death Syndrome (SODS), is caused by the fungal pathogen (*Phytopthora ramorum*). This disease was first reported in 1995 in central California where it has caused widespread mortality in tanoak and oak species. The disease also manifests as a twig and foliar disease on many other species including members of the Rhododendron genus, including camellia species which prove to be a potential route of spread as infected nursery stock is moved around the country for ornamental landscaping purposes. *P. ramorum* has been confirmed in various states in the southeast, most recently in Greenville County, SC where a residential landscape site is confirmed to have a *P. ramorum*-positive *Rhododendro*n Sp. *'Catawbiense Boursault'*. No evidence of *P. ramorum* has been recovered from early detection surveys in Virginia. However, in the event that this organism is introduced to our forests, most likely through infected nursery stock utilized in surrounding areas, the GWNF would be at a moderate to moderately high risk for impacts from ramorum blight. Figure B5.6 displays a map of risk for ramorum blight (Kelley, et al., 2005).

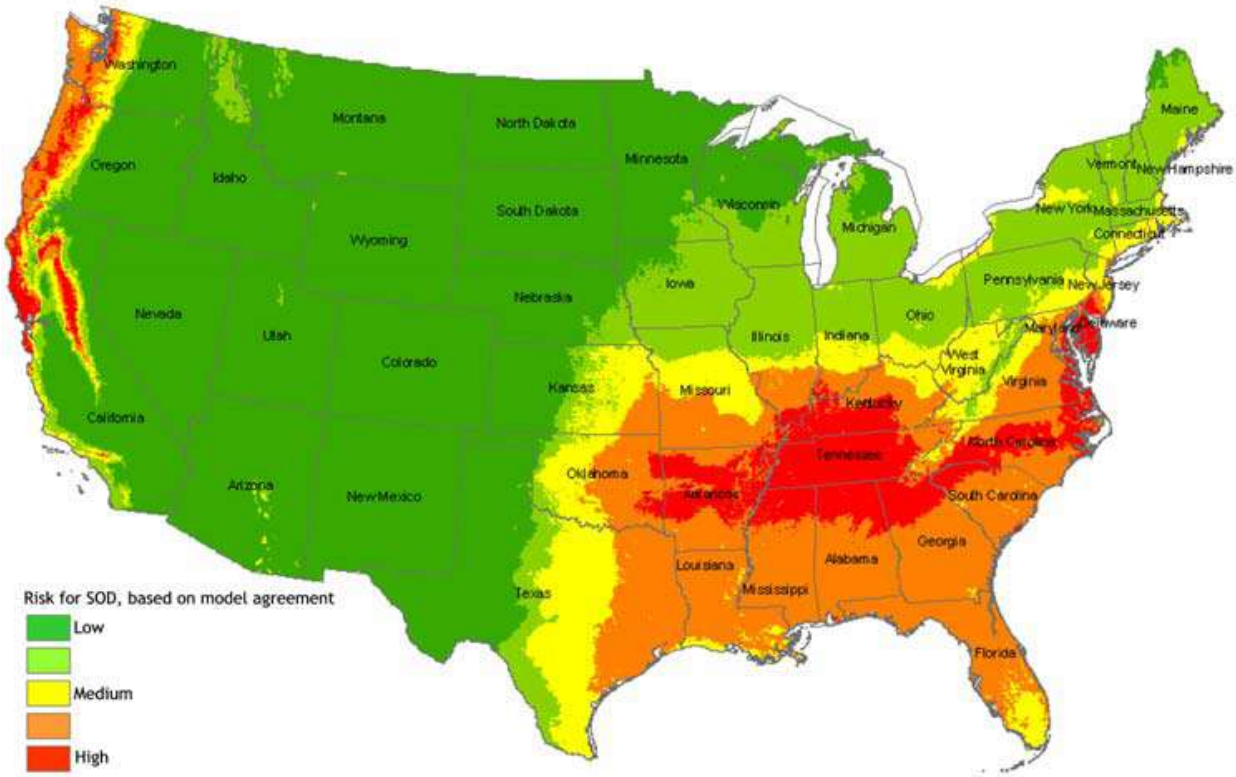


Figure B5.6—Risk for Sudden Oak Death in the conterminous United States: results from five spatially referenced models.

DIRECT AND INDIRECT EFFECTS

Given the risk and the widespread occurrence of susceptible host types (oaks, rhododendrons, and mountain laurel) on the GWNF, there is a concern about the potential impact of this disease in our ecosystems. Unfortunately, very little is known regarding the potential impacts of ramorum blight here in the east or possible treatments to manage this disease at this time. No difference regarding the risk or treatment of ramorum blight is expected between the alternatives.

CUMULATIVE IMPACTS

Similar to the discussion above, there is a concern about the potential impact of this disease in our ecosystems. Unfortunately, very little is known regarding the potential impacts of ramorum blight here in the east or possible treatments to manage this disease at this time. We cannot identify any cumulative actions or activities that would combine with the GWNF activities to alter the impacts of ramorum blight.

B6 – FIRE - WILDFIRE AND PRESCRIBED FIRE

The presence of fire begins long before humans arrived in North America. Evidence of lightning fires exists as fusain in coal layers and as lightning scars on petrified trees (Pyne, 1982). Even today, lightning and thunderstorms are abundant, and Pyne surmised, "A phenomenon of such magnitude and longevity has unquestionably kindled profound evolutionary consequences". This great and persistent selecting force has influenced ecosystem traits and characteristics since fuels and lightning first interacted. The result is a forest with diversity and flexibility that is well adapted to fire occurrence. Fire has no doubt been a major selection force in our forest ecosystems, both lightning and anthropogenic. Many communities and species require fire to sustain populations. Oak and southern yellow pine communities have been major components of these forests for thousands of years. These communities promote and require fire. Recurring fire has been a part of the ecosystem for thousands of years. Burning is the oldest sustained land management force on these forests. No other practice can be said to have such a track record with known results.

A clearer picture of change over time is gained when we focus on the period since the last ice age. Dramatic changes in plant and animal communities have occurred during this post-glacial period. Importantly, humans made their way onto the North American scene during this period. The ecosystems developed within the influences of both climatic and human forces. The question often debated is whether human ignition, for those thousands of years, should be considered when determining the “natural” state of ecosystems. Several points seem clear. The forests have been continually changing. The diversity and flexibility of these natural systems are necessary to react to change. Fire is an important mechanism to retain that diversity and flexibility.

Early human occupation of Virginia dates back to approximately 11,500 BP during the Paleoindian period (Barber, 1996). European contact was relatively early in the region of the George Washington and Jefferson National Forests, Barber (1996) notes European contact did not occur in the Ridge and Valley area until the 1670's, and the written historical record of fire is rich with accounts from travelers and explorers. The obvious conclusion, common to each account, was the extensive use of fire by Native Americans. The effect, likewise, was extensive. Early observations describe vast areas of grassy savannas, commonplace smoke and fire, clearings and fields and apparent utilization of fire-managed vegetation (Maxwell, 1910; Day, 1953; Pyne, 1982; Hammett, 1992; Brown, 2000). Maxwell contains a great number of accounts, but his perspective certainly reflects the bias and prejudices of the opponents to light burning. From all accounts, regardless of their perspective, burning by the Native Americans was a commonplace practice, serving many needs.

Methods of constructing fire histories in the east for pre-European settlement times have relied largely on sediment records (Craig, 1969; Watts, 1979; Patterson and Backman, 1988; Patterson and Sassaman, 1988; Wilkins et al., 1991; Kneller and Peteet, 1993; Patterson and Stevens, 1995; Delcourt and Delcourt, 1996). These studies typically extract a core of sediment from a pond or bog, and that core is then sampled for pollen, plant macrofossils, and/ or charcoal.

Though a scarcity of suitable sites has limited the number of such investigations, ponds and bogs have provided a number of valuable sites in the Central Appalachians. Sites within or near the Forests are: Potts Pond (Watts, 1979) in Alleghany County; Hack (Spring) Pond and Quarles Pond (Craig, 1969), in Augusta County; Brown's Pond (Kneller and Peteet, 1993) in Bath County; and another study that includes Brown's Pond and also Green Pond, in Augusta County, near Sherando Lake (Patterson and Stevens, 1995).

Common to each study is the dynamic nature of the composition of plant communities. Climate is the determinant mechanism that propels this continuum of change along a geologic time scale (Patterson and Backman, 1988). Fire acts within this continuum on a shorter scale, to provide an important catalyst that selects one plant over another. Watts (1979) agrees that this "migration of single species is an opportunistic response to changes in climate and environmental circumstances independent of other species". From 7,880 BP to the present, oak has been the dominant genus, comprising more than 50% of the pollen record. Pine is also present, increasing within this time period from 3% to 22%, with both white pine and yellow pines being represented. Chestnut stays below 1% until the upper, later half of the profile. The continued dominance of oak corresponds with relatively greater amounts of charcoal deposits. Blackgum was also found on Potts Mountain (Watts, 1979) during this period. Watts had also noted an earlier rise in American chestnut at Potts Mountain.

Patterson and Stevens (1995) correlated charcoal surface area to pollen abundance, signifying the relative importance of fire for sampled time periods. Brown's Pond (Bath County) and Green Pond (Augusta County) were examined. Similar to other studies, they agree that the vegetation around Brown's Pond has changed little over the past 1,000 to as much as 4,000 years, with oak, hickory and chestnut representing important taxa. Also, ragweed was consistently present during this period, an indicator of agricultural activity.

Green Pond, on the other hand, showed a marked increase in total pine pollen, from <20% before the chestnut decline to over 40% more recently. Diploxylon pines (hard pines; i.e. pitch, table mountain, shortleaf, and Virginia) are more important than at Brown's Pond. Also of significance is the recent reduction in oak pollen since the chestnut decline, from > 40% to less than 30%, suggesting local vegetative changes.

They then looked at the amount of charcoal surface area found, relative to the pollen samples. At Green Pond, evidence suggests fire presence both before and after European settlement. They determined that fire had a significant impact on vegetation around the time of European settlement. Those high charcoal values are followed by a sharp increase in pine pollen. This charcoal peak was between the increase in agricultural pollen and before the chestnut decline. The data suggests that fire in early post-European settlement resulted in a dramatic change in vegetation.

At Brown's Pond, high charcoal to pollen ratios appear at 650 years BP, ~2,000 BP, and 4,210 years BP. The average ratio prior to European settlement is slightly higher than post-settlement, with two fires clearly evident since Euro-settlement. The higher pre-euro-settlement values indicate the long historical role fire has played in the hardwoods. The authors suggest that long interval fire regimes have been important in maintaining the vegetative composition typical of the central Appalachians.

Patterson and Sassaman (1988) compared amounts of sedimentary charcoal to archaeological sites and found that fires were common near larger Native American populations and where their land-use practices were greatest. Charcoal records prior to European settlement and post-settlement show little difference, except during the slash fires associated with the logging boom at the turn of the century.

These records clearly suggest that fires have been important in that area for the past 4,000 years, during a period of low lightning incidence. Human use of fire has been important in determining plant community composition (see also Sutherland, and others, 1993).

Delcourt and Delcourt conclude by stating, "If management goals of the U.S. Forest Service include maintaining populations of fire-adapted pines and certain oak species that are currently declining because of active fire suppression, then future management tools clearly must include prescribed burning. The lesson from the Horse Cove example of prehistoric human use of fire is that fires of limited extent, focused on particular portions of the landscape, and excluded from others, can promote a heterogeneous mosaic of different vegetation types, some of which include clearly fire-adapted species, and others of which include fire-intolerant species. In order to maintain both old growth mesic hardwoods and fire-adapted pines within the same forest district, an optimal management plan would be based upon an understanding of the effects of different frequencies and intensities of fire applied to varying portions of the topographic-edaphic gradient and different areal extents of impact. Work of vegetation ecologists such as Runkle (1982, 1985) and Barden (1980, 1981) indicates that equilibrium, old growth mixed mesophytic forests will regenerate only under a disturbance regime that includes infrequent windthrow to open canopy gaps but which explicitly excludes fire (see also Clark and Royall, 1996). Promotion of Appalachian oak forests, including relatively widely spaced oak groves or "oak orchards" with sparse understory of grass and bracken fern (Stephenson et al. 1993), on the other hand requires use of frequent ground fires such as may have been used by prehistoric Native Americans to maintain their hunting and gathering grounds. Furthermore, periodic crown fires along exposed ridge crests may be necessary for regeneration of fire-adapted endemic pine species".

The George Washington National Forest was established in 1918 and the national direction regarding fire was quite clear in the early days of the Forest Service (Pyne, 1982)..."Forest fires have no place in any forest but as a result of ignorance, carelessness, and indifference (Anonymous, 1936)". The practitioners of "controlled burning" battled against an enormous campaign set at the national level to stop all fire. With that new direction of suppressing all fires, that major force of selection that had been present since the ice age was suddenly

altered. The consequences of that well-intentioned but misguided policy would not be obvious for several decades. The selection process that influenced plant and animal communities now changed with the absence of fire.

Perhaps, though, in defense of the dedicated firefighters during these times, this is the way it had to happen. The use of fire-fighting equipment, intelligence, weather forecasts, budgets and fire behavior prediction have only recently enabled prescribed burning on a substantial level. Recent scientific literature regarding plant and animal reactions and effects are now better known. We have better data on pre-Euro-American settlement conditions. And now we are beginning to understand some of the more dramatic long-term impacts of fire exclusion, as plant and animal populations and conditions of forest ecosystems are altered.

Several other studies have approached the issue of fire occurrence, what it has been in the past and the implications of fire exclusion. Dendropyrochronology studies provide valuable information such as the season of fire occurrence since trees lay down early season and late season wood in each tree ring per year; the number of fire scars on an individual tree provides data on fire frequency; and, by cross dating fire scars on different trees that occurred in the same year one is able to approximate the spatial extent of a fire.

Sutherland et al., 1993, sought to "reconstruct the historical relationship between fire and community structure using both the age and species composition approach in combination with tree-ring fire history analysis". Their study was one of the first in the Central Appalachians to use fire scars on pines to examine fire history. The study site on Brush Mountain in southwest Virginia west of Blacksburg, noted the loss of table mountain pine (*Pinus pungens*) recruitment since fire suppression in the late 1930's. Major recruitment of *P. pungens* occurred twice during the 1800's, probably due to exceptionally hot fires. The fire scar chronology indicated that fire occurred frequently (every 9-11 years) throughout the 19th century and early 20th century. Most of those fires occurred during the dormant season, most likely in early spring. The hot recruitment fires may have been during the growing season. They stated, "Fire suppression is most likely the cause of a dramatic change in the composition of the Brush Mountain communities during the last 60 years (Williams and Johnson, 1990). In the past, fire clearly promoted integrity of the *Pinus pungens* community on Brush Mountain".

Subsequent fire history studies using dendrochronology at multiple sites and a larger sample size of scarred trees on both the GWNF and Jefferson National Forest found that the fire interval from the early 1700's to the 1930's ranged from 2 to 9 years (Aldrich, et.al. 2010; DeWeese, 2007; Lafon and Grissino-Mayer, 2005). Additional unpublished work by Aldrich has pushed this timeframe back to the mid-1600's which pre-dates European settlement in western Virginia. Work by Lafon in the southern Blue Ridge has found similar intervals for the same timeframe.

To examine fire history further back in time recent studies have examined and dated charcoal found in soil layers. A study on southwestern North Carolina found that fires burned regularly across the studied landscape for at least the past 4,000 years. These fires were not confined to the dry oak-pine dominated ridges but extended downslope into areas that are today dominated by mesic hardwood forests (Fesenmyer and Christensen, 2010).

WILDLAND FIRE SUPPRESSION

Fires generally fall into one of two categories: wildfires or prescribed burns. A wildfire is a fire resulting from an unplanned ignition; it requires a management response to control its spread based on resources at risk, fuel conditions, and predicted weather and fire behavior. A prescribed fire is any fire ignited by management actions to meet specific objectives.

AFFECTED ENVIRONMENT

In a study of wildland fire records on the George Washington National Forest, (Adams 1994) found that, between 1915 and 1993, there were 2,198 fire records on file. The vast majority (76%) were small fires less than 10 acres. Only 1% of the fires were greater than 1,000 acres. Early records, prior to 1950, are

incomplete, but several significant trends can be determined. Nearly 40% of the fire starts were attributed to arson and smoking. An additional 14% were of unknown origin. Lightning accounted for approximately 14% of all fires during that time period. Though this data is from in-service records of fire reports, it is assumed to accurately reflect trends in the data. The study also shows a typical spring and fall (April and November) fire season, attributed mostly to human starts. Lightning fires occur from the late spring through the summer with the highest months being May, July, and April (see Table B6.1). During the 20 year period, 1990 through 2010, lightning fires accounted for 25% of all fires while the remaining 75% were attributed to human causes, with arson accounting for 36% of the total fire workload. During that same period the statistics were nearly identical as what Adam's had found, 73% of all fires were 10 acres or less and only 1% of all fires reached 1,000 acres in size or greater. Since suppression action was initiated on all the wildland fires, there is no conclusive way to now accurately predict how large the fires would have become had suppression action not been taken. This information would assist in helping managers apply prescribed fire to the various forested ecosystems at levels to mimic the role of what naturally occurred.

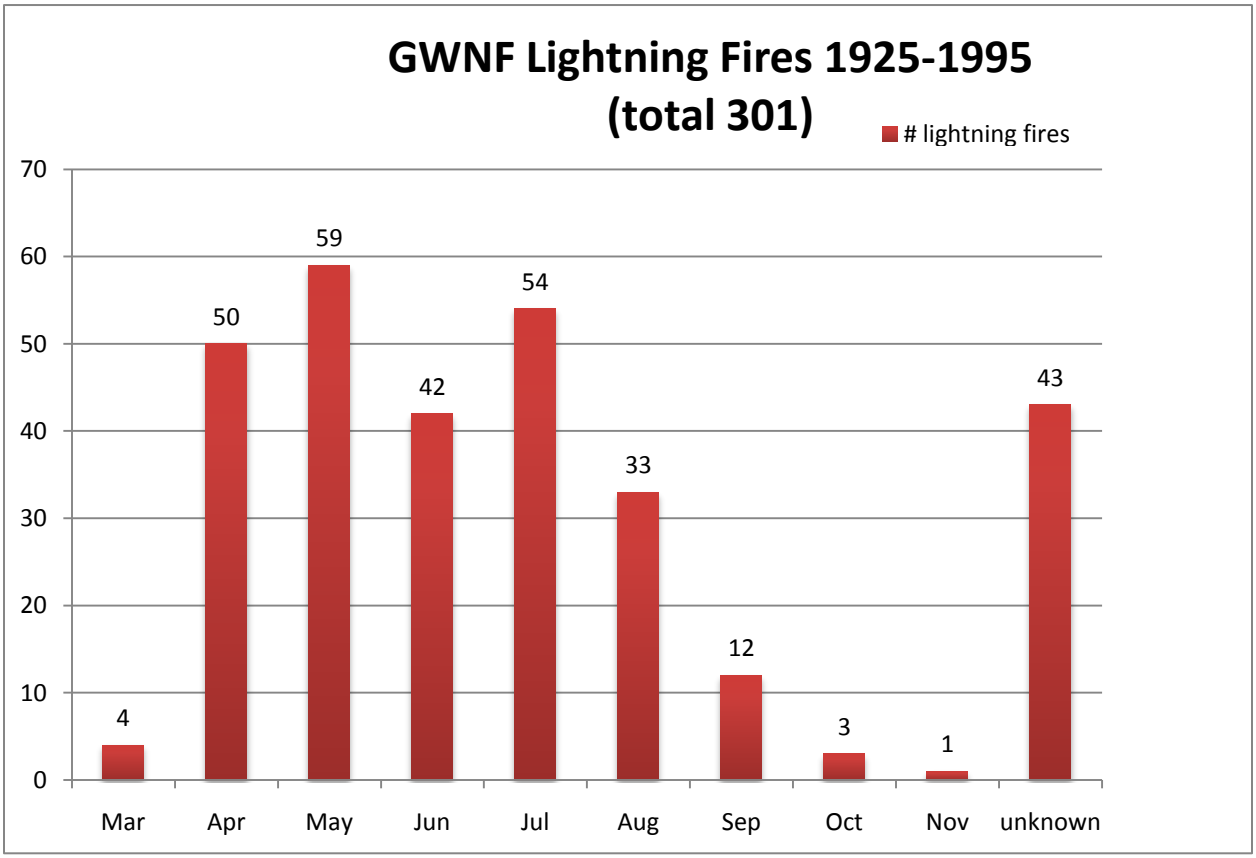


Figure B6.1 Lightning Fires

Fire is a random event and is therefore unpredictable as to its spatial occurrence. During spring and fall fire seasons, arson and carelessness is the leading cause of our human wildland fire starts. Though we may know the area an arsonist is working, the next start is always an unknown. Law enforcement officials on the George Washington and Jefferson National Forests have been very successful in recent years in apprehending and prosecuting a number of arson cases on the forests that have led to prison sentences. We may be able to reduce, to a degree, human-caused fires through active fire prevention, education, and enforcement programs. The second leading cause of wildland fire starts is lightning. Lightning is an extremely random event that is dependent upon the weather systems that occur.

Table B6.1 shows the wildland fire history for 1990-2010 for both the George Washington and Jefferson National Forests. The largest lightning fire on the George Washington National Forest during the 21 year time period was 914 acres and occurred on the Eastern Divide Ranger District in June 2008. The largest human-

caused fire during that same time period was 4,505 acres and occurred on the Glenwood Pedlar Ranger District in March of 2008. The average number of fires per year during the time period was 44 and the average acres burned were 2,441.

Generally, southern aspects had higher occurrences. Human-caused fires began largely on the lower slopes (following road and settlement patterns) and lightning was distributed on mid to higher slopes.

Volunteer Fire Departments (VFD's) gradually assumed the role of the local, less formal warden crews. VFD's are well-distributed through the valleys and are trained, equipped and quick to respond. Their rapid response has kept most roadside fires to minimal acres. Not all areas of the Appalachians have this committed response. VFD's have, no doubt, prevented many wildland fires from involving homes and structures.

Table B6.1 Recent Wildland Fire History for the George Washington and Jefferson National Forests

Year	No. of Fires by Cause		Total	
	Lightning	Human	No. of Fires	Acres Burned
1990	3	44	47	1,197
1991	6	52	58	2,028
1992	3	20	23	408
1993	6	20	26	362
1994	12	50	62	572
1995	3	49	52	5,685
1996	2	20	22	89
1997	6	37	43	1,013
1998	2	59	61	2,754
1999	30	43	73	2,028
2000	16	43	59	2,126
2001	3	64	67	2,650
2002	28	3	61	5,426
2003	0	18	18	128
2004	4	14	18	213
2005	1	24	25	382
2006	11	25	36	6,813
2007	12	35	47	3,886
2008	10	37	47	10,750
2009	4	24	28	594
2010	14	35	49	2,162
Total	176	716	922	51,266
Average			44	2,441

The firefighting organization continues to evolve, as interagency and intra-agency cooperation multiplies available resources, communication improves, and aircraft is utilized. Firefighter and public safety is always the primary consideration for all suppression strategies and tactics. The full range of management responses from direct attack to monitoring a fire is available to the fire manager and line officer. Strategies and tactics for the fire should be commensurate with resource values at risk. Natural barriers such as rock slides, riparian areas, roads, etc. are used whenever possible to construct firelines to mitigate impacts to soil, vegetation and water; reduce costs of line construction; and to provide for additional safety considerations. The Fire Management Plan (FMP) is the implementation guide for the Fire Management program on the National

Forest. The FMP describes in detail the fire suppression organization, the prescribed fire program, smoke management concerns and guidelines, the prevention program and all other relevant aspects of the Fire Management program.

The George Washington National Forest is relatively fragmented and therefore is adjacent to private land along much of its boundary. There is increasing pressure as additional growth occurs in these areas. More people desire to live in wooded surroundings and typically work at maintaining a natural vegetative state surrounding their property to provide a more isolated setting that will block the view of any adjacent structures. While this is aesthetically pleasing, the increased vegetation can quickly become hazardous fuel in the event of a wildland fire. From a suppression standpoint, anytime there is a wildland fire in the wildland urban interface, more resources respond with a threat of structure involvement. These fires are much more expensive to suppress and are almost always multi-jurisdictional.

Wildland fires occurring in the wilderness use MIST (Minimum Impact Suppression Techniques) techniques for fire suppression operations. Safety is still the primary consideration though when selecting strategies and tactics, tools and equipment, we utilize those that will have the least impact on the environment. Strategies that allow the fire to burn to natural barriers are favored and if fireline must be constructed, then it should be of a minimum width and depth to check fire spread. Limbing, bucking, and felling of trees or snags are minimized unless they are a safety hazard or threaten security of the fireline and then are only removed to a level to prevent additional fire spread.

AFFECTED ENVIRONMENT

FUELS MANAGEMENT

Recent research (Pyne, 1982; Sutherland, 1993; Hicks, 2000; Hutchinson and Sutherland, 2000; Kay, 2000; Shumway et al., 2001; Schular and McClain, 2003) and research recently completed (Lafon and Grissino-Mayer, 2007) has shown the frequency and role that periodic fire (both human and lightning caused) has played in shaping the vegetation our landscape supports. Historical records indicate that Native Americans used low intensity fires in our area prior to European settlement and early European settlers continued this practice. Fire was used in efforts to drive game, but more importantly to improve wildlife habitat, maintain open meadows and grasslands, and clear undergrowth, especially in proximity to settlements (Pyne, 1982; Van Lear and Waldrop, 1989; Delcourt and Delcourt, 1997, 1998). The woodland structure (open park-like understory) and tree composition (American chestnut, oak, & yellow pine) of these forests was long influenced and maintained by these fires. Ongoing tree-ring and fire scar studies being conducted in the mid-Appalachians (including western and southwest Virginia) indicate that from at least the early-1700's until the 1930's our forests burned on an interval of approximately three to ten years and that occasionally more intense stand-replacing fires occurred. Earlier than the 1700's, studies of charcoal deposits in pond and wetland sediments indicate fire has been common in our landscape for thousands of years. However since the 1930's suppression became the way all fires were managed. All wildland fires were immediately suppressed regardless of cause and low intensity burning (commonly called light burning) methods were abandoned. All fire, both wildland and low intensity burning, was considered harmful to the forest. With seventy years of fire exclusion, forest structure and composition has, and is continuing, to change. Oak dominated forests are being replaced by more shade-tolerant species, such as white pine, red maple, and striped maple. Table-mountain pine, pitch pine, and even oak (all fire-adapted and/or fire-maintained species) are in sharp decline over most of their natural range. Rhododendron, which should be located in moist north-facing drainages, is now encroaching onto upper drier slopes. Today, prescribed burning is used to mimic the early Native American, settler, and lightning caused fires.

For years 1993 through 2010, the George Washington National Forest (not including the Jefferson National Forest) prescribed burned a total of 89,577 acres ranging from a low of 170 acres in 1991 to a high of 10,156 acres in 2010. The 21-year average is 4,266 acres per year and the past 10-year average is 6,388 acres. Not all of these acres are separate and unique burns. Several of these prescribed burn areas have been burned two or three times during this period. Factors such as appropriate weather and fuel conditions, availability of equipment (e.g. helicopter, engine, dozer, UTV, etc.), availability of qualified personnel, ongoing wildland fires, and funding play a critical role in determining how many acres are prescribed burned in any given year. Most

prescribed burns on the George Washington National Forest are conducted between late February and early May. All prescribed burn projects must have a NEPA analysis completed and a burn plan prior to burn implementation. The burn plan contains specific burning objectives and parameters under which the burn will be conducted to meet specific resource management objectives.

Table B6.2 Number of Acres Prescribed Burned by Year 1990 – 2010 on GWNF:

Year	Prescribed Burning, Acres
1990	1,092
1991	170
1992	970
1993	1,870
1994	795
1995	1,741
1996	1,339
1997	1,465
1998	6,564
1999	5,523
2000	4,172
2001	3,135
2002	2,322
2003	7,188
2004	7,103
2005	9,285
2006	4,914
2007	3,335
2008	9,563
2009	6,875
2010	10,156
Total	89,577

Prescribed fire is an important and ecologically appropriate management tool. Both natural fuels and artificially produced management-activity fuels must be managed over time to meet long-term resource management objectives. Artificially produced fuels have been of little concern, because of the small volume generated, but may have to be managed in the future. In a research burn conducted in the Blue Ridge Experimental Forest in Macon County, NC, (Clinton, Vose, Swank, Berg and Loftis, 1998) more than 50 percent of the mass in litter and small wood was lost during burning. In this study, both fire intensity and severity were moderate. In addition to fire behavior, fuel size and flammability were important determinants of fuel mass consumption. Small wood is more completely consumed at lower temperatures than larger wood; plots high in wood mass in small size classes would lose more mass than plots with similar mass in larger size classes. Burning conditions that produce a more intense fire i.e. longer flame lengths with shorter residence times which equates to a lower severity fire with higher rates of spread would consume less of the humus layer and the associated nutrients though overstory mortality could become an issue dependent upon the type of commercial harvest method. Thus, this proves a strong case for using prescribed burning to treat the resultant slash from commercial harvest operations. Small logging slash, primarily in the form of foliage and fine branches, although temporarily dangerous as a fuel carrier in the case of an ignition, are a short-term problem, often decomposing within the first 4-5 years by white rot fungi in warm, moist environments according to Harvey et al. On the George Washington National Forest, logging contractors leave tops cut at 4” DBH left where the tree was felled and the rest of the logging slash is lopped and scattered to decay more quickly which consequently lessens the threat of a fire threat and distributes the fuel more evenly so if a fire did occur, or a prescribed fire were utilized to treat the slash, the fire severity would be lower and less intense. The EPA states, in their 1998 policy document entitled Interim Air Quality Policy on Wildland and Prescribed Fires, that while future air quality concerns from prescribed fire may arise, the EPA is on record stating that fire should function, as nearly as

possible, in its natural role in maintaining healthy wildland ecosystems and to protect human health and welfare by mitigating the impacts of air pollutant emissions on air quality and visibility.

Fuels management considers both the dead and live fuel components within the fuel complex. These components vary widely across the forest according to ecosystems, insect and disease outbreaks, moisture or drought conditions, and the natural processes that occur without active vegetative management.

The dead fuel components are snags, dead pine needles and leaf litter, dead trees on the forest floor, and shrubs, forbs and graminoids that have fuel moisture low enough to be consumed in the flaming front of a fire. They comprise the available fuels and these values vary seasonally. Snags are becoming more of a hazard on the George Washington National Forest with the increasing incidence of gypsy moth, southern pine beetle and oak decline. Snags create a significant safety hazard during wildland fire suppression.

Prescribed fire and mechanical fuels treatments are designed to reduce the risk of intense and unplanned wildland fires by decreasing the amount of available fuel that the fire is able to consume and thus carry the fire. Both methods are utilized to restore fire regimes within or near an historical range. Since 2001 when the National Fire Plan (NFP) was implemented, there has only been one mechanical fuels treatment completed on the George Washington National Forest. A couple of reasons for the low number of completed mechanical treatments are the high cost per acre of the treatments, mechanical treatments are almost 10 times the cost of prescribed burning, most projects range in size from 20 – 70 acres in size so they are usually much smaller and are much more labor intensive hence the higher cost per acre. Examples of mechanical fuels treatments are lopping and scattering of branches of larger diameter trees, thinning of small diameter saplings and the mastication or mowing of large grassy openings. Condition Classes are a function of the departure from historical fire regimes resulting in alterations of key ecosystem components such as species composition, stand structure, successional stage, stand age, and canopy closure. One or more of the following activities may have caused this departure: fire exclusion, timber harvesting, grazing, introduction and establishment of non-native invasive plant species, insects and disease (introduced or native), or other past management activities.

Fire Condition Class is a measure of general wildland fire risk and ecosystem condition defined as follows:

Condition Class 1:
- Fire regimes are within or near an historical range.
- The risk of losing key ecosystem components is low.
- Fire frequencies have departed from historical frequencies by no more than one return interval.
- Vegetation attributes (species composition and structure) are intact and functioning within an historical range.

Condition Class 2:
- Fire regimes have been moderately altered from their historical range.
- The risk of losing key ecosystem components has increased to moderate.
- Fire frequencies have departed (either increased or decreased) from historical frequencies by more than one return interval. This results in moderate changes to one or more of the following: fire size, frequency, intensity, severity, or landscape patterns.
- Vegetation attributes have been moderately altered from their historical range.

Condition Class 3:
- Fire regimes have been significantly altered from their historical range.
- The risk of losing key ecosystem components is high.
- Fire frequencies have departed from historical frequencies by multiple return intervals. This results in dramatic changes to one or more of the following: fire size, frequency, intensity, severity, or landscape patterns.
- Vegetation attributes have been significantly altered from their historical range.

There is a need to change the Fire Regime Condition Class (FRCC) on the GWNF from a FRCC 3 towards a FRCC 2 and eventually perhaps a FRCC 1 on as much of the Forest as possible. FRCC 3 is a condition of the

landscape that is highly departed from its natural (historical) regime of vegetation characteristics; fire frequency, severity and pattern; and other associated disturbances. FRCC 2 defines a condition that has moderately departed from the natural (historical) regime and FRCC 1 defines a fire regime that is within the natural (historical) range of variability. *Fire Regime Condition Class*, developed by the Forest Service with partners in nine other land management agencies and nongovernmental organizations, is a "standardized tool for determining the degree of departure from natural vegetation, fuels and disturbance regimes". (*For detailed information on this subject, visit* http://www.frcc.gov). Agencies involved in developing the FRCC were the Forest Service, National Park Service, U.S. Fish and Wildlife Service, The Nature Conservancy, U.S. Geologic Survey, Systems for Environmental Management, Bureau of Land Management, Missoula Fire Lab, and Bureau of Indian Affairs.

The George Washington National Forest uses both prescribed fire and mechanical treatments to reduce fuel loading, to break-up fuel continuity (both vertically and horizontally), and to reduce rates of spread and therefore fire size, intensity, and severity. Nationally, the direction is to increase hazardous fuels treatment in the wildland urban interface areas. Those areas are the most expensive areas to suppress wildland fires and pose the greatest threat to public and firefighter safety. Though there is not a one-to-one correlation between acres treated and suppression dollars saved or fewer acres burned, there is sufficient evidence to show that areas that have been treated typically exhibit lower rates of spread, less intensity, less severity, and a smaller final fire size under normal conditions.

In addition to prescribed fire, wildland fire management includes the ability to utilize unplanned lightning ignitions by analyzing various parameters such as weather, fuel conditions and expected fire behavior to determine if the lightning fire is within prescription parameters so the fire could be purposefully used to meet prescribe fire management objectives.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

Prescribed fire is also a valuable tool to provide wildlife habitat; for managing rare communities that require periodic fire to maintain plant viability; for hard pine species such as pitch and table mountain pine; for a silvicultural site preparation tool; for increasing forage; and for regenerating oak stands on highly productive sites (Brose and Van Lear 1999). Table B6.3 displays the acres of prescribed fire by Alternative in an average year over the next decade.

Table B6.3 Prescribed Burning by Alternative

	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Acres Prescribed Burned annually	3,000	12,000-20,000	Limited TES	5,000-12,000	20,000	12,000-20,000	12,000-20,000
Acres of Fireline (dozer)	3	11-17	0	4-11	17	11-17	11-17

Alternative E would be the largest prescribed burn program since it has a strong focus on restoration. Alternative C would generate the smallest prescribed burn program as prescribed burning would be limited to managing TES species without an emphasis on ecosystem restoration. Alternative A has the acres estimated to be prescribed burned annually in the current Plan. Alternative D has an emphasis on commodity production and opportunities for prescribed burning are limited. Alternatives B, F, and G have a program that includes an emphasis on restoration while taking into account fluctuations in weather and funding that may limit the number of acres likely to be burned annually.

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 that is prepared for each prescribed

fire. A smoke management plan is required for each burn plan. More detail on smoke and air quality is provided in the Air Resource section of Chapter 3 of the EIS.

Prescribed fire can have positive and negative effects on non-native invasive plants. These effects may be mitigated by pre-treating NNIS to reduce the ability of that species to disperse and become established in the burn area and along control lines. After burning follow-up treatments can suppress or eliminate NNIS from the area. This information is analyzed for each burn and addressed in the burn plan that is prepared for each prescribed fire. More detail on NNIS is provided in the Non-native and invasive species section of Chapter 3 in this EIS.

Our strategy for responding to wildland fires is based on the ecological, social, and legal consequences of each fire. The circumstances under which the fire occurs and the likely effects on firefighter and public safety dictate the appropriate response and subsequent management. Wildland fires are unplanned natural ignitions that may be human-caused or result from natural storm events (i.e. lightning). All wildland fires are managed according to the prevailing Federal Wildland Fire Management Policy. All wildland fires managed for resource benefits follow appropriate unplanned natural ignitions use, implementation procedure reference guides, and are assessed following a decision support process that examines the appropriate range of responses within the context of the LRMP. All alternatives will treat response to wildland fire similarly; main factor that would affect response most notably would be the amount of Wilderness and the strategic differences in management.

SECTION C – SOCIAL AND ECONOMIC ENVIRONMENT

C1- RECREATION

National Forests provide over 191 million acres of public land within the United States. National Forests in the Southern Appalachian region contribute approximately 4 million acres to the national total and provide unique settings for a variety of outdoor recreation activities such as primitive and developed camping, hunting, fishing, hiking, backpacking, horseback riding and off-highway vehicle driving, canoeing/kayaking and whitewater rafting as well as picnicking, sightseeing, nature watching, walking for pleasure and driving for pleasure.

ANALYSIS AREA

Market areas have been established for different national forests to better evaluate public demand for recreation opportunities. Past research has demonstrated that most national forest visits originate from within a 75-mile (1 ½ hour driving time) radius. Variation in preferences varies surprisingly little for broad population groups (i.e., age strata) across geographic areas. Therefore, the use of a market area provides a reasonable basis for assessment of recreation demand (*George Washington National Forest Recreation Realignment Report* Overdest and Cordell, 2001). For this analysis, the market area has been defined as all counties that fall within a 75-mile straight-line radius from the national forest border. For the George Washington National Forest (GWNF), the market area entails portions of Virginia, West Virginia, Pennsylvania, Maryland and North Carolina. The population living within the market area is about 9,200,204 (Source: U. S. Census Bureau. July 1, 2004 estimate). Table C1.1 provides a summary of the cities, counties and population within the market area

Table C1.1 Summary of States, Counties, Cities and Population within the Market Area for the GWNF

DC and States	Number of Counties & Cities	Population
DC	1	553,523
MD	9	2,794,633
PA	6	523,223
VA	83	4,351,587
WV	32	977,238
TOTAL	131	9,200,204

Source: National Survey on Recreation and the Environment, Southern Research Station, Last Updated August 2010

AFFECTED ENVIRONMENT

The most populated counties in the market area are Fairfax, Virginia, and Montgomery and Prince George's Counties, Maryland, followed by Washington, DC. Other large municipalities within the market area include Alexandria, Arlington, Blacksburg, Charlottesville, Fredericksburg, Harrisonburg, Lynchburg, Manassas, Staunton, Vienna, and Winchester, Virginia; Beckley, Bluefield, Elkins, Martinsburg and Princeton, West Virginia; and Frederick and Silver Spring, Maryland.

Opportunities for outdoor recreation within the market area are not limited to the GWNF. Within the market area, the U.S. Forest Service offers additional opportunities on the Jefferson and Monongahela National Forests. The National Park Service offers opportunities in Shenandoah National Park, Blue Ridge Parkway, Harpers Ferry National Historic Park, C&O Canal National Historic Park, multiple historic sites, and the National Capital Region (mall, memorials and historic sites in Washington, DC). All of these areas connect and expand opportunities for recreation on federally managed public lands. The Appalachian National Scenic Trail also provides a unique long distance hiking opportunity north to south across the entire length of the market area. It connects multiple National Forests and Parks as well as State Forests and Parks from northwest Georgia to northwest Maine, with approximately one-fourth of its length being in Virginia.

A key finding of the Southern Forest Resource Assessment is that "of public ownerships, Federal tracts typically are large and mostly undeveloped. They fill a niche of providing back-country recreation. State parks and forests are usually smaller and more developed." (Southern Forest Resource Assessment, Chapter 11: Forest-Based Outdoor Recreation, H. Ken Cordell and Michael A. Tarrant, 2002.) Within the Commonwealth of Virginia, many state parks are located within a 75-mile radius of the GWNF border. Claytor Lake, Douthat, Fairystone, James River, Lake Ana, Shenandoah, Sky Meadows and Smith Mountain State Parks provide higher levels of development including overnight lodges and/or cabins. Smith Mountain Lake and Claytor Lake provide water-based recreation opportunities within the Market Area. West Virginia State Parks and Forests within the GWNF market area include Cacapon Resort, Lost River, Cass Scenic Railroad, Seneca, Watoga, Beartown, Greenbrier, Moncove Lake, Babcock, Bluestone and Pipestem. Likewise, a majority of these West Virginia State Parks and Forests offer highly developed recreation facilities.

The George Washington National Forest provides approximately 1 million acres of public land in the Valley and Ridge and Blue Ridge physiographic regions of western Virginia and eastern West Virginia. The Shenandoah Valley divides the George Washington National Forest into two separate sections. Each section provides a variety of unique recreation opportunities.

RECREATION DEMAND & TRENDS

Recreation demand is a complex mix of people's desires and preferences, availability of time, range of price, and offering of facilities. The evaluation of current and future demand for recreation on the George Washington National Forest is based on recent surveys that identify and quantify:

- Estimated number of current recreation visits to the George Washington National Forest;
- Participation rates for recreation activities within the forest market area;
- Future activity demand based on projected population growth; and
- Activity demand by demographic strata.

The National Visitor Use Monitoring (NVUM) effort by the Forest Service has provided baselines for estimating current use of recreation sites. The 2001 and 2006 NVUM surveys data is not specific to each national forest, but rather the survey findings combined recreation use and activities for both the George Washington and Jefferson National Forests. The annual visits to the GWNF alone were estimated based on the percent of recreation sites, trailheads and access points included in the sites inventory for the 2006 NVUM that are on the GWNF. The estimated annual visits provided in Table C1.2 below only account for people engaging in recreation activities; they do not include the millions of people that drive through the national forest without stopping to recreate, unless they did so for the purpose of viewing scenery.

Table C1.2 Fiscal Year 2006 Estimated Recreation Use on the George Washington National Forest

Type of Recreation Sites	2006 Total Annual Estimated GW & Jeff Site Visits	2006 Total Annual Estimated GWNF Site Visits*	2006 Percentage of Total Estimated National Forests Site Visits*
Day-Use Developed Sites	399,800	202,200	19.5%
Overnight-Use Developed Sites	212,800	102,300	9.9%
Wilderness	47,100	11,200	1.1%
General Forest Areas	1,010,300	721,600	69.5%
Special Events and Organizational Camps	4,200	Not estimated	0.0%
Total Estimated Site Visits	1,674,200	1,037,300	100.0%

Source: National Visitor Use Monitoring Results, Data Collected Fiscal Year 2006, Report Last Updated March 2009.

*Site Visit is defined as the entry of one person onto a National Forest site or area to participate in recreation activities for an unspecified period of time.

Based on this NVUM data, the "developed recreation" day and overnight use areas combined makes up almost one-third of the estimated recreation site visits on the GWNF. Approximately two-thirds of recreation site visits can be defined as "dispersed recreation" that occurs away from developed sites in general forest areas and designated Wilderness. About one-third of 1% of recreation site visits are attributed to organized special use events and camps that occur in both developed and dispersed recreation settings.

People within the defined market area for the GWNF engage in a variety of recreation activities. Table C1.3 lists the types of activities ranked in order from highest to lowest participation rates based on the 2000-2004 National Survey on Recreation and the Environment (NRSE), an on-going national telephone survey sponsored by the U.S. Forest Service. The data here is specific to participation in activities in which the market area population engaged, although the activities may or may not have occurred on the George Washington National Forest.

Table C1.3 Types of Activities in Which the Market Area Population Engages (On and Off National Forest System Lands)

RECREATIONAL ACTIVITY	Market Area Survey	
	Percent	# of People*
Walk for pleasure	87.7%	6,303,054
Family gathering	75.2%	5,405,870
Visit historic sites	64.0%	4,602,377
Visit nature centers, etc.	63.7%	4,581,037
Picnicking	63.3%	4,551,409
View/photograph natural scenery	63.2%	4,545,428
Driving for pleasure	61.3%	4,406,426
Sightseeing	60.3%	4,332,833
View/photograph other wildlife	48.8%	3,510,264
Swimming in an outdoor pool	48.6%	3,489,977
View/photograph wildflowers, trees, etc.	48.3%	3,471,564

RECREATIONAL ACTIVITY	Market Area Survey	
	Percent	# of People*
Visit a beach	47.5%	3,416,639
Swimming in lakes, streams, etc.	45.4%	3,260,576
Bicycling (any type)	42.9%	3,083,258
Boating (any type)	38.8%	2,789,632
Day hiking	38.3%	2,751,542
Visit a wilderness or primitive area	35.2%	2,532,350
View/photograph birds	33.3%	2,392,019
Snow/ice activities (any type)	32.1%	2,307,625
Visit a farm or agricultural setting	30.5%	2,194,107
Gather mushrooms, berries, etc.	29.9%	2,150,416
Visit other waterside (besides beach)	29.1%	2,092,235
Freshwater fishing	25.2%	1,809,067
Visit prehistoric/archeological sites	25.2%	1,810,139
Mountain biking	25.1%	1,800,834
Motorboating	22.2%	1,592,503
View/photograph fish	22.1%	1,591,664
Developed camping	21.9%	1,571,514
Warmwater fishing	19.5%	1,399,697
Drive off-road	19.2%	1,379,365
Coldwater fishing	14.1%	1,009,775
Primitive camping	13.3%	959,277
Saltwater fishing	11.6%	831,240
Hunting (any type)	11.5%	827,106
Canoeing	11.3%	809,605
Backpacking	10.9%	781,897
Downhill skiing	10.5%	754,489
Rafting	10.3%	743,500
Big game hunting	10.1%	728,982
Horseback riding (any type)	9.5%	682,560
Sailing	8.5%	609,380
Use personal watercraft	8.1%	584,063
Horseback riding on trails	7.9%	569,578
Small game hunting	7.8%	561,735

Source: 2000-2004 National Survey on Recreation and the Environment. USDA Forest Service. Southern Research Station. Athens, Georgia. *George Washington NF local area: 131 counties, 16 and older population (2004 Census estimate).

The Resources Planning Act (RPA) Assessment reports on the status and trends of the Nation's renewable resources on all forest and rangelands, as required by the Forest and Rangeland Renewable Resources Planning Act of 1974. The RPA mandates periodic assessments of the condition and trends of the Nation's renewable resources including recreation, fish, wildlife, biodiversity, forest and range resources as well as land use change, climate change and urban forestry. Consistent with this Act, the U.S. Forest Service Southern Research Station and the University of Georgia, Athens, develop and present outdoor recreation participation projections for specific recreation activities or recreation composites for regions of the United States. Future renewable resource conditions are influenced by changes in population, economic growth, and land uses. Using these major drivers, three equally likely scenarios were used by the 4th Assessment by the Intergovernmental Panel on Climate Change (IPCC 2007) and are adopted by the U.S. Forest Service and University of Georgia in developing projections for participation in outdoor recreation.

Table C1.4 provides national projections in public participation in outdoor recreation activities. This list of individual activities or activity composites was derived from the National Survey on Recreation and the Environment. An individual is said to have participated in an outdoor recreation activity if he reported engaging in that activity at least once in the preceding 12 months.

Table C1.4 Fifty Year Projected Activities in Outdoor Recreation on GWNF (in thousands)

Recreation Activity	2010	2020	2030	2040	2050	2060
Camping						
Developed Camping	105.16	117.44	130.13	140.87	151.81	163.68
Resorts, Cabins	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL FOR GROUP	105.16	117.44	130.13	140.87	151.81	163.68
Driving						
Driving For Pleasure	47.77	53.38	59.19	64.06	68.98	74.36
Other Motorized Travel	0.83	0.93	1.03	1.12	1.20	1.30
Motorized Water Travel	24.42	27.23	29.74	32.29	35.36	38.78
TOTAL FOR GROUP	73.02	81.55	89.96	97.47	105.54	114.45
Fishing						
Fishing	189.82	208.12	224.94	238.62	253.22	268.93
General						
General Relaxing	74.05	82.75	91.75	99.30	106.93	115.28
Swimming	57.19	64.51	71.78	78.49	85.70	93.63
TOTAL FOR GROUP	131.24	147.27	163.53	177.79	192.63	208.91
Hiking						
Hiking/Walking	210.56	237.34	265.76	291.31	318.09	347.74
Hunting						
Hunting	99.49	104.57	108.09	110.14	112.29	114.34
Nature						
Visiting Historical Sites	0.00	0.00	0.00	0.00	0.00	0.00
Visiting Nature Centers, VIS	1.23	1.38	1.54	1.69	1.83	1.99
Gathering Berries, Natural Products	10.92	12.31	13.74	15.00	16.31	17.75
Nature Study	0.00	0.00	0.00	0.00	0.00	0.00

Recreation Activity	2010	2020	2030	2040	2050	2060
TOTAL FOR GROUP	12.15	13.69	15.28	16.68	18.14	19.74
Off-Highway Vehicles						
Off-Highway Vehicles	8.34	9.03	9.56	10.15	10.88	11.65
Primitive Camping						
Primitive Camping	5.01	5.52	6.00	6.44	6.91	7.42
Backpacking, Camp in Unroaded Areas	3.34	3.68	4.00	4.29	4.61	4.95
TOTAL FOR GROUP	8.35	9.20	10.01	10.73	11.52	12.36
Picnicking						
Picnicking	7.36	8.22	9.11	9.86	10.63	11.46
Trails						
Bicycling	15.13	17.05	18.88	20.79	22.99	25.46
Horseback Riding	2.52	2.82	3.08	3.37	3.73	4.13
Non-Motorized Water Travel	1.67	1.82	1.93	2.07	2.24	2.42
TOTAL FOR GROUP	19.32	21.69	23.90	26.23	28.96	32.02
Viewing						
Viewing Scenery	117.33	131.12	145.38	157.35	169.43	182.66
Viewing Wildlife, Birds, Fish	72.95	82.47	92.70	100.67	108.36	116.76
TOTAL FOR GROUP	190.28	213.60	238.08	258.02	277.80	299.42
Wilderness						
Wilderness	11.48	12.64	13.75	14.75	15.83	16.99
TOTAL FOR ALL GROUPS	1,066.56	1,184.35	1,302.08	1,402.63	1,507.33	1,621.68

Data Source: Bowker, J. M., and Askew, Ashley (forthcoming). Outdoor Recreation Participation Projections 2010 to 2060. In: Outdoor Recreation Trends and Futures: Technical Document Supporting the Forest Service 2010 RPA Assessment. GTR-SRS-XXX. Asheville, North Carolina: U.S. Department of Agriculture, Southern Research Station. The data for three projections scenarios were averaged by Paul Arndt, Regional Planner, U.S. Forest Service Southern Region. Omitted from the list are various winter sports, which are not relevant to projections for the Southern Region.

The activities with the most projected per capita participation by year 2060, nationally, are hiking/walking, fishing, viewing scenery, developed camping, viewing wildlife and general relaxing. The activities with the greatest percent of growth in participation from 2010 to 2060 are bicycling, hiking/walking, horseback riding, swimming, visiting nature centers, gathering forest products such as berries, viewing wildlife and motorized water sports.

Demographic information collected for the 2001 Recreation Realignment report within the market area revealed trends that were popular across a variety of demographic groups (age, gender, number of people per household, race and ethnic strata). At the time of the Recreation Realignment effort, these were primarily those that do not require specialized skills or equipment and that can engage multi-generations together. The ten most popular activities on the George Washington National Forest, according to the Recreation Realignment Report, were viewing/photographing wildlife and birds, viewing/photographing features and scenery, swimming, hiking or walking for pleasure, visiting a Wilderness, gathering forest products, fishing, camping in a developed site, and ATV/OHV use.

RECREATION SUPPLY

For planning purposes, recreation supply is defined as the opportunity to participate in a desired recreation activity in a preferred setting to realize desired and expected experiences. Recreationists choose a setting and activity to create a desired experience. Three components of supply are settings, activities and facilities. The US Forest Service manages a supply of settings and facilities.
The Recreation Opportunity Spectrum (ROS) is a planning tool used to identify and evaluate the supply of recreation settings on national forests. Four ROS classes were inventoried on the George Washington National Forest. These settings include Semi-Primitive Non-Motorized (SPNM), Semi-Primitive Motorized (SPM), Roaded Natural (RN), and Rural (R).

Primitive (P) is the most remote, undeveloped recreation setting. These settings are generally unmodified, natural environments located at least three 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 were no areas on the George Washington National Forest that met the inventory criteria for Primitive.

Semi-Primitive Non-Motorized (SPNM) areas are predominated by a natural or natural appearing environment. Interaction between visitors is low, but there may be evidence of other users. They are managed to achieve a sense of remoteness, although SPNM areas can be as small as 2,500 acres in size 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.

Semi-Primitive Motorized (SPM) areas are natural or natural appearing. Interaction between visitors is low, but there often is evidence of other users. Motorized use is permitted. SPM accounts for areas on the National Forest that either buffer SPNM areas or stand alone as tracts of land 1,500 acres or larger with a low road density of 1.5 miles of road/1,000 acres.

Roaded Natural (RN) 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. RN areas are located within a half mile of a road and usually provide higher levels of development such as campgrounds, picnic areas and river access points.

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 forest and include only highly developed recreation sites. They are so small that they are represented with a point, rather than a polygon, in our Geographic Information System. Acreage in the Rural ROS class is negligible.

Table C1.5 Current Distributions of ROS Classes as Inventoried on the George Washington National Forest

Recreation Opportunity Spectrum (ROS) Class	Current ROS Inventory Acres on the GWNF (approximate acres)	Current Percentage of each ROS Class on the GWNF
Semi-Primitive Non-Motorized - SPNM	198,281	18.6%
Semi-Primitive Motorized - SPM	210,992	19.8%
Roaded Natural - RN	656,596	61.6%
Total	1,065,872	100%

Source: GWNF Geographic Information System (GIS inventory data)

There are no lands on the GWNF that meet the inventory requirements for Primitive ROS setting (due to proximity to roads). However, the GWNF manages all designated Wilderness (42,674 acres) as Primitive ROS setting.

The Southern Appalachian Assessment: Social, Cultural, Economic Technical Report (SAA)[1] provides data about landscape settings in 10 ecological sections of the Southern Appalachians. The report includes settings on both public and private lands. It states that about 5% of the region is developed into urban settings and 12% is developed into suburban or transitional settings. Approximately 45% of the landscape is in rural settings, 2% are covered in large rivers and lakes and 3% could not be determined using satellite imagery. About 8% of the area in the study provides Primitive or Semi-Primitive settings, with 100% of the Primitive settings being provided on public lands.

DEVELOPED RECREATION

A developed site is characterized by a built environment containing a concentration of facilities and services used to provide recreation opportunities to the public. They typically represent a significant investment in facilities and management under the direction of an administration unit in the National Forest System. Recreation sites are developed within different outdoor settings to facilitate desired recreational use. Developed recreation sites include such facilities as campgrounds, picnic areas, shooting ranges, swimming beaches, interpretive sites, visitor centers and historic sites. Developed recreation sites provide different levels of user comfort and convenience based on the assigned Recreation Opportunity Spectrum (ROS) setting. The development scale for recreation sites range from 1 to 5, with the lower end of the scale representing the most primitive, natural settings. Site amenities are provided only if needed for the protection of resources. The upper end of the scale represents the highest level of development and facilities for the comfort and enjoyment of the visitor.

The George Washington National Forest has three development scale 5 recreation areas: Bolar Mountain, Sherando Lake and Trout Pond. Each is a recreation complex offering amenities and services for the comfort of users. They offer multiple types of camping facilities (family and group) and campsites with utility hookups. The campground roads and walkways are paved, bathhouses have flush toilets and warm water showers, campsites are numbered and delineated, and each complex offers a highly developed day use area. There is an entrance station and on-site staff and volunteers. A percentage of the campsites are available by reservation.

Brandywine Lake, Cave Mountain Lake and Morris Hill are three examples of development scale 4 campgrounds. They also offer many facilities for the comfort of users including bathhouses with flush toilets and showers and have day use areas. However they are smaller in scale than the development scale 5 sites and they do not offer utility hookups. Volunteer campground hosts are on-site during the peak use season.

Hidden Valley and North Creek are examples of development scale 3 campgrounds. They have gravel roads, numbered campsites, restroom facilities that may have vaults rather than flush toilets and no showers. There is typically, but not always, an on-site volunteer campground host during peak season weekends.

Development scale 2 sites include campgrounds like Greenwood Point, McClintic Point and Little Fort. These provide facilities for the protection of resources rather than for visitor comfort. These are smaller areas offering vault toilet buildings, gravel roads (except Greenwood Point that is accessed only by boat or hiking trail), campsites typically are no numbered or delineated, and rarely, if ever, is there an on-site volunteer host. Some do not offer drinking water or trash collection – users pack in drinking water and pack out trash. Mowing is done infrequently or not at all.

[1] Southern Appalachian Man and the Biosphere (SAMAB). 1996. The Southern Appalachian Assessment Social/Cultural/Economic Technical Report. Report 4 of 5. Atlanta: U.S. Department of Agriculture, Forest Service, Southern Region.

SUPPLY OF DEVELOPED RECREATION SITES

The Forest Service defines the capacity of developed recreation sites in terms of "people at one time" that a site can support, called PAOTs. Currently, there are 59 developed sites managed by the George Washington National Forest to accommodate different recreation activities. Tables C1.6 and C1.7 illustrate the different types of facilities provided across the forest and their current capacity in PAOTs.

Table C1.6 Current Supply of Day-Use Developed Areas on George Washington NF

Site Type	Number of Sites	Total Capacity (PAOTs)
Motorized Boating Sites*	2	350
Campgrounds & Complexes**	21	6,740
Horse Campgrounds	1	25
Interpretive Sites	10	815
Observation Sites	4	485
Picnic Sites	10	730
Swimming Sites*	7	945
Target Ranges	4	120
Grand Total	59	10,210

Source: INFRA-Recreation Sites Report. INFRA is a Forest Service database that contains all developed recreation sites inventory data.

*Coles Point offers both a swimming area and a boat ramp. The entire capacity of Coles Point is listed with the swimming site.

** All of the level 5 campgrounds and three of the level 4 campgrounds have day lakes with sand swimming beaches. The capacity of these day use areas is included with the Campgrounds & Complexes.

Several development scale 2 campgrounds on the George Washington National Forest developed over time in response to riparian resource degradation and sanitation concerns in concentrated use areas along popular river and stream corridors. Facilities installed to protect resources have included vault toilets, designated parking areas and hardened impact areas for camping. A couple of examples where developed facilities are provided to protect resources from the impacts of what were originally dispersed recreational uses are Oronoco and North River campgrounds. The supply of the lower development scale facilities provided by the George Washington National Forest currently exceeds demand. Occupancy is typically low at the majority of the development scale 2 and low 3 recreation sites, with seasonal variability. For most of the lower development scale sites, occupancy increases during spring and fall hunting seasons, but rarely to full capacity at most sites.

At the upper end of the development scale, the public demand for campsites is greater than the demand for lower development scale sites. However, demand rarely exceeds supply, except during the summer holiday weekends. The exception to this is Sherando Lake family campground, which routinely fills to capacity throughout the summer. Across the George Washington National Forest, demand for campsites with utility hookups exceeds supply. The Forest has not installed additional utility hookups in recent years due to the cost of installation and ongoing maintenance, desires to reduce the carbon footprint, and in keeping with our Forest's recreation niche which is primarily trails and dispersed recreation. State parks and privately owned campgrounds meet some of the public demand for sites with utility hookups and other amenities for visitor comfort. State parks and private sector campgrounds are typically more highly developed than Forest Service campgrounds.

DISPERSED RECREATION

Developed Sites That Support Dispersed Recreation Uses: Dispersed recreation is defined as those activities that occur outside of developed recreation sites such as boating, hunting, fishing, hiking and biking. Parking is also provided at two hang gliding sites, although those sites have received little use and little maintenance in recent years. There are 58 developed recreation sites that support dispersed use of the forest such as trailheads, trail shelters and boat ramps. Table C1.7 provides a summary of the developed areas used to access dispersed recreation opportunities on the national forest.

Table C1.7 Developed Access Points for Dispersed Recreation on the George Washington NF

Site Type	Number of Sites	Total Capacity (PAOTs)
River and Lake Boating Access	9	325
Fishing Sites	7	701
Observation Sites	3	96
Hang Gliding Sites	4	70
Trail Shelters	13	109
Trailheads	20	1,307
Grand Total	56	2,608

Source: INFRA-Recreation Sites Report, 08/20/2010. INFRA is a Forest Service database that contains all developed recreation sites inventory data.

Trails: The George Washington National Forest offers approximately 1,078 miles of trails. The majority are for non-motorized, multiple uses and are shared by hikers, equestrians and bicyclists. Notable exceptions are the Appalachian National Scenic Trail and several short interpretive trails that are open to hikers only and trails in designated Wilderness where bicycles are prohibited. Also excluded from multiple uses are some trails within developed recreation areas. Approximately 65 miles on three trail systems provide motorized use opportunities. All three trails are open to all-terrain vehicles and motorbikes, and one of the three trails has portions open to off-road or four-wheel drive trucks.

Table C1.8 gives a breakdown of the miles of trail that are managed for various types of uses. The total trail miles do not add up to the total National Forest System Trail miles because of the overlap in uses allowed.

Table C1.8 Approximate Miles of Trail Offered on the George Washington NF

Type of Trail	Miles	Comment
Wilderness	68	
Non-Wilderness	1,010	
Trail miles that allow hikers	1,078	
Trail miles that allow equestrians	811	All except Appalachian Trail, interpretive trails, and trails within developed recreation areas including angler trails
Trail miles that allow bicyclists	794	All except Appalachian Trail, trails in designated Wilderness, interpretive trails and certain trails within developed recreation areas including angler trails
Trail miles that allow ATVs and OHVs	65	Allowed on designated motorized trails only

Source: INFRA-Trails Report, 08/30/2010

Demand for long-distance trails for special recreation events, such as long-distance mountain bicycling, equestrian endurance rides and runner marathons, has increased in recent years. The demand is greatest among the equestrian and mountain biking communities. Events are not permitted in designated Wilderness and neither of these user groups is permitted on the Appalachian National Scenic Trail. Concern has been expressed among some in these user groups that any additional Wilderness designations exclude, to the extent possible, trails that currently are used, or that by their connectivity to other trails could be used, for long-distance trail riding opportunities and special recreation events.

There is more demand than supply for motorized trail opportunities. There is a goal in the current George Washington National Forest Land and Resources Management Plan to add a new motorized trail in the area of Archer Run. However, the Archer Run area does not meet the environmental criteria for establishing a new ATV trail. Furthermore, due to concerns with resource damage on and off trail, the Patterson Mountain all-terrain vehicle trail on the north end of the Jefferson National Forest is temporarily closed and potentially could be closed permanently, putting more stress on the motorized trails of the George Washington National Forest. Public concern was expressed during at least one public meeting about losing local economic benefits of motorized trail users who travel to West Virginia to find an adequate supply of this type of recreation opportunity.

The ability of the national forest to provide such a significant trails program is largely dependent on the volunteer workforce that helps with maintenance of trails. In fiscal year 2010, volunteers contributed 50,928 hours to the dispersed recreation program, equivalent to 28 full time employees. The motorized trail program relies heavily on grants from the Virginia Recreational Trails Fund program. While support from volunteers and the grant programs have been consistent, a decline in either of these programs will have negative implications for the sustainability of the dispersed recreation program.

Hunting and fishing are traditional and popular dispersed recreational uses of the George Washington National Forest. The Forest Service manages the habitats that sustain populations of small and big game species as well as cold and warm water fisheries. The Virginia Department of Game and Inland Fisheries and the West Virginia Department of Natural Resources stock certain streams and lakes. Table C1.9 provides acres currently managed for fish and wildlife habitat emphasis.

Table C1.9 Acres of Current Fish and Wildlife Habitat Emphasis Areas

Type of Fish & Wildlife Habitat Emphasis	Unit of Measure
General Big & Small Game Habitat	315,801 Acres
Early Successional Habitats	33,442 Acres
Stocked (Put & Take) Streams	67 Miles of Streams
Stocked (Put & Take) Reservoirs	2,830 Acres

Sources: Data for game and early successional habitats – spreadsheet titled "ROS_Acres_AltsComparison_10.21.2010.xlsx" provided by GIS Specialist; this table include acres for prescription areas 8 and 13 only, which emphasize wildlife habitat management. Data for stocked streams and reservoirs was obtained from the Virginia Department of Game and Inland Fisheries website at http://www.dgif.virginia.gov/fishing/stocking/ and West Virginia Department of Natural Resources at http://www.wvdnr.gov/Fishing/Regs10/TroutStocking.pdf.

DIRECT, INDIRECT EFFECTS AND CUMULATIVE EFFECTS

Existing recreation demand is expected to grow for a variety of activities including dispersed and developed recreation. Existing uses of the National Forest will increase as recreation demand and population grows over the next ten years.

General themes were developed for each alternative that emphasize different resource management objectives. Alternative A is the current management alternative and it provides the baseline for evaluating

other alternatives. Each alternative theme and its allocation of prescription areas provide the parameters for redefining the current distribution of the Recreation Opportunity Spectrum (ROS) which has implications for both developed and dispersed recreation settings, facilities development and potentially for road management. The suitability of road construction was a factor in determining the effects of each alternative to recreation.
National Forest management could affect recreation by constructing or removing recreation facilities and improvements, changing their development level, restricting, prohibiting or encouraging use, altering the land to make it suitable or unsuitable for use, and changing the landscape setting. Evaluation of potential recreation effects requires that these elements be considered: activities, setting, and experiences.

Refer to other sections of the DEIS for additional environmental consequences related to Scenery, Wild & Scenic Rivers, Wilderness, Potential Wilderness Areas, Special Areas and Cultural resources.

RECREATION OPPORTUNITY SPECTRUM (ROS)

Table C1.10 provides a comparison by alternative of the percent of acres in the current ROS inventory that could potentially change because they are allocated to prescription areas with an emphasis that may be inconsistent with that setting. Specifically, prescription areas where construction of permanent roads is allowed are inconsistent with semi-primitive non-motorized (SPNM) and semi-primitive motorized (SPM) ROS settings. The construction of low level temporary roads is consistent with SPM, but not with SPNM. Allocations to the Recommended Wilderness prescription area might result in the closing of roads, which is not consistent with the Roaded Natural ROS setting.

Under the current management plan that has been in place since 1993, about 123,000 acres of inventoried SPM and SPNM (about 30% of total SP acres) are in management areas that allow road building. About 188,000 acres of inventoried RN areas (also about 30% of total RN acres) have been allocated to areas managed to provide settings that lean to the semi-primitive end of the spectrum. While it is important to analyze the potential consequences of allocating lands to prescriptions that may be inconsistent with their inventoried ROS status, it should also be noted that the allocations of areas to management prescriptions that allow or prohibit road building have not resulted in a significant change in the ROS inventory since 1993.

Table C1.10 Percent of Acres in Prescription Areas with Emphasis That May Not Be Consistent With Current Inventoried ROS Classification

ROS Class	ALT A	ALT B	ALT C	ALT D	ALT E	ALT F	ALT G
SPNM* **198,281 acres**	10-15%	15-20%	<1%	15-20%	10-15%	5-10%	10-15%
SPM* **210,995 acres**	45-50%	60-65%	5-10%	40-45%	45-50%	45-50%	50-55%
RN** **656,596 acres**	25-30%	35-30%	55-60%	25-30%	30-35%	25-30%	30-35%

*The first two rows for SPNM and SPM indicate the potential percent of acres that could move toward the RN end of the spectrum. The SP inventory status will not change unless new roads are constructed of the development level and distance to the current ROS boundary that would result in an inventory change, whether the road is inside or outside of the national forest.
**The last row, for RN, indicates the percent of inventoried RN acres that would be allocated to prescriptions that are managed more consistently with semi-primitive settings. The RN inventory status will not change unless roads are permanently closed that would make a difference in that RN inventory.

The Alternative that would bring about the least change to the SPNM and SPM inventoried acres is Alternative C. Alternative F also fundamentally provides for the protection of SPNM recreation settings. The alternatives in the middle of the pack for protecting SPNM are Alternatives A, E and G. The alternatives that would result in the most potential change to the SPNM inventory are B and D.

Areas of SPM occur in multiple prescription areas that would allow the construction of permanent roads, including utility corridors, ATV use areas, dispersed recreation, range, Wild and Scenic Rivers (recreation classification), mix of successional habitats (suitable and unsuitable), early successional habitat (suitable and unsuitable), timber production, mosaics of wildlife (suitable and unsuitable), source water watersheds, and Indiana bat-secondary. Alternative B provides the potential for the greatest number of inventoried SPM acres to change. This is followed by Alternative G and then Alternatives E and F, then finally D. Alternative G has an objective to maintain 85% of the inventoried SPM areas in their SPM settings. Alternative G also includes a strategy to close newly constructed roads in SPM areas as soon as the immediate access need is met. With this objective and strategy the actual amount of existing SPM areas that may not be consistent with the current inventory should be near zero. Alternative C substantially protects the SPM recreation settings.

The Alternatives that provide for management of the RN areas most consistently with the RN end of the spectrum are A, D and F, followed by E, G and then B with percent of area that would be managed more toward the SP end of the spectrum. Alternative C manages the highest percent of RN acres as being on the SP end of the spectrum.

Under Alternative C, and to a lesser extent Alternative F, effects of changes in ROS settings will be positive for those visitors seeking a more remote experience, and less positive or potentially negative for those visitors who prefer a more developed experience. Under Alternatives B and D, the effects of change in settings will be positive for those visitors seeking increased access and a more developed recreation setting, and less positive or potentially negative for those visitors who prefer a more remote experience. In Alternatives A, E and G, the changes in the recreation settings will result in less affects but changes will favor increasing RN and decreasing SP.

Increasing remote settings may be associated with road closures in some areas, both seasonal and permanent. Closing roads increases the satisfaction of visitors that prefer solitude and fewer disturbances by motorized vehicles. Road closure often reduces wildlife poaching, litter and the development of unauthorized trails.

Increasing developed settings may be associated with construction of new permanent roads whether they are constructed primarily for management or recreational purposes. Increased motorized access to more areas of the national forest increases the satisfaction of visitors who hunt, fish, photograph scenery, birdwatch, pick berries, and disperse camp. The roads themselves are often enjoyed by people with limited mobility and/or limited time to recreate on the national forest.

DEVELOPED RECREATION

Developed recreation is not a significant issue and it does not vary significantly by alternative. Alternatives A, B, and D would maintain a developed recreation program similar to the current level, except Alternatives D and F might see increased amenities or expansion in existing recreation sites. Under Alternatives C and E there would be closure of some recreation sites. No new developed recreation sites are included in any of the alternatives. Table C1.11 displays allocation of capacity in terms of People At One Time (PAOT) by alternative to existing developed recreation capacity.

Table C1.11 Estimated Capacity (PAOTs) of Developed Recreation Areas by Alternative

Site Type	Alt A Capacity (Baseline)	Alt B Increase 0-5%	Alt C Decrease 5-15%	Alt D No change	Alt E Decrease 5-15%	Alt F Increase 5-15%	Alt G Increase 0-5%
Water Based Recreation: Swimming, boating, developed fishing	1,295	1,295-1,360	1,230-1,490	1,295	1,230-1,490	1,360-1,500	1,295-1,360
Overnight Use: Family, Equestrian, Group Campgrounds	6,765	6,765-7,100	6,425-7,780	6,765	6,425-7,780	7,105-7,775	6,765-7,100
Interpretive and Observation Day Use Sites*	1,300	1,300-1,365	1,300	1,300	1,300	1,365-1,495	1,300-1,365
Day Use Picnic Sites	730	730-765	570	730	570	765-840	730-765
Target Ranges	120	120-125	120	120	120	130-160	120-125
Grand Total	10,210	10,720	9,185	10,210	9,185	10,725-11,770	10,720

*Interpretive and observation sites would likely not see the same percent of decrease as other site types due to the benefits that public awareness and education through interpretation of resources can have in achieving the desired conditions, goals and objectives for the national forest.

In all alternatives there will be an emphasis to upgrade the accessibility of existing and expanded sites, which are considered high priority improvements. Effects include a greater satisfaction for users of all abilities as more sites become accessible. Families of all ages and ability levels can share the same facilities and site furnishings, and visitors will find their choices have broadened in selecting campsites, picnic sites, shooting range lanes, and other types of developed recreation sites.

None of the alternatives will meet the local market demand for developed recreation. The effects of unmet demand will be greatest with Alternatives C and E, followed closely by Alternatives A, B, D and G. Alternative F meets more of the developed recreation demand than the others, but this will diminish with time as the population increases while the amount of public lands offering these opportunities remain fairly static. Some sites will become increasingly overused and crowded. Initially this may occur only at peak times such as holidays and weekends; but over time this could extend to much of the primary recreation season from Memorial Day to Labor Day. This will result in lower satisfaction levels and some visitors will have unmet expectations. Some will seek the supply of developed recreation on state, county and private lands.

Hotspots of developed recreation are sites that are consistently at or over their design capacity. On the George Washington National Forest these include areas such as Sherando Lake throughout most of the summer as well as Bolar Mountain and Trout Pond Recreation Areas on most weekends and holidays. Hotspots of use for developed recreation will broaden over time to other recreation areas and into the shoulder use seasons. Upgrades of facilities, putting sites on the national reservation service, and implementing visitor use controls should help alleviate problems of overuse at these sites.

Some management actions will affect developed recreation and effects will depend on the proximity and magnitude of the activity. These activities include construction, reconstruction and maintenance of roads and trails, insect and disease control, prescribed burning and pesticide use. Some activities have short term effects such as prescribed burning or pesticide use that decrease the satisfaction of the visitors in the area for a short time. Other activities such as road construction or major repairs to facilities may influence satisfaction

on a longer basis, perhaps up to a year. Other natural causes such as wildfires or tornadoes can greatly affect developed recreation areas long-term or permanently.

Roads are needed to access developed recreation areas. Because no new developed recreation areas are proposed under any alternative, the degree to which new roads are constructed is not a significant factor for developed recreation. The degree to which roads might be closed could potentially be a factor, if it would result in closing vehicular access to an existing developed recreation area. Alternative C provides for the most potential miles of road decommissioning. Alternatives A and D provide for the least miles of road to be decommissioned.

Natural causes such as wildfires can greatly affect developed recreation areas long-term or permanently. The use of prescribed burning in the vicinity of developed recreation areas results in the reduction of fuels for wildfires. Alternative E provides the largest prescribed burning program, while Alternative C provides for the least.

DISPERSED RECREATION

The George Washington National Forest currently has over one thousand miles of trails. Agency trail managers have struggled to meet targets related to maintaining existing trails to standard and question the ability of the national forest to continue to sustain the current level of trail miles. However, user groups that enjoy both non-motorized and motorized trails, including active volunteer organizations that help accomplish trail maintenance, would like to see the trail miles on the national forest increased.

Non-Motorized Trails: With the exception of the Appalachian National Scenic Trail, trails in Wilderness and some paved interpretive trails, this national forest allows and encourages multiple uses of its non-motorized trails. The biggest changes between the alternatives is with the miles of trail currently open to mountain bicycles that would be closed to that use if Recommended Wilderness Study areas are designated by Congress as Wilderness. The second influential factor in trail miles is the provision in some alternatives that an increase in trail miles can occur but with no net increase in the amount of trail maintenance that would be required. This would be accomplished through relocating or decommissioning unsustainable trails, adding new trails or trail connectors in appropriate locations, and constructing trails using design standards that result in minimal maintenance needs and maximum sustainability. The following table indicates the proposed change from current miles of trail as proposed in each Alternative.

Table C1.12 Estimated Changes in Non-Motorized Trail Miles Open to Various User Types

Type of Trail	ALT A	ALT B	ALT C	ALT D	ALT E	ALT F	ALT G
Hiking, Pack-and-Saddle, Mountain Bicycling	Increase 0-3% <30 miles	No net change	Increase <3% <30 miles	Increase 5-10% 50-100 miles	No net change	Increase <3% <30 miles	Increase <3% <30 miles
Affect of Wilderness Designation on Mountain Bicycling*	No change	Loss of 9 miles of trail	Loss of 434 miles of trail	Loss of 1 mile of trail	Loss of 11 miles of trail	Loss of 70 miles of trail	Loss of 9 miles of trail

* The allocation of land to Recommended Wilderness will not affect mountain bike use in those areas. However, if Recommended Wilderness Areas are designated as Wilderness by Congress, then all mechanical and motorized transport forms of recreation, such as mountain bicycling, will be prohibited according to the Wilderness Act of 1964.

Motorized Trails and Roads for OHV Use: Mixed comments were received regarding the level of motorized trail opportunities that should be provided. Some comments suggested eliminating or decreasing opportunities for off-highway (OHV) and all-terrain vehicles (ATV). Most of the comments related to motorized recreation referenced high-clearance 4x4 trails and roads for OHV use. Some people desiring this type of opportunity requested that OHV routes be specifically identified and managed for that use.

Some comments received requested that the current level of ATV trails provided be maintained or increased. The site requirements for constructing new motorized trails are difficult to meet. The proposed Archer Run ATV Trail in the 1993 Forest Plan did not meet site requirements. The following table indicates the proposed change from current miles of motorized trails and featured OHV routes by Alternative.

Table C1.13 Estimated Change from Existing Miles of Motorized Trails by Alternative

Type(s) of Motorized Use Allowed	ALT A	ALT B	ALT C	ALT D	ALT E	ALT F	ALT G
ATVs* and motor-cycles	increase 10-25% or 6-16 miles	No change	No change	Increase 25-60%; or 16-40 miles	No change	Increase up to 10% or 6 miles.	Increase 5-10% or 3-6 miles
OHVs**	Increase 0-25 miles; roads are featured for OHVs.	No featured OHV roads; current level of high clearance roads	No roads managed for OHVs	Increase 20-40 miles; roads are featured for OHVs	No roads managed for OHVs	No featured OHV roads; current level of high clearance roads	No featured OHV roads; current level of high clearance roads

*ATV = Unlicensed four-wheeled vehicle, 50" wide or less, controlled by handle bar (not steering wheel), and has a seat that is straddled.
**OHV = Street legal, 4-wheel drive, high clearance vehicle.

Allocations of land to prescription areas for ATV/OHV trail riding opportunities will increase noise disturbance and may lessen the experience of other recreation participants such as hikers, hunters, fishermen, campers, and those seeking solitude.

Alternative A increases trail construction of both motorized and non-motorized trails and identifies featured OHV roads. Under Alternative A or D, the improved and expanded trail systems will reduce some of the unauthorized off-trail use.

Alternatives B and E include no significant increase or decrease in the current motorized or non-motorized miles of trail. Specific OHV roads are not featured in Alternative B, but high clearance roads will continue to be provided for OHV use at the current level. Under Alternative E, no roads are managed for OHVs. Other than this distinction in the OHV program, both Alternatives have an emphasis on maintaining the current dispersed recreation trails program.

Alternative C has the greatest potential for decreased miles of trail available to mountain bicycling users in the future. Mountain bikes will continue to be allowed in Recommended Wilderness areas, but are prohibited by law when Congress designates an area as Wilderness. Alternative C provides for increased miles of non-motorized trail, as long as there is no increase in trail maintenance costs. Alternative C makes maintenance of the trail system more challenging, as hand tools must be used rather than power tools in areas designated as Wilderness. Alternative C would reduce opportunities for recreation special events on the Forest if Recommended Wilderness areas are designated by Congress as Wilderness. This would include several annual recreation events such as long-distance pack and saddle enduros and running marathons. Alternative C includes no management for OHV roads, but does allow that existing ATV/OHV trails remain open.

The alternative with the most emphasis on expanding the existing overall trails program is Alternative D. It provides the greatest increases in the dispersed recreation trail systems, including hiking, mountain biking, horseback riding, ATV, OHV and interpretive trails. Alternative D increases dispersed recreation access points such as boat ramps and trailheads the greatest. This will result in greater user satisfaction, increased use of trails and easier access to different parts of the forest for some users. Alternative D also provides for increased interpretive trails that will enhance experiences for most visitors. Also, sharing information with users about ecosystems, history and resource management through interpretation often results in good partners in management.

However, with improved trails and increased access, some people may experience user conflicts as visitor levels on trails increase. Increases in the trail system could also have effects of more litter, safety concerns, law enforcement needs, search and rescue needs, and increased risk of wildland fires. The sustainability of this expanded dispersed recreation program is not addressed in Alternative D.

Alternative F focuses on improving the existing miles of non-motorized trails and improves and expands the existing ATV/OHV trail systems. It promotes a sustainable trails program that allows for expansion only when the resulting level of maintenance will be equivalent to or less than the existing maintenance needs. The improved trail system will increase user satisfaction and sustainability, and will decrease soil movement and sedimentation.

Alternative G provides for increased motorized and non-motorized trail miles when it is beneficial for the resources (such as relocations off of steep slopes and wet areas) and the extra miles result in no net increase in maintenance. Alternative G does not identify featured OHV routes, but provides for the current level of high clearance roads to be maintained for OHV use.

Scoping comments indicated a need to evaluate the closure of all existing ATV/OHV trail systems. This option was not included in any alternative due to its effects on current uses. If all of the current ATV/OHV trail systems were closed, the following effects could be expected:

- Loss of all legal recreation opportunities for ATV operators
- Loss of revenue to local communities from ATV users
- Increase in illegal use of ATVs on the forest
- Small decrease in sedimentation in streams draining the existing trail systems
- Reduction in noise in the vicinity of the existing trail systems on the Forest and adjacent private land
- Additional funding available to maintain other trails

All of the alternatives include a prescribed fire program. The preparation and execution of a prescribed burn can temporarily close trails, which may result in short-term dissatisfaction by trail users who need to postpone a recreation trip or find an alternative trail. Trails are sometimes used as control lines during a prescribed burn which can result in physical damage to the trail tread and/or trail profile. Fire lines that use trails and then veer off may appear to trail users to be a new trail. Standards will require the trails be repaired and any fire lines that merge into trail be rehabilitated following a prescribed fire, but the full restoration may require vegetative growth that takes time. The physical impacts to the trail environment can negatively impact the trail user's experience. Alternative E would have the largest prescribed burning program and therefore has the most potential for causing temporary closures to trails and temporary disturbances to the physical condition of trails. Alternative C, which would have a very limited prescribed burning program, has the least potential for negative impacts to trails.

The construction and presence of roads in close proximity to trails, and particularly when they physically cross trails, decreases trail user satisfaction due to noise, dust, safety concerns, and an interrupted trail use experience. Maintenance of the road may also result in damage to the trail at that intersection. Water runoff from the road could damage the trail tread and lead to increased maintenance needs. The alternatives that would have the most impacts on trails are A and D, as they allow for the most miles of new road construction and the least miles of road decommissioning. The alternatives that would have the least impacts, and potential for enhancing trails, are D and F because they provide for the least amount of new miles of road construction are the most miles of road decommissioning.

Many trails traverse ridge tops or have a ridge top viewpoint or rock outcrop as a destination. Industrial wind development would negatively impact trails and trail users' experience if access roads are in close proximity to or cross trails (for the same reasons cited above). The location of wind tower pads and turbines could displace trails and trail destinations on ridge tops. Alternatives C and E would provide the most protection to trails, as they do not allow for any wind development. Pertaining to industrial wind development, Alternative D has the

potential for the most impacts to trails, as it makes the entire Forest available for proposals for wind development. Alternative A is silent on direction for wind development.

Hunting and Fishing: The national forests are the largest provider of hunting and fishing opportunities in Virginia. Table C1.14 provides the approximate acreages by alternative for habitats conducive for big and small game hunting.

Table C1.14 Estimated Total Acres of Big & Small Game Emphasis Areas by Alternative (in thousands)

Type of Game Habitat (Management Prescription Area)	Rx Area	ALT A	ALT B	ALT C	ALT D	ALT E	ALT F	ALT G
Mix of Successional Habitats	8A1 8A1U	258 69.7	0 0	0 0	316.9 0	0 0	0 0	0 0
Early Successional Habitat	8B 8BU	38.9 0.8	0 0	0 0	34.0 0	0 0	0 0	0 0
Bear/Remote Habitat	8C 8CU	74.4 61.2	0 0	0 0	124.8 0	0 0	0 0	0 0
Mosaic of Habitats	13 13U	0 0	568.9 0	0 245.7	0 0	491.8 3.3	350.4 108.8	507.0 0
Suitable Acres Unsuitable Acres		371.3 131.7	568.9 0	0 245.7	475.7 0	491.8 3.3	350.4 108.8	507.0 0
TOTAL ACRES % of GWNF (approx.)		503.0 47%	568.9 53%	245.7 23%	475.7 45%	495.1 46%	459.3 43%	507.0 48%

Alternatives that allocate additional acres to big and small game emphasis areas will increase and enhance the hunting and wildlife viewing opportunities on the national forest. Alternatives A and D allocate acres to prescription areas specific to the type of habitat being emphasized, including early successional, mixed successional, and bear/remote habitat. Alternatives B, C, E, F and G allocate acres to a single prescription area with emphasis on providing mosaics of habitats for a variety of terrestrial species, including both game and non-game species.

Alternative B provides the greatest total acres of the forest with an emphasis on providing wildlife habitat. Alternative B provides the most opportunities for hunting and hunter satisfaction, with 53% of the national forest allocated to the mosaics of habitat prescription area. Alternatives G, A and E are next with the most acres allocated specifically to wildlife habitat management prescriptions, at 48%, 47% and 46% respectively.

Under Alternative D, acres of habitat management for big and small game hunting decreases only slightly from the current Forest Plan (Alternative A), but an emphasis on tourism and increased public access points will result in improved hunting and wildlife viewing opportunities.

Alternative C provides the least acres to prescription areas that emphasize habitat management, and provides the least variety of big and small game hunting opportunities. This alternative allocates about 23% of the national forest into the mosaics of habitat prescription area. The emphasis in this alternative is to slowly progress toward late successional forest habitats. The affects of this reduced variety of habitats is that some

forest users who enjoy hunting species that require early to mid successional habitats will find their opportunities decreasing as time passes. This results in lower user satisfaction among those hunters. On the other hand, people who prefer hunting for species found in late successional forest habitats will have increased opportunities and increased satisfaction.

Some areas may become easier to access under Alternatives B, G and E and some areas may become more difficult to access under Alternative C.

Some specific areas on the forest will not be managed for game species that were in the past; this will affect hunters more negatively by decreasing the places or the success ratio. Some areas will be managed differently than in the past and hunter satisfaction may increase in those areas. 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. Hunting is not allowed on Sundays during the hunting season and use in the general forest area, including trails could be higher during those days.

The quantity of stocked (put and take) streams and reservoirs are not expected to change over alternatives.

C2 – 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.

AFFECTED ENVIRONMENT

The 1993 Forest Plan Revision identified 12 streams that were eligible for inclusion in the National Wild and Scenic River System. The 12 eligible rivers or river segments traverse 12 counties in Virginia and West Virginia and have a combined length of 253.55 miles. A summary of the rivers determined to be eligible is Appendix D.

Rivers found eligible need further study to determine if they meet suitability criteria and should be recommended to Congress for addition to the Wild and Scenic River system. Until a final determination is made as to suitability or nonsuitability, the Forest Service is obligated to protect those qualities that made the rivers eligible.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

In all alternatives, protection is provided within a one-quarter mile corridor on each side of an eligible river (one-half mile total). Management activities allowed within this corridor are designed to meet the minimum protection requirements, given the river's potential classification.

C3– CULTURAL RESOURCES

AFFECTED ENVIRONMENT

The George Washington National Forest contains a multitude of sites representing past human events. Beginning with Native American occupations dating as early as 8000 B.C., the variety of cultural resources is impressive. Prehistoric sites include multi-use base camps, transient camps, hunting and gathering stations, quarries, lithic reduction stations, and rock-shelter occupations. The most common site type is often referred to as a lithic scatter and represents a short-term occupation where stone tools were made and/or sharpened and may be associated with a plethora of ancillary activities.

The earliest sites date to the Archaic Period and span the time from 8000 B.C. to 1000 B. C. Throughout this period, small bands of hunters and gatherers occupied both the mountains and the lower elevations exploiting a wide variety of forest resources. As the Archaic period came to an end, exploitation patterns began to focus on the riverine resources with more sedentary sites found along the rivers. This trend continued through the Woodland Period from about 1000 B.C. to A.D. 1650 where the rich alluvial soils were utilized in an intensification of gardening. The raising of horticulture foods, such as corn, beans, and squash, coupled with increased sedentism, led to an increase in population. Hunting and gathering remained important aspects of the economy and the higher elevations continued to be exploited. Native American sites are found throughout the Forest for all time periods with the exception of the Ice Age Paleo-Indian. Unknown Paleo-Indian sites may exist on the Forest but have yet to be located.

With the advent of the European occupation of the New World, Native American sites decreased in numbers with a concomitant increase in Euro-American sites. The area that is now the George Washington National Forest was first explored by the Europeans in the 17th century and intensive settlement began in the first and second quarters of the 18th century. Welsh, Scotch-Irish, Swedish, and German immigrants traveled down the Great Valley into the area that is now western and southwestern Virginia. The first historic site types were home and farmsteads closely followed by mills. As extractive industries developed through the 19th century, western Virginia and eastern West Virginia became a high producer of iron and timber. Historic sites for this period include log cabins and outbuildings associated with agriculture, cemeteries, mills, schools, iron furnace complexes, mines, colliers pits, logging camps, turnpikes and railroad features. The George Washington National Forest contains a large number of these historic features as well as later sites relating to the Civilian Conservation Corps that attempted to counter some of the environmental damage brought about by over-exploitation.

Standing structures are also important aspects of the historic era and require proactive management. Examples of significant structures on the George Washington National Forest include the Warwick house, Sherando Lake pavilion, Mount Torry Furnace, and Woodstock Tower.

Cultural resources are important resources that require inventory, evaluation, protection, and interpretation. Cultural resource management was previously viewed as a support function for timber management; currently, the trend is toward a resource treatment that recognizes the value of cultural resources in their own right. In order to manage these resources, complete inventories need to be implemented across the Forest. At that point, management alternatives can be developed and National Register of Historic Places nominations completed based on a full regional perspective.

Interpreting cultural resources for the public is an important aspect of cultural resource management. Standing structures readily lend themselves to public education and opportunities exist at the iron furnaces, Confederate Breastworks, and recreation areas originally constructed by the Civilian Conservation Corps. Archaeological sites, because of their fragility, are better interpreted off-site. Forest Service visitor information centers, local museums, historical societies, and traveling exhibits offer opportunities for education. The Forest also needs to recognize its responsibility to address research questions and share information with the lay and professional publics.

DIRECT AND INDIRECT EFFECTS

Direct and indirect affects to historic or cultural resources could result from both natural and human-caused events. These vary depending upon the type of resource, the fragility of the resource, and the type of disturbance, but could include soil disturbance to varying depths, wildland fire and prescribed fire, vegetation removal, erection of new structures, looting or vandalism, and land use changes.

Accordingly, five types of ground disturbing land management activities that vary in magnitude (acres or miles) have the greatest potential to affect cultural resources. These include: timber management, road construction, fire management, mineral management, and recreation use. To a lesser degree, other forms of land management, such as landownership adjustment (land exchange), special use permits, structures management, and wildlife management can also affect cultural resources.

Timber harvests may directly affect unknown significant cultural resources when soil is significantly disturbed by heavy machinery and vehicles, when trees are felled on historic ruins or cemeteries, when logs are skidded across sites, or indirectly when erosion is caused by removal or disruption of vegetation cover or increased surface soil exposure. In general terms, even-aged harvesting may create moderate to heavy disturbance for significant properties located on the ground surface or at shallow depths, and such disturbance may occur over most of the stand or area being harvested. An uneven-aged harvest or single tree selection would similarly disturb the properties located on the surface and in the upper soil matrix, but disturbed areas would be dispersed within the harvest area.

Table C3.1 Estimated Harvest Acres and Allowable Sale Quantity for Timber Management Activities by Alternative, First Decade

Activity	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Acres harvest, in thousands, first decade	30	30	0	49	18	10	30
Allowable Sale Quantity, in million cubic feet, first decade	47	54.3	0	101	31.1	20.4	54.3

Alternative D potentially affects the greatest number of acres through timber harvesting and Alternatives C and F the least. With any timber harvest method, the skid trails, log landings, and other areas where vehicle use is concentrated would receive the greatest depth of disturbance and thus provide the most significant direct effects to significant cultural properties. Indirect affects could include deterioration of sites and artifacts from subsequent erosion and increased site vandalism from increased access and surface exposure of historic sites.

Compliance-related inventories or Phase I inventory surveys would be conducted prior to timber harvest under any timber management program.

New road construction may directly affect unknown sites, given variables specific to each portion of construction. Disturbance within a construction corridor may remove soil containing cultural deposits, depending on the local situation. In cases where fill is added, cultural resources may be buried deeper. This may protect the site from compaction or rutting, while at the same time essentially precluding additional scientific study using conventional technology. Maintenance or reconstruction of existing roads presents less potential for direct effects to intact archeological sites because the majority of damage to an unknown site probably occurred during the original construction. Access to cultural resources provided by roads, however, may result in indirect effects to significant properties by facilitating increased vandalism. Indirect effects also may include erosion of cultural resources subsequent to road construction. Also, artifact exposure during construction could promote site vandalism.

Table C3.2 Miles of Road Construction per Year by Alternative

	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Road Construction, miles	2.9	1.5	0	4.1	1	0.5	1.5

Alternatives A and D potentially has the greatest adverse affects on cultural resources, while Alternatives C and F would have the least adverse affects.

Cultural resources may be directly and indirectly affected by heat damage to artifacts and sites and erosion of sites resulting from wild fires or prescribed fires. High-temperature wildland fire could pose direct effects to cultural resources by damaging surface or shallow archeological sites, standing structures, and cemetery markers. Sites of the historic period are most subject to direct effects from these events because many of these properties are more likely to exhibit surface artifacts. Studies show that wildfire, and in some cases higher temperature prescribed burns, may alter the character and condition of surface artifacts such as melting glass, "crazing" lithic and ceramic artifacts, and burning wood structures.

Prescribed fire could also similarly directly affect surface sites or very shallow site deposits and artifacts, but because of reduced temperature, to a much lesser degree than those fires resulting from wildland fire. However, wooden structures and cemetery markers could still be damaged, as could surface artifacts.

Fire lines installed with tractor-plow units, whether for wildfires or prescribed burns, could directly affect cultural resources by physically displacing artifacts located at shallow levels or on the ground. The nature of displacement is primarily laterally, as the plow folds soil and artifacts to each side of the fire line. When multiple parallel fire lines are used for wildland fire control, it would be possible to disturb a large portion of a small site. Fire lines established using a disc harrow would have less impact than those made with a tractor plow. In these cases lateral soil displacement would be minimal, but some fragile surface artifacts or artifacts located in shallow deposits may be broken.

Fires lines installed for prescribed burns are less likely to directly or indirectly affect historic resources since proposed fire plow lines in areas of prescribed burns are inventoried and field surveyed for the presence of cultural resources prior to project implementation. Under normal conditions, however, cultural surveys do not precede emergency fire line construction. Thus, there is a high potential for unknown properties to be affected by wildfire suppression. Indirect effects following the installation of fire lines and burning may include erosion losses due to the removal or burning of vegetation cover or further deterioration of artifact or feature condition following damage by high temperatures.

Table C3.3 Acres of Prescribed Fire per Year and Use of Unplanned Ignitions

	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Prescribed Fire, acres per year	3,000	12,000-20,000	Limited	5,000-12,000	20,000	12,000-20,000	12,000-20,000
Unplanned Ignitions	Allowed to achieve forest goals	Use to attain ecological objectives for bio-diversity	Allow to burn as much as possible	Use to attain ecological objectives for bio-diversity	Use to attain ecological objectives	Use to attain ecological objectives for bio-diversity	Use to attain ecological objectives for bio-diversity

Alternative E potentially affects the greatest number of acres through prescribed fire and Alternative C the least. Alternatives B, F and G follow Alternative E for having the most potential adverse affects on cultural resources.

Recreation management may be categorized as consisting of three types: concentrated developed recreation areas, dispersed recreation areas, and trails (off road vehicle trails, horse trails, and foot trails). In general, direct effects to significant cultural resources can result from installation of recreation facilities and expansion of recreation facilities and recreation use areas. Indirect effects could include soil erosion and compaction of cultural resources due to visitor use, and access to given locales could result in archeological site vandalism. These indirect effects could especially occur with illegal expansions off of established off road vehicle trails.

The incidence of vandalism and illicit collection is very much influenced by visitor use. Greater visitor use to some areas will lead to the increase of vandalism, illicit collection, littering and disturbance to cultural sites under all alternatives. Opening areas to timber production and timber manipulation, recreation use, and roads and trails will result in an increase in site disturbance and vandalism in inaccessible areas that previously were naturally protected from direct, indirect, and cumulative effects. While cultural properties situated in recreation areas and along designated trails and road corridors can be signed, monitored, patrolled and protected, the impacts outside of these areas are largely uncontrolled and the extent of impact unknown. However, the Forest Service does have the authority to close a specific road, trail or area that has considerable adverse effects to cultural resources (36 CFR 295.5, 36 CFR 800.9, and 43 CFR 8342) and prosecute, under 36 CFR 296.4 and other laws, those who willfully destroy or loot significant historic properties.

Table C3.4 Percent Change in Developed Recreation Capacity and Dispersed Recreation Trail Miles by Alternative

	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Developed Recreation, capacity	No change	Increase 0-5%	Decrease 5-15%	No change	Decrease 5-15%	Increase 5-15%	Increase 0-5%
Trails, miles	Increase 0-3%	No net change	Increase <3%	Increase 5-10%	No net change	Increase <3%	Increase <3%

No new developed recreation areas are planned under any of the Alternatives. Increases in capacity will be achieved by expanding existing recreation areas. The majority of this is expected to occur within already disturbed area. The greatest impacts to archaeological resources, related to recreation, will likely come from construction of new miles of trail. Alternative D affects the greatest number of acres through trail construction, and Alternative E the least.

Even though special use permits involve decreased federal jurisdiction of an area, the potential direct effect to significant cultural resources located in special use areas would be low, in most cases. This is partially due to the small acreages involved in special use areas and the limitations imposed upon special uses for the purposes of resource protection. Indirect effects to significant cultural properties located in special use areas, however, can occur through erosion and vandalism of cultural resources resulting from increased access and use of permit areas.

Analysis of effects to significant cultural resources located on lands placed under special use permit is performed programmatically in compliance with existing laws and regulations (36 CFR 296, 800, and the PMOA with the Tennessee SHPO) and occurs on a case-by-case basis apart from alternatives. As such, effects to cultural resources resulting from special use permits are not affected by alternative.

Exploration and development of leasable minerals, oil, gas, and mineral materials may impact cultural resources through access road construction, pipeline construction, well pad placement, and actual removal and displacement of minerals and soil. Mineral extraction may produce severe, albeit localized, direct effects to significant cultural resources as the overburden containing historic resources are removed. Indirect effects could include damage to significant cultural resources located outside the area of immediate mining resulting from erosion, the installation of road accesses and equipment staging areas, and vandalism and looting resulting from increased access to these historic properties.

Analysis of effects of minerals management to significant cultural resources is performed programmatically in compliance with existing laws and regulations (e.g., 36 CFR 296, 800, and the PA with the Virginia SHPO) and occurs on a case-by-case basis separate from alternatives. Therefore, effects to cultural resources resulting from minerals management are not affected by alternative.

Structures located on the George Washington National Forest that are determined to be historically significant are protected and maintained under the terms and conditions of existing federal laws and guidelines. The construction of new facilities could directly affect an unknown significant prehistoric or historic property. In most cases of concrete slab or footing construction, disturbance may extend into or below soil strata containing archeological deposits. Lighter facilities, such as boardwalks, piers, or structures located on pier foundations, would present less potential for damage although the potential remains.

The construction of new structures, or alteration or removal of historic structures could also directly affect significant cultural resources. An adverse effect is found when an undertaking may alter, directly or indirectly, any of the characteristics of a historic property that qualify the property for inclusion in the National Register, in a manner that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association. Construction of a new structure can introduce a visual effect that conflicts with or diminishes the historic setting and context of a property. Indirect effects could include erosion or vandalism of significant cultural resources facilitated by public access following construction of structures in the immediate vicinity.

Analysis of effects to significant historic structures and the effects of the construction of structures to cultural resources is performed programmatically in compliance with existing laws and regulations (e.g., 36 CFR 296, 800, and the PA with the Virginia SHPO) and occurs apart from alternatives. As such, effects to cultural resources resulting from land exchange from federal jurisdiction are not affected by alternative.

CUMULATIVE EFFECTS

Apart from these common effects, potential maximum direct, indirect and cumulative effects to cultural resources can be assessed according to the maximum extent within which ground-disturbing activities can potentially occur for each alternative. The principal proposed ground-disturbing activities include: timber, road construction, fire management and recreation. As articulated above, direct ground disturbing effects are estimated to be least in Alternative C and greatest in Alternative D.

Cumulatively, the repeated implementation of these project activities could, over time, result in the degradation of sites, a potential reduction in the number of intact historic properties, and increased site vandalism. However, the standards common to all alternatives are designed to inventory, evaluate, and preserve significant cultural resource values through avoiding, minimizing, or mitigating negative effects of these management activities.

C4- WILDERNESS AND INVENTORIED ROADLESS AREAS

AFFECTED ENVIRONMENT

WILDERNESS

The GWNF currently has six designated Wildernesses: Ramseys Draft, Rich Hole, Rough Mountain, St. Mary's, Three Ridges, and the Priest totaling about 40,000 acres or roughly 4% of the forest's area. One area, St. Mary's addition, totaling about 1,500 acres, was recommended for designation in the 1993 Forest Plan, but has not been designated. It continues to be managed to retain its wilderness attributes pending Congressional action on whether to designate or have the agency study it further.

The Desired Condition is to protect and perpetuate the wilderness character and values of these areas as directed in the Wilderness Act and subsequent Wilderness designating legislation including providing opportunities for solitude, education, physical and mental challenge, inspiration, scientific study and primitive recreation. Wilderness ecosystems are the result of natural succession and natural processes with as little human intervention as possible while retaining wilderness character. There should be little evidence of visitor use and low interaction among users. The few trails and associated facilities present are retained primarily to protect the wilderness resources. No motorized use is permitted. The plan provides specific standards for management of the various resources and activities that are or could potentially occur in the wildernesses including, recreation, fire, lands, minerals, fish and wildlife, insects and disease, research, search and rescue, special uses, and hydrology.

NATIONAL SCENIC AREAS

National Scenic Areas are also designated by Congress. Unlike Wilderness, there is no national direction for managing National Scenic Areas. The direction for a National Scenic Area is identified in the designating legislation. The GWNF has one National Scenic Area, Mt. Pleasant. The Mt. Pleasant National Scenic Area is about 7,700 acres in size. It is managed to: 1) ensure appropriate protection and preservation of the area's scenic quality, water quality, natural characteristics, and water resources; 2) Protect and manage vegetation to provide wildlife and fish habitat consistent with item 1; 3) provide areas that may develop characteristics of old-growth forests; and 4) provide a variety of recreation opportunities that are consistent with the preceding purposes.

POTENTIAL WILDERNESS AREAS

The first step in the evaluation of potential wilderness is to identify and inventory all areas within the National Forest System that satisfy the definition of wilderness. For areas in the Eastern United States (east of the 100th Meridian), the agency's evaluation yields one of the two following options: a) Manage the area for multiple uses other than wilderness; or b) Administratively recommend the area as a Wilderness Study Area to the United States Congress. Congress would then determine whether they want the agency to study any area further.

Final agency guidance (Forest Service Handbook (FSH) 1909.12 Chapter 70) on identifying potential areas was released on January 31, 2007. The methodology used to identify the Potential Wilderness Areas is described in *Guidance on How to Conduct the "Potential Wilderness Area Inventory" for the George Washington National Forest Plan.*

The Forest identified the following 37 areas as Potential Wilderness Areas (Table C4.1). Appendix C contains an evaluation of each of these areas in relation to their availability, capability, and the need to be recommended for designation as wilderness

Table C4.1 Potential Wilderness Areas

Potential Wilderness Name	Total GWNF Acres
Adams Peak	8,226
Archer Knob	7,110
Beards Mountain	10,152
Beech Lick Knob	14,087
Big Schloss	28,347
Crawford Knob	14,851
Dolly Ann	9,524
Duncan Knob	5,973
Elliott Knob	11,070
Galford Gap	6,689
Gum Run	14,547
High Knob	18,447
Jerkemtight	27,314
Kelley Mountain	12,892
Laurel Fork	10,236
Little Alleghany	15,395
Little Mare Mountain	11,918
Little River	30,227
Massanutten North	16,530
Oak Knob - Hone Quarry Ridge	16,343
Oliver Mountain	13,049
Paddy Knob	5,987
Potts Mountain	7,863
Ramseys Draft Addition	19,072
Rich Hole Addition	12,165
Rich Patch	5,625
Rough Mountain Addition	2,063
Saint Mary's North	3,006
Saint Mary's South	1,651
Saint Mary's West	278
Shaws Ridge	7,268
Shawvers Run Addition	84
Three Ridges Addition North	83
Three Ridges Addition South	187

Potential Wilderness Name	Total GWNF Acres
Three Ridges Addition Southwest	9
Three Ridges Addition West	90
Three Sisters	9,871
TOTAL ACRES	372,631

INVENTORIED ROADLESS AREAS

During the revision of the Forest Plan completed in 1993, the Forest completed a similar inventory and identified the areas as Inventoried Roadless Areas. In the late 1990's the Forest Service decided to develop consistent guidance for managing all of the Inventoried Roadless Areas on all National Forests. These Inventoried Roadless Areas became part of the national Roadless Area Conservation Rule in 2001. This rule has since been the subject of numerous lawsuits and its status is still to be determined in court. Due to the interest in these areas and the lack of resolution of the litigation, this analysis will address the management options for each of the Inventoried Roadless Areas in addition to the analysis of the Potential Wilderness Areas. The 1993 GW Plan EIS evaluated 27 inventoried roadless areas totaling more than 260,000 acres. The Plan allocated the roadless areas among the various Management Areas. Three areas, totaling about 12,000 acres were recommended for wilderness study: St. Mary's Addition, Three Ridges, and the Priest. The vast majority of the remaining acreage was allocated to Remote Highlands (121,000 acres), Special Management Areas (60,000 acres), and Special Interest Areas (32,000 acres). The Special Management Areas included Big Schloss, Little River, Laurel Fork, and Mt. Pleasant, each with its own Desired Future Condition and standards. According to the Plan, 89% of the roadless acreage is allocated to management areas which would preserve the roadless character. On the remaining 11%, approved projects could alter the roadless nature of a given area.

Two areas (Southern Massanutten and The Friar) from the 1993 roadless area inventory were not included in the Potential Wilderness Area inventory. The Friar is too small in size (2,051 acres) and Southern Massanutten has about 70 percent of the area underlain by privately owned minerals.

The Inventoried Roadless Areas and their relation to the Potential Wilderness Areas are displayed in Table C4.2.

Table C4.2 Potential Wilderness Areas and Inventoried Roadless Areas

Potential Wilderness Name	Potential Wilderness Area Acres	Inventoried Roadless Area Acres
Adams Peak	8,226	7,282
Archer Knob	7,110	
Beards Mountain	10,152	7,504
Beech Lick Knob	14,087	
Big Schloss	28,347	20,811
Crawford Knob	14,851	9,852
Dolly Ann	9,524	7,866
Duncan Knob	5,973	
Elliott Knob	11,070	9,391

Potential Wilderness Name	Potential Wilderness Area Acres	Inventoried Roadless Area Acres
Galford Gap	6,689	
Gum Run	14,547	12,620
High Knob	18,447	12,871
Jerkemtight	27,314	16,849
Kelley Mountain	12,892	7,742
Laurel Fork	10,236	10,053
Little Alleghany	15,395	10,207
Little Mare Mountain	11,918	
Little River	30,227	27,180
Massanutten North	16,530	9,459
Oak Knob - Hone Quarry Ridge	16,343	10,852
Oliver Mountain	13,049	13,089
Paddy Knob	5,987	
Potts Mountain	7,019	
Ramseys Draft Addition	19,072	12,814
Rich Hole Addition	12,165	10,919
Rich Patch	871	
Rough Mountain Add	2,063	1,154
Saint Mary's North	3,006	
Saint Mary's South	1,651	1,478
Saint Mary's West	278	
Shaws Ridge	7,268	
Shawvers Run Addition	84	
Southern Massanutten		12,080
The Friars		2,051
Three Ridges Add North	83	
Three Ridges Add South	187	
Three Ridges Add SW	9	
Three Ridges Add West	90	
Three Sisters	9,871	8,154
TOTAL GWNF ACRES	372,631	242,278

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

WILDERNESS

Wilderness has many positive effects. As stated above, wilderness preserves natural systems and provides places of solitude for visitors. However, there are environmental effects within wilderness from many sources. Recreational use can have negative impacts to the quality, character and integrity of the wilderness resource due to overuse. Some of these negative impacts include soil compaction; vegetation loss due to disturbance and/or replacement by non-native species such as noxious weeds on trails and campsites caused by heavy recreation use; 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/ecological processes and biodiversity, through human disturbance.

Other environmental effects which 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.

No significant new management direction is being proposed for any of the existing six designated wilderness areas on the forest under any of the alternatives so there are no significant direct, indirect, or cumulative effects to the existing wilderness resource. Additions to existing wildernesses are proposed under some alternatives by allocating adjacent lands to proposed wilderness study areas. See the potential wilderness area discussion below.

NATIONAL SCENIC AREAS

Identification of recommended National Scenic Areas is not a requirement of forest planning. However, several areas were identified during scoping for recommendation.

In Alternative D the 8,000 acre Adams Peak area is recommended as an NSA. This would change the area from its current management as Remote Highlands. A small portion of the area that is suitable for timber harvest is excluded from the NSA, so no suitable land is affected by the recommendation.

Since the actual management of any NSA would be determined by the legislation, it is assumed for this analysis that the legislation would be similar to that used to designate other NSAs in Virginia.

Designation as a National Scenic Area would likely prevent the construction of roads, the harvest of timber, the development of minerals, and construction associated with special use permits. Non-motorized recreation would continue, including bicycle use and hunting. The use of prescribed fire would be allowed. Designation would likely require survey and posting of the boundary. It would highlight the area and potentially increase use and income to the local community. Any desired future changes in management of the area would require legislation rather than a plan amendment.

In Alternative F National Scenic Area recommendations include the Virginia portion of Shenandoah Mountain between Highway 33 and Highway 250, Kelley Mountain, and Adams Peak for a total of 130,000 acres.

POTENTIAL WILDERNESS AREAS

Decisions on the Potential Wilderness Areas have environmental consequences, regardless of whether or not they are recommended for wilderness study areas. The magnitude of the effects varies by alternative depending upon the management prescription area to which each area is assigned.

Table C4.3 summarizes all Potential Wilderness Area allocations by category across the alternatives. Three categories are used to summarize how each Potential Wilderness Area is allocated in the alternatives. These categories are: 1) Recommended Wilderness Study; 2) Remote Character (includes Remote Backcountry, Recommended National Scenic Area, Shenandoah Mountain Crest - Cow Knob Salamander Area, Special

Biological Areas and Wild and Scenic River Corridors); and 3) Other (management prescription areas not designed to maintain the remote character of the area).

Table C4.3 Management Prescription Area Allocations within Potential Wilderness Areas and Inventoried Roadless Areas

Potential Wilderness Name	PWA Acres	IRA Acres	PWA-IRA Acres	ALT A			ALT B			ALT C		
				Recomm Wild Ac	Remote Ac	Other Ac	Recomm Wild Ac	Remote Ac	Other Ac	Recomm Wild Ac	Remote Ac	Other Ac
Adams Peak (PWA, IRA)	8,200		900			900		900		900		
		7,300			7,200	100		7,300		7,300		
Archer Knob (PWA)	7,100		7,100			7,100			7,100	7,100		
Beards Mountain (PWA, IRA)	10,100		2,600			2,600		2,600		2,600		
		7,500			7,200	300		7,500		7,500		
Beech Lick Knob (PWA)	14,100		14,100			14,100		5,600	8,500	14,100		
Big Schloss (PWA, IRA)	28,300		7,600			7,600			7,600	7,600		
		20,800			20,800			20,800		20,800		
Crawford Knob (PWA, IRA)	14,800		5,000			5,000			5,000	5,000		
		9,900			8,500	1,400		8,600	1,300	9,900		
Dolly Ann (PWA, IRA)	9,500		1,700			1,700			1,700	1,700		
		7,900			4,900	3,000		7,100	800	7,900		
Duncan Knob (PWA)	6,000		6,000			6,000			6,000	6,000		
Elliott Knob (PWA, IRA)	11,100		1,700			1,700			1,700	1,700		
		9,400			8,700	700		9,200	200	9,400		
Galford Gap (PWA)	6,700		6,700			6,700			6,700	6,700		
Gum Run (PWA, IRA)	14,500		1,900			1,900			1,900	1,900		
		12,600			12,500	100		12,600		12,600		
High Knob (PWA, IRA)	18,400		5,600			5,600			5,600	5,600		
- Dry Run (IRA)		7,200			3,500	3,700		6,700	500	7,200		
- Skidmore (IRA)		5,600			5,600			5,600		5,600		
Jerkemtight (PWA, IRA)	27,300		10,500			10,500			10,500	10,500		
		16,800			16,000	900		16,000	800	16,800		
Kelley Mountain (PWA, IRA)	12,900		5,200			5,200			5,200	5,200		
		7,700			7,700			7,700		7,700		
Laurel Fork (PWA, IRA)	10,200		200			200			200	200		
		10,000			10,000			10,000		10,000		

Potential Wilderness Name	PWA Acres	IRA Acres	PWA-IRA Acres	ALT A			ALT B			ALT C		
				Recomm Wild Ac	Remote Ac	Other Ac	Recomm Wild Ac	Remote Ac	Other Ac	Recomm Wild Ac	Remote Ac	Other Ac
Little Alleghany (PWA, IRA)	15,400		5,200			5,200			5,200	5,200		
		10,200			7,200	3,000		9,500	700	10,200		
Little Mare Mountain (PWA)	11,900		11,900			11,900			11,900	11,900		
Little River (PWA, IRA)	30,200		3,000			3,000			3,000	3,000		
		27,200			26,100	1,000	12,600	13,500	1,000	27,100		
Massanutten North (PWA, IRA)	16,500		7,100			7,100			7,100	7,100		
		9,500			9,300	200		9,500		9,500		
Oak Knob-Hone Quarry Ridge (PWA, IRA)	16,300		5,500			5,500			5,500	5,500		
		10,800			9,400	1,400		10,000	800	10,800		
Oliver Mountain (PWA, IRA)	13,100											
		13,100			13,100			13,100		13,100		
Paddy Knob (PWA)	6,000		6,000			6,000			6,000	6,000		
Potts Mountain (PWA)	7,000		7,000			7,000			7,000	7,000		
Ramseys Draft Add. (PWA, IRA)	19,100		6,300			6,300			6,300	6,300		
		12,800			12,700	100	3,100	9,700	0	12,800		
Rich Hole Addition (PWA, IRA)	12,200		1,200			1,200			1,200	1,200		
		10,900			7,600	3,300	4,700	4,700	1,500	10,900		
Rich Patch (PWA)	900		900			900			900	900		
Rough Mountain Add. (PWA, IRA)	2,100		900			900			900	900		
		1,200				1,100		1,100		1,100		
St Mary's North (PWA)	3,000		3,000			3,000			3,000	3,000		
St Mary's South (PWA, IRA)	1,700		200			200			200	200		
		1,500		1,500				1,500		1,500		
St Mary's West (PWA)	300		300			300	300			300		
Shaws Ridge (PWA)	7,300		7,300			7,300			7,300	7,300		

Potential Wilderness Name	PWA Acres	IRA Acres	PWA-IRA Acres	ALT A			ALT B			ALT C		
				Recomm Wild Ac	Remote Ac	Other Ac	Recomm Wild Ac	Remote Ac	Other Ac	Recomm Wild Ac	Remote Ac	Other Ac
Shawvers Run Add (PWA)	100		100			100			100	100		
Three Ridges Add North (PWA)	100		100			100			100	100		
Three Ridges Add South (PWA)	200		200			200			200	200		
Three Ridges Add SW (PWA)	9		9			9			9	9		
Three Ridges Add West (PWA)	100		100			100			100	100		
Three Sisters (PWA, IRA)	9,900		1,700			1,700			1,700	1,700		
		8,200			8,200			8,200	0	8,200		
Southern Massanutten (IRA)												
		12,100			12,100			12,100		12,100		
The Friars (IRA)												
		2,000			2,000			2,000		2,000		
Whites Peak												
			4,200		4,200						4,200	
TOTAL ACRES IN ALL AREAS	372,609	242,200	149,009	1,500	224,500	165,109	20,700	223,100	143,009	386,809	4,200	0

Potential Wilderness Name	PWA Acres	IRA Acres	PWA-IRA Acres	ALT D			ALT E			ALT F		
				Recomm Wild Ac	Remote Ac	Other Ac	Recomm Wild Ac	Remote Ac	Other Ac	Recomm Wild Ac	Remote Ac	Other Ac
Adams Peak (PWA, IRA)	8,200		900		900			100	800		900	
		7,300			7,300			7,300			7,300	
Archer Knob (PWA)	7,100		7,100		0	7,100		7,100			0	7,100
Beards Mountain (PWA, IRA)	10,100		2,600		800	1,800		2,600			800	1,800
		7,500			7,500			7,500			7,500	
Beech Lick Knob (PWA)	14,100		14,100		5,600	8,500		14,100		11,600	2,500	
Big Schloss (PWA, IRA)	28,300		7,600		200	7,400		200	7,400		7,600	
		20,800			20,800			20,800		7,200	13,600	
Crawford Knob (PWA, IRA)	14,800		5,000			5,000		2,500	2,500		2,500	2,500
		9,900			8,500	1,400		9,900			9,900	
Dolly Ann (PWA, IRA)	9,500		1,700			1,700		500	1,200		400	1,200
		7,900			7,300	500		7,900			7,900	
Duncan Knob (PWA)	6,000		6,000		100	5,900		3,700	2,300		4,700	1,300
Elliott Knob (PWA, IRA)	11,100		1,700			1,700			1,700		1,700	
		9,400			9,400			9,400	0		9,400	
Galford Gap (PWA)	6,700		6,700			6,700			6,700		6,700	
Gum Run (PWA, IRA)	14,500		1,900		500	1,400		1,900			1,900	
		12,600			12,600			12,600			12,600	
High Knob (PWA, IRA)	18,400		5,600		300	5,300		5,600			5,600	
- Dry Run (IRA)		7,200			7,200			7,200			7,200	
- Skidmore (IRA)		5,600			5,600			5,600		5,600		
Jerkemtight (PWA, IRA)	27,300		10,500		100	10,400		6,200	4,300		6,200	4,300
		16,800			16,100	800		16,800			16,800	
Kelley Mountain (PWA, IRA)	12,900		5,200		4,900	300		4,900	300		4,900	300
		7,700			7,700			7,700			7,700	
Laurel Fork (PWA, IRA)	10,200		200		200			200		200		
		10,000			10,000			10,000		10,000		

Potential Wilderness Name	PWA Acres	IRA Acres	PWA-IRA Acres	ALT D			ALT E			ALT F		
				Recomm Wild Ac	Remote Ac	Other Ac	Recomm Wild Ac	Remote Ac	Other Ac	Recomm Wild Ac	Remote Ac	Other Ac
Little Alleghany (PWA, IRA)	15,400		5,200			5,200			5,200	5,200		
		10,200			9,200	1,100		9,100	1,100	10,200		
Little Mare Mountain (PWA)	11,900		11,900		200	11,700		11,900			6,500	5,400
Little River (PWA, IRA)	30,200		3,000		641	2,400		3,000			600	2,400
		27,200			27,200		12,700	14,500		12,700	14,500	
Massanutten North (PWA, IRA)	16,500		7,100		2,000	5,000		2,000	5,000		2,000	5,000
		9,500			9,500			9,500			9,500	
Oak Knob-Hone Quarry Ridge (PWA, IRA)	16,300		5,500		1,100	4,400		5,500			5,500	
		10,800			9,600	1,200		10,800			10,800	
Oliver Mountain (PWA, IRA)	13,100											
		13,100			13,100			13,100		8,700	4,400	
Paddy Knob (PWA)	6,000		6,000		900	5,100		900	5,100		6,000	
Potts Mountain (PWA)	7,000		7,000		100	7,000		7,000		4,200	2,800	
Ramseys Draft Add. (PWA, IRA)	19,100		6,300		800	5,400		1,600	4,700		6,200	
		12,800			12,800		3,100	9,700		12,400	400	
Rich Hole Addition (PWA, IRA)	12,200		1,200			1,200			1,200	200	1,000	
		10,900		4,700	4,700	1,500	4,700	4,700	1,500	10,900		
Rich Patch (PWA)	900		900		900			900			900	
Rough Mountain Add. (PWA, IRA)	2,100		900		100	800	900			900		
		1,200			1,200		1,200			1,200		
St Mary's North (PWA)	3,000		3,000		3,000			3,000			3,000	
St Mary's South (PWA, IRA)	1,700		200		200		200			200		
		1,500			1,500		1,500			1,500		
St Mary's West (PWA)	300		300	200	100		200	100		200	100	
Shaws Ridge (PWA)	7,300		7,300		100	7,200		7,300			7,300	

Potential Wilderness Name	PWA Acres	IRA Acres	PWA-IRA Acres	ALT D			ALT E			ALT F		
				Recomm Wild Ac	Remote Ac	Other Ac	Recomm Wild Ac	Remote Ac	Other Ac	Recomm Wild Ac	Remote Ac	Other Ac
Shawvers Run Add (PWA)	100		100		100			100			100	
Three Ridges Add North (PWA)	100		100		100			100		100		
Three Ridges Add South (PWA)	200		200		200			200		200		
Three Ridges Add SW (PWA)	9		9		9			9		9		
Three Ridges Add West (PWA)	100		100		100			100		100		
Three Sisters (PWA, IRA)	9,900		1,700		600	1,100		200	1,500		1,700	
		8,200		5,500	2,600			8,200		5,500	2,600	
Southern Massanutten (IRA)												
		12,100			12,100			12,100			12,100	
The Friars (IRA)												
		2,000			2,000			2,000			2,000	
Whites Peak												
			4,200	4,200				4,200		4,200		
TOTAL ACRES IN ALL AREAS	372,609	242,200	149,009	14,600	250,350	126,200	24,500	314,109	52,500	113,209	246,300	31,300

Potential Wilderness Name	PWA Acres	IRA Acres	PWA-IRA Acres	ALT G		
				Recomm Wild Ac	Remote Ac	Other Ac
Adams Peak (PWA, IRA)	8,200		900		100	800
		7,300			7,300	
Archer Knob (PWA)	7,100		7,100		4,900	2,200
Beards Mountain (PWA, IRA)	10,100		2,600		800	1,800
		7,500			7,500	
Beech Lick Knob (PWA)	14,100		14,100		8,300	5,800
Big Schloss (PWA, IRA)	28,300		7,600		200	7,400
		20,800			20,800	
Crawford Knob (PWA, IRA)	14,800		5,000			5,000
		9,900			8,600	1,300
Dolly Ann (PWA, IRA)	9,500		1,700		500	1,200
		7,900			7,900	
Duncan Knob (PWA)	6,000		6,000		3,400	2,600
Elliott Knob (PWA, IRA)	11,100		1,700			1,700
		9,400			9,400	0
Galford Gap (PWA)	6,700		6,700			6,700
Gum Run (PWA, IRA)	14,500		1,900		1,900	
		12,600			12,600	
High Knob (PWA, IRA)	18,400		5,600		1,500	4,100
- Dry Run (IRA)		7,200			7,200	
- Skidmore (IRA)		5,600			5,600	
Jerkemtight (PWA, IRA)	27,300		10,500		6,800	3,600
		16,800			16,800	
Kelley Mountain (PWA, IRA)	12,900		5,200		2,400	2,800
		7,700			7,700	
Laurel Fork (PWA, IRA)	10,200		200		200	
		10,000			10,000	

Potential Wilderness Name	PWA Acres	IRA Acres	PWA-IRA Acres	ALT G		
				Recomm Wild Ac	Remote Ac	Other Ac
Little Alleghany (PWA, IRA)	15,400		5,200		100	5,000
		10,200			10,200	
Little Mare Mountain (PWA)	11,900		11,900		4,500	7,400
Little River (PWA, IRA)	30,200		3,000		1,600	1,500
		27,200		9,300	17,800	
Massanutten North (PWA, IRA)	16,500		7,100		2,000	5,000
		9,500			9,500	
Oak Knob-Hone Quarry Ridge (PWA, IRA)	16,300		5,500		5,500	
		10,800			10,800	
Oliver Mountain (PWA, IRA)	13,100					
		13,100			13,100	
Paddy Knob (PWA)	6,000		6,000		900	5,100
Potts Mountain (PWA)	7,000		7,000			7,000
Ramseys Draft Add. (PWA, IRA)	19,100		6,300		2,900	3,400
		12,800		6,100	6,700	
Rich Hole Addition (PWA, IRA)	12,200		1,200		200	1,000
		10,900		4,700	6,200	
Rich Patch (PWA)	900		900		900	
Rough Mountain Add. (PWA, IRA)	2,100		900			900
		1,200			1,200	
St Mary's North (PWA)	3,000		3,000		3,000	
St Mary's South (PWA, IRA)	1,700		200			200
		1,500			1,500	
St Mary's West (PWA)	300		300			
				300		
Shaws Ridge (PWA)	7,300		7,300		7,300	

Potential Wilderness Name	PWA Acres	IRA Acres	PWA-IRA Acres	ALT G		
				Recomm Wild Ac	Remote Ac	Other Ac
Shawvers Run Add (PWA)	100		100			100
Three Ridges Add North (PWA)	100		100		100	
Three Ridges Add South (PWA)	200		200		200	
Three Ridges Add SW (PWA)	9		9		9	
Three Ridges Add West (PWA)	100		100		100	
Three Sisters (PWA, IRA)	9,900		1,700		200	1,500
		8,200			8,100	
Southern Massanutten (IRA)						
		12,100			12,100	
The Friars (IRA)						
		2,000			2,000	
Whites Peak						
			4,200		4,200	
TOTAL ACRES IN ALL AREAS	372,609	242,200	149,009	20,400	285,309	85,100

Potential Wilderness Areas that are Recommended for Wilderness Study

Allocation of Potential Wilderness Areas, or portions of these areas, to Recommended Wilderness Study would increase the number of areas 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. Like wilderness, these are areas where the naturalness, undeveloped conditions, and representative ecosystems would be preserved. The highest priority for management would be to preserve the characteristics of the area that resulted in its consideration for wilderness study, pending actual wilderness designation. Recommended Wilderness Study Areas are not available for activities such as vegetative management or road construction. Pending actual wilderness designation, existing roads and trails and wildlife openings can be maintained using motorized equipment and bicycles can continue to use trails in these areas.

The remainder of this section describes the effects that would occur if the areas were designated as wilderness by Congress. Potential Wilderness Areas and Inventoried Roadless Areas recommended for wilderness study are displayed by alternative in Table C4.4. Alternative C recommends all of the Potential Wilderness Areas and Southern Massanutten and the Friars Inventoried Roadless Areas for wilderness study. This would result in about 40 percent of the GWNF in wilderness. The largest wilderness would be Little River at about 30,000 acres in size. Little River would be separated by a Forest Service Road from Ramseys Draft (about 25,000 acres). Four other wilderness areas (Shaws Ridge, Gum Run, Oak Knob/Hone Quarry Ridge, and High Knob) are also adjacent to Ramseys Draft or Little River and are separated by Forest Service Roads. The total complex of these areas would be about 110,000 acres in size. Alternative C would also recommend 5 areas on the northern end of the Forest, where there are currently no wilderness areas. These wilderness areas would be closer to the population in the Washington metro area.

Table C4.4 Numbers of Areas and Acres Allocated to Recommended Wilderness Study by Alternative

	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Adams Peak			8,226				
Archer Knob			7,110				
Beards Mountain			10,152				
Beech Lick Knob			14,087			11,600	
Big Schloss			28,347			7,218	
Crawford Knob			14,851				
Dolly Ann			9,524				
Duncan Knob			5,973				
Elliott Knob			11,070				
Galford Gap			6,689				
Gum Run			14,547				
High Knob			18,447			5,617	
Jerkemtight			27,314				
Kelley Mountain			12,892				
Laurel Fork			10,236			10,236	
Little Alleghany			15,395			15,395	
Little Mare Mountain			11,918				
Little River		9,348	30,227		12,657	12,657	9,348
Massanutten North			16,530				
Oak Knob - Hone Quarry Ridge			16,343				
Oliver Mountain			13,049			8,712	
Paddy Knob			5,987				
Potts Mountain			7,019			4,183	
Ramseys Draft Addition		6,114	19,072		3,130	12,412	6,114

	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Rich Hole Addition		4,703	12,165	4,703	4,703	11,169	4,714
Rich Patch			871				
Rough Mountain Add			2,063		2,063	2,063	
Saint Mary's North			3,006				
Saint Mary's South	1,478		1,651		1,651	1,654	
Saint Mary's West		278	278	179	178	179	278
Shaws Ridge			7,268				
Shawvers Run Addition			84				
Southern Massanutten			12,080				
The Friars			2,051				
Three Ridges Add North			83			83	
Three Ridges Add South			187			187	
Three Ridges Add SW			9			9	
Three Ridges Add West			90			90	
Three Sisters			9,871	5,549		5,549	
Whites Peak				4,255		4,255	
Total	1,478	20,443	386,762	14,686	24,382	113,268	20,454

Alternatives B, E, and G focus on recommending stand-alone wilderness areas and wilderness area additions that could result in wilderness areas of a size and scale where natural processes can begin to be the dominant influence on the areas.

Alternative F was based on recommendations from a number of wilderness advocacy groups. Many of the Potential Wilderness Area boundaries were adjusted to accommodate important bicycle trails, roads and other uses that would be excluded with wilderness designation. This alternative could result in about 14 percent of the GWNF in wilderness.

Table C4.5 displays the ecological subsections represented currently by designated wilderness on the forest as well as those that could potentially be added after wilderness studies are completed.

Table C4.5 Ecological Sections/Subsections represented by Wilderness or Recommended Wilderness Study areas by Alternative, acres

Ecological Section/Subsection	Existing Wilderness	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
M221Da - Blue Ridge Section/Northern Blue Ridge Subsection	111,215	1,478	278	38,344	9,983	1,829	12,006	278
M221Aa - Northern Ridge and Valley Section/ Ridge and Valley Subsection	86,090	0	20,490	283,226	4,703	22,553	83,329	20,490
M221Ab - Northern Ridge and Valley Section/Great Valley of Virginia	0	0	0	34,583	0	0	0	0
M221Bd - Allegheny Mountains Section/Eastern Allegheny Mountain and Valley	11,174	0	0	20,374	0	0	7,698	0

Ecological Section/Subsection	Existing Wilderness	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
M221Ba – Allegheny Mountains Section/Northern High Allegheny Mountain	56,913	0	0	10,236	0	0	10,236	0

Direct effects of managing wilderness study areas include maintaining soil, hydrologic and atmospheric conditions prevailing within the areas. Roads would be a priority for closure and rehabilitation or a return to a natural state. Water quality and air quality would remain high and the imprint of human influence would generally diminish over time.

If the recommended wilderness study areas become designated wilderness, 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 and use levels would be expected t remain about the same as currently takes place. The total wilderness recreation carrying capacity would essentially increase, allowing enhanced opportunities for solitude, challenge, and primitive recreation experiences. However, road closures would result in decreased access for some activities. A decrease in opportunities for bicycling, off-highway vehicles and other forms of recreation requiring motorized transport or mechanized equipment would result. Bicycle and motorized use would be displaced to other areas.

Table C4.6 shows, by alternative, the miles of system trail that would be closed to bicycle and/or motorcycle use if the recommended wilderness study areas were designated as wilderness. Bicycle use is the most heavily affected across the alternatives.

Table C4.6 Miles of Trails to be Closed to Bicycles and Motorcycles by Alternative if Recommended Wilderness Study Areas become Wilderness

	A	B	C	D	E	F	G
Trails to be closed to bicycles	0	9	434	1	11	70	9

Bicycles are also allowed on closed roads across the GWNF, unless otherwise specified. Table C4.7 enumerates miles of road that would be decommissioned and thus closed to motorized and bicycle use. Alternative C would close the highest number of miles, in 16 separate areas.

Table C4.7 Miles of Road to be Closed by Alternative if Recommended Wilderness Study Areas become Wilderness

	A	B	C	D	E	F	G
Roads to be decommissioned	0	0	159	3	1	19	0

Maintenance of trails and facilities, including the Appalachian Trail and associated shelters sites would be done using hand tools only and access would be made using non- mechanized/non-motorized means. Access would be made using non-mechanized/non-motorized means. Currently competitive events are held on some of the trails on the GWNF. These would not be allowed on the sections of trail in designated wilderness. Current events would only be affected in Alternative C.

Research (Cordell 1999) indicates that additional wilderness would potentially increase National Forest visitation. This, in turn, would increase economic benefits resulting from tourism in the surrounding local communities. However, there would also be a reduction in economic benefits associated with the

management, harvesting, manufacturing and retail sale of timber products from these areas since timber management activities would not be allowed. The reduction of timber harvest opportunities would be greatest in Alternative C (Table C4.8). Alternative F is the only other alternative that would affect timber harvest, since the other alternatives only recommend areas that are currently unsuitable for timber production. There would be reduced opportunities to recover commercial minerals and mineral exploration and development will be hindered.

Table C4.8 Effects of Wilderness Designation on Timber and Mineral Resources

	A	B	C	D	E	F	G
	Acres Recommended for Wilderness Study						
Lands Tentatively Suitable for Timber Production	1,116	19,182	346,329	12,739	22,645	106,273	19,182
Lands Suitable for Timber Production in 1993 Forest Plan	0	1,202	78,278	1,485	2,688	20,350	1,202
Lands Underlain with Privately Owned Minerals	253	0	37,280	581	2,956	9,976	0

As shown in Table C4.8, Alternative C has the greatest amount of acreage and number of areas with privately owned subsurface mineral rights. Requests for access to these interests would be recognized and reasonable access granted. The potential for development of energy minerals and other leasable and common minerals is estimated to be low, but if gas deposits in the Marcellus shale on the GWNF are found to be sufficient for development, this could change. There are no existing federal oil or gas leases or other Federal mineral leases in effect in any of the areas recommended for wilderness study. These areas are administratively unavailable for federal oil and gas and other federal mineral leases, pending final Congressional action. These areas are not available for mineral materials for commercial purposes. Administrative use of mineral materials is allowed but use and impacts would be extremely low.

Wilderness areas that have extensive boundaries adjacent to private lands can cause management problems. This reduces access to the area for the general forest user and for Forest Service managers. Unauthorized uses, such as ATV trails, other trails, clearing and temporary or permanent structures can occur, with very limited opportunities to find or correct the problems. It can also exacerbate fire and rescue needs in the wilderness area. The areas recommended for wilderness study with the greatest boundary concerns are displayed in Table C4.9.

Table C4.9 Private Land Boundaries (Miles and Percent of the Perimeter) on Recommended Wilderness Study by Alternative

	Alt A		Alt B		Alt C		Alt D		Alt E		Alt F		Alt G	
PWA Name	**Miles**	**%**	**Miles**	**%**	**Miles**	**%**	**Miles**	**%**	**Miles**	**%**	**Miles**	**%**	**Miles**	**%**
Adams Peak					21.2	68%								
Archer Knob					6.2	22%								
Beards Mountain					26.3	70%								
Beech Lick Knob					19.5	51%					14.7	47%		
Big Schloss (Three High Heads in Alt F)					23.1	35%					1.2	6%		
Crawford Knob					20.0	58%								
Dolly Ann					11.8	54%								
Duncan Knob					9.2	44%								
Elliott Knob					2.7	9%								
Galford Gap					16.3	66%								
Gum Run					17.8	50%								
High Knob					14.2	28%					2.8	14%		
Jerkemtight					14.9	21%								
Kelley Mountain					6.8	21%								
Laurel Fork					16.9	77%					16.9	77%		
Little Alleghany					39.0	75%					39.0	75%		
Little Mare Mountain					12.2	33%								
Little River			0	0%	8.1	21%	1.2	6%	1.2	6%	1.2	6%	0%	0%
Massanutten North					48.6	69%								
Oak Knob - Hone Quarry					4.7	15%								
Oliver Mountain					34.3	77%					27.3	79%		
Paddy Knob					9.8	50%								
Potts Mountain					11.0	32%					2.1	14%		
Ramseys Draft Add.			0	0%	10.2	19%			0%	0%	6.5	34%	0%	0%
Rich Hole Addition			3.8	29%	12.9	36%	3.8	29%	3.8	29%	12.9	35%	3.8	29%
Rich Patch					9.1	37%								
Rough Mountain Add.					5.4	54%			5.4	54%	5.4	54%		
Saint Mary's North					0.7	6%								
Saint Mary's South	2.0	19%			5.9	56%			5.9	56%	5.9	56%		
Saint Mary's West			0.5	19%	0.5	19%	0.5	19%	0.5	19%	0.5	19%	0.5	19%

	Alt A		Alt B		Alt C		Alt D		Alt E		Alt F		Alt G	
PWA Name	**Miles**	**%**	**Miles**	**%**	**Miles**	**%**	**Miles**	**%**	**Miles**	**%**	**Miles**	**%**	**Miles**	**%**
Shaws Ridge					26.4	87%								
Shawvers Run Add.					0.6	32%								
Southern Massanutten														
The Friars														
Three Ridges Add. N					0.8	33%					0.8	33%		
Three Ridges Add. S					1.6	51%					1.6	51%		
Three Ridges Add. SW					0.3	40%					0.3	40%		
Three Ridges Add. W					1.1	65%					1.1	65%		
Three Sisters					5.7	30%	5.0	29%			5.0	29%		
Whites Peak							9.4	58%			9.4	58%		

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 will 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 will succeed to forest. New permanent wildlife openings would not be created. These factors would reduce habitat for early successional species. Fish stocking in areas recommended for wilderness study would be restricted to reestablishment or maintenance of indigenous, threatened, endangered, or sensitive species with Forest Supervisor authorization. Rare communities and threatened and endangered species would be managed within the limitation of activities allowed within wilderness study areas.

Many of the areas contain wildlife openings managed by mowing, constructed wildlife ponds or special habitat management areas. These openings would no longer be maintained.

Some of the areas contain TES species, rare plants or rare communities. The significance of the effects on these resources depends upon the number of areas and the kinds and intensity of activities in the areas. Wilderness designation can have mixed effects on these resources. Designation prevents many types of activities (such as road construction, habitat manipulation, mineral developments, special use development) that could adversely affect the resources. Designation can also prevent, or significantly increase the cost and efficacy of management activities that could enhance habitat conditions for these resources. Many rare communities need, or are enhanced by, fire. The use of prescribed fire in wilderness is difficult, so species that need fire would likely only be enhanced by wildfires. In addition, several of the areas contain acidified streams. Treating acidified streams in wilderness, is possible, but difficult. See Table C4.10.

Table C4.10 Effects on Wildlife and Vegetation Communities by Alternative if Recommended Wilderness Study Areas become Wilderness

Alternative	Area Supporting Table Mountain Pine, (Acres)	Presence of TESLR species, that DO NOT need active management	Area contains TES and/or FS sensitive species or habitat enhanced by human intervention or disturbance	Presence of Acidified streams	Special Biological Areas (Acres)
A	0	None	None	No	0
B	473	Cow Knob Salamander, Swamp pink	Barrens tiger beetle, Sword leaved phlox, Turkey beard, Mtn paper birch, coal skink; Big Levels salamander	Yes, 2 areas	7,379
C	14,234	Cow Knob Salamander, Swamp pink, Waterfan lichen, Va northern flying squirrel, Southern water shrew, NE bulrush, McGraw Gap xystodesmid, Rock skullcap, Roughhead shiner, Virginia sneezeweed, Bald eagle, Southern water shrew, Southern rock vole;	Barrens tiger beetle, Sword leaved phlox, Turkey beard, coal skink; Big Levels salamander, Millboro leatherflower, Pearly everlasting, Ground juniper, Phlox buckleyi, App grizzled skipper, Smooth coneflower, Shale barren rockcress; Sand grape, Phlox buckleyi, Plains forstweed, N. bristly sarsaparilla, Least trillium, Slender wheatgrass, Mountain paper birch, Wild chess, Variable sedge, Bristly black currant, Morning Warbler, Pirate bush,	Yes, 14 areas	64,595
D	22	Swamp pink	Big Levels salamander	Yes, 1 area	101

Alternative	Area Supporting Table Mountain Pine, (Acres)	Presence of TESLR species, that DO NOT need active management	Area contains TES and/or FS sensitive species or habitat enhanced by human intervention or disturbance	Presence of Acidified streams	Special Biological Areas (Acres)
E	796	Cow Knob Salamander, Swamp pink	Barrens tiger beetle, Sword leaved phlox, Turkey beard, Mtn paper birch, coal skink; Big Levels salamander, Millboro leatherflower	Yes, 2 areas	4,312
F	3,964	Cow Knob Salamander, Swamp pink, NE bulrush, Waterfan lichen, Va northern flying squirrel, Southern water shrew; McGraw Gap xystodesmid, Rock skullcap,	Barrens tiger beetle, Sword leaved phlox, Turkey beard, Mtn paper birch, coal skink, Big Levels salamander; Millboro leatherflower; Pearly everlasting, Ground juniper, Phlox buckleyi, App grizzled skipper, Smooth coneflower, Shale barren rockcress;	Yes, 6 areas	18,412
G	473	Cow Knob Salamander, Swamp pink	Barrens tiger beetle, Sword leaved phlox, Turkey beard, Mtn paper birch, coal skink; Big Levels salamander	Yes, 2 areas	7,379

Educational opportunities for the scientific study of natural ecological processes would increase.

Fire management may be affected by designation of additional wilderness areas. Under emergency situations, mechanized equipment and motorized transport, use of helicopters, air tankers, and other aircraft may be approved by Forest Supervisors and/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, enhance the natural systems that are fire-dependant. It would benefit recreation 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.

Several of the areas have a history of wildland fire, either naturally ignited or human-caused. All or a portion of the acres in each of these areas would be included in the Forest's planned prescribed burning program. A Recommended Wilderness Study designation would likely limit this management activity.

Additional human-caused effects to wilderness study areas are similar to those found in wilderness such as soil compaction; vegetation loss or disturbance; non-native species introduction; 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/ecological processes and biodiversity, through human disturbance.

Potential Wilderness Areas Managed to Retain Their Remote Character

In the alternatives, some of the Potential Wilderness Areas, or portions of these areas, are allocated to management prescription areas that will retain the characteristics of the area that made it qualify as a Potential Wilderness Area. Due to management direction in the Forest Plan, these remote areas would still qualify for placement on the Potential Wilderness Area Inventory according to final agency guidance (Forest Service Handbook (FSH) 1909.12 Chapter 70) on identifying potential areas when the GWNF Forest Plan is revised in ten to fifteen years. In other words, future options for recommending these areas as wilderness

study will not be forgone. Alternative prescriptions that would maintain the remote character of these areas include Backcountry Recreation (12D), Recommended National Scenic Area, Research Natural Area (4B), Shenandoah Mountain Crest (8E7), and large blocks of Special Biological Areas (4D), like Kelley Mountain. These areas are all unsuitable for timber production.
In Alternative A, the Backcountry Recreation prescription prohibits road construction with some exceptions to provide for site-specific needs. Examples of these exceptions where new road construction could be allowed include: 1) to access approved mineral activities; (2) where the new road is the only prudent alternative to serve resource needs in adjacent management areas and it will minimally impact this management area; (3) to relocate existing roads; (4) to provide access to trailheads; or (5) to provide access to private land if no other route is feasible.

In Alternatives B, C, D, E, F, and G, roads may not be constructed or reconstructed in the Backcountry Recreation prescription areas unless:

(1) A road is needed to protect public health and safety in cases of an imminent threat of flood, fire, or other catastrophic event that, without intervention, would cause the loss of life or property;

(2) A road is needed to conduct a response action under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) or to conduct a natural resource restoration action under CERCLA, Section 311 of the Clean Water Act, or the Oil Pollution Act;

(3) A road is needed pursuant to reserved or outstanding rights, or as provided for by statute or treaty;

(4) Road realignment is needed to prevent irreparable resource damage that arises from the design, location, use, or deterioration of a system road that cannot be mitigated by road maintenance. Road realignment may occur under this paragraph only if the road is deemed essential for public or private access, natural resource management, or public health and safety;

(5) Road reconstruction is needed to implement a road safety improvement project on a system road determined to be hazardous on the basis of accident experience or accident potential on that road;

(6) The Secretary of Agriculture determines that a Federal Aid Highway project, authorized pursuant to Title 23 of the United States Code, is in the public interest or is consistent with the purposes for which the land was reserved or acquired and no other reasonable and prudent alternative exists; or

(7) A road is needed in conjunction with the continuation, extension, or renewal of a mineral lease on lands that are under lease or for a new lease issued immediately upon expiration of an existing lease. Such road construction or reconstruction must be conducted in a manner that minimizes effects on surface resources, prevents unnecessary or unreasonable surface disturbance, and complies with all applicable lease requirements, land and resource management plan direction, regulations, and laws. Roads constructed or reconstructed pursuant to this paragraph must be obliterated when no longer needed for the purposes of the lease or upon termination or expiration of the lease, whichever is sooner.

In Alternatives B, C, D, E, F, and G, timber harvest is restricted in the Backcountry Recreation prescription areas as follows:

Timber may not be cut, sold, or removed, except as provided in (a).

(a) Timber may be cut, sold, or removed if one of the following circumstances exists. The cutting, sale, or removal of timber in these areas is expected to be infrequent.

(1) The cutting, sale, or removal of generally small diameter timber is needed for one of the following purposes and will maintain or improve one or more of the remote area characteristics;

(i) To improve threatened, endangered, proposed, or sensitive species habitat; or

(ii) To maintain or restore the characteristics of ecosystem composition and structure, such as to reduce the risk of uncharacteristic wildfire effects, within the range of variability that would be expected to occur under natural disturbance regimes of the current climatic period;

(2) The cutting, sale, or removal of timber is incidental to the implementation of a management activity not otherwise prohibited; or

(3) The cutting, sale, or removal of timber is needed and appropriate for personal or administrative use.

In Alternatives B and D, one additional exception where timber harvest would be allowed in the Backcountry Recreation prescription area is as follows:

Or (4) Salvage of dead and dying trees is needed and the remote character of the area is not impaired by the harvest activity.

In Alternative D the remote backcountry portion of Beech Lick Knob is not identified as unsuitable for wind development. A proposal for wind energy development in that area could be accepted for analysis. If approved, wind turbines, associated transmission lines and access roads could be constructed. This is an exception to the above prohibitions on management.

Areas managed for their remote character would provide opportunities for solitude and remoteness. Non-motorized dispersed recreation activities such as hiking, horseback riding, camping, mountain biking, fishing, and hunting would continue and use levels would be expected to remain about the same as currently takes place. Maintenance of trails and facilities, including the Appalachian Trail and associated shelters sites would be done using current mechanized and non-mechanized means. Current competitive events would continue.

Mineral leasing would be constrained with No Surface Use stipulations.

Existing access would continue to provide for fire and rescue needs, law enforcement needs, other resource management needs and public access.

Natural ecological processes would continue including plant succession. Larger blocks of undeveloped land and existing low open road density will favor area sensitive and disturbance sensitive species. However, prescribed fire and maintenance of existing old fields, wildlife openings and other habitat improvements for fish and wildlife will continue to provide some habitat for early successional species and species that need open woodland conditions. Habitat improvements for TES species, rare plants or rare communities can be completed.

Potential Wilderness Areas Managed for Other Resources

In the alternatives, allocation of some of the Potential Wilderness Areas, or portions of these areas, are made to other management prescription areas. These management prescription areas may allow timber harvesting, mineral development that involves surface occupancy, changes in land ownership pattern, or construction of improvements like buildings, fences, roads, transmission lines, communication installations, and/or campgrounds. In other words, future options for recommending these areas as wilderness study may be forgone. Management prescription allocations in a Forest Plan do not necessarily commit an area to development. Before a decision is made to actually conduct one of these activities (for example: build road or harvest timber in a Potential Wilderness Area, a site-specific analysis must be conducted)

The remote character in these areas may be diminished over time. The naturalness of these areas may be reduced by the interruption of natural ecological processes. Vegetation composition and structure may be manipulated resulting in a greater diversity of age-classes among forest types. Opportunities for solitude and remoteness may decrease. Sights and sounds of human activities may be more obvious. Additional roads and trails may be constructed. Noise levels and soil erosion may increase and air and water quality may decrease but water quality will meet State and Federal standards.

Alternative G includes an objective to assure that management activities in Potential Wilderness Areas (including areas allocated to these "Other Resource" management prescription areas) will only be done if they will not affect the Potential Wilderness Area to the point that it would no longer meet the definition of a Potential Wilderness Area.

INVENTORIED ROADLESS AREAS

The Inventoried Roadless Areas, like the Potential Wilderness Areas, are allocated to different sets of management prescription areas in various alternatives. The Inventoried Roadless Areas recommended for wilderness study are discussed in the above section on Potential Wilderness Areas.

Alternative A does not have direction that requires that all inventoried roadless areas retain their roadless characteristics, yet the management prescribed for the areas accomplishes nearly the same result. Ninety-five percent of the roadless areas are classified as unsuitable for timber production. There are very limited provisions for the harvest of dead or dying trees along the perimeters of some of these areas. In the George Washington Plan, road construction is prohibited on 88 percent of the areas with some exceptions to provide for site-specific needs. Examples of these exceptions where new road construction could be allowed include: 1) to access approved mineral activities; (2) where the new road is the only prudent alternative to serve resource needs in adjacent management areas and it will minimally impact this management area; (3) to relocate existing roads; (4) to provide access to trailheads or (5) to provide access to private land if no other route is feasible.

In Alternative C, all of the Inventoried Roadless Areas are recommended for wilderness study.

In Alternatives F and G all of the Inventoried Roadless Areas that are not recommended for wilderness study have direction to maintain their roadless character. For the recommended National Scenic Areas, direction is dependent upon the authorizing legislation, but it is assumed that this direction will maintain the roadless character of the Inventoried Roadless Areas. For areas not recommended for wilderness study, the following management direction will apply to all Inventoried Roadless Areas in Alternatives F and G (direction similar to the 2001 Roadless Area Conservation Rule):

Roads may not be constructed or reconstructed unless:

> *(1) A road is needed to protect public health and safety in cases of an imminent threat of flood, fire, or other catastrophic event that, without intervention, would cause the loss of life or property;*
>
> *(2) A road is needed to conduct a response action under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) or to conduct a natural resource restoration action under CERCLA, Section 311 of the Clean Water Act, or the Oil Pollution Act;*
>
> *(3) A road is needed pursuant to reserved or outstanding rights, or as provided for by statute or treaty;*
>
> *(4) Road realignment is needed to prevent irreparable resource damage that arises from the design, location, use, or deterioration of a system road that cannot be mitigated by road maintenance. Road realignment may occur under this paragraph only if the road is deemed essential for public or private access, natural resource management, or public health and safety;*
>
> *(5) Road reconstruction is needed to implement a road safety improvement project on a system road determined to be hazardous on the basis of accident experience or accident potential on that road;*
>
> *(6) The Secretary of Agriculture determines that a Federal Aid Highway project, authorized pursuant to Title 23 of the United States Code, is in the public interest or is consistent with the purposes for which the land was reserved or acquired and no other reasonable and prudent alternative exists; or*
>
> *(7) A road is needed in conjunction with the continuation, extension, or renewal of a mineral lease on lands that are under lease or for a new lease issued immediately upon expiration of an existing lease.*

Such road construction or reconstruction must be conducted in a manner that minimizes effects on surface resources, prevents unnecessary or unreasonable surface disturbance, and complies with all applicable lease requirements, land and resource management plan direction, regulations, and laws. Roads constructed or reconstructed pursuant to this paragraph must be obliterated when no longer needed for the purposes of the lease or upon termination or expiration of the lease, whichever is sooner.

Timber may not be cut, sold, or removed, except as provided in (a).

(a) Timber may be cut, sold, or removed if one of the following circumstances exists. The cutting, sale, or removal of timber in these areas is expected to be infrequent.

(1) The cutting, sale, or removal of generally small diameter timber is needed for one of the following purposes and will maintain or improve one or more of the remote area characteristics;

(i) To improve threatened, endangered, proposed, or sensitive species habitat; or

(ii) To maintain or restore the characteristics of ecosystem composition and structure, such as to reduce the risk of uncharacteristic wildfire effects, within the range of variability that would be expected to occur under natural disturbance regimes of the current climatic period;

(2) The cutting, sale, or removal of timber is incidental to the implementation of a management activity not otherwise prohibited; or

(3) The cutting, sale, or removal of timber is needed and appropriate for personal or administrative use.

In Alternatives B, D and E, most of the Inventoried Roadless Areas that are not recommended for wilderness study have the same direction as described for Alternatives F and G. However, in a few of the areas (nine in Alternative B, six in Alternative D and two in Alternative E) active management (including road construction and timber harvest) would be allowed where active management has occurred along existing roads regularly over the past forty years. These areas are identified in Table C4.11. All other areas of Inventoried Roadless Areas would be managed under direction similar to the terms of the 2001 Roadless Area Conservation Rule. In addition, Alternatives B and D allow salvage harvest from existing roads with no new road construction in any of the Inventoried Roadless Areas. Given the past experience with gypsy moth and expectation of continued mortality from this and other invasive pests, this option allows for the removal of dead trees with little impact on the remote character of the Inventoried Roadless Areas.

Table C4.11 Portions of Inventoried Roadless Areas where Roadless Character Would Not be Retained

Inventoried Roadless Area	Total Acres	Portion of Area Without Requirement to Maintain Roadless Character (Acres)						
		Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Crawford Mountain	9,852	N/A	1,200		1,400			
Dolly Ann	7,866	N/A	800		600			
Dry River (WV)	7,254	N/A	500					
Elliott Knob	9,391	N/A	200					
Jerkemtight	16,849	N/A	800		800			
Little Alleghany	10,207	N/A	700		1,000	1,000		
Little River	27,180	N/A	1000					
Mill Mountain/Rich Hole Addition	10,919	N/A	1,500		1,500	1,500		
Oak Knob	10,852	N/A	800		1,200			

In Alternative D the following Inventoried Roadless Areas are not identified as unsuitable for wind development: Little Alleghany, Oliver Mountain, Elliott Knob, Crawford Knob, and Northern Massanutten. A proposal for wind energy development in these areas could be accepted for analysis. If approved, wind turbines, associated transmission lines and access roads could be constructed. This is an exception to the above prohibitions on management in Inventoried Roadless Areas.

C5- SCENERY

AFFECTED ENVIRONMENT

The majority of the George Washington National Forest can be seen from adjacent or interior roads, trails or waterways largely due to the mountainous terrain and the supply of roads and trails. The more scenic landscapes (those inventoried as High or Moderate under the Scenery Management System (SMS)) are generally associated with or occur adjacent to high use roads, the Appalachian National Scenic Trail, National Recreation Trails, high use trails, lakes, rivers and streams, state and Forest Service designated scenic byways, and highly developed recreation areas.

The George Washington National Forest is located within Central Appalachian Broadleaf-Coniferous Forest Meadow Province and within the Valley and Ridge, Northern Blue Ridge and Appalachian Plateau sections as described by Bailey and others (1994). The landscape is about 80% mature forest with closed canopy. Elevations in the GWNF range from high points over 4,000 feet to lower elevations of less than 1,000 feet along some rivers and streams. Views beyond the immediate foreground are influenced by the viewer's elevation, terrain surrounding the viewer, as well as vegetation type and density. The steep to rolling ridges and valleys characterizing the forest are covered with an almost-continuous canopy of soft- to medium-textured rounded tree forms, creating a natural-appearing landscape character. The exception to this is the cultural landscapes, such as developed recreation areas, historic furnaces, and pastoral areas. These are typically found at lower elevations, often along rivers or streams and always along roads.

Over the last two decades, gypsy moth and southern pine beetle infestations have contributed to or caused tree mortality in some oak and pine stands resulting in visible patches of dead trees and scattered openings in the forest canopy. Groups of tall, gray, defoliated stems, varying in size from less than an acre to more than 25 acres, eventually give way to an emerging deciduous and evergreen understory. This process is speeded by active salvage operations in areas where human health and safety is critical. Hemlock woolly adelgid have caused mortality to individual trees as well as patches of hemlock, primarily in drainages and other cool, moist sites.

Of the seven Land Use Themes described in the Southern Appalachian Assessment, the existing GWNF landscapes can be grouped predominantly into four: Natural Evolving, Natural Appearing, Rural-Forested and Rural–Pastoral/Agricultural.

- Designated Wildernesses (42,674 acres) are lands where ecological processes predominate, are characteristically Natural Evolving landscapes.
- The vast majority of the Forest (about 1,000,000 acres) is characterized as Natural Appearing.
- Rural-Forested is a very small category that includes the Forest's most highly developed recreation areas.
- Rural-Pastoral/Agricultural is an equally limited category composed of open areas, often under special use permit for grazing, hay production or to perpetuate a pastoral scene.

Historically, the landscape character of Natural Evolving that dominated lands that now comprise the George Washington National Forest included open woodlands. This component of the landscape character declined dramatically since the turn of the previous century, mainly due to fire suppression. Characterized by an open mature tree canopy and a stable understory of native grasses, forbs and shrubs, open woodlands generally retained a natural, forested appearance interspersed with a mosaic of natural openings. The landscape featured structurally diverse forest communities, ranging from rich cove and mesic hardwood/pine forests, with predominantly closed canopies, to xeric pine/hardwood open woodlands, with a mosaic of grass/forb/shrub understories. A mid- to late-successional forest dominated the landscape. That historic, naturally evolving landscape contained both visual diversity and harmony. Alternatives B, C, E, F and G provide for acres allocated to mosaic of wildlife habitats including the restoration (to varying degrees) of the historic role of fire in the ecosystem and on scenery in terms of influencing landscape character.

EXISTING VISUAL QUALITY

The scenic resources of the George Washington National Forest are currently managed in accordance with the George Washington Forest Plan. The scenic resource management direction in the Forest Plan is the Visual Quality Objective (VQO), which were determined by the Visual Management System (VMS). The scenic resource inventory has been updated to comply with the Scenery Management System (SMS), which replaced the VMS in 1995. Under SMS, Forest Plans establish Scenic Integrity Objectives (SIOs). [2] Table C5.1 provides a crosswalk between VQOs used in the current George Washington Forest Plan, and SIOs to be used in the Revised Forest Plan.

Table C5.1 Crosswalk Between VQOs and SIOs

Visual Quality Objective (VQO)	Scenic Integrity Objective (SIO)
Preservation (P)	Very High (VH)
Retention (R)	High (H)
Partial Retention (PR)	Moderate (M)
Modification (M)	Low (L)
Maximum Modification (MM)	Very Low (VL)

For planning purposes, Scenic Integrity Objectives (SIOs) were established for each prescription. These range from Very High (VH unaltered) to Low (L moderately altered). The SIOs define the different levels of alteration affecting the visual resource that is acceptable.

Table C5.2 SMS Inventory

Scenic Integrity Objectives	Acres	% of GWNF Land
Very High	45,763	4.3%
High	349,805	32.8%
Medium	203,363	19.1%
Low	466,681	43.8%

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

The scenic resource is affected by management activities altering 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, which result in visual alterations inconsistent with the assigned SIO and landscape character goal, even with mitigation, affect scenery. Management activities that have the greatest potential for affecting scenery are road construction,

[2] See *Landscape Aesthetics, A Handbook for Scenery Management, Agricultural Handbook Number 701* for description of the SMS system and cross-walk between the SMS-SIOs and the VMS-VQOs. The SMS inventory of George Washington National Forest lands identify Scenic Classes from 1 (highest level) to 7 within each prescription area. Each Scenic Class is assigned a Scenic Integrity Objective of Very High, High, Moderate or Low.

timber production, insect and disease control, special use utility rights-of-way, and mineral extraction. Other management activities that also can affect the scenic resource at a lesser degree are habitat management, prescribed burning, fire suppression, land exchange, old growth forest management, recreation, administrative site facility construction, and wildlife management. Natural processes can also affect scenery, such as wildland fires, insect and disease infestations, and the spread of non-native invasive vegetation.

In all Alternatives, the following prescription areas are assigned a Scenic Integrity Objective (SIO) of Very High across all scenic classes: designated Wilderness and Little Laurel Run Research Natural Area. In Alternative A, recommended Wilderness is also assigned a SIO of Very High.

In all Alternatives, the following prescription areas are assigned a SIO of High across all scenic classes: Appalachian Trail corridor, eligible Wild and Scenic Rivers (scenic classification), geologic areas, riparian corridors and remote backcountry. In Alternatives B through G, recommended Wilderness is assigned a SIO of High across all scenic classes.

In Alternative A, the following prescription areas are assigned a SIO of Low across all scenic classes: administrative sites, communications sites and utility corridors. In Alternatives B through G, there are no prescription areas assigned a SIO of Low across all scenic classes.

Table C5.3 below provides the distribution of SIOs across all alternatives.

Table C5.3 Scenic Integrity Objectives (SIOs) by Alternative (Acres)

SIO	Alt A*	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
VH	45,763	45,028	44,972	44,972	44,972	44,970	44,971
H	349,805	374,408	594,472	379,210	450,269	499,890	432,963
M	203,363	199,216	237,678	196,132	178,843	160,927	182,157
L	466,681	446,776	188,343	445,151	391,381	359,676	405,374

*No Action Alternative

Alternatives that receive the highest acreage to Very High and High SIOs would result in more protection and enhancement to the scenic resources than alternatives having fewer acres assigned to the higher SIOs. Alternative A assigns the most acres to both the Very High SIO and the Low SIO. Alternatives C through G all provide for more acres in the High SIO than Alternative A. Alternative C shifts the most acres of modification VQO/low SIO to High SIO. The Alternatives that offer the least protection for the scenic resource are A and B and D.

All alternatives propose prescribed burning, as detailed in Table C5.4 below. Drifting smoke, blackened rock outcrops and charred tree trunks would be the main negative visual effect. Visual contrast from fireline construction could also be evident. The contrast levels and duration vary with fire intensity. Blackened vegetation usually last a short time but charring of trees may be evident for many years. Repetitive burning reduces overall visual diversity. It often results in loss of valued mid- and understory species such as flowering dogwood, but tends to promote herbaceous flowering species. Prescribed fire repeated over time produces stands with open understories allowing views farther into the landscape.

Table C5.4 Planned Prescribed Burning Program by Alternative, acres per year

	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Prescribed Burns, acres per year	3,000	12,000 - 20,000		5,000 - 12,000	20,000	12,000 - 20,000	12,000- 20,000

Alternative E has the most acres in the prescribed burning program, and therefore the greatest potential for altered scenery, while Alternative C has the least.

Alternatives B, E, F and G, assign acres to prescription area 13, Mosaics of Wildlife Habitat. This prescription emphasizes, among other projects, restoring open woodlands that once existed as part of the natural evolving landscape. This would be achieved primarily through an expanded program of controlled burns to restore the historic role of wildland fires in the ecosystem. The openings created by these fires benefitted many species of wildlife, grass forbs, and understory and mid-story species, including many flowering shrubs and edge-loving trees. These openings and the diversity of vegetative and wildlife species found in them influenced the landscape character.

Prescribed fires planned in Alternatives B, D, E, and G would be larger and hotter than prescribed fires conducted under the current Forest Plan. These fires, several thousand acres in size, would result in blackened and charred trees, including large patches of dead trees, that could be visible for several years. However, within a year, vegetation will grow in these natural appearing openings and with time would dominate the characteristic landscape. These openings are anticipated to provide added diversity to both the visual and biologic resources.

Project analysis would take into account the desired condition of a landscape character theme that contains these openings that appear to mimic natural wildfires. In scenic class 1 areas with a High SIO, any elements that visually appear to be human caused, such as roads, and that would be deemed not to meet that High SIO, would be avoided by implementing mitigation measures.

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 some control efforts, such as removal of infected trees, may appear to visitors to be similar to clearcutting; but this can be avoided by implementing mitigation measures. Forest Service managers have the least flexibility to treat or control insects and disease infestations in Alternative C if recommended Wildernesses are designated by Congress as Wilderness. Alternatives D, E, F and G provide the least potential affects to scenery due to insect and disease outbreaks. Under these alternatives, non-native and invasive species (NNIS) are treated aggressively, prevention and control in disturbed and/or high use areas is emphasized, Integrated Pest Management (IPM) techniques are used, and a priority is placed on preventing spread to adjacent private lands. Alternatives A and B have less potential impacts than Alternative C but more than Alternatives D, E, F and G. Alternative A focuses primarily on controlling gypsy moth and Alternative B increases recognition of non-native and invasive species. Both A and B make use of IPM techniques.

Utility rights-of-way (ROW) have a high potential of affecting the scenic resource for a long duration. Cleared ROWs, utility structures contrast and may be incongruent with existing landscape. Cleared ROWs contrast in form, line, color, and texture when compared to the natural appearing landscape.

Industrial wind development can have significant impacts on the scenic resource. Wind turbines hundreds of feet in length are erected on large concrete pads on ridgetops, visually breaking into the skyline when viewed from any angle except perhaps from an airplane. Roads are needed to access each wind turbine site, altering the form, line, color and texture of the natural landscape. Alternatives C and E would provide the most protection to the scenic resources, as they do not allow for any wind development. Alternative D has the potential for the most impacts to scenery, as it makes the entire Forest available for proposals for wind development. Alternatives B, F and G restrict wind development in the most visually, socially and environmentally sensitive areas, but do not protect all areas from the potential impacts of wind development on scenery. Alternative A is silent on wind development.

Mineral management and development activities can involve a range of alterations from small surface structures along existing roads to major landform alteration, as well as form, line, color, and texture contrasts, causing substantially adverse scenic impacts. Alternative C has the least potential for negative impacts due to oil and gas leasing, as it does not allow any acres for this use. Alternative A has the potential for the most impacts due to oil and gas leasing, making 960,000 acres (90% of the Forest) available for standard or controlled surface occupancy. It contains no direction related to the development of Marcellus shale.

Alternative D makes available 720,000 acres and Alternative B makes available 700,000 acres for leasing under standard or controlled surface occupancy stipulations. Both allow for the development of Marcellus shale, but specific standards would be used related to hydrofracking.

Road maintenance, especially rights-of-way maintenance, affects scenery. 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.

Table C5.5 Miles of Road Construction per Year by Alternative

	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Road Construction, miles per year	2.9	1.5	0	4.1	0.9	0.5	1.5

Related to roads, Alternatives C and F would have the least impacts to the scenic resource while Alternatives A and D would have the greatest potential for impacting scenery. Additionally, Alternative C would decommission 28 miles of road per year in the first decade of the Revised Forest Plan and Alternative F would decommission 18 miles. Alternative A does not provide for decommissioning of roads.

Vegetation management has the great potential to alter the landscape and impact the scenic resource. Timber harvest practices can cause long-term effects on scenery by altering landscape character through species conversion, reduction in species diversity, manipulation of the prominent age class, and alteration of opening sizes, locations, and frequencies. The potential effects may be positive or negative, depending on their consistency with the desired future condition of the landscape.

Table C5.6 Estimated Harvest Acres and Allowable Sale Quantity for Timber Management Activities by Alternative, First Decade

	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Acres harvest, in thousands, first decade	23	30	0	42.5	18	10	30
Allowable Sale Quantity, in million cubic feet, first decade	47	54.3	0	101	31.1	20.4	54.3

Related to timber production, Alternative C would have the least adverse affect on the scenic resource and Alternative D would have the greatest potential for adverse affects to scenery. Of the alternatives that provide for an active timber program, Alternative F would have the least affect on the scenic resources of the Forest.

Of the management applications, even-aged management may be the most impacting. Among the even-aged regeneration methods, clearcutting and seed-tree harvest produces the highest visual contrasts because they remove the most forest canopy and create openings with visible roads and/or skid trails. These openings would vary in their effects on scenery depending on location, size, shape and distance from viewing platforms. Openings that repeat the size and general character of surrounding natural openings, with the least contrast in line, texture and shape, would impact scenery the least.

Single-tree selection and group selection harvest are normally less evident because they do not cause large openings in the canopy. Uneven-aged regeneration methods can affect scenery, causing contrasts in form, line, color, and texture from slash production. All impacts as a result of timber harvest are short-term because of rapid vegetation growth.

Site preparation activities 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, reducing visual variety through elimination of target species. Table C5.6 provides the allowable sale quantity (ASQ) and annual harvest program by alternative.

Recreation facilities are deviations to the natural landscape. None of the alternatives provide for the development of new developed recreation sites. Alternatives B, F and G provide for expanding the capacity of some existing recreation sites. Forest Service recreation facilities are designed to blend into the landscape without major visual disruption. Alternatives C and E would result in closing and decommissioning some recreation areas. All man-made elements would be removed and the site put back to grade. Vegetation would eventually grow in and the casual observer would not be able to tell that a developed area had once existed there.

Designation of wilderness will generally cause positive effects to the scenery. Barring serious infestations by insects or disease, old-growth forest character will be created over time. What it lacks in visual variety, it makes up for with an intact, natural appearing landscape. Alternative C provides for the most recommended Wilderness at about 22% of the George Washington land base. Alternative F is next highest for recommended Wilderness acres, at about 9% of the Forest. Alternatives A, B and G provide for the least acres being allocated to recommended wilderness study areas.

C6- TIMBER MANAGEMENT

AFFECTED ENVIRONMENT

FORESTED AREA

The GWNF includes approximately 1,065,000 acres of National Forest System land in Virginia and West Virginia. Of this, approximately 1,059,000 acres are known to be forested. As indicated in Table C6.1, the majority of the land area within each county is forested with a considerable variance in the percentage of national forest land located within each county.

Table C6.1 Percentage of Forested Land and GWNF Land by County

County	% Forested	% GWNF
Alleghany, VA	60%	49%
Amherst, VA	76%	19%
Augusta, VA	52%	30%
Bath, VA	94%	51%
Botetourt, VA	66%	4%
Frederick, VA	61%	2%
Hampshire, WV	77%	1%
Hardy, WV	82%	14%
Highland, VA	82%	22%
Monroe, WV	57%	<1%
Nelson, VA	84%	7%
Page, VA	47%	13%
Pendleton, WV	75%	11%
Rockbridge, VA	68%	12%
Rockingham, VA	58%	25%
Shenandoah, VA	51%	23%
Warren, VA	55%	5%

FOREST LAND TENTATIVELY SUITABLE FOR TIMBER PRODUCTION

During forest land and resource management planning, the Forest Service is required to identify lands unsuited for timber production (16 USC 1604(k); 36 CFR 219.14). The initial stage (Stage I) identifies land tentatively suitable for timber production. Refer to Appendix B for detailed explanation of the three stages of land suitability determination. Table C6.2 displays lands eliminated in Stage I suitability analysis to determine acres tentatively suitable for timber production.

Table C6.2 Stage I Acres Tentatively Suitable for Timber Production

Category of Stage I Lands	Acres
Total GWNF Acres	**1,065,000**
Non-Forest Land	(7,000)
Forest Land	**1,058,000**
Withdrawn for Existing Wilderness	(43,000)
Withdrawn for Existing National Scenic Area	(8,000)
Withdrawn for Research Natural Areas	(3,000)
Irreversible Damage & Not Restockable	(29,000)
Incapable of Producing Industrial Wood	(65,000)
Stage I Tentatively Suitable for Harvest	**910,000**
Stage I Unsuitable for Harvest	**155,000**

AGE CLASS DISTRIBUTION

Most of the timber on the GWNF is currently in the 90-130 year old age class as evidenced by Table C6.3 showing current age class distribution. A majority of the Forest is either at or beyond currently specified rotation ages. Meanwhile, the very small amounts of acres (1-3%) in the younger age classes result from the lower levels of management in the past on this Forest. The age class imbalance is dramatic and is indicative of non-regulated forest management.

Table C6.3 Percentage of Forest by Age Class on the GWNF Base Year 2010.

Age Class	Percent
1-10	1%
11-20	3%
21-30	2%
31-40	4%
41-50	1%
51-60	0%
61-70	1%
71-80	5%
81-90	13%
91-100	22%
101-110	18%
111-120	8%
121-130	7%
131-140	5%
141-150	4%
151+	6%
Total	100%

COMMUNITY TYPES

As the forest ages, it will experience increasing insect and disease problems. Gypsy moth populations will continue to cycle up and down naturally. Varying amounts of mortality are expected in the two oak-associated communities types which dominate the GWNF; Northeastern Interior Dry-Mesic Oak Forest and Central and Southern Appalachian Montane Oak Forest. These community types comprise 36% and 41%, of the total forested acreage, respectively. With these oak-associated community types comprising about 77% of the total forested acreage, substantial periodic gypsy moth defoliations and oak decline events resulting in subsequent mortality is anticipated. No community type conversions were modeled in the plan. No reliable methodology is currently available to quantify the specific extent of future natural type conversions due to natural forest succession and/or gypsy moth/oak decline mortality.

Salvage operations will be continuing as we attempt to salvage the dying trees prior to the oak losing their capability to stump sprout and regenerate the next stand to a desirable oak component to meet desired future conditions.

FOREST SERVICE HISTORIC IMPORTANCE

The Southern Appalachian Assessment (SAA, 1996) indicates that the USDA Forest Service is the area's largest single landholder. Thus, the action of the region's national forests can hold more sway over markets than those of any other single landowner. The supply behavior of the public sector is, however, exceedingly difficult to predict. Timber supply from the national forests is governed by laws, agency policy and regulations and a management approach that addresses multiple uses as well as ecological conditions (SAA.1996.Rpt 4-113).

The Southern Appalachian Assessment (SAA) indicates that the pattern of timber production from the national forests has changed considerably. Between 1977 and 1994, the national forests in the SAA averaged 36.6 million cubic feet (MMCF) or 183 million board feet per year. For the years 1983, 1986, 1989, and 1992, the national forests provided between 10-12 percent of total production in the SAA. Since national forests have 17 percent of the timberland, their share of total production reflects a less intensive management approach than on private land (SAA, 1996 Rpt 4:122).

Timber production on the GWNF has experienced a similar decline which has continued since 1993 to the present. The following Table C6.4 displays total sold volume in Hundred Cubic Feet (CCF) and Thousand Board Feet (MBF) on the GWNF from the first year of plan implementation (1993) through FY 2009. The most recent 3 year average volume sold (2007-2009) reflects an almost 300% drop as compared to the 3 year average of 1993-1995.

Table C6.4 Total Timber Volume Sold

FY	CCF	MBF
1993	61,925	34,059
1994	53,227	29,275
1995	47,384	26,061
1996	37,340	20,537
1997	34,942	19,218
1998	15,342	8,438
1999	27,351	15,043
2000	18,365	10,101
2001	22,624	12,443
2002	24,540	13,497
2003	22,009	12,105

FY	CCF	MBF
2004	33,468	18,407
2005	21,409	11,775
2006	22,047	11,024
2007	16,362	8,181
2008	22,416	11,208
2009	16,403	8,202

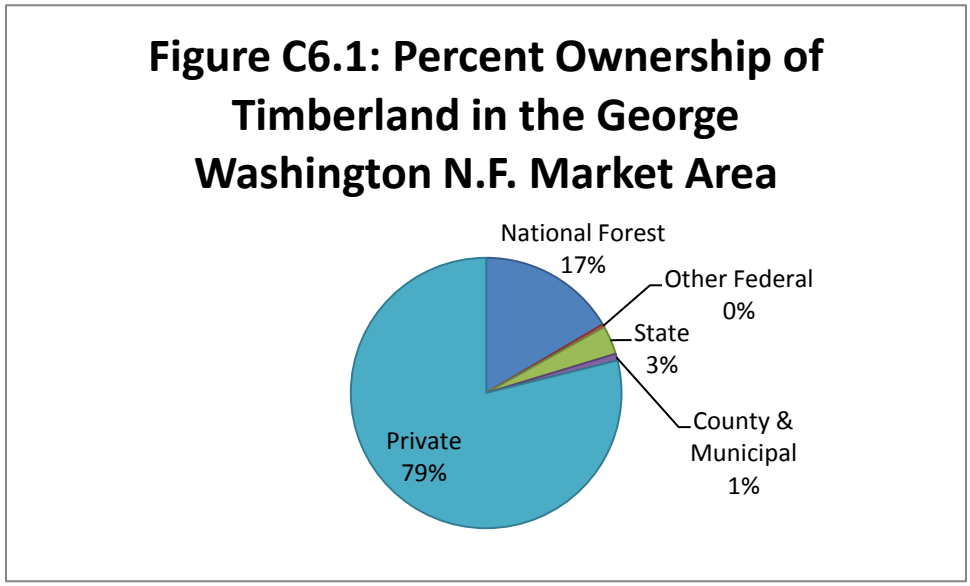
During the period from 1993-2009, the harvest cutting methods by acres displayed in Table C6.5 were utilized to implement the timber management program objectives from the first year of plan implementation. There has been a relatively steady decline in total acres harvested on the GWNF since 1993. A steady decline in the total acres harvested by clearcutting has occurred from 1993 to 2005 with a slight increase in more recent years. Clearcutting acres have averaged less than five percent of total annual harvested acres for the last ten years.

Table C6.5 Acres by Harvest Cutting Method for Harvested Volume by Fiscal Year

Fiscal Yr.	Clearcut	Shelterwood	Selection	Thinning	Salvage	Special	TOTAL
1993	890	938	644	212	587	0	3,271
1994	496	1,121	251	259	866	0	2,993
1995	277	1,281	55	262	832	0	2,707
1996	232	875	0	172	685	0	1,964
1997	209	1,103	0	64	1,839	0	3,215
1998	133	739	0	82	495	0	1,449
1999	41	436	1	92	714	0	1,284
2000	90	428	173	125	438	0	1,254
2001	67	668	97	244	86	0	1,162
2002	5	646	48	133	49	0	881
2003	0	579	57	49	104	0	789
2004	0	625	0	111	44	0	780
2005	0	962	29	104	81	0	1,176
2006	25	459	36	247	50	7	824
2007	22	364	6	340	0	0	732
2008	9	556	0	46	0	0	611
2009	70	344	0	345	74	0	833
10 yr. Av.	29	563	45	174	93	1	904
5 yr. Av.	25	537	14	216	41	1	835
3 yr. Av.	34	421	2	244	25	0	725

FOREST SERVICE TIMBER INVENTORY

Information regarding the supply of timber was compiled using the most recent available Forest Inventory and Analysis (FIA) data. Of the 19.2 million acres in the wood product market area for the George Washington National Forest, 12.5 million acres are inventoried as timberland. Figure C6.1 provides the percentage of area of timberland within broad ownership classes. The two largest categories include privately held and National Forest Service (NFS) lands (including the entire George Washington National Forest and then portions of the Jefferson and Monongahela National Forests) accounting for 96% of the timberland in this market area. The George Washington National Forest comprises approximately 5.5% of the land within the market area.



We estimate 7-8 bcf (Billion Cubic Feet) of timber supply on economically available timberland in the market area and considering landowner attitudes. We can expect this to grow by about 0.57 bcf per year. Annual demand is about .3 bcf per year; less than the net growth of all live timber, indicating a sustainable resource.

Approximately 2 bcf of live standing volume within the market area is found on the GWNF. Of this total live volume, 1.8 bcf, or 86%, of this volume is in large diameter stands (>19 inches average DBH). Similarly, about 1.9 bcf, or 90%, of this volume is greater than 60 years old. Thus, a vast majority of the standing timber on the GWNF is of sawtimber size and mature in the timber production/economic sense. However, of the 2 bcf in live standing volume on the GWNF, we estimate only .51 bcf of that would be available on the GWNF after considering economic availability and current lands unsuitable for timber production.

Biomass fuels for the generation of energy are gaining interest and support in many parts of the south. The potential to supply biomass fuels from the GWNF is included in the aforementioned estimates. Of the .51 bcf available as supply, anywhere from 0 to .25 bcf could potentially be utilized as biomass fuel, or a maximum of 8.75 million tons forest-wide. The upper bound of this estimate is the small roundwood component usually utilized in paper production plus the traditionally non-merchantable material in branches and tops; we presume that no sawtimber would be utilized as biomass fuels. However, it is important to note that under current management the entire Forest only produces about 70,000 tons of wood, including sawtimber. This puts the almost 9 million ton figure identified as a maximum into perspective; it is probably not realistic.

The GWNF comprises a very small market share within this market area. We estimate that we control about .5 bcf of the total live volume available for supply. When we compare this to the 8 bcf estimated to be available in the entire market area, the GWNF comprises about 6% of the total live inventory. However, when we consider the variation in quality of supply and the demand for quality timber, the GWNF may have a slightly more significant role to play. Demand for high quality products is greater, we expect increased pressure on high quality timber, and the GWNF has a proportionally higher percentage of large diameter (equating to high quality) timber on NFS lands as compared to Non-Industrial Private Forest (NIPF) lands (albeit only slightly higher). So, while the primary producers of the timber industry within this market area do not depend on the

timber from the GWNF to any large extent, the GWJ can play a more significant role in the supply of high quality sawtimber. In terms of biomass fuels, the GWNF would likely comprise an even smaller share of the market, if such a market were to develop. Typically, energy production mills that utilize wood in part or in whole require a million or more tons of fiber annually. Realistic estimates, under current management, indicate that the GWNF could produce perhaps 30,000 tons annually within any given 50 mile radius around a mill location.

Although the scope of this analysis is very broad encompassing some 64 counties in 3 States, we believe it is also important to consider the role of NFS lands on a more local level. NFS lands occupy more than 30% of three of counties in the market area and a few more counties contain 20-30% NFS lands. Certainly the role that the timber supply from NFS lands play in these local economies is quite important and should not be lost or discounted when taking a larger view.

DIRECT, INDIRECT EFFECTS AND CUMULATIVE EFFECTS

SUITABILITY

As displayed in Table C6.2 above, approximately 85% (911,000 acres) of the Forest is "tentatively suitable" for timber harvest. Table C6.6 displays the acreage unsuitable for timber production and suitable for timber production for the seven alternatives considered. None of the alternatives used more than 48% of the lands tentatively suitable for timber production. Alternative D contains the most lands suitable for timber production. Suitable acres vary from 0 to 503,000 acres.

Table C6.6 Determination of Lands Suitable for Timber Production from the Stage III Analysis

Alternative	Acres Unsuitable for Production	Acres Suitable for Production	Percent Suitable for Production
A	715,000	350,000	33%
B	579,000	486,000	46%
C	1,065,000	0	0%
D	583,000	482,000	45%
E	699,000	366,000	34%
F	787,000	278,000	26%
G	626,000	439,000	41%

ALLOWABLE SALE QUANTITY

Table C6.7 displays the allowable sale quantity (ASQ) for all products in million cubic feet (mmcf) and million board feet (mmbf) for each alternative considered in detail in the DEIS. ASQ is the maximum amount of timber that can be sold on lands suitable for timber production during the first decade of implementing any alternative.

Standard Region 8 conversion of 5.0 board feet per cubic foot was used in Table C6.7 calculations to convert from cubic feet to board feet.

These alternatives have ASQs ranging from 0 to 101 mmcf per decade. As Table C6.7 indicates the alternatives explore a wide range of volume outputs to achieve a wide variety of desired future conditions.

Table C6.7 Allowable Sale Quantity for all Products (MMCF) by Decade

Alternative	MMCF	MMBF
A*	47	235
B	54.3	271
C	0	0
D	101	505
E	31.1	155
F	20.4	102
G	54.3	271

*The volume shown for Alternative A (current Forest Plan) uses the same Regional conversion factor as the other alternatives, which is different from the conversion factor shown in the 1993 Forest Plan.

Table C6.8 displays ASQ for each alternative by decade. Table C6.9 displays Long-Term Sustained Yield Capacity, Inventory Volume, and estimated acres treated by Alternative. The long-term sustained-yield capacity (LTSYC) is defined as "the highest uniform wood yield from lands being managed for timber production that may be sustained under a specified management intensity consistent with multiple-use objectives (USDA Forest Service 1982 CFR 219.3)". LTSYC is the potential average growth (mean increment) of the forest on acres allocated to timber production after the stand has reached a managed stand structure. It can be thought of as steady state timber output after the existing stands have been cut and each acre allocated to timber production has settled into a particular management intensity and rotation age. NFMA regulations require: "each sale schedule shall provide for a forest structure that will enable perpetual timber harvest which meets the principle of sustained yield and multiple-use objectives of the alternative (219.13(D))". The perpetual timber harvest constraint meets the NFMA requirement by ensuring that the forest contains as much timber inventory volume in the last period as a forest would have, on the average, under the management intensities selected in the analysis. All of the ASQs are well within current demand of 300 mmcf per year with reasonable likelihood of selling.

Table C6.8 Allowable Sale Quantity for All Products by Decade (MMCF)

Alternative	Decade 1	Decade 2	Decade 3	Decade 4	Decade 5
A*	47	47	47	47	47
B	54.3	55.4	60.9	63.3	67.5
C	0	0	0	0	0
D	91.8	91.8	101.0	101.6	111.7
E	31.1	33.0	36.3	39.9	40.4
F	20.4	20.4	21.6	23.8	25.0
G	54.3	55.4	60.9	63.3	67.5

*The volume shown for Alternative A (current Forest Plan) uses the same Regional conversion factor as the other alternatives, which is different from the conversion factor shown in the 1993 Forest Plan.

Table C6.9 Long-Term Sustained Yield Capacity, Inventory Volume, Allowable Sale Quantity, and Acres Regenerated by Alternative

Unit of Measure	Alternative						
	A	B	C	D	E	F	G
	MMCF/Year						
Long Term Sustained Yield Capacity	5.8	6.2	0	10.7	4.9	3.4	6.2
Inventory Volume, Decade 1	21.58	23.59	0	40.16	15.64	9.48	23.59
Allowable Sale Quantity	4.7	5.4	0	9.2	3.1	2.0	5.4
	Acres/Year						
Acres Regenerated, Decade 1	23,000	30,000	0	42,500	18,000	10,000	30,000

TIMBER SALE PROGRAM QUANTITY

The Timber Sale Program Quantity (TSPQ) is the volume of timber planned for sale during the first 10 years. It includes the volume harvested from the suitable land base plus planned volume from unsuitable lands. For this analysis no harvest was planned on unsuitable lands under any alternative. Therefore the ASQ discussed previously equates to the TSPQ. The preceding tables also constitute the sale schedule by alternative.

NET PRESENT REVENUES

The following Table C6.10 displays the average annual net present value in millions of dollars for the timber program using SPECTRUM costs and revenues. This table shows how the projected revenues of the timber program within each decade and each alternative compare to the costs of the timber program. The “net” value is how much average annual revenues exceed costs. For Alternative A, the Spectrum model solved for the objective function to maximize present net value. For Alternative D, Spectrum solved for the objective function to maximize volume. For Alternatives B, E, F and G, the model solved for the objective function to maximize early successional habitat. Since Alternative C does not have a timber program, there are no values shown. The variation within each alternative across the decades is reflective of the model choosing different combinations of harvest methods and wood product classes that vary in their costs and revenues.

Table C6.10 Average Annual Net Present Value in Millions of Dollars for the Timber Program

Alternative	Decade 1	Decade 2	Decade 3	Decade 4	Decade 5
A	(2.00)	(1.35)	(0.91)	(0.62)	(0.42)
B	1.24	4.68	7.09	3.53	4.24
C	0	0	0	0	0
D	15.70	8.18	6.40	6.64	5.74
E	(0.24)	2.21	3.63	2.76	2.54
F	(1.06)	0.81	1.59	1.62	1.16
G	1.24	4.68	7.09	3.53	4.24

DEMAND

The process paper "George Washington National Forest Timber Supply and Demand Analysis" established The GWNF market area as generally being within a 50-mile radius around the Forest's boundary. Approximately 217 sawmills, 3 paper/pulp mills, and 3 engineered wood product manufacturers are located within the GWNF market area with a combined consumption of 300 mmcf of roundwood annually. Approximately 30% of this material is used for the production pulp and paper. The remainder is used in the manufacture of sawtimber or engineered products.

The ownership distribution of the "economically available" timber supply mirrors the general pattern of timberland ownership in the market area, with approximately 80 percent of the supply on NIPF land, 17 percent on the National Forest (8.5 percent on the GWNF), and the remainder in Other Federal, State, and County/Municipal lands. If the GWNF were to satisfy the current demand within the market area of 300 mmcf/year, in the same proportion as the economically available resource supply, the estimated annual demand for products from the George Washington National Forest would be 25.5 mmcf (300 mmcf times 0.085 = 25.5 mmcf). This supply is well within the ASQ for Alternatives A, B, D, E, and G. The ASQ for Alternatives C and F would not meet this demand for timber products.

Currently, the demand for biomass fuels on the GWNF, other than traditional firewood, is negligible. There are 2 electrical cogeneration plants of any size within the market area; one located in Pittsylvania County and the other in Campbell County. Combined, these plants have the capacity to utilize approximately 1.25 million tons per year. There is an indication that one of these plants will soon be taken off-line, reducing the potential capacity to about 1 million tons per year. There no plants that produce fuel pellets from raw wood products. We do not have the technology at this time to economically produce bio-fuels (e.g. ethanol) from wood, although those processes are being researched and perfected. While we foresee an increase in demand for biomass fuels over the life of this analysis, it appears that there may actually be a decrease in such demand in the near future. We cannot reliably predict or quantify that demand at this time.

SUPPLY AND DEMAND COMPARISON

Table C6.11 displays the annual timber sale quantity as a percentage of the current demand. Demand from the forest is equal to 25.5 mmcf/year for the first 10 years of plan implementation.

Table C6.11 Supply (ASQ) as a Percent of Current Annual Demand

Alternative	MMCF	% of Demand
A	4.7	18
B	5.4	21
C	0	0
D	9.2	36
E	3.1	12
F	2.0	8
G	5.4	21

As displayed in the table above, no alternative meets or exceeds current market demand. Alternatives meet between 0% and 36%% of current demand for timber products.

When the market is segmented into high, average, and low quality categories, the current demand for the high value category is estimated to be about 0.9 mmcf per year of high quality hardwood sawtimber for the GWNF, if the forest were to satisfy current demand in the same proportion as the economically available resource supply. As indicated in Table C6.11 Alternative D would provide the highest level of high value sawtimber. Other alternatives provide considerably less in descending order from Alternative B, G, A, E, F, and C.

Presumably the supply/demand relationship as it relates to biomass fuels under each alternative would roughly follow the same relationship displayed in Table C6.11 above. Since current demand is negligible and we cannot reliably predict future demand, even approximate figures for each alternative cannot be computed. Further, it is worth stressing that the Forest Service does not control how the raw material is utilized, other than restrictions on the removal of branches and tops that would result from whole tree harvesting. Alternatives A, C, E, F, and G would prohibit whole tree harvesting altogether and so would have less potential to supply a biomass raw material as compared to Alternatives B and D. However, all alternatives, except C, will supply some level of small roundwood. Whether this material is used to produce paper or biomass energy is solely related to local market conditions in the area at the time; we do not control that aspect. This factor further contributes to the inability to estimate our supply or role in biomass fuels markets in any meaningful way.

AGE CLASS DISTRIBUTION

Table C6.12 displays expected age class distribution in 2030, by alternative, following 30 years of plan implementation.

As Table C6.12 indicates in 30 years, the majority of the forested acres in each alternative will be in stands with a stand age greater than 100 years. Projected levels of timber harvesting to create early, sapling/pole, and mid seral stage habitats in any alternative will not offset this further "aging" of the Forest. Alternatives C and F will have the highest percentage of stands 100 years and older with 85-88%. Alternatives E and G are grouped at about 82%, and Alternatives A, B, G, and D are the lowest at 79%. Conversely, Alternative D will have the greatest percentage of habitats less than forty years of age with 15%. Alternatives A, B, and G are grouped at about 10%. Alternative E is 7% followed by Alternative F and C at 4 and 1%, respectively.

Table C6.12 Estimated Percentage of Forest by Age Class and Alternative on the GWNF Base Year 2040

Age Class	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
1-10	3	3	0	5	2	1	3
11-20	3	3	0	5	2	1	3
21-30	3	3	0	4	2	1	3
31-40	1	1	1	1	1	1	1
41-50	3	3	3	3	3	3	3
51-60	2	2	2	2	2	2	2
61-70	4	4	4	3	4	4	4
71-80	1	1	1	1	1	1	1
81-90	0	0	0	0	0	0	0
91-100	0	1	1	1	1	1	1
101-110	3	4	5	4	4	4	4
111-120	11	11	14	11	11	13	11
121-130	20	19	22	19	20	21	19
131-140	17	17	18	18	18	18	17
141-150	8	8	8	8	8	8	8
151+	20	20	21	19	21	21	20
Total	100	100	100	100	100	100	100

METHODS OF HARVEST

Table C6.13 displays the method of timber harvest by alternative for the first 10 years of plan implementation.

As Table C6.13 displays, the seven alternatives explore the use of a wide range of timber harvesting methods to meet a variety of desired future conditions. Uneven-aged harvest methods have generally been limited to lands that have a manageable individual area of at least 100 acres, with slopes less than 30 percent, and within ½ miles of existing roads for physical and economic reasons. All alternatives employ various amounts of group selection, except for Alternative C which employs none. The greatest amount of clearcutting is employed in Alternative D, followed in decreasing amounts by Alternatives A, B, E, G, F, and C. All alternatives employ various mixes of shelterwood harvesting, and significant thinning is employed in Alternatives B, E, and G.

Table C6.13 Acres by Method of Harvest for the First 10 Years for all Harvest Methods

Alternative	GS	CC	SWR	SW-2 Stage	Salvage	Thin	Total
A	8,000	3,000	16,000	3,000	930	1,740	32,670
B	500	900	21,300	7,300		4,000	34,000
C	0	0	0	0	0	0	0
D	500	8,500	6,900	26,600		2,000	44,500
E	500	900	14,600	2,000		4,000	22,000
F	500	500	4,500	4,500		2,000	12,000
G	500	900	21,300	7,300		4,000	34,000

GS = Uneven-aged Management using Group Selection. CC= Clearcut. All commercial trees are removed at initial regeneration harvest. SWR-Two aged shelterwood where 20-40 square feet of residual trees of commercial species 8-14 inch dbh are retained which may be removed at a later thinning of the new stand or at final rotation of the new stand. SW-2 Stage= True two step shelterwood. First entry leaves about 50 BA (1/2 of original stand) and occurs about 10-20 years before final harvest cut that completely removes overstory.

Table C6.14 displays the relative amount of even-aged, two-aged and uneven-aged silvicultural systems employed during the first 10 years of plan implementation by alternative.

Table C6.14 Percentage of Regeneration Acres for Even-Aged, Two-Aged, and Uneven-Aged Silvicultural Systems by Alternative in the First 10 Years

Alternative	Even-Aged	Two-Aged	Uneven Aged
A	22%	71%	7%
B	27%	71%	2%
C	0	0	0
D	83%	16%	1%
E	16%	81%	3%
F	50%	45%	5%
G	27%	71%	2%

C7- MINERALS MANAGEMENT

AFFECTED ENVIRONMENT

FEDERAL LEASABLE MINERALS MANAGEMENT

Management of the federal leasable mineral resources is a shared responsibility between the U.S. Department of Interior and the USDA, Forest Service. The Bureau of Land Management (BLM) has a major role in issuing and supervising operations on licenses, permits, and leases for federal leasable minerals. The BLM cooperates with the Forest Service to ensure that impacts upon surface resources are mitigated and that the land affected is reclaimed. The Forest Service is also involved in the federal issuing of licenses, permits, and leases and in administering on-the-ground operations on NFS lands. Over the past decades, Congress has expanded the role of the Forest Service in the federal leasable minerals process.

The Revised Forest Plan will make a leasing decision only on federal oil and gas. The Revised Forest Plan does not make a leasing decision on other federal leasable minerals, but does consider whether leasing other federal leasable minerals would be a suitable use for various management prescriptions.

FEDERAL OIL AND GAS

Through the passage of the 1920 Mineral Leasing Act, Congress established a program to provide for oil and gas development on federal lands, including the National Forests reserved from the public domain. This Act authorizes the Secretary of the Interior to issue leases for the disposal of certain minerals (including coal, oil, oil shale, and gas). The Mineral Leasing Act for Acquired Lands of August 7, 1947 extended the provisions of the mineral leasing laws to acquired National Forest System lands and requires the consent of the Secretary of Agriculture prior to leasing. The National Forest Systems lands on the George Washington National Forest are acquired lands. The purpose of the Act is "to promote the mining of coal, phosphate, sodium, potassium, oil, oil shale, gas, and sulphur on lands acquired by the United States."

Minerals Policy Act of 1970 states: "The Congress declares that it is the continuing policy of the Federal Government in the national interest to foster and encourage private enterprise in

> (1) the development of economically sound and stable domestic mining, minerals, metal and mineral reclamation industries,
>
> (2) the orderly and economic development of domestic mineral resources, reserves, and reclamation of metals and minerals to help assure satisfaction of industrial, security and environmental needs,..."

The Energy Security Act of June 30, 1980 directs the Secretary of Agriculture to process applications for leases and permits to explore, drill and develop resources on National Forest System lands, notwithstanding the current status of the Land and Resource Management Plan (Forest Plan). As part of the Federal Onshore Oil and Gas Leasing Reform Act of 1987, Congress again recognized the Forest Service's role in the federal oil and gas leasing program, and provided additional authority for Forest Service in regard to leasing and administration of surface operations during oil and gas development. The implementing regulations for this Act (36 CFR 288E) provide the basis for the analysis of Alternatives and decisions on federal oil and gas leasing in the Revised Forest Plan.

Executive Order 13212 (Actions to Expedite Energy-Related Projects) of May 18, 2001 states "executive departments and agencies (agencies) shall take appropriate actions, to the extent consistent with applicable law, to expedite projects that will increase the production, transmission, or conservation of energy." The Executive Order 13212 requires that: "For energy-related projects, agencies shall expedite their review of permits or take other actions as necessary to accelerate the completion of such projects, while maintaining safety, public health, and environmental protections."

The Energy Policy Act of 2005 required the Secretary of Interior and the Secretary of Agriculture to enter into a memorandum of understanding (MOU) to ensure timely processing of oil and gas lease applications and

surface use plans of operation, and eliminate duplication of effort by providing for coordination of planning and environmental compliance efforts. In 2006 the Forest Service and Bureau of Land Management signed the MOU establishing joint policies and procedures for timely environmental analysis of oil and gas leasing and operations on National Forest System (NFS) lands.

The federal oil and gas leasing program provides natural gas and other energy minerals needed by people, and provides a source of revenue to federal and local governments. Federal oil and gas leases are issued by competitive sale. A competitive sale may generate federal revenue from a bonus bid, as well as the annual rental fees for the lease acreage. If a lease is drilled and goes into production, the federal government receives a royalty on production. The revenue generated from the federal leases is shared with States and in turn with all the counties on the Forest. The federal government provides the States with 25 percent of the revenues from federal leasing (annual rental fees, production royalties, bonus bids) for distribution to the counties for schools and roads.

OTHER FEDERAL LEASABLE MINERALS

Historically, iron mining and some coal mining occurred on the Forest. But there is no recent interest in these or other hardrock leasable minerals. Some geothermal leasing occurred on the Forest in the 1980s, but there has been no recent interest in geothermal leasing.

The Forest does not have any lands subject to mining claims under the Mining Law of 1872 ("locatable minerals"). Minerals, such as metallic minerals, that would be "locatable minerals" on public domain lands in the western U.S. are "leasable minerals" on acquired lands in the eastern U.S. As a result, leasable minerals on the Forest include not only oil, gas, coal, and geothermal, but also hardrock or "locatable minerals" such as iron, manganese, and gold.

Under the Revised Forest Plan, if a company were to apply for a leasable mineral other than oil and gas for some area on the Forest, then an environmental analysis including public involvement would be conducted by the Forest Service in cooperation with the BLM. Then the federal government would decide whether to issue a lease.

FEDERAL MINERAL MATERIALS

Mineral materials include aggregate, landscaping rock, rip-rap, flagstone, and other rock or earth construction materials. Mineral materials are managed by the USDA Forest Service (36 CFR 288C), and are not federal leasable minerals. Mineral materials are essential to manage the Forest and provide public access. The Forest operates pits or quarries to supply mineral materials to support a wide range of management programs: to build and maintain trails, roads, campgrounds; to control erosion and sedimentation; to restore riparian and aquatic habitat; to prevent or repair flood damage; etc. The Forest also uses mineral materials extracted from mines off the Forest. Most of the mineral materials used by the Forest are extracted from mines off the Forest.
The Forest also issues mineral material permits to the public. The Forest also can make mineral materials available as free use to governmental agencies, such state road departments.

A continuing supply of mineral materials is essential to manage the Forest and provide public access. As a result, all Alternatives require some level of continued mining to supply mineral materials required to implement the Alternative. Under all Alternatives, most of the mineral materials for Forest management would likely be supplied by mines off the Forest, with lesser amounts of mineral materials supplied by sources on the Forest. Private Mineral Rights (Reserved and Outstanding Mineral Rights)

Private mineral rights (reserved and outstanding mineral rights) underlie about 16 percent of the Forest (Figure D.1). These outstanding or reserved mineral rights (non-federal mineral rights) are partial or complete mineral interests. Reserved rights are those retained in part or in whole by the seller when the federal government acquired the tracts comprising the National Forest. Outstanding rights are mineral rights owned and retained by a third party when federal government acquired the tracts comprising the National Forest. Of the privately-owned mineral rights, about 76 percent are mineral rights outstanding to third parties, and 24 percent are mineral rights reserved by the grantor at the time of acquisition by the federal government.

The only active operation under private mineral rights is a shale mine in operation since the 1980s on the Pedlar Ranger District. Since 1993 reclamation of the previous shale mine has occurred, while additional mining has occurred in recent years. In 2005 the James River Ranger District received a proposal to exercise private mineral rights by mining. Forest Service requested additional information about the proposal, but has not received the information. To date, the proponent has not pursued the proposal with the Forest Service.

Just because mineral rights are privately owned does not automatically mean that the mineral rights will be exercised to explore and develop minerals. In fact, the exercise of private mineral rights on the George Washington National Forest going back for decades is rare. Mineral deposits suitable for mining are scarce on the Forest. For example, there has never been a private mineral rights oil and gas well developed on the George Washington National Forest. However, due to recent interest in natural gas in the Marcellus Shale, the future has the potential for an increase in exploration and development of private mineral rights on the Forest.

Private mineral rights are constitutionally protected property rights. Forest Plan regulations (36 CFR 219.22) require that outstanding and reserved mineral rights (private mineral rights on NFS lands) shall be recognized to the extent practicable in Forest planning.

A Comptroller General Report to Congress (GAO/RCED-84-101; July 26, 1984) found that the Forest Service in the eastern U.S. failed to provide Congress with information about private mineral rights and their potential effect on wilderness management. After designating many Wilderness areas in the eastern U.S., Congress was concerned about tens of millions of dollars that the Forest Service then said could be needed to acquire private mineral rights in several Wildernesses. The Forest Service was faced with management problems, litigation, and administrative costs, and was looking to Congress to purchase the private mineral rights. The GAO noted: “Recent attempts by the federal government to acquire private mineral rights and prevent development in eastern wilderness areas have caused considerable controversy and congressional debate primarily because of the high costs associated with these purchases.”

The GAO recommendation to the Secretary of Agriculture was: “Because the Forest Service did not analyze the potential problems or costs associated with private mineral rights when it developed its 1979 wilderness recommendations, GAO recommends that the Secretary direct the Forest Service’s southern and eastern regional offices to do this type of analysis when reevaluating its wilderness recommendations. This analysis should include for each area consideration of private mineral development potential, the government’s ability to control mineral development if it occurs, the need to acquire private mineral rights, and a range of acquisition costs.”

These problems (management conflicts, litigation, and high costs) apply not only to Wilderness, but to 1) any highly restrictive surface use designation that conflicts with exercise of private mineral rights on National Forest System lands, and 2) management area direction that impose severe restrictions on use of the surface or prohibit certain activities such as road construction or mining. Examples include Special Biological Areas, Appalachian Trail Locations/Relocations, Wild & Scenic River designations, Recommended Wilderness Study Areas, or Remote Backcountry prescriptions. In 1997, the Jefferson National Forest spent more than $300,000 to acquire private minerals interests and lands to shut down a private sand mine deemed inappropriate near the Appalachian Trail in Smyth County.

The 5th Amendment to the U.S. Constitution provides that private property shall not be taken for public use without just compensation. In addition to designations or Plan direction that prohibit mining or are de facto prohibitions on mining, a “taking” can have other forms. For example, the time required to process private mineral activities under the Forest Plan's framework might result in unreasonable delays that amount to a "taking" of the mineral rights. Executive Order 12630 “Governmental Actions and Interference with Constitutionally Protected Property Rights" requires federal decision-makers to 1) evaluate carefully the effect of their administrative actions on private property rights, and 2) to show due regard to these 5th amendment rights and to reduce the risk of undue or inadvertent burdens on the federal treasury. Concern about government "takings" of private property rights is a national issue.

DIRECT AND INDIRECT EFFECTS

For effects related to federal oil and gas leasing, refer to Section D of this Chapter.

The areas of suitable use for leasable minerals other than oil and gas vary by Alternative and depend on the mix of prescriptions with permissible suitable uses in each Alternative. Alternative A provides the most areas and Alternative C the least areas of suitable use for leasable minerals other than oil and gas; Alternatives F, B, E, G, and D provide intermediate levels of areas of suitable use for leasable minerals other than oil and gas.

In terms of potential effects from ground disturbing activities associated with leasable minerals other than oil and gas, Alternative A and D have the most potential and Alternative C has the least potential for effects; Alternatives F, B, E, and G have intermediate potential for effects. The potential for the Forest to receive a request for a leasable mineral other than oil and gas that would result in actual exploration or development activity in the next 15 years is estimated to be low.

The areas of suitable use to meet demand from the public and public agencies vary by Alternative and depend on the mix of prescriptions with permissible suitable uses in each Alternative. Alternative A provides the most areas and Alternative C the least areas of suitable use to meet public demand; Alternatives F, B, E, G, and D provide intermediate levels of areas of suitable use to meet public demand.

In terms of potential effects from ground disturbing activities associated with Forest administrative use and public use of mineral materials, Alternative A and D have the most potential and Alternative C has the least potential for effects; Alternatives F, B, E, and G have intermediate potential for effects.

There are two potential effects relating to outstanding and reserved mineral rights:

- The potential effects of outstanding and reserved mineral operations on federal surface management. The reasonably foreseeable development relates to exploration and development of Marcellus shale. These effects for each Alternative are considered as part of the cumulative effects in federal oil and gas leasing section.
- Potential effects of highly restrictive surface management direction on the exercise of outstanding and reserved mineral rights on the National Forest, such as the potential for “taking” of private mineral rights due to federal action or inaction that prevents or unreasonably delays private mineral operations in some areas. These potential effects are discussed below.

The federal government acquired about 16% of the Forest subject to private mineral rights (reserved or outstanding mineral rights). The exercise of private mineral rights to explore and develop minerals on NFS lands is a private decision, a constitutionally protected property right.

All Forest Plan Alternatives are subject to these existing private rights (outstanding and reserved mineral rights).

Failure to consider private mineral rights under the Forest when allocating management prescriptions and selecting an Alternative could produce incompatible and conflicting land uses, resulting in 1) unnecessary and preventable resource conflicts, 2) inability to achieve desired future conditions in some areas, 3) public controversies that could have been avoided, 4) situations ripe for “takings” of private mineral rights, 5) multi-million costs to federal government to avoid potential “takings”. The potential for conflict with the exercise of private mineral rights is particularly high where management activities are prohibitive or severely restrictive, such as in recommended wilderness study areas or inventoried roadless areas. The Alternatives vary in the extent to which they create potential conflicts with private mineral rights. An indicator of the potential for conflict is the degree of restrictions or prohibitions that the Alternatives place on federal oil and gas leasing availability. Ranging from least potential to most potential for conflict and potential “takings” of private mineral rights are Alternatives A, B, D, G, F, E, and C.

CUMULATIVE EFFECTS

Past and present actions have had limited conflict with the exercise of private mineral rights on Forest. Future actions under Alternative A would result in similar cumulative effects. Alternative B, D, G, F, E, and C increase the potential for conflict with the exercise of private mineral rights on Forest, and so, increase the potential cumulative effects relating to conflicts.

C8 - ROADS SYSTEM MANAGEMENT

AFFECTED ENVIRONMENT

System roads of the George Washington National Forest currently total 1,823 miles and serve a variety of resource management and access needs. Over the past several years, the system has been fairly stable with regards to total mileage, Objective Maintenance Level (OML) breakdown, and type of resource management support. Projected road construction mileage varies by alternative.

There is an effort currently ongoing with regards to management of the Forest road system referenced as a Travel Analysis Process (TAP). This effort is aimed at the identification of the minimum road system necessary to meet management objectives and identify opportunities for increased resource protection, eliminating the backlog of deferred maintenance, optimal performance of maintenance, and better service to Forest users. Road recommendations based on the TAP are incorporated into the Forest Plan and must be further analyzed and implemented through project level NEPA by 2017.

The reasonable foreseeable development and decommissioning scenario is based on the TAP and the amount of acres harvested for each alternative and summarized in Table C8.1 below.

Table C8.1 Road Construction and Decommissioning, miles

	Alternative						
	A	B	C	D	E	F	G
Current Roads	1,823	1,823	1,823	1,823	1,823	1,823	1,823
Special Use Roads – Not part of Minimum Roads System	50	50	50	50	50	50	50
Potential Forest Highways – Not part of Minimum Roads System	107	107	107	107	107	107	107
Roads to be Decommissioned		160	160	80	160	160	160
Potential Additional Decommissioning from future wilderness designation	0	0	124	3	1	17	1
Acres Timber Harvested	3,000	3,000	0	4,250	1,800	1,000	3,000
Road Construction (miles during decade)	29	15	0	41	9	5	15
Minimum road system at end of 10 years	1,695	1,521	1,382	1,624	1,514	1,494	1,520

One strategy identified in the TAP includes identification of roads that would be better and more efficiently maintained as a Forest Highway with the primary maintainer being the Virginia Department of Transportation (VDOT). These include current Forest roads that have a primary function of other than Forest access and use. Examples include roads that primarily function as commuter routes for work and school or service private property. Currently, 804 miles of George Washington National Forest roads are Forest Highways. An additional 107 miles have been identified as possible candidates for addition to the Forest Highway system. It is anticipated that at least a portion of the 107 miles of road will be upgraded and converted to a Forest Highway within the current Plan period.

TAP shall be implemented through the extensive use of project level roads analysis for decisions regarding changes to the road system. These analyses will be conducted to provide managers with data to make informed decisions concerning road system changes, additions, and deletions. Analyses will be conducted in accordance with current Forest Service Guidelines. A completed analysis will inform future management decisions on the merits and risks of building new roads in previously unroaded areas; relocating, upgrading, or decommissioning existing roads; managing traffic; and enhancing, reducing, or discontinuing road maintenance (USDA Forest Service 1999).

Table C8.2 Maintenance Levels of Current Road System and Transportation Analysis Objective, miles

	Operational Maintenance Level - Current Condition	Objective Maintenance Level - TAP	Change from Current
Maint Level 1	245	155	(90)
Maint Level 2	1,008	1,013	5
Maint Level 3	465	301	(164)
Maint Level 4	97	33	(64)
Maint Level 5	8	5	(3)
Decommission	1	160	159
Special Use	-	50	50
Existing Forest Highways	810	810	-
Potential Forest Highways	-	107	107
Grand Total	2,634	2,634	
Minimum Road System	1,822	1,507	
% of High Clearance roads	69%	77%	9%
% of Passenger Car roads	31%	23%	-9%

Management of the Forest's roads will also include intensive on-the-ground field condition surveys followed by clear and concise reporting of the existing condition. This process will include condition surveys on a random sample of the Forest's Operational Maintenance Level (OML) 1, 2, 3, 4, and 5 roads each year. Maintenance levels are recommended in the TAP and summarized in table C8.3.

Special use permit roads are roads identified in the TAP as not needed for Forest Service management but provide access for a permitted or special use by an other than Forest Service entity. Maintenance responsibility for these routes will be borne by the permitted entity. Where these routes are no longer needed, used or not being maintained, they will be decommissioned.

Table C8.3 Maintenance Levels and Road Status, miles

	Alternative						
	A	B	C	D	E	F	G
Maintenance Level 1 - Closed in storage for future use	245	155	105	155	155	145	155
Maintenance Level 2 - High Clearance, seasonal or admin	1,037	1,042	943	1,119	1,029	1,015	1,029
Maintenance Level 3 - Passenger Car	465	301	297	313	301	302	301
Maintenance Level 4 - Passenger Car, collector	97	33	33	33	33	33	33
Maintenance Level 5 - Passenger Car, 2-lane, paved, arterial	8	5	5	5	5	5	5

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

As Table C8.1 indicates, the largest potential increases in road mileage over the Plan period are in the areas of timber management. In comparison, the potential contributions to road system mileage for Recreation and related activities is relatively small and would, under all the Alternatives, be offset by the planned rate of decommissioning. This Table indicates that the potential net mileage range from a low of 1,383 miles for Alternative C to a potential high of 1,695 miles for Alternative A over the plan period.

C9 - LAND USE

AFFECTED ENVIRONMENT

The proclamation boundary of the Forest encompasses almost 1.8 million acres, however only approximately 59% of those acres are National Forest system land, or land acquired by the National Park Service and administered by the Forest Service. National forest land is interspersed with land that remains in private ownership.

As of November 2010, the Forest property boundaries totaled over 1,832 miles. In an ongoing effort, 40% of these boundaries have been marked and can be readily identified by the general public. Generally, forest ownership consists of mountains and ridge tops, with the valleys remaining in private ownership. This results in an ownership pattern that is long and narrow and for that reason; there are few opportunities in a north/south direction to get from the west side of the forest to the east side without crossing national forest at some point.

Table C9.1 Boundary Lines and Planned Level of Maintenance

District	Boundary Miles	Range of Boundary Line Maintenance (Miles per Year)	
		Low	High
Lee Ranger District	310.85	17	26
North River Ranger District	550.33	30	45
Pedlar Ranger District	363.16	20	30
Warm Springs Ranger District	296.75	16	24
James River Ranger District	310.95	17	26
Total	1,832.03	100	150

The intermingled ownership pattern causes some Forest tracts to be inaccessible to the public and difficult to manage.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

All alternatives have similar land adjustment programs aimed at consolidating national forest ownership, however each alternative has a different emphasis or priority. Lands are to be added through either acquisition or exchange.

C10 - SPECIAL USES

AFFECTED ENVIRONMENT

Special Use authorizations are issued for multiple purposes to individuals, corporations, and other government agencies. The predominant uses are for public roads, communication facilities, and utility rights-of-way. Water uses are the next major use category and private road access is the fifth major use category. The total number and acres of area under permit are summarized below, as of November 2010.

Table C10.1 Special Use Permits

District	Permits	Acres
Lee	85	351
North River	99	1,588
Pedlar	75	514
Warm Springs	72	713
James River	75	1,397
Totals	406	4,563

Special use authorizations for personal use are a minor land commitment such as private road easements and permits, well/springs, cultivation, etc.

There are no authorizations for recreation residences on the Forest.

Recreation special uses such as those for outfitter/guides and competitive recreation events provide recreation opportunities to the public that the Forest does not provide.

UTILITY CORRIDORS

AFFECTED ENVIRONMENT

Rights-of-way 50 feet and greater in width located within designated utility corridors comprise linear rights-of-way under authorization, and are primarily electric lines in excess of 138,000 KV and natural gas transmission lines.

Facilities in utility corridors are authorized by special use authorization. When compatible, new uses are accommodated by widening existing corridors rather than designating new corridors.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

All alternatives designate areas as unsuitable for new utility corridors in certain areas (i.e. Wilderness and special areas), with Alternative C having the most area designated as unsuitable. In addition to those areas where new corridors are unsuitable, all alternatives also discourage or somehow restrict development of new corridors in additional management prescription areas.

Although all alternatives have areas where new corridors are considered unsuitable and also restricted, there are opportunities under each alternative to cross national forest system lands with new utility corridors.

COMMUNICATION SITES

AFFECTED ENVIRONMENT

There are ten classified communications sites on Forest as summarized by District. Most have multiple users that conduct high powered broadcasts typically AM, FM radio, Television and cellular communications. Some are considered low power sites that use less than 1,000 watts of radiated power (ERP) for radio communications. The Forest Service also uses many of these sites for its own radio communications. Access is predominately by state highway to a Forest Service road to the site. Sites are summarized in Table C10.2:

Table C10.2 Communication Sites

District	Site	Year Approved	Use	FS Use	Use Type
Lee	Signal Knob	1978	Single	No	AM, FM, TV
Lee	Great North Mtn	1980	Multiple	Yes	AM, FM, TV, ERP
Lee	Big Mtn	1978	Multiple	Yes	AM, FM, TV, ERP
North River	Elliot Knob	1977	Multiple	Yes	AM, FM, TV, ERP
North River	White Grass Knob	1982	Single	No	ERP
North River	Reddish Knob	1991	Multiple	No	ERP
James River	North Mountain	1979	Multiple	No	ERP
James River	Fore Mountain	1994	Single	No	AM, FM, TV, ERP
Pedlar	Rocky Mountain	1977	Multiple	Yes	AM, FM, TV, ERP
Warm Springs	Duncan Knob	1977	Multiple	No	ERP

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

All alternatives designate areas as unsuitable for new communication sites in certain areas (i.e. Wilderness and special areas). In addition to those areas where new sites are unsuitable, all alternatives also discourage or somehow restrict development of new sites in additional management prescriptions, with Alternative C having the most and Alternative D being the least restrictive.

Although all alternatives have areas where new sites are considered unsuitable and also restricted, the effect on the establishment of a nationwide communication system is negligible. The major demand for new communication sites nationwide is to provide wireless coverage. Due to the interspersed ownership pattern of national forest system lands, with the mountain ridges being in Forest ownership and the valleys being held in private ownership, most wireless sites are best located on private land along major travel ways and not on ridge tops located well away from these roadways. As the wireless communication grid expands to more rural locations, the need for demand for new sites is anticipated to increase, however it is expected that for the most part, in the foreseeable future, this need will be able to be met by locating at existing sites, co-locating on electric transmission towers and other improvements, or by locating on private land.

C11 – RANGE

AFFECTED ENVIRONMENT

These lands include approximately 155 acres of improved pastures on three allotments, all on the Lee District. Livestock grazing of cattle is used primarily to help maintain these lands in an open grassland or grass/forb/shrub stage and to preserve the open, pastoral setting on selected portions of the Forest. While these areas provide forage for livestock and aid the local economy, they also to provide a variety of recreational opportunities such as maintaining scenic views, picnicking, and wildlife viewing. These early successional habitats along with their intermingled, isolated patches of woodlands also provide valuable habitat for a variety of wildlife species including deer, turkey, rabbits, voles, raptors, and a variety of migratory songbirds. Livestock grazing has a long history in this area. It is likely the earliest settlers capitalized on the open grassland conditions of the Great Valley and other significant open areas that were maintained for centuries by Native Americans and animals such as bison and elk.

Livestock grazing is managed through a site-specific Allotment Management Plan and Environmental Assessment supported by a thorough analysis of the range situation as directed by the 2200 section of the Forest Service Manual and pertinent handbooks. All grazing use is by permit only. Grazing of livestock on National Forest requires the development of a variety of range improvements and livestock control measures. These include structures such as fences, water developments, corrals, gates and cattleguards. Most of these improvements are typically constructed by the Forest Service and maintained annually to Forest Service standards by the grazing permittee. In most cases, funding from all available sources is insufficient to meet the needs of this program on all these lands.

Forage production appears good on most allotments and livestock numbers are adjusted as necessary to meet the carrying capacity and provide for wildlife needs. Even though the allotments are grazed to maintain the pastoral setting of these lands, impacts on soils and water are occurring. The Moody, Whitting, and Zepp Tannery allotments are currently being grazed with varying degrees of riparian protection or animal access to stream channels.

Although pastureland acreage has been significantly reduced over the last 50 years, pastures still comprise approximately 7 percent of the Southeastern United States (USDA Forest Service 2001). For Southern Appalachian Assessment Area, pastures comprise approximately 17 percent of the area, 99 percent of which is on private land (SAMAB 1996).

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

Grazing is a small program on the GWNF. Grazing would likely continue at current permitted levels on the three current allotments under all alternatives except C. It would continue as long as it is useful in maintaining the desired habitat and not causing damage to other resources. Under Alternative C, grazing under permit would be discontinued. The current grazing allotments are part of the grassland/shrubland ecotype on the GWNF, an important habitat component for many high priority species, especially area sensitive grassland species. If these areas were not grazed, they would continue to be managed as grassland/shrublands, with the possible exception of those allotments located along the South Fork of the Shenandoah River, where bottomland hardwood restoration is a priority goal.

C12 – SOCIAL AND ECONOMIC IMPACT ANALYSIS

An analysis of social values and economic conditions helps evaluate the complex interactions of the surrounding human environment with the biological and physical resources of the Forest. The social and economic influences of people can impact the condition of, and demand for, natural resources. Similarly, almost all National Forest management activities have the potential to directly or indirectly affect the social and economic environment, through people's values, beliefs and attitudes as well as the economic and social structures of communities. This section first characterizes and then evaluates potential impacts related to social factors (demographics, values, resource management concerns and opportunities); economic factors (jobs, income, payments in lieu of taxes, economic diversity and dependency of local communities); and the financial efficiency (present net values) of the agency's resource programs. More details on social and economic conditions can be found in Appendix E of the Analysis of the Management Situation for the GWNF.

AFFECTED ENVIRONMENT

On a regional level, the George Washington National Forest (GWNF) is located at the northern end of the Southern Appalachian Mountains. The Southern Appalachian Mountains range from the Shenandoah Valley and extend southward from the Potomac River to northern Georgia and the northeastern corner of Alabama. The Southern Appalachian Mountains include seven states and 135 counties, covering approximately 37 million acres. On a more local level, the George Washington National Forest occupies approximately 1,065,000 acres, of which about 90% are in Virginia and 10% are in West Virginia. These acres occur in thirteen counties in Virginia and four counties in West Virginia and are in close proximity to Washington, DC, as well as several cities in central Virginia such as Richmond and Charlottesville. The region surrounding the Forest is a mix of ownerships, ranging from the Monongahela National Forest on the west, the Jefferson National Forest on the south, the Shenandoah National Park (USDI National Park Service) on the east, a number of state parks and forests, and an extensive intermingling of private lands. This highlights the unique niche that the GWNF fills in providing biological habitat and resources for ecological and species diversity and in providing social and economic opportunities for a large and growing population base.

For the counties containing GWNF lands, Bath and Alleghany Counties have about 50 percent of their acres comprised of national forest lands. Five additional counties (Amherst, Augusta, Highland, Rockingham, and Shenandoah) have from 20-25% of their acres comprised of national forest lands.

Table C12.1 George Washington National Forest Boundary Lands

County, State	County Square Miles	NF Area in Square Miles	GWNF Acres	% NF Area of County Area
Alleghany, VA	455	222	141,873	49%
Amherst, VA	479	90	57,877	19%
Augusta, VA	1,006	306	196,057	30%
Bath, VA	535	271	173,705	51%
Botetourt, VA	543	20	13,047	4%
Frederick, VA	425	8	4,885	2%
Highland, VA	416	91	58,267	22%
Nelson, VA	474	31	19,825	7%
Page, VA	314	42	27,082	13%
Rockbridge, VA	610	71	45,542	12%
Rockingham, VA	871	218	139,783	25%
Shenandoah, VA	513	119	76,057	23%
Warren, VA	216	10	6,290	5%
Hampshire, WV	642	5	3,518	1%
Hardy, WV	584	81	52,047	14%
Monroe, WV	474	1	428	<1%
Pendleton, WV	698	77	49,106	11%
VIRGINIA	287,148	1,500	960,290	1%
WEST VIRGINIA	162,684	164	105,099	0%
TOTAL	449,832	1,665	1,065,389	0%

Source: USDA Forest Service "Land Areas of the NF System", 2007, http://www.fs.fed.us/land/staff/lar/2007/lar07index.html

SOCIAL ENVIRONMENT

Information about population characteristics helps describe the general nature of a community or area. An analysis of population trends can help determine if changes are occurring for specific groups defined by age, gender, education level, or ethnicity, thereby influencing the nature of social and economic relationships in the community.

POPULATION

Virginia's population increased from 5.35 million in the 1980 Census to 7.08 million in the 2000 Census. The increase between 1980 and 1990 was a 15.7 percent and 14.4 percent between 1990 and 2000. Meanwhile West Virginia experienced a decrease from 1.95 million in 1980 to 1.81 million in 2000. Population decreased from 1980 to 1990 by 8.0 percent and increased from 1990 to 2000 by 0.8 percent. Much of this growth in Virginia was spurred by growth in the major cities in the state, especially in the northern Virginia-Washington, DC area. West Virginia, meanwhile, does not have many large cities to spur growth and the economy is relatively less diversified than that of Virginia.

The report "Virginia Demographic Profile 2009" from the Council on Virginia's Future (covf@virginia.edu) estimated that Virginia's population in 2008 was 7.77 million, which is a 10% increase from the 2000 Census, maintaining Virginia's position as the 12th most populous state in the country. The Northern (Alexandria/Fairfax area), Central (Richmond/Charlottesville area) and Valley (Harrisonburg area) regions had the highest percentage gains in population in Virginia. The report identified three specific trends as shaping the future for Virginia:

1) **Selective decentralization will increase.** People are moving away from central cities and counties to surrounding suburbs and exurbs. Rural counties adjacent to metro areas are likely to grow in population as space and affordable housing become harder to obtain. Counties with significant quality-of-life advantages, those with access to urban amenities and those with a diversified, service-based economy are prone to rapid growth.
2) **The population will continue to age.** By 2030, nearly one in every five Virginians is projected to be 65 years or older.
3) **Racial and ethnic diversity will increase.** While non-Hispanic Whites will continue to be the majority of Virginia's population in the next few decades, the proportion of Asians and Hispanics will grow.

The Council on Virginia's Future report also estimated that Virginia's 11 metropolitan areas contain about 86% of the state's population. Almost 69% of all Virginians live in just three metropolitan areas: Northern Virginia, Richmond, and Virginia Beach, all of which are within a few hours' drive from the George Washington National Forest.

Within the counties having GWNF lands, Table C12.2 shows the population trends for all GWNF counties combined. The trends show a growth of more than half the rate of Virginia between 1980 and 1990 (8.9 percent versus 15.7 percent) and slightly more than Virginia's growth rate between 1990 and 2000 (15.7 percent versus 14.4 percent).

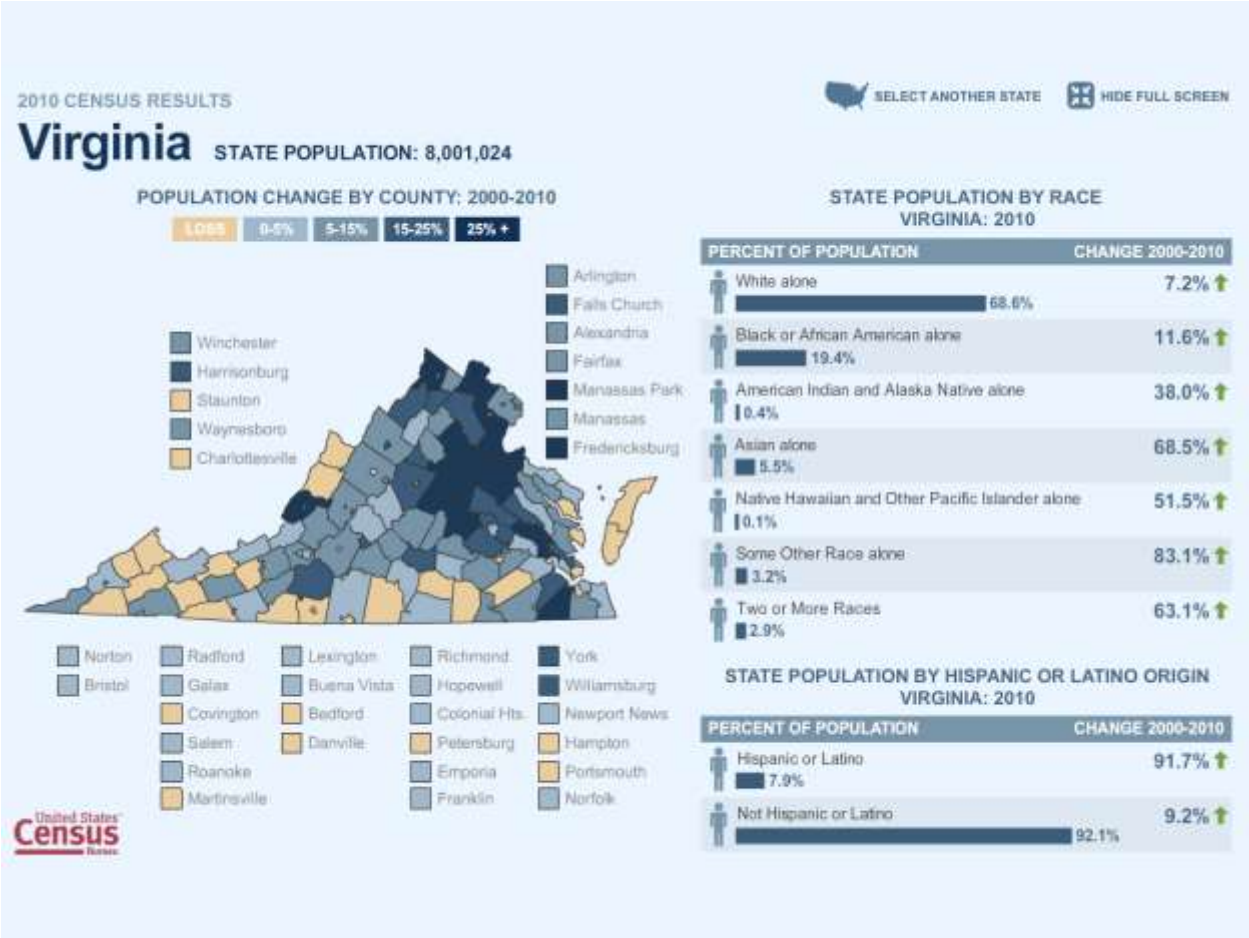
Table C12.2 Population Change for Counties with GWNF Ownership

1980	1990	2000	% Change 1980-1990	% Change 1990-2000
441,922	481,105	556,747	8.9%	15.7%

Source: U.S. Census Bureau from USDA NRIS HD Model

Population outside of counties with GWNF ownership is also important to consider from a recreation demand perspective. Research on recreation use of National Forests typically suggests that most national forest visits originate from within a 75-mile (1 ½ hour driving time) radius from the national forest border. Using this definition, the GWNF market area for recreation entails portions of Virginia, West Virginia, Pennsylvania, Maryland and the District of Columbia. The population living within the market area is about 9.2 million (Source: U. S. Census Bureau. July 1, 2004 estimate). The most populated counties in the market area are Fairfax, Virginia, and Montgomery and Prince George's Counties, Maryland, followed by Washington, DC. Other large municipalities within the market area include Alexandria, Arlington, Blacksburg, Charlottesville, Fredericksburg, Harrisonburg, Lynchburg, Manassas, Staunton, Vienna, and Winchester, Virginia; Beckley, Bluefield, Elkins, Martinsburg and Princeton, West Virginia; and Frederick and Silver Spring, Maryland.

Although the results of the 2010 U.S. Census survey are not fully released yet, the following map shows county-level population changes in Virginia from 2000 to 2010 and illustrates the amount and location of growth in Virginia (West Virginia data is not available for the Draft EIS, but should be available for the Final EIS).



Source: U.S. Census Bureau website: http://2010.census.gov/2010census/data/, accessed March 8, 2011

MINORITIES

Table C12.3 shows the population of the forest and Virginia and West Virginia by race for 1980, 1990, and 2000. In 2000, 92% of the population in the counties that contain NF land was White, as compared to 72% and 95% for Virginia and West Virginia, respectively. The trend for Hispanics in GWNF counties has gone from less than 1% to over 2%. The largest increases occurred in Rockingham and Shenandoah Counties. In these two counties the share of Hispanics increased from less than 1% in 1980 to over 5% in Rockingham and over 3% in Shenandoah by 2000. Most of the GWNF counties' share of the Black population has been less than one percent. Amherst and Nelson Counties had the highest share in 2000 with approximately 20% and 15%, respectively. According to the University of Virginia's Weldon Cooper Center for Public Service, in 2007 70.4% of Virginians were White, 19.6% were Black or African American, 4.8% were Asian and 6.5% were Hispanic.

Table C12.3 Racial Composition of GWNF in Virginia and West Virginia*

	Race	1980	1990	2000
GWNF Counties	Hispanic	0.6%	0.7%	2.3%
	Black	5.7%	5.5%	5.4%
	White	93.9%	93.7%	91.8%
Virginia	Hispanic	1.5%	2.5%	4.7%
	Black	18.9%	18.8%	19.6%
	White	79.1%	77.5%	72.3%
West Virginia	Hispanic	0.7%	0.4%	0.7%
	Black	3.3%	3.1%	3.2%
	White	96.2%	96.2%	95.0%

Source: U.S. Census Bureau from USDA NRIS HD Model
*Percentages do not add to 100% because other ethnic categories are not included

AGE

Table C12.4 shows the share of population as represented by youth (age 17 or less) and the elderly (age 62 or greater). The percentage of youth has fallen from 1980 to 2000. During 2000, the GWNF counties had a youth population share that was approximately 2% less than Virginia and about 0.5% more than West Virginia. The aging population, on the other hand, has grown in all three areas over the three census periods. During 2000, the GWNF counties had an elderly population share that was 3.4% more than Virginia and 1.3% less than West Virginia. According to the University of Virginia's Weldon Cooper Center for Public Service, Virginia's population of age 65 and older is expected to grow from 11.2% in 2000 to about 18.8% in 2030.

Table C12.4 Population Age of GWNF Counties, Virginia, West Virginia

	1980	1990	2000
GWNF Counties			
Age 17 or less	26.7%	23.1%	22.8%
Age 62 or greater	14.8%	16.5%	16.8%
Virginia			
Age 17 or less	27.6%	24.3%	24.6%
Age 62 or greater	11.8%	13.1%	13.4%
West Virginia			
Age 17 or less	28.7%	24.8%	22.3%
Age 62 or greater	15.0%	18.1%	18.1%

Source: U.S. Census Bureau from USDA NRIS HD Model

POPULATION DENSITY

A rural area is defined as towns and areas with less than 2,500 persons. The rural nature of the area is contrasted with the states in the table below. The GWNF counties are becoming less rural over time. In 1980, 70% of these areas were considered rural. The land area has changed to about 58% rural in 2000. Compared with Virginia and West Virginia, the decrease in rural area was from 34 to 27% in Virginia and 64 to 54% of

land area in West Virginia from 1980 to 2000. Thus, urbanization has occurred at a faster pace on the forest than overall within either state.

Table C12.5 Percentage of Population in Rural Areas

	1980	1990	2000
GWNF Counties	70.3%	66.4%	57.6%
Virginia	34.0%	30.6%	27.0%
West Virginia	63.8%	63.9%	53.9%

Source: U.S. Census Bureau from USDA NRIS HD Model

Stein and others (2007) projected future housing density increases on private rural lands at three distances (0.5, 3, and 10 miles) from the external boundaries of all national forests and grasslands in a report entitled "National Forests on the Edge, Development Pressures on America's National Forests and Grasslands." This study ranked National Forest System lands according to the land area of adjacent private lands projected to experience increased housing density. Stein estimated that between 2000 and 2030, a substantial increase in housing density will occur on more than 21.7 million acres of rural private land (8 percent of all private land) located within 10 miles of national forests and grasslands across the conterminous United States. In the East, almost all national forests are projected to experience moderate or high increases in residential development. The GWNF was found to have the most acreage of increases in housing density of all national forests and grasslands, with projected changes on more than 1.4 million adjacent private rural acres by the year 2030. The authors identified several significant implications for the management and conservation of national forest resources, ecological services, and social and cultural amenities from this study, including: impacts on native fish and wildlife habitats and populations; impacts from invasive species, impacts on recreation access, management and quality of recreation experiences; impacts on fire management; impacts on water quality and hydrology; and impacts on law enforcement.

LIFESTYLES, ATTITUDES AND VALUES

Since the beginning of the George Washington National Forest's planning process, numerous public meetings were held to allow people an opportunity to express their wants, needs and demands for access to and use of national forest resources. Many of these divergent views were used to develop the range of alternatives considered in this analysis. Public meetings, however, typically represent only a portion of the public's interests and do not always represent those who do not or cannot attend meetings.

In Virginia and West Virginia, each county periodically produces a County Comprehensive Plan that is typically a joint effort between the local planning commission, the county board of supervisors and the citizens of the county. The County Comprehensive Plans consider existing trends of development and probable future needs and identifies goals and objectives for the county. By reviewing these plans, the Forest can determine what opportunities it has to contribute to a county's goals and objectives. All of these plans had a recurring theme throughout their plans that identified the importance of the natural environment in determining a county's quality of life. The following goals and objectives were found in most of the plans:

- Preserve the relationship of the county to the surrounding forested and agricultural environment
- Increase economic development but maintain the rural and cultural character of the county
- Develop and promote tourism as it relates to the scenic and recreational resources of public lands in the county
- Wisely use natural resources and protect ground and surface waters, soils, scenery and air quality
- Several plans also identified the need to protect ridgelines and scenic viewsheds from development

ECONOMIC ENVIRONMENT

The Virginia Outdoors Plan (2007) characterizes the economy surrounding the GWNF as being 'driven by a diverse blend of industry, agriculture and tourism. Since the area was first settled, agriculture has been a mainstay of the Shenandoah Valley. During the Civil War, the valley was described as the breadbasket of the Confederacy, with more than 300 armed conflicts waged in the region. With the planning and construction of Interstates 66 and 81 beginning in the 1950s, manufacturing in the valley became more diverse. Second home developments and an extended tourist season led to increased use of the Shenandoah Valley, generating economic benefits and attracting new local residents based on a rural quality of life with access to the Northern Virginia-Washington, D.C. metropolitan area. Many of the region's residents are now employed outside their home jurisdiction in the northern Virginia area. Increasingly, the Northern Shenandoah Valley's mountain and valley open spaces are giving way to development that is cluttering historic landscapes and causing a loss of the distinctive qualities of the valley. Agriculture, forestry and tourism are the primary industries for the Central Shenandoah Valley. Some of the highest proceeds in the state from agriculture and forestry are received in this region.'

When giving an overview of the economic characteristics of an area, indicators such as per capita income, unemployment rates, poverty rates, transfer payments, and household composition are used to measure economic progress, viability and stability. Many of these indicators are displayed, by county and over time, in Appendix E of the Analysis of the Management Situation for the GWNF.

PER CAPITA INCOME

Per capita income is a relative measure of the wealth of an area. It constitutes the personal income from all sources divided by the population of that area. According to the 2010 Statistical Abstract (US Census Bureau), the per capita income for Virginia is $44,224 (7th in nation) and for West Virginia it is $31,641 (49th in nation).

UNEMPLOYMENT AND POVERTY

Other indicators of relative economic prosperity are the percent of the workforce out of work and percent in poverty. Unemployment rates vary dramatically over time, depending in large part on the national economy. Some areas, however, have protracted unemployment problems because of educational attainment and lack of skills. According to the 2010 Statistical Abstract (US Census Bureau), the 2008 unemployment rate for Virginia was 4.0% (42th in nation) and 4.3% (39th in nation) in West Virginia. In 2008, Virginia had 10.2% (39th in nation) of its population under the poverty rate and West Virginia had 17.0% (6th in nation).

HEADS OF HOUSEHOLDS

Another factor indicating relative poverty and social disunity for an area is the percent of households headed by females. The greater the percentage is, the more likely that these households may be in a poverty status. A lower female head of household percent may indicate greater social cohesion from the extended family. For the GWNF county area, households headed by females with children increased from about 4.2% in 1990 to about 6% in 2000, which is similar to that in West Virginia. However, Virginia's rate of female house-holders increased from nearly 6% to over 8%.

ECONOMIC DIVERSITY

Analyzing the major economic sectors of an economy allows insight into the degree of economic diversity and what industries may be driving its growth. Tables C12.6 and C12.7 are derived from the IMPLAN model, which is an input-output economic modeling program that uses a database of economic statistics from major government sources such as the Regional Economic Information System (REIS), Bureau of Economic Analysis, Bureau of Labor Statistics and the US Census Bureau. The Manufacturing sector is the most significant part of the GWNF county area economy, followed by the Wholesale and Retail Trade sector and then the Services sector. Recreation associated with wildland use is hard to estimate because it is not a single sector of an economy but comprises several of the services and retail industries. Other than the slight decrease in importance of manufacturing, the composition of other sectors of the area economy has not changed greatly from 1990. Services increased from 20.7% to 24.2% in 2000 as measured by employment change, or a 3.6%

annual increase. Other sector share changes include Wholesale and Retail Sales' employment change of 2.6% per year (changing from a 19.5% to 20.5% share), and Government whose share decreased slightly from 14.0% to 12.9% over the decade.

Table C12.6 Industrial and Service Sectors Contributions to Employment and Income within the GWNF County Area

	1990 Employment % of Total Economy	2000 Employment % of Total Economy	% Average Annual Change 1990-2000	1990 Labor Income % of Total Economy	2000 Labor Income % of Total Economy	% Real Average Annual Change 1990-2000
Total Manufacturing	20.3	19.4	1.6	29.9	27.1	2.3
Wood Products	1.5	1.5	2.4	1.7	1.8	3.6
Wood Furniture & Fixtures	0.6	0.3	-4.3	0.7	0.4	-2.2
Paper & Pulp Products	0.9	0.9	1.7	2.1	1.7	1.5
Wild land Recreation	NA	NA	NA	4.2	2.7	3.9
Total Economy*	264,778**	323,524**	2.0	$6,626.8**	$9,191.0**	3.9

Source: IMPLAN 1990 and 2000 Data
*Real rates of change were determined by inflating 1990 & 2000 data to 2004 with the Gross National Product Price Index Deflator
**Represents dollar totals for category
NA = Not Available

Table C12.7 Aggregated Major Industrial Sectors for the GWNF Counties Local Economy — 1990 & 2000 Data

Copyright MIG 2003 Industry	Total Value Added* 1990	Percentage of Total 1990	Total Value Added* 2000	Percentage of Total 2000	Percent Annual Change 1990-2000
Other Agriculture	$581.6	6.3%	$486.9	3.2%	-1.8%
Range	$47.5	0.5%	$65.8	0.4%	3.3%
Total Agriculture	$629.1	6.8%	$552.7	3.6%	-1.3%
Minerals	$94.7	1.0%	$59.6	0.4%	-4.5%
Construction	$462.6	5.0%	$940.5	6.2%	7.4%
Other Manufacturing	$2,405.5	26.2%	$2,824.1	18.6%	1.6%
Wood Products	$71.3	0.8%	$120.7	0.8%	5.4%
Pulp & Paper	44.670	0.5%	$79.3	0.5%	N/M
Furniture & Fixtures	$30.4	0.3%	$9.9	0.1%	0.0%
Total Wood Based Industries	$146.4	1.6%	$209.9	1.4%	3.7%

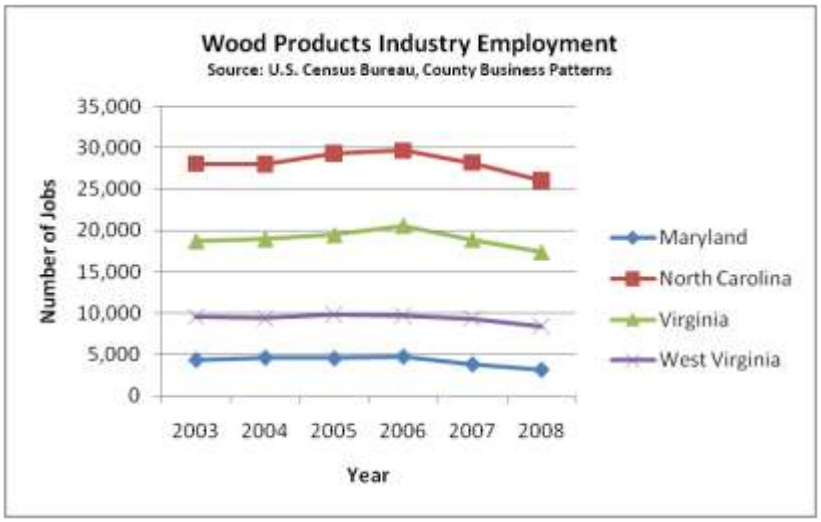
Copyright MIG 2003 Industry	Total Value Added* 1990	Percentage of Total 1990	Total Value Added* 2000	Percentage of Total 2000	Percent Annual Change 1990-2000
Total Manufacturing	$2,551.9	27.8%	$3,034.0	20.0%	1.7%
Transportation & Public Utilities	$1,172.2	12.8%	$1,524.0	10.0%	2.7%
Wholesale & Retail Trade	$1,319.9	14.4%	$3,390.4	22.3%	9.9%
Finance, Insurance, Real Estate	$1,181.6	12.9%	$2,150.7	14.1%	6.2%
Services	$1,210.8	13.2%	$2,097.6	13.8%	5.6%
Government	$545.5	5.9%	$1,443.9	9.5%	10.2%
Other Misc.	$18.2	0.2%	$9.8	0.1%	N/M
Totals	$9,186.5	100.0%	$15,203.2	100.0%	5.2%

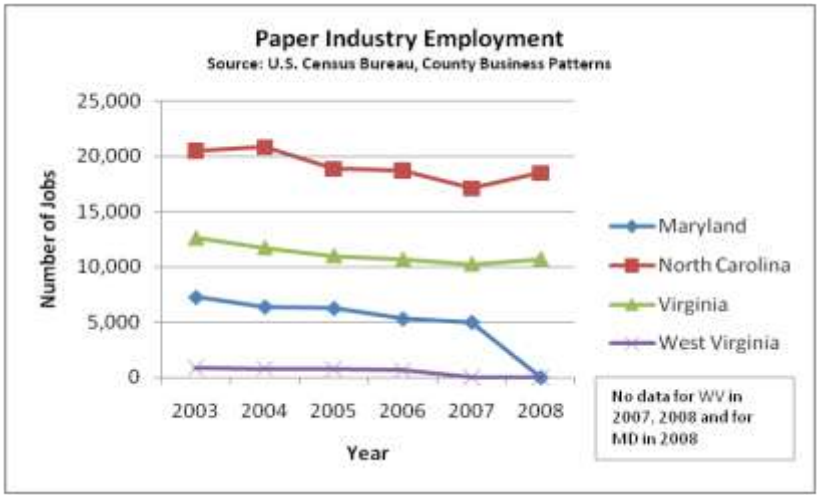
Of the industries and services that use forest or wildland-related resources, only the wood products sector and the recreation and tourism activities can be examined in more detail. The current range program and the oil and gas leasing program on the GWNF are too minimal to have any impact on the local economy.

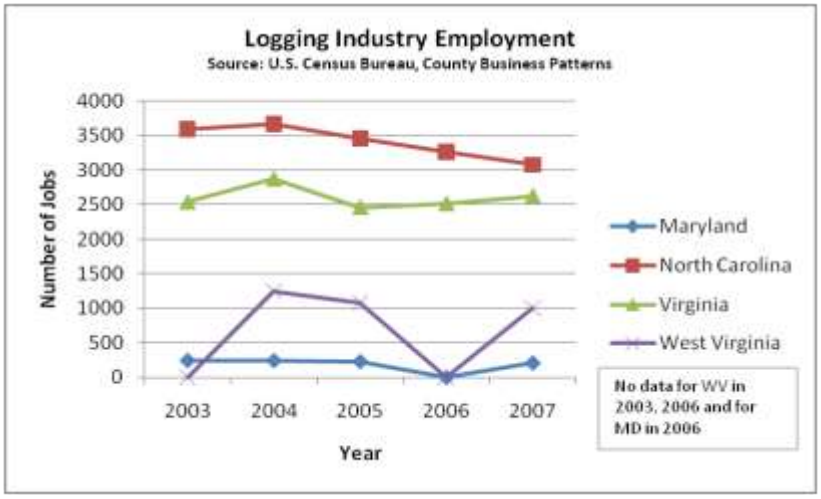
WOOD PRODUCTS

Timber harvest levels on NFS lands declined over the past 15 years, but were relatively stable between 2000 and 2003 and increased slightly between 2003 and 2005. See Timber Management Affected Environment for specific analysis of timber harvest trends.

The following charts show the changes in employment for the timber products industry on a regional level, from 2003 to 2008.







RECREATION AND TOURISM

Recreation and tourism economic contributions related to National Forest management are difficult to identify within the IMPLAN Retail and Service sectors because the sectors cover such a diversity of recreation and tourism factors. However, there are a few other sources of recreation data that can provide some insight.

Stynes and White (2005) analyzed national forest visitor spending profiles developed from the USDA Forest Service National Visitor Use Monitoring (NVUM) project surveys over a four year period. Table C12.8 presents the national spending averages across all national forest visits based on the spending reports of 19,113 visitors sampled on 119 national forests between January, 2000 and September, 2003. Table C12.9 shows the national spending averages by several primary activities. Although Stynes and White stated that NVUM economic survey sample sizes are too small at the individual forest level (there were 158 economic survey samples for the GWNF and JNF) to reliably capture spending for individual forests, the authors did estimate that the average spending for day trips on the GWNF and JNF combined as $55 (2003 dollars) and for overnight trips as $75 per party per trip.

Table C12.8 National Forest Visitor Spending Profiles by Trip Type and Spending Category, $ per party per trip

	Non-Local Visitor			Local Visitor		
Spending Category	Day Trip	Overnight Trip on NF	Overnight Trip off NF	Day Trip	Overnight Trip on NF	Overnight Trip off NF
Lodging	$ 0	$ 25.3	$ 64.9	$ 0	$ 16.2	$ 17.6
Restaurant	13.6	25.3	58.9	6.1	13.6	21.5
Groceries	7.6	36.5	31.3	5.4	41.1	23.5
Gas and Oil	16	37.3	35.8	11.7	27.7	25.9
Other Transportation	1	3	7.5	0.2	0.2	1
Activities	3.9	8	15.5	1.8	3.8	6.8
Admissions/Fees	5.2	10.2	9	3.42	10.5	8.4
Souvenirs/Other	4.3	15.6	22.4	4.2	11.2	11.4
Total	51.6	161.2	245.3	32.8	124.3	116.1

Table C12.9 Spending Averages by Primary Activities and Trip Type, $ per party per trip

	Non-Local Visitor			Local Visitor		
Primary Activity	Day Trip	Overnight Trip on NF	Overnight Trip off NF	Day Trip	Overnight Trip on NF	Overnight Trip off NF
Biking			343	20		
Developed Camping		140	146		128	127
Driving	40		166	24		
Fishing	42	205	238	33	125	148
General Relaxing	46	158	245	33	125	148
Hiking	37	147	276	20	79	83
Hunting	44	201	250	51	174	130
Multiple Activities			173	36		
OHV Use	62	147	182	38		
Picnic	59			38		
Primitive Camping/Backpacking		105	104			
Viewing	52	213	225	27		134

Another way to look at economic diversity is the Shannon Weaver Diversity Index (USDA 2005d). A large number of economic sectors within an economy allows for more resiliency to downturns in any one sector. The Shannon Weaver Diversity Index ranges between 0 (no diversity) and 1.0 (perfect diversity). These two extremes would occur when there is only one industry in the economy (no diversity) and when all industries contribute equally to the region's employment (perfect diversity). Table C12.10 contrasts the change in diversity from 1990 to 2000 at the four-digit Standard Industrial Code (SIC), or at the individual industry level.

Table C12.10 Shannon-Weaver Entropy Indices

	1990 Index	2000 Index	Percent Change
GWNF Counties	.60128	.60883	1.17
Virginia	.70796	.70342	-0.64
West Virginia	.69591	.69607	0.02

Source: USDA Forest Service, Information Monitoring Institute

The indices measuring diversity indicate significantly more diversity in both states than in the GWNF county area during the 1990-decade. In 1990 the George Washington area had an index of .60128 versus Virginia's .70796 and West Va.'s .69591. Because the GWNF county area comprises only 17 counties, a less diverse condition can be expected versus a larger area, such as Virginia and West Virginia, which would have more varied characteristics.

ECONOMIC TRADE

A principle way an economy grows is by export of goods and services. Most typically, manufacturing activity is thought of as providing most of this export related activity. However, services and retail trade can be considered "export" industries if significant visitors come in from outside in travel related activities to bring in new dollars to an economy. A manufacturing industry can be a net importer if it imports more of a commodity or service than it exports.

Table C12.11 shows that the George Washington's local economy increased its net importing characteristic in 2000 by almost double from 1990. The 1990 decade saw the total economy's reliance on imports increase tremendously, thereby becoming more reliant on outside areas for its goods and services production. Such a characteristic causes dollars to leak out of the economy faster (and hence reduce having a greater multiplier capability) than if the economy was a net exporting one.

Meanwhile, all three segments of the Wood Products manufacturing showed net exporting increases. Total manufacturing also gained a significant share in net exporting, by almost doubling its amount in 1990. Other than Construction, Manufacturing, and Minerals, all other major sectors showed an increase of net imports from 1990.

Table C12.11 Exporting of Selected Industries in millions of 2000 dollars

	1990 Net Exports*	2000 Net Exports
Wood Furniture & Fixtures	$2.5	$12.5
Paper & Pulp Products	$459.8	$491.4
Wood Products	$0.0	$160.5
Total Manufacturing	$965.4	$1,817.1
Total of All Sectors	-$1,463.3	-$2,860.6

Source: IMPLAN 1990 and 2000 Data
*1990 Dollars Converted to 2000 Dollars via GDP Price Deflator; in millions of dollars

In summary, the George Washington area economy became more reliant on imports during the 1990's. More dollars, therefore, flowed out of the economy than flowed in, decreasing the ability of enhancement of further economic activity through the multiplier effect. However, manufacturing including wood based industries were a net exporter of manufacturing goods, providing "new" monies for the local economy.

FEDERAL PAYMENTS

Counties receive two types of payments when federal lands are located within their boundaries. The first of these is Payment in Lieu of Taxes (PILT). These payments are based on the acreage of National Forest System lands within each county. The second payment is based on revenue-producing activities (such as timber harvest, mineral extraction, special use permits) on NFS lands to compensate for loss of property tax revenue. The Secure Rural Schools and Community Self-Determination Act of 2000 (Public Law 106-393), was enacted to provide five years of transitional assistance to rural counties affected by the decline in revenue from timber harvests on federal lands. The last payment authorized under P.L. 106-393 was for FY 2006; however, the Act was amended and reauthorized in 2008 and was set to expire in 2011. The Act gives Counties the option of receiving payments based on either: the Twenty-Five Percent Fund (25% of receipts from NFS revenue-producing activities generated within that County); or a funding amount that is based on several factors, including acreage of Federal land, previous payments, and per capita personal income. These funds can be used for improvements to public schools, roads, stewardship projects, watershed and ecosystem improvements, community protection and strengthening of local economies. Tables C12.12 and C12.13 highlight the payments made under PILT and the Secure Rural Schools and Community Self-Determination Act for the last three years.

Table C12.12 Payment in Lieu of Taxes (PILT)

County, State	2007	2008	2009
Alleghany, VA	$150,295	$240,286	$243,345
Amherst, VA	$47,645	$76,239	$76,962
Augusta, VA	$223,709	$357,462	$362,266
Bath, VA	$184,200	$290,482	$278,208
Botetourt, VA*	$88,667	$144,705	$149,664
Frederick, VA	$5,173	$8,267	$8,369
Highland, VA	$56,551	$90,471	$91,526
Nelson, VA	$28,120	$44,864	$45,536
Page, VA	$84,901	$133,786	$136,452
Rockbridge, VA*	$71,583	$115,597	$118,056
Rockingham, VA	$200,716	$320,280	$325,269
Shenandoah, VA	$79,820	$127,621	$129,232
Warren, VA	$29,109	$46,973	$46,205
Hampshire, WV	$5,076	$8,056	$8,247
Hardy, WV	$75,002	$119,032	$121,849
Monroe, WV*	$29,198	$46,337	$47,433
Pendleton, WV**	$123,500	$196,519	$205,174
Virginia	$1,250,489	$1,997,033	$2,011,090
West Virginia	$232,776	$369,944	$382,703
TOTAL	$1,483,265	$2,366,977	$2,393,793

* - includes Jefferson NF
** - includes Monongahela NF

Table C12.13 Payments to States under the Secure Rural Schools and Community Self-Determination Act

County, State	FY 2007	FY 2008	FY 2009
Alleghany, VA	$83,974	$221,404	$234,008
Amherst, VA	$34,000	$93,181	$98,128
Augusta, VA	$115,383	$242,363	$257,013
Bath, VA	$103,078	$160,507	$182,166
Botetourt, VA*	$44,901	$83,906	$70,335
Frederick, VA	$2,914	$5,843	$5,262
Highland, VA	$34,323	$93,504	$87,986
Nelson, VA	$11,117	$5,760	N/A
Page, VA	$16,082	$60,635	$54,515
Rockbridge, VA*	$38,857	$90,162	$96,184
Rockingham, VA	$82,679	$40,614	N/A
Shenandoah, VA	$45,009	$22,089	N/A
Warren, VA	N/A	$1,827	N/A
Hampshire, WV	$2,159	$9,219	$8,716
Hardy, WV	$34,431	$104,740	$117,169
Monroe, WV*	$12,089	$50,763	$49,673
Pendleton, WV**	$210,798	$321,007	$289,044
Virginia	$612,317	$1,121,795	N/A
West Virginia	$259,477	$485,729	N/A
TOTAL	$871,794	$1,607,524	N/A

* - includes Jefferson NF
** - includes Monongahela NF

DIRECT, INDIRECT AND CUMULATIVE SOCIAL ENVIRONMENT EFFECTS

Perhaps the most important effect related to the social environment is the continuing increase in population in many Virginia counties within close proximity of the George Washington National Forest. Most of the areas with the greatest population growth (over 25%) either contain NFS lands or are within a short travel time from the Forest. Many people move to these areas to be within commuting distance of employment opportunities in urban/metro areas such as Northern Virginia, Richmond and the coastal region of Virginia, while still living in a more rural setting. As the more rural communities become more populated, social expectations of residents related to Forest management can change. Long-term residents of rural communities generally value the natural scenery and quality of life more highly than the conveniences that increased development in services can bring.

The effects of this population growth are likely most felt in the demand for, and use of, a variety of recreation opportunities on the Forest. In addition to population growth, another social factor that affects the recreation experience is the increasing average age of the population. Therefore the need for some recreationists to have remote settings to escape an increasing population should be balanced with the need for more accessible settings for older recreationists. The alternatives developed for the EIS address the different types of recreation in various ways and those effects are discussed in more detail within the Recreation section of the EIS. In general, Alternative C, and to a lesser extent Alternative F, is more favorable for those recreationists

seeking a more remote experience, because of the decreased amount of roads, increase in recommended wilderness study areas and decreased amount of timber harvest. However, motorized access to more areas of the national forest increases the satisfaction of visitors who hunt, fish, photograph scenery, birdwatch, pick berries, disperse camp or drive for pleasure. The roads themselves are often enjoyed by people with limited mobility and/or limited time.

Developed recreation does not vary significantly by alternative. In all alternatives there will be an emphasis to upgrade the accessibility of existing and expanded sites, which are considered high priority improvements. None of the alternatives will meet the local market demand for developed recreation. The effects of unmet demand will be greatest with Alternatives C and E, followed closely by Alternatives A, B, D and G. Alternative F meets more of the developed recreation demand than the others, but this will diminish with time as the population increases while the amount of public lands offering these opportunities remain fairly static. Some sites will become increasingly overused and crowded. Initially this may occur only at peak times such as holidays and weekends; but over time this could extend to much of the primary recreation season from Memorial Day to Labor Day. This will result in lower satisfaction levels and some visitors will have unmet expectations. Some will seek the supply of developed recreation on state, county and private lands.

The biggest effect for non-motorized recreation is with the miles of trail currently open to mountain bicycles that would be closed to that use if Recommended Wilderness Study areas are designated by Congress as Wilderness. Alternatives C and F allocate the most acres to Recommended Wilderness Study. This would also have a lesser effect on horseback use on trails in these areas. Although horses are allowed in Wilderness, it can become more difficult to maintain those trails for horseback use without the use of mechanized equipment. An additional effect would be on the loss of opportunities for long-distance bicycling and equestrian events through Wilderness.

Other effects from an increasing population include: impacts on native fish and wildlife habitats and populations; greater opportunities for the spread of non-native invasive species, impacts on recreation access, management and quality of recreation experiences; impacts on fire management and suppression; impacts on water quality and hydrology; increases in special use permit requests, and impacts on law enforcement.

ENVIRONMENTAL JUSTICE AND CIVIL RIGHTS

A specific consideration of equity and fairness in resource decision-making is encompassed in the issues of environmental justice and civil rights. Executive Order 12898, “Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations,” provides that “each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations.” Principles for considering environmental justice are outlined in Environmental Justice Guidance under the National Environmental Policy Act (Council on Environmental Quality (CEQ) 1997). The Executive Order makes clear that its provisions also apply fully to programs involving Native Americans. The Executive Order also contains emphasis on the potential effects of agency actions on subsistence consumption of fish, vegetation or wildlife. The Executive Order also requires agencies to work to ensure effective public participation and access to information.

To fulfill these principles, environmental justice was considered throughout the land management planning process in the following phases:

1. Scoping and Public Participation – Efforts were made by the forest to reach as many people in the area as possible, through mailings, newspaper articles, news releases, radio interviews and contacts with federal, state and local governments, churches, libraries, non-profit organizations, civic associations, industries, academia, and other types of organizations. Participation was sought in various locations and formats throughout the planning area.

2. Determining the Affected Environment – The Social and Economic Environment section of Chapter 3 of the EIS presented information related to population growth, minority populations, population density, income, unemployment and poverty, households, and economic diversity in the area directly affected by

George Washington National Forest management and compared this information within a more regional context when appropriate. There were no segments of the population identified that depend on subsistence consumption of fish, wildlife or vegetation within the planning area. No areas were identified that had significant minority populations, high poverty and unemployment rates, negative population growth, or depressed housing values.

DIRECT, INDIRECT AND CUMULATIVE ECONOMIC ENVIRONMENT EFFECTS

The management of the George Washington National Forest has the potential to affect jobs and income within its area of influence. Employment and income estimates were determined by using the input-output model IMPLAN (Impact for Planning Analysis). Due to substitution effects from competing non-government sources (such as similar volume of timber harvesting which may occur on private lands if national forest timber is not offered to the market), these jobs are characterized as being associated with local economic activity initiated by Forest Service programs and activities, rather than caused by these activities. The database in IMPLAN represents Census 2000 information for 528 economic sectors. On the Forest, effects are based on changes in six major Forest-level outputs: the amount of timber volume and type of product to be harvested, payments to states (counties), Forest Service expenditures, recreation use, and mining leases. For purposes of estimating the socio-economic impact, counties and cities that contain forest acreage were selected as the impact area. The input /output analysis is based on the interdependencies of the production and consumption elements of the economy within the impact area. Industries purchase from primary sources (raw materials) and other industries (manufactured goods) for use in their production process. These outputs are sold either to other industries for use in their production process or to final consumers. The structure of interdependencies between the individual sectors of the economy forms the basis of the input/output model. The flow of industrial inputs can be traced through the input/output accounts of the IMPLAN model to show the linkages in the impact area economy. This allows the determination of estimated economic effects (in terms of employment and income).

EMPLOYMENT

Table C12.14 illustrates how the proposed alternatives differ from the current management direction (Alternative A) for potentially affecting jobs in the local economy.

Table C12.14 Employment by Program by Alternative (Average Annual, Decade 1, jobs contributed)

Resource	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Recreation	152	154	131	162	145	162	157
Wildlife and Fish	91	92	77	97	86	97	94
Timber	109	130	0	235	73	47	130
Minerals*	339	256	2	256	50	194	50
Payments to States/Counties	57	57	57	57	57	57	57
Forest Service Expenditures	339	348	311	362	340	338	349
Total Forest Service Management	1,087	1,037	578	1,169	752	895	836
Percent Change from Current	0.0%	-4.6%	-46.8%	+7.4%	-30.8%	-17.7%	-23.1%

* The estimates for the Minerals Program include the effects from horizontal drilling if it is allowed in the alternative.

Table C12.15 Employment by Major Industry by Alternative (Average Annual, Decade 1, jobs contributed)

Industry	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Agriculture	68	77	7	125	47	34	77
Mining*	105	80	4	80	19	62	19
Utilities	2	2	1	3	1	2	2
Construction	14	14	11	15	12	13	13
Manufacturing	25	27	7	40	17	17	23
Wholesale Trade	35	32	12	35	18	27	21
Transportation & Warehousing	34	30	9	33	16	24	18
Retail Trade	99	97	58	107	75	88	83
Information	10	9	4	10	6	8	7
Finance & Insurance	23	20	8	22	12	17	13
Real Estate & Rental & Leasing	29	26	9	28	15	21	16
Prof, Scientific, & Tech Services	61	53	16	57	28	44	30
Mngt of Companies	16	12	2	13	4	10	5
Admin, Waste Mngt & Rem Serv	35	31	13	34	19	27	21
Educational Services	10	9	4	10	6	8	7
Health Care & Social Assistance	52	50	21	57	32	41	37
Arts, Entertainment, and Rec	28	28	19	30	23	27	26
Accommodation & Food Services	128	127	92	136	109	125	119
Other Services	35	33	13	39	21	27	24
Government	273	273	266	275	270	272	271
Total Forest Management	1,082	1,030	578	1,151	749	894	830
Percent Change from Current		-4.8%	-46.6%	+6.4%	-30.8%	-17.4%	-23.3%

* The estimates for the Minerals Program include the effects from horizontal drilling if it is allowed in the alternative.

LABOR INCOME

Labor income is employee compensation (value of wages and benefits) plus the income to sole proprietorships. Labor income for the first decade for each resource program expenditure is given by alternatives in Table C12.17. Impacts to the local economy sectors are shown in Table C12.16.

Table C12.16 Labor Income by Program by Alternative (Average Annual, Decade 1, thousand dollars)

Resource	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Recreation	$4,666	$4,737	$4,030	$4,994	$4,469	$4,984	$4,835
Wildlife and Fish	$2,867	$2,911	$2,437	$3,065	$2,734	$3,059	$2,971
Timber	$3,388	$4,056	$0	$7,440	$2,283	$1,458	$4,056
Minerals	$18,167	$13,709	$79	$13,709	$2,644	$10,394	$2,645
Payments to States/Counties	$2,334	$2,334	$2,334	$2,334	$2,334	$2,334	$2,334
Forest Service Expenditures	$10,582	$11,555	$7,558	$13,046	$10,723	$10,473	$11,580
Total Forest Service Management	$42,004	$39,303	$16,437	$44,589	$25,187	$32,702	$28,421
Percent Change from Current	0.00%	-6.40%	-60.90%	6.20%	-40.00%	-22.10%	-32.30%

Table C12.17 Labor Income by Major Industry by Alternative (Average Annual, Decade 1, thousands dollars)

Industry	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Agriculture	$1,721	$1,970	$101	$3,261	$1,170	$809	$1,966
Mining	$7,586	$5,759	$160	$5,769	$1,224	$4,406	$1,235
Utilities	$253	$233	$104	$260	$148	$197	$164
Construction	$593	$577	$457	$604	$501	$547	$518
Manufacturing	$1,446	$1,499	$360	$2,173	$900	$950	$1,258
Wholesale Trade	$2,060	$1,845	$714	$2,028	$1,063	$1,567	$1,189
Transportation & Warehousing	$1,471	$1,271	$350	$1,401	$610	$1,025	$687
Retail Trade	$2,571	$2,497	$1,493	$2,737	$1,931	$2,299	$2,122
Information	$560	$514	$248	$557	$336	$452	$366
Finance & Insurance	$1,290	$1,155	$455	$1,257	$675	$971	$740
Real Estate & Rental & Leasing	$575	$494	$144	$530	$241	$404	$264
Prof, Scientific, & Tech Services	$3,458	$2,940	$796	$3,105	$1,376	$2,406	$1,481
Mngt of Companies	$1,161	$932	$136	$972	$312	$737	$336
Admin, Waste Mngt & Rem Serv	$850	$766	$331	$831	$466	$658	$509
Educational Services	$276	$259	$117	$291	$171	$220	$192
Health Care & Social Assistance	$2,500	$2,351	$1,012	$2,650	$1,537	$1,969	$1,726
Arts, Entertainment, and Rec	$574	$569	$419	$609	$491	$567	$535
Accommodation & Food Services	$2,725	$2,712	$2,034	$2,899	$2,369	$2,718	$2,579
Other Services	$1,111	$1,038	$431	$1,178	$660	$860	$747
Government	$9,021	$9,647	$6,577	$10,737	$8,873	$8,873	$9,531
Total Forest Management	$41,804	$39,028	$16,437	$43,848	$25,050	$32,638	$28,146
Percent Change from Current	0.00%	-6.60%	-60.70%	+4.90%	-40.10%	-21.90%	-32.70%

GEORGE WASHINGTON NATIONAL FOREST'S CURRENT ROLE

Finally, Table C12.18 illustrates the percentage contribution of the GWNF's current management program (Alternative A) to the area's economy. The George Washington NF is associated with 0.12% of the total local economy's jobs, and 0.10% of the labor income. Retail Trade, Accommodation and Food Services and Government are the sectors of the economy that show the most benefit from the Forest's activities.

Table C12.18 Current Role of Forest Service-Related Contributions to the Area Economy

	Employment (jobs)		Labor Income (Thousands of 2011 dollars)	
Industry	Area Totals	FS-Related	Area Totals	FS-Related
Agriculture	29,015	72	$275,559	$1,744
Mining*	7,238	110	$474,654	$7,782
Utilities	3,234	3	$343,678	$293
Construction	70,928	16	$2,975,493	$657
Manufacturing	99,786	33	$6,083,625	$1,818
Wholesale Trade	28,430	53	$1,691,993	$3,095
Transportation & Warehousing	38,715	43	$1,736,814	$1,815
Retail Trade	131,269	167	$3,587,658	$4,319
Information	14,914	12	$893,183	$684
Finance & Insurance	32,595	26	$1,904,470	$1,481
Real Estate & Rental & Leasing	37,331	34	$587,095	$648
Prof, Scientific, & Tech Services	48,825	66	$2,822,183	$3,709
Mngt of Companies	12,429	17	$931,526	$1,270
Admin, Waste Mngt & Rem Serv	50,106	41	$1,285,395	$1,006
Educational Services	24,722	11	$731,435	$331
Health Care & Social Assistance	122,867	61	$6,122,913	$2,933
Arts, Entertainment, and Rec	21,039	53	$371,489	$1,132
Accommodation & Food Services	80,486	186	$1,603,514	$3,861
Other Services	67,312	42	$2,076,612	$1,316
Government	185,407	278	$11,387,887	$9,433
Total	1,106,649	1,323	47,887,178	49,329
FS as Percent of Total	---	0.12%	---	0.10%

* The estimates for the Minerals Program include the effects from horizontal drilling.

FINANCIAL EFFICIENCY

When discussing the evaluation of Forest Plan alternatives, the regulations state that the evaluation 'shall compare present net value, social and economic impacts, outputs of goods and services, and overall protection and enhancement of environmental resources' [36 CFR 219.12(h)]. Present net value is defined as 'the difference between the disputed value (benefits) of all outputs to which monetary values or established market prices are assigned and the total discounted costs of managing the planning area' [36 CFR 219.3] and is the primary criteria used to measure the financial efficiency of the different resource management programs. The analyzed benefits include market values, where the Forest Service receives money for timber, range, special uses, etc, and non-market values. Non-market values can be assigned for activities such as wildlife viewing and recreation using values from Resource Pricing and Valuation Procedures for the 1990 Resource Planning Act (RPA) program.

There are many values associated with National Forests that cannot be expressed in monetary terms. Many values are highly personal and subjective in nature. These, however, may be the greatest value of National

Forests to the nation. The regulations state that plans 'shall provide for multiple use and sustained yield of goods and services from the National Forest System in a way that maximizes long term net public benefits in an environmentally sound manner' [36 CFR 219.1]. The NFMA regulations define net public benefits as: 'An expression used to signify the overall long-term value to the nation of all outputs and positive effects (benefits) less all associated inputs and negative effects (costs) whether they can be quantitatively valued or not. Net public benefits are measured by both quantitative and qualitative criteria rather than a single measure or index' [36 CFR 219.3]. Because not all values are expressed in monetary terms and therefore not included in the financial efficiency analysis does not mean that they have been excluded from the determination of 'net public benefits.' For those resources that can be reasonably valued via market data (e.g. timber, minerals and range) and for those non-market resources that have Forest Service estimated values from research (recreation), we have presented values in the present net value calculations. For resources that have no values estimated by generally accepted methods, we will discuss them in a narrative fashion as part of the assessment of net public benefits that is made in the Record of Decision for the George Washington National Forest Plan.

The cumulative total present net values between all of the alternatives are fairly close together. Although some program emphases change between alternatives, both the costs and benefits change at a proportional rate, making the net PNV more comparable.

Table C12.19 Cumulative Decadal Present Net Values of Benefits and Costs (millions of dollars, 4% discount rate cumulative to midpoint of 5th decade)

Present Value Benefits by Program:	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Range	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Timber	$36	$68	$0	$123	$38	$22	$68
Minerals	$24	$19	$4	$20	$6	$16	$6
Recreation	$1,163	$1,181	$1,007	$1,242	$1,111	$1,244	$1,205
Wildlife	$661	$669	$562	$713	$640	$698	$684
Total Present Value Benefits	**$1,884**	**$1,937**	**$1,573**	**$2,098**	**$1,795**	**$1,980**	**$1,963**
Present Value Costs by Program:							
Range	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Timber	$41	$47	$0	$80	$27	$17	$47
Roads/Engineering	$29	$30	$25	$32	$29	$28	$30
Minerals	$4	$4	$4	$5	$4	$4	$4
Recreation	$84	$84	$78	$90	$78	$90	$84
Wildlife	$12	$14	$8	$15	$14	$14	$14
Soil, Water and Air	$30	$29	$15	$29	$29	$29	$29
Protection/Forest Health	$26	$42	$26	$33	$48	$42	$42
Lands	$9	$9	$9	$9	$9	$9	$9
Planning/Inventory/Monitoring	$9	$9	$9	$9	$11	$9	$9
Total Present Value Costs	**$244**	**$268**	**$174**	**$302**	**$249**	**$242**	**$268**
Cumulative Total Present Net Value	**$1,640**	**$1,669**	**$1,399**	**$1,796**	**$1,546**	**$1,738**	**$1,695**

C13 – WIND ENERGY DEVELOPMENT

Wind energy is renewable and can reduce the use of fuels generating carbon gases and positively affect climate change. Wind energy development is a priority for Federal agencies. The Forest Service is the only agency in the east that can accommodate wind development within its multiple-use mission and has the land base to accommodate this development.

AFFECTED ENVIRONMENT

Nationally, the best areas for wind energy are the plains and the coast. The U.S. Department of Energy has identified many of the ridges on the Forest as potentially able to support wind energy production (Figure C13.1). The USDA Forest Service and National Renewable Energy Laboratory (2005) identified 35,810 acres of the GWNF with a high potential for wind area development. The GWNF is in close proximity to growing population centers that would benefit from additional and clean energy production.

Wind energy development has not occurred on the Forest. A project is under construction in Highland County adjacent to the GWNF.

Alternative A. This is an emerging issue. Ridgeline development associated with wind energy development is not discussed in the George Washington 1993 Forest Plan. Basically, the special use process would be used to consider any applications for wind energy development. No areas are considered to be unsuitable for wind energy development, though management area guidance would limit road construction and clearing activities in some areas.

Alternatives B, F, and G would allow consideration of wind energy development proposals on some areas of the Forest. Proposals for development would be evaluated and if accepted, would be analyzed through the NEPA process. The following areas are unsuitable for wind energy development:

- Wilderness
- Recommended Wilderness
- Special Biological Areas
- Research Natural Areas
- Special Geologic Areas
- Shenandoah Mountain Crest – Cow Knob Salamander Area
- Indiana Bat Protection Areas
- Appalachian Trail Corridor
- Blue Ridge Parkway Scenic Corridor
- Remote Backcountry Areas
- Mt. Pleasant National Scenic Area

Alternatives C and E prohibit the development of wind energy across the GWNF.

Alternative D is similar to Alternatives B, F, and G except that wind energy development proposals would be considered in several remote backcountry areas. The areas identified as unsuitable contain many of the ridges with high potential for wind energy development. To increase the availability of high potential sites, this alternative removes the ridgelines from some of the remote backcountry areas from the list of unsuitable areas for wind development. Wind energy development proposals could be considered in the following remote backcountry areas: Little Alleghany, Oliver Mountain, Elliott Knob, Crawford Knob, Northern Massanutten, Beech Lick Knob and Church Mountain. Aside from wind energy development proposals (including associated road and transmission line access); these backcountry areas would be managed like the other remote backcountry areas.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

For purposes of analysis, the following assumptions were made regarding possible wind energy development.

Table C13.1 Potential Wind Energy Development

	Wind energy development						
	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Sites, #		1		3		1	1
Turbines, #		15		45		15	15
Openings, acres		57		172		57	57
Transmission, miles		1		3		1	1
Road construction, miles		1.8		5.5		1.8	1.8
Road Improvement, miles		3		9		3	3

Alternatives A, C, and E would have no wind energy development. They would not address the need for alternative energy sources and they would not provide jobs, taxes and economic returns to the local communities from construction and operation of the turbines.

Effects of the development on soils, scenery, aquatic resources, geologic resources and water are addressed in those sections of the EIS. Potential effects on wildlife include the long term occupation of the ridgelines with openings, roads and turbines. Ridgelines are used by many birds and bats during migrations and during resident activities.

TIMBER MANAGEMENT

In the short term, wind development would generate wood products as sites are cleared for turbines, transmission lines, and access. Because most of the development is assumed to occur on ridgetops with poor site productivity, the vast majority of product resulting from this activity would be pulpwood. Relatively low volumes and values per acre would be realized. Table C13.2 provides an estimate of the acres and volume that would result from clearing for wind energy development.

Table C13.2 Volume (ccf) of pulpwood and acres cleared that would result from wind development.

	Wind energy development					
	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F
Openings, acres		57		172		57
Transmission, miles		4		11		4
Road construction, miles		7		20		7
Total Acres Cleared		68		203		68
Total Volume Produced (ccf)	0	680		2030		680

In the long term, these acres would be taken out of wood and fiber production. No future production of wood can be expected on these acres.

THREATENED & ENDANGERED & SENSITIVE SPECIES

Commercial wind power development has rapidly expanded across the Appalachians. Multiple sites have been developed in West Virginia and one site is being constructed in Virginia west of Monterey in Highland County. There is growing concern that Indiana bats and Virginia big-eared bats, plus several other rare bat species like the small-footed bat, may be threatened by the recent surge in construction and operation of wind turbines across the species' range. This potential for increasing mortality and population decline has been exacerbated by the recent establishment and rapid spread of White Nose Syndrome (WNS) throughout the eastern U.S. which has killed millions of bats and has lead to the precipitous decline of many once common bat species like small brown and red bats. Bats are often killed during wind tower operations when they fly into the lower pressure area surrounding the trailing edge of spinning blades and suffer extreme barotrauma where decompression causes capillaries in the lungs to explode (Baerwald, et al., 2008). Bats are most affected during periods of fall migration when they often follow ridgetops and come into contact with wind towers built along those same ridgetops. Until the fall of 2009, no known mortality of an Indiana bat had been associated with the operation of a wind turbine/farm. The first documented wind-turbine mortality event occurred during the fall migration period in 2009 at a wind farm in Benton County, Indiana. Research is now under way to develop operation or engineering guidelines to avoid and minimize take of bats and assess the magnitude of the threat. A recent study has shown that injury and death to bats (and also birds) during periods of spring and fall migrations can be reduced by 44 to 93% with an annual power loss of 1% by raising the cut-in speed for blade spin and tower operation to 11-14 mph from the current industry standard of 8-9 mph (Arnett, et.al, 2010). Currently this is the only proven mitigation option that will reduce bat mortality.

The Bald eagle (*Haliaeetus leucocephalus*) was delisted from federal status as Threatened by the FWS, but is considered a Sensitive Species by the Regional Forester (USDA 2007). The Bald eagle and golden eagle (*Aquila chrysaetos)* are protected by the Bald and Golden Eagle Protection Act (Eagle Act) and the Migratory Bird Treaty Act (MBTA). Neither law has take provisions as mitigation measures to protect Bald or golden eagles from a variety of harmful actions and impacts. Bald eagles and other large raptors are known to be negatively affected by commercial wind towers (Bell and Smallwood 2010, FWS 2009). Bald eagles, golden eagles and other large raptors are vulnerable to colliding with wind tower blades, especially during spring and fall migration periods. Wind energy projects can also affect bald and golden eagles by degrading or fragmenting habitat, and by introducing new sources of disturbance (noise, construction activity, permanent changes to the landscape, barriers to movement, and increased human activity). Furthermore, both bald and golden eagles may be attracted to forest openings around wind turbines to feed, particularly if sources of carrion (large birds killed by collisions) are present. Both eagle species are increasing in population, especially during the non-breeding season, in the central Appalachians (Katzner et al. 2009). The FWS's National Bald Eagle Management Guidelines recommend siting wind turbines away from known nests, foraging areas, and communal roost sites (FWS 2007).

NON-NATIVE INVASIVE PLANTS

Alts A, C, and E would have no wind power development and would not create disturbed habitat that would promote NNIP infestations. Alt B and F would create ground disturbance from the openings created for the wind tower sites, transmission lines, and road construction. These disturbed areas would be potential sites for NNIP infestations. The roads and transmission lines could act as dispersal corridors for NNIP. Alt D would create three times the ground disturbance over Alts B and F. Aggressive control treatments for NNIP could mitigate the impacts of the ground disturbing activities.

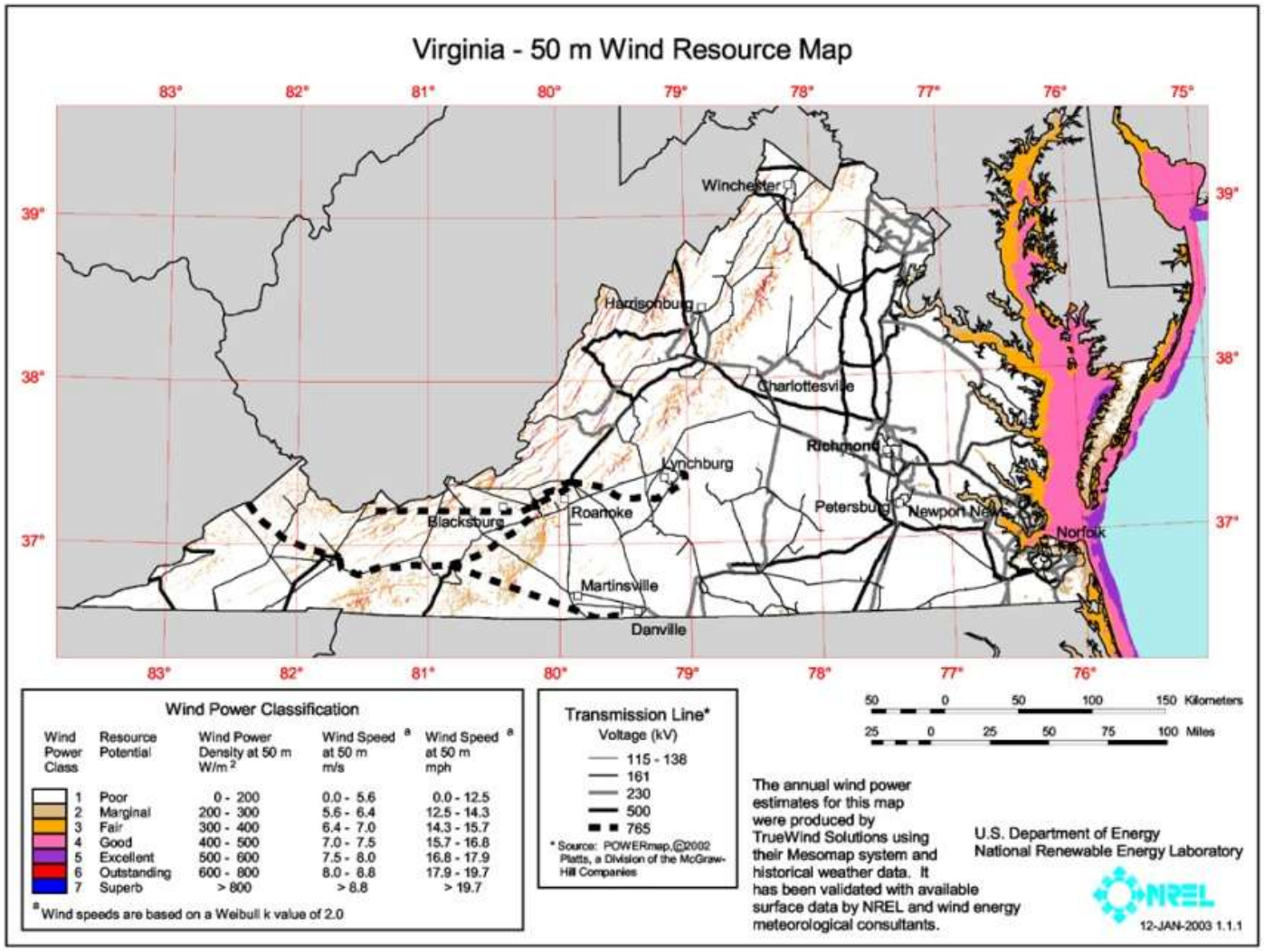


Figure 13.1 Virginia Wind Energy Potential

C14 - OTHER EFFECTS

RELATIONSHIP OF SHORT-TERM USE 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 Forest, such as prescribed burning. Long-term refers to a period greater than ten 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 forest-wide management standards ensure that long-term productivity would not be impaired by the application of short-term management practices.

Each alternative in the Forest Plan was analyzed using the SPECTRUM linear programming model (See Appendix B – Description of the Analysis Process), 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 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 Jefferson National Forest.

The management prescriptions and the effects of implementing the revised Forest Plan will be monitored. Evaluation of the data collected will determine if standards for long-term productivity are being met, or if management practices need to be adjusted. Monitoring requirements and standards apply to all alternatives, and are included in Chapter 5 of the revised Forest Plan.

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.

In the case of the Federal oil and gas leasing discussed in the minerals section of this Chapter, actual extraction of oil and gas would be considered an irreversible commitment, since this is a non-renewable resource. However, the decision to actually permit this extraction will occur following receipt of an Application for Permit to Drill,

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 Prescription and following Virginia'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 evaluation 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 Riparian Management Prescription. The direction of this prescription is embedded in all management prescriptions. 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.

Protective measures for riparian areas include the delineation of riparian corridors on perennial and intermittent streams. Management activities within the riparian corridor must comply with the previously mentioned State BMPs 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 forest-wide standards for management of ephemeral stream zones.

UNAVAILABLE OR INCOMPLETE INFORMATION

The George Washington National Forest has used the most current scientific information available 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 determined through the monitoring and evaluation process.

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SECTION D – FEDERAL OIL AND GAS LEASING AVAILABILITY

In 1987 Congress updated and enlarged the Forest Service role and authority in leasing federal oil and gas on National Forest System lands (Federal Onshore Oil and Gas Leasing Reform Act of 1987). The lands administratively available to leasing for the Revised Forest Plan was developed based on the law and the implementing regulations (36 CFR 228E) as well as the wide range of laws applicable to National Forest System lands. The federal oil and gas leasing availability decision varies for each Forest Plan Alternative and is displayed in Federal Oil and Gas Leasing Availability by Alternative Table. The Forest Service would authorize the BLM to offer as specific lands for federal oil and gas leasing the lands designated as administratively available under each Alternative. The Forest Service would not authorize the BLM to offer as specific lands for federal oil and gas leasing the lands designated as administratively unavailable under each Alternative.

Table D1- Federal Oil and Gas Leasing Availability by Alternative (thousands of acres)

	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Standard Lease Terms*	145	625.1	0	614.4	541.2	496.3	555.9
Controlled Surface Use Stipulation*	825	151.8	0	161.6	159.6	105.3	161.0
Timing Stipulation*	0	13.7	0	13.7	13.7	13.7	13.7
No Surface Occupancy Stipulation*	41	202.4	0	200.9	274.7	158.1	262.7
Horizontal Drilling Moratorium Stipulation Horizontal Drilling Operations Control Stipulation	0	993.0	0	990.6	0	742.0	0
No Horizontal Drilling Stipulation	0	0	0	0.0	989.2	31.5	993.2
Administratively Unavailable	3.1	22.1	1,015.2	24.5	26.0	241.8	22.0
Legally Unavailable	50.7	50.8	50.7	50.7	50.7	50.7	50.7

* In Alternatives B, D, E, F and G the lease is restricted by Stipulations on horizontal drilling.
Note: The Horizontal Drilling Stipulations acres apply to same acres with Stipulations (CSU, Timing, NSO) and Standard Lease terms for vertical wells.
Note: The No Horizontal Drilling Stipulation acres in Alt F are in public water supply watersheds.

The determination of lands administratively available is based on the benefit mix designed for each Management Prescription. Congressionally withdrawn areas, such as Wilderness and Mt Pleasant National Scenic Area (NSA), are legally unavailable for leasing. For each Management Prescription not closed by law, the design of the Management Prescription included consideration of whether lands would be administratively available or unavailable for federal oil and gas leasing, and if available, under what terms and conditions. The lease availability options are: 1. administratively unavailable, 2. available with standard lease terms and conditions, 3. available with Controlled Surface Use (CSU) or Timing Stipulation, 4. available with No Surface Occupancy Stipulation (NSO). Each Management Prescription was assigned one of these options based on the multiple benefit mix of the Management Prescription as shown in Table D2.

Table D2. Oil and Gas Leasing Options by Management Prescription Area

Rx	Management Prescription Area Description	Oil and Gas Leasing
1A	Designated Wilderness	Administratively Unavailable
1B	Recommended Wilderness Study	Administratively Unavailable
2C2	Eligible Wild and Scenic River-Scenic	CSU
2C3	Eligible Wild and Scenic River-Recreation	CSU
4A	Appalachian Trail	NSO
4B1	Research Natural Area	NSO
4C1	Geologic Area	CSU
4D	Special Biological Area	CSU
4D1	Key Natural Heritage Community Area	CSU
4E	Cultural/Heritage Area	NSO
4F	Mt Pleasant National Scenic Area	Administratively Unavailable
4FA	Recommended National Scenic Area	Administratively Unavailable
5A	Administrative Site	Standard
5B	Communication Site	Standard
5C	Utility Corridor	Standard
7A1	Scenic Byway	CSU
7B	Scenic Corridors and Viewsheds	CSU
7C	ATV Use Area	Standard
7D	Concentrated Recreation Areas	CSU
7E	Dispersed Recreation Areas	Standard
7E1	Dispersed Recreation Areas-Unsuitable	Standard
7E2	Dispersed Recreation Areas-Suitable	Standard
7F	Blue Ridge Parkway	CSU
7G	Pastoral Landscapes	Standard
8A1	Mix of Successional Habitats	Standard
8A1U	Mix of Successional Habitats-Unsuitable	Standard
8B	Early Successional Habitats	Standard
8BU	Early Successional Habitats-Unsuitable	Standard
8C	Black Bear/Remote Habitats	Standard
8CU	Black Bear/Remote Habitats-Unsuitable	Standard
8E4a	Indiana Bat-Primary	Administratively Unavailable
8E4b	Indiana Bat-Secondary	Timing
8E7	Shen Mtn Crest-Cow Knob Salamander	CSU
9A1	Source Water Watershed Protection	CSU
10B	Timber Production	Standard
10BU	Timber Production-Unsuitable	Standard
11	Riparian Area and Corridor (Lake Moomaw)	CSU
12D	Remote Backcountry	NSO
13	Mosaics of Habitat-Suitable	Standard
13U	Mosaics of Habitat-Unsuitable	Standard

The Alternatives respond to the oil and gas issue by varying the lease available/unavailable acres as well as the lease available constraints (Stipulations) that form a different mix of Management Prescriptions under each Alternative. The administratively available/unavailable to lease status for each Management Prescription is found in the Forest Plan by reference to the Forest-wide standard for oil and gas leasing and, if present, a Management Prescription standard for oil and gas leasing that differs from the Forest-wide standard.

As a further response to Marcellus Shale concerns, additional Stipulations were developed and applied to the Alternatives to the existing Forest Plan (Alt A). The Horizontal Drilling Moratorium Stipulation and the Horizontal Drilling Operations Control applies to all Management Prescriptions where leasing is administratively available in the Alternatives to the existing Forest Plan (Alt A). A No Horizontal Drilling Stipulation prohibiting horizontal drilling applies to 1) Management Prescriptions where leasing is administratively available in Alternative E, and 2) public water supply areas in Management Prescriptions where leasing is administratively available in Alternative F. Stipulations are shown in Appendix I.

EXISTING CONDITIONS COMMON IN ALL ALTERNATIVES:

1. Congressionally withdrawn areas, such as Wilderness and Mt Pleasant National Scenic Area (NSA), are legally unavailable for federal oil and gas leasing.

2. Existing federal oil and gas leases are valid existing rights in place before the Revised Forest Plan is approved. Existing leases would be managed under the existing leases terms and conditions until the leases expire, terminate or are relinquished, at which time the lands would be administratively available or unavailable based on the Management Prescription of the area.

3. The federal government owns 100% mineral rights on about 84% of the Forest. Private parties own mineral rights on about 16% of the Forest. These outstanding or reserved mineral rights are partial or complete mineral interests. Private mineral rights are constitutionally protected property rights. In each alternative, decisions on federal oil and gas leasing apply to federally-owned mineral rights, and do not apply to privately-owned mineral rights (outstanding or reserved mineral rights) on NFS lands. Oil and gas exploration and development on private minerals on NFS lands can occur regardless of which alternative is chosen. If the federal government were to acquire private mineral rights that include oil and gas rights, then these newly-acquired federal mineral rights would be administratively available or unavailable based on the Management Prescription of the area.

ENVIRONMENTAL PROTECTIONS COMMON TO FEDERAL OIL AND GAS LEASING IN ALL ALTERNATIVES

Federal oil and gas leasing is subject to a wide range of federal and state laws and regulations to apply and enforce environmental protections on oil and gas exploration and development. The Department of Interior and the Department of Agriculture each have roles and regulations in administering the leasing laws Congress established for the federal oil and gas leasing program on National Forests System lands. The BLM and Forest Service each have regulations providing for environmental protections in leasing and on-the-ground operations under a lease.

1. Federal oil and gas leases have environmental protection requirements, such as in Section 6 of the standards lease terms:

   "Conduct of operations - Lessee shall conduct operations in a manner that minimizes adverse impacts to the land, air, and water, to cultural, biological, visual, and other resources, and to accomplish the intent of this section. To the extent consistent with lease rights granted, such measures may include, but are not limited to, modification to siting or design of facilities, timing of operations, and specification of interim and final reclamation measures."

2. Proposed lease operations are subject to a wide range of laws and regulations, including Endangered Species Act, Archaeological Resources Protection Act, Federal Water Pollution Control Act, Clean Water Act, Clean Air Act, National Environmental Policy Act, and all the other environmental protection laws and

regulations applicable to National Forest System lands. Under a federal law such as the Endangered Species Act, the Forest Service at the APD stage can control or prohibit surface occupancy of any size acreage, when justified, without a lease stipulation.

3. Two levels of environmental protections are developed from two levels of National Environmental Policy Act applied to federal oil and gas leasing. In addition to the environmental analysis under NEPA and the environmental protections developed here for leasing availability, a second environmental analysis under NEPA and environmental protections would be required for proposed operations under a lease. The Forest Service would be lead agency and BLM a cooperating agency for NEPA for the federal decision on proposed operations on NFS lands.

After a federal oil and gas lease is issued, the leaseholder cannot construct a road, drill a well, or conduct ground disturbing operations until the federal government (BLM and Forest Service) reviews and approves plans for each proposed well, road, and associated facilities. Before ground disturbing operations can occur, the leaseholder must submit for review and approval an Application for Permit to Drill (APD) that includes a Drilling Plan and a Surface Use Plan of Operations.

4. BLM regulations for federal oil and gas lease operations have environmental protections requirements, including Onshore Oil and Gas Orders. BLM regulation Onshore Oil and Gas Order No. 1 contain environmental protection requirements for the Drilling Plan and Surface Use Plan of Operations in the APD. For example, the Drilling Plan includes ground water protection requirements such as Section IIID3:

> The Drilling Plans must be in sufficient detail to permit a complete appraisal of the technical adequacy of, and environmental effects associated with, the proposed project. The Drilling Plan must adhere to the provisions and standards of Onshore Oil and Gas Order Number 2 (see 53 FR 46790) (Order 2) and, if applicable, Onshore Oil and Gas Order Number 6 (see 55 FR 48958) (Order 6), and must include the following information:
>
> a. Names and estimated tops of all geologic groups, formations, members, or zones.
>
> b. Estimated depth and thickness of formations, members, or zones potentially containing usable water, oil, gas, or prospectively valuable deposits of other minerals that the operator expects to encounter, and the operator's plans for protecting such resources.
>
> c. The operator's minimum specifications for blowout prevention equipment and diverter systems to be used, including size, pressure rating, configuration, and the testing procedure and frequency. Blowout prevention equipment must meet the minimum standards outlined in Order 2.
>
> d. The operator's proposed casing program, including size, grade, weight, type of thread and coupling, the setting depth of each string, and its condition. The operator must include the minimum design criteria, including casing loading assumptions and corresponding safety factors for burst, collapse, and tensions (body yield and joint strength). The operator must also include the lengths and setting depth of each casing when a tapered casing string is proposed. The hole size for each well bore section of hole drilled must be included. Special casing designs such as the use of coiled tubing or expandable casing may necessitate additional information.
>
> e. The estimated amount and type(s) of cement expected to be used in the setting of each casing string. If stage cementing will be used, provide the setting depth of the stage tool(s) and amount and type of cement, including additives, to be used for each stage. Provide the yield of each cement slurry and the expected top of cement, with excess, for each cemented string or stage.
>
> f. Type and characteristics of the proposed circulating medium or mediums proposed for the drilling of each well bore section, the quantities and types of mud and weighting material to be maintained, and the monitoring equipment to be used on the circulating system.

The Surface Use Plan of Operations in the APD includes such requirements as:

> Section IIID4g: Methods for Handling Waste: The Surface Use Plan of Operations must contain a written description of the methods and locations proposed for safe containment and disposal of each type of waste material (e.g., cuttings, garbage, salts, chemicals, sewage, etc.) that results from drilling the proposed well. The narrative must include plans for the eventual disposal of drilling fluids and any produced oil or water recovered during testing operations. The operator must describe plans for the construction and lining, if necessary, of the reserve pit.

Section IIID4j: Plans for Surface Reclamation: The operator must submit a plan for the surface reclamation or stabilization of all disturbed areas. This plan must address interim (during production) reclamation for the area of the well pad not needed for production, as well as final abandonment of the well location.

BLM regulation Onshore Oil and Gas Order No. 1 also contains General Operation Requirements with environmental protections for cultural and historic resources, Endangered Species Act, safety, and surface protection such as Section IVc:

> Surface Protection. Except as otherwise provided in an approved Surface Use Plan of Operations, the operator must not conduct operations in areas subject to mass soil movement, riparian areas, floodplains, lakeshores, and/or wetlands. The operator also must take measures to minimize or prevent erosion and sediment production. Such measures may include, but are not limited to:
>
> – Avoiding steep slopes and excessive land clearing when siting structures, facilities, and other improvements; and
> – Temporarily suspending operations when frozen ground, thawing, or other weather-related conditions would cause otherwise avoidable or excessive impacts.

Onshore Oil and Gas Order No. 2 contains environmental protection requirements for Drilling Operations, such as: Section IIIB: "The proposed casing and cementing programs shall be conducted as approved to protect and/or isolate all usable water zones, lost circulation zones, abnormally pressured zones, and any prospectively valuable deposits of minerals."

Standard lease terms and federal regulations allow the Forest Service and BLM to 1) control surface use of proposed activities in the lease area, and 2) prohibit surface occupancy on some areas within the lease area. For example, a proposed oil and gas facility, such as a road, can be relocated up to 200 meters without any stipulation.

5. Proposed lease operations are subject to environmental protection requirements in 1) Forest Service regulations, including the 36 CFR 228E regulations developed to implement Federal Onshore Oil and Gas Leasing Reform Act of 1987, and 2) the Forest Plan. For example, the Forest Service oil and gas regulation surface use requirements (36 CFR 228.108) require environmental protections relating to access facilities, cultural resources, fire prevention, fisheries, wildlife, plant habitat, threatened and endangered species, safety, wastes including drilling wastes, watershed protection including surface water and groundwater, erosion and sediment production, riparian areas and wetlands, and reclamation. Soil losses would be reduced or minimized through the application of Best Management Practices on a site-specific basis. Examples of such practices include use of erosion curtains to protect drainages, surfacing roads, water bars and check dams to control runoff, stockpiling of topsoil for reclamation and revegetation, and use of rip-rap to control gullying and head-cutting. Other measures include appropriate engineering design of roads, well pads, and ancillary facilities; and avoidance of steep and/or unstable slopes and sensitive soils.

The Stipulation for National Forest System lands would be part of all leases on NFS lands and requires the lessee to comply with the Secretary of Agriculture's rules and regulations for use and occupancy of National Forest System lands prior to approval of a permit/operation plan by the Secretary of Interior.

6. Proposed lease operations are subject to the State laws and regulations governing oil and gas operations, including requirements for environmental protection and reclamation. The Virginia Division of Gas and Oil's responsibilities include regulating the effects of gas and oil operations both on and below the surface, and include issuing permits, inspection of well sites and gathering pipelines, reclamation of abandoned well sites, and promotion of resource conservation practices. Operation plans must include information such as:

   - The pre-development condition of the site
   - The construction to be undertaken on the site including information on acreage to be disturbed, blasting activities, proposed new roads, and existing access roads
   - The erosion and sediment control plan
   - All well site equipment and facilities
   - The design and operation of any pits
   - The drilling and stimulating plan, including information on the water and constituents of the drilling fluids
   - Management and disposal of pit fluids, produced waters, drill cuttings and solids

The Virginia Division of Gas and Oil (DGO) reviews all applications and may deny a permit or require the applicant to submit more information or amend the proposed operation plan to ensure that the operator will comply with the law and regulation. Applicants must post a bond to guarantee that money is available for site reclamation and plugging should the operator fail to perform the work. The operator may not begin site work until DGO issues a permit.

According to the Virginia Division of Oil and Gas (2002), "Virginia's Gas and Oil Act of 1990 and the regulation authorized by that act, provides a comprehensive program to protect public safety and the environment from potential impacts associated with gas and oil exploration and development. The law and regulation govern activities from prior to the initial disturbance of land for site preparation until after a well is plugged and reclaimed. The installation and operation of gathering pipelines are also governed by the law and regulation. The Department of Mines, Minerals and Energy's (DMME) Division of Gas and Oil (DGO) is responsible for administering the law and regulation. The law and regulation require an operating permit and place special emphasis on water quality protection, erosion and sediment control, and protection of the public from safety hazards. The requirements are designed to prevent offsite disturbances from gas and oil operations."

The State of West Virginia has a generally similar framework of law, regulation, and permit requirements for oil and gas operations in West Virginia

REASONABLE FORESEEABLE DEVELOPMENT SCENARIO (RFD)

Projections of the kind and amount of oil and gas activity that could be reasonably anticipated were made in order to analyze the environmental effects that could occur as a result of federal oil and gas leasing under each alternative. Forest Service regulations (36 CFR 228.102 (c) (3 and 4)) require the analysis to "project the type/amount of post-leasing activity that is reasonably foreseeable as a consequence of conducting a leasing program consistent with that described for each alternative" and "analyze the reasonable foreseeable impacts of post-leasing activity under (c)(3) of this section as a part of the analysis." This post-leasing activity is the oil and gas activity, including construction of roads, well pads, pipelines, that would be expected under each alternative.

Projecting the post-leasing activity is a multi-step process that begins with a Reasonable Foreseeable Development Scenario (RFD) prepared by the Bureau of Land Management (BLM) (Appendix K). The RFD

provides a baseline projection of post-leasing activity from which projections for each alternative are developed. To provide the baseline projection the BLM prepared a Reasonable Foreseeable Development Scenario based on the assumption that all the Forest except areas withdrawn from leasing by law (Wilderness and National Scenic Area) would be available for oil and gas leasing under standard lease terms and conditions (Appendix BLM RFD). The BLM baseline RFD estimates post-lease activity of 319 natural gas wells (Marcellus Shale) and associated surface disturbance including wells pads, roads, and pipelines over a 15 year planning horizon.

The BLM baseline RFD assumptions for surface disturbance are modified here by increasing the acres of surface disturbance associated with pipelines and by including estimates of water use for drilling and hydraulic fracturing. The resulting RFD assumptions for surface disturbance, water use, and reclamation are:

DRILLING PHASE:

- Seismic Exploration (Vibroseis): 163 miles on existing roads (casual use minimal disturbance)
- Exploration/Evaluation Well Pad (vertical well) - (300'x300' pad): 2.07 acres per pad
- Exploratory/Evaluation Well Pad (vertical well) Access Road (30'x 1.5 miles/well): 5.45 acres per road
- Development Well Pad (vertical well) - (300'x300'): 2.07 acres per pad
- Development Well Pad (vertical well) Access Roads (1.0 miles/well): 3.64 acres per road
- Development Well Pad (horizontal wells, 3 wells per pad) (500'x500' pad): 5.74 acres per pad
- Development Well Pad (horizontal wells, 3 wells per pad) Access Road (2.0 miles/pad): 7.27 acres per pad
- Water use for drilling vertical well: 20,000 gallons per well.
- Water use for drilling horizontal well: 100,000 gallons per well.

POST-DRILLING AND PRODUCTION PHASE:

- Initial Reclamation: Part of Exploration/Evaluation Well Pad (vertical well) reclaimed: 1.84 acres per pad
- Part of Exploration/Evaluation Well Pad (vertical well) used for production: 0.23 acres per pad
- Initial Reclamation: Part of Development Well Pad (vertical well) reclaimed: 1.84 acres per pad
- Part of Development Well Pad (vertical well) used for production: 0.23 acres per pad
- Water use for hydraulic fracturing of vertical well: 400,000 gallons per well.
- Water use for hydraulic fracturing of horizontal well: 5,000,000 gallons per well.
- Initial Reclamation: Part of Development Well Pad (horizontal wells, 3 wells per pad) reclaimed: 5.22 acres per pad
- Part of Development Well Pad (horizontal wells, 3 wells per pad) used for production: 0.52 acres per pad
- Pipelines along road (additional 20' width along 90% of road miles): 2.42 acres per mile.
- Pipelines not along roads (10% of road miles) and pipelines connecting to the area or field (additional mileage estimated at 10% of road miles) - (30' wide corridor estimated as 20% of road miles): 3.64 acres per mile.
- Off well site production facilities: 25 acres
- Final Reclamation: road acres + well pad acres + pipeline acres+ off well site production facilities acres.

Table D3 GWNF Baseline Reasonably Foreseeable Development

	GWNF federal and private mineral ownerships Baseline RFD			
	Exploration/evaluation wells (vertical)	Development wells (vertical)	Development wells (horizontal)	Total
Number of wells	20	50	249	319
Roads (miles)	30	50	166	246
Roads (acres)	109	182	604	895
Well Pads (acres)	41	103	476	621
Road & Well Pads (acres)	150	285	1,080	1,516
Well pads initial reclamation (acres)	37	92	433	562
Well pads in production (acres)	5	12	43	59
Pipelines (miles)	33	55	183	271
Pipelines (acres)	96	160	531	787
Off Site Production Facilities (acres)	0	0	0	25
Production reclamation (acres)	210	353	1,178	1,766
Total reclamation (total disturbance) (acres)	246	445	1,611	2,328
Water use for drilling (1,000s of gallons)	400	1,000	24,900	26,300
Water use for hydraulic fracturing (1,000s of gallons)	8,000	20,000	1,245,000	1,273,000

Using these assumptions, the modified RFD is shown in the Table D3-GWNF Baseline RFD Table. This projection of future oil and gas activity is based on the assumption that all the Forest except areas withdrawn from leasing by law would be available for oil and gas leasing under standard lease terms and conditions. Because each alternative will have more restrictive constraints on availability of federal oil and gas leasing, each alternative will project less oil and gas activity than the GWNF baseline RFD. Before projecting the future federal oil and gas activity that varies by alternative, the following section will consider the part of the future activity (GWNF baseline RFD Table) that is common to all alternatives and does not vary by alternative.

OIL & GAS ACTIVITY COMMON TO ALL ALTERNATIVES

Common to all alternatives are 1) private mineral rights on NFS lands, and 2) existing federal oil and gas leases.

PRIVATE MINERAL RIGHTS ON NFS LANDS

The federal government owns 100% mineral rights on about 84% of the Forest. Private parties own mineral rights on about 16% of the Forest (Figure D1–Non-federal mineral rights on GWNF). These outstanding or reserved mineral rights are partial or complete mineral interests. Private mineral rights are constitutionally protected property rights. Decisions on federal oil and gas leasing apply to federally-owned mineral rights, and

do not apply to privately-owned mineral rights (outstanding or reserved mineral rights) on NFS lands. Oil and gas exploration and development on private mineral rights on NFS lands can occur regardless of which alternative is chosen. Assuming 16% of the GWNF Baseline RFD is due to exercise of private mineral rights on the Forest, the projected oil and gas activity for private mineral rights is included in the Table D3-GWNF Baseline RFD Table.

If the federal government were to acquire any private mineral rights that include oil and gas rights, then the availability of the lands for federal oil and gas leasing would be determined by the Forest Plan direction in effect at that time.

EXISTING FEDERAL OIL AND GAS LEASES

As of September 2010, federal oil and gas leases were in effect on about 1% of the Forest (12,412 acres). Oil and gas exploration and development on existing federal oil and gas leases can occur regardless of which alternative is chosen. Assuming 1% of the GWNF Baseline RFD is due to existing federal oil and gas leases, the projected oil and gas activity for existing federal oil and gas leases is included in the Table D3-GWNF Baseline RFD Table. Existing federal oil and gas leases would be managed under the existing leases terms and conditions until the leases expire, terminate or are relinquished, at which time the availability of the lands for federal oil and gas leasing would be determined by the Forest Plan direction in effect at that time.

SUMMARY

Assuming 16% of the GWNF Baseline RFD is due to private mineral rights and 1% is due to existing federal oil and gas leases, the projected oil and gas activity common for all alternatives is assumed to be 17% of the GWNF Baseline RFD and is shown in the Table D3-GWNF Baseline RFD Table.

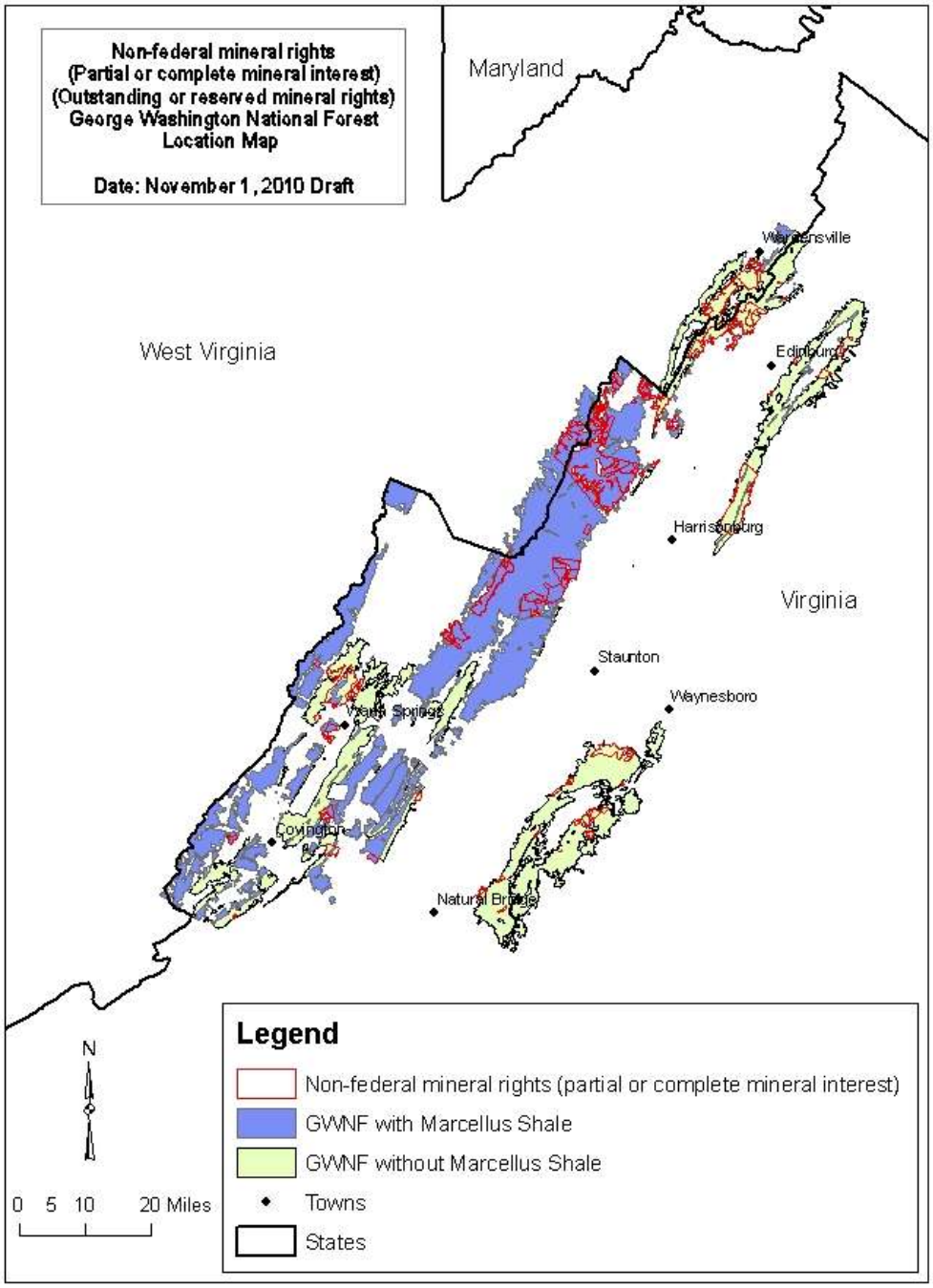

Figure D1– Non-federal mineral rights on GWNF

MARCELLUS SHALE

The Marcellus Shale in Virginia and West Virginia is shown in Figure D2–Marcellus Shale in Virginia and West Virginia, location map. The Marcellus Shale on GWNF is shown in Figure D3–Marcellus Shale on GWNF in Virginia and West Virginia. The mineral status of the GWNF and relationship to Marcellus Shale is shown in GWNF Mineral Status and Marcellus Shale Table.

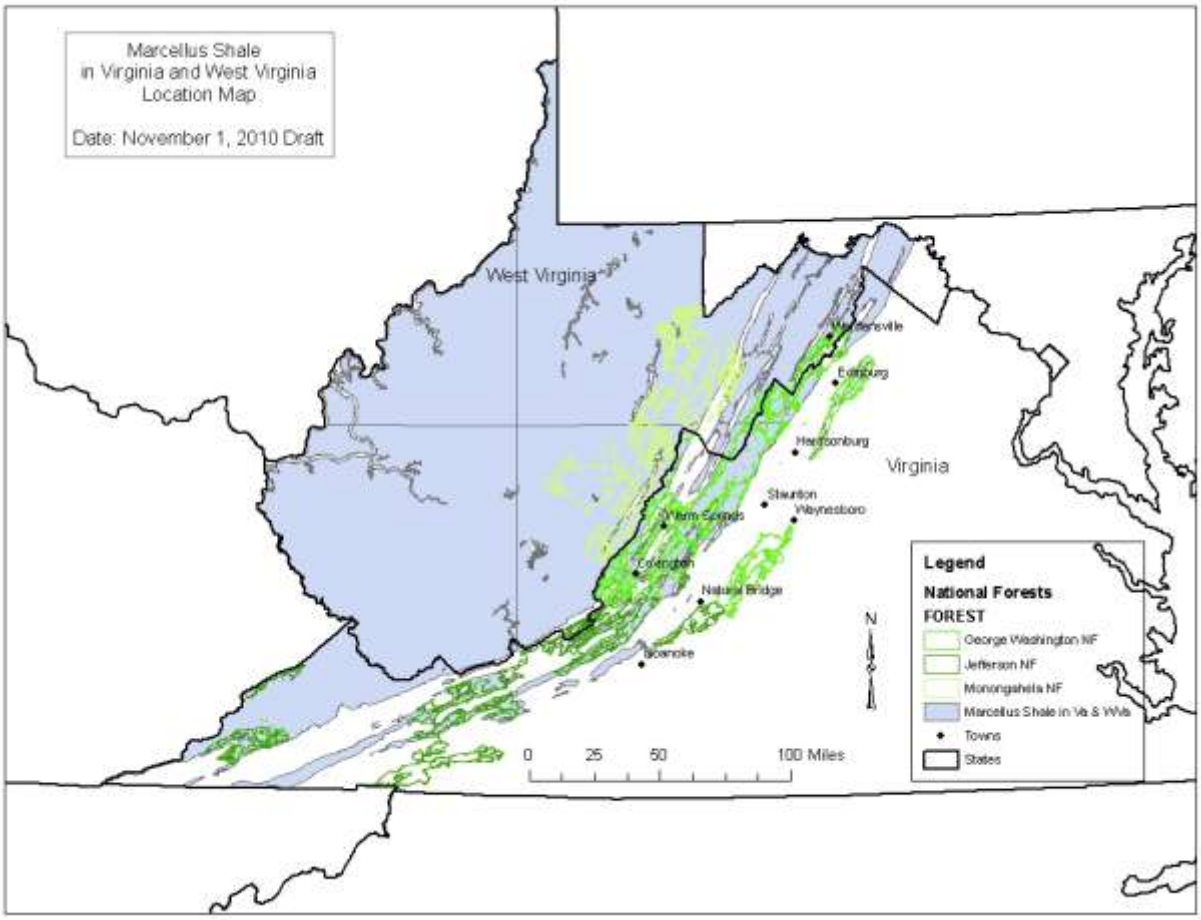

Figure D2 – Marcellus Shale in Virginia and West Virginia, location map.

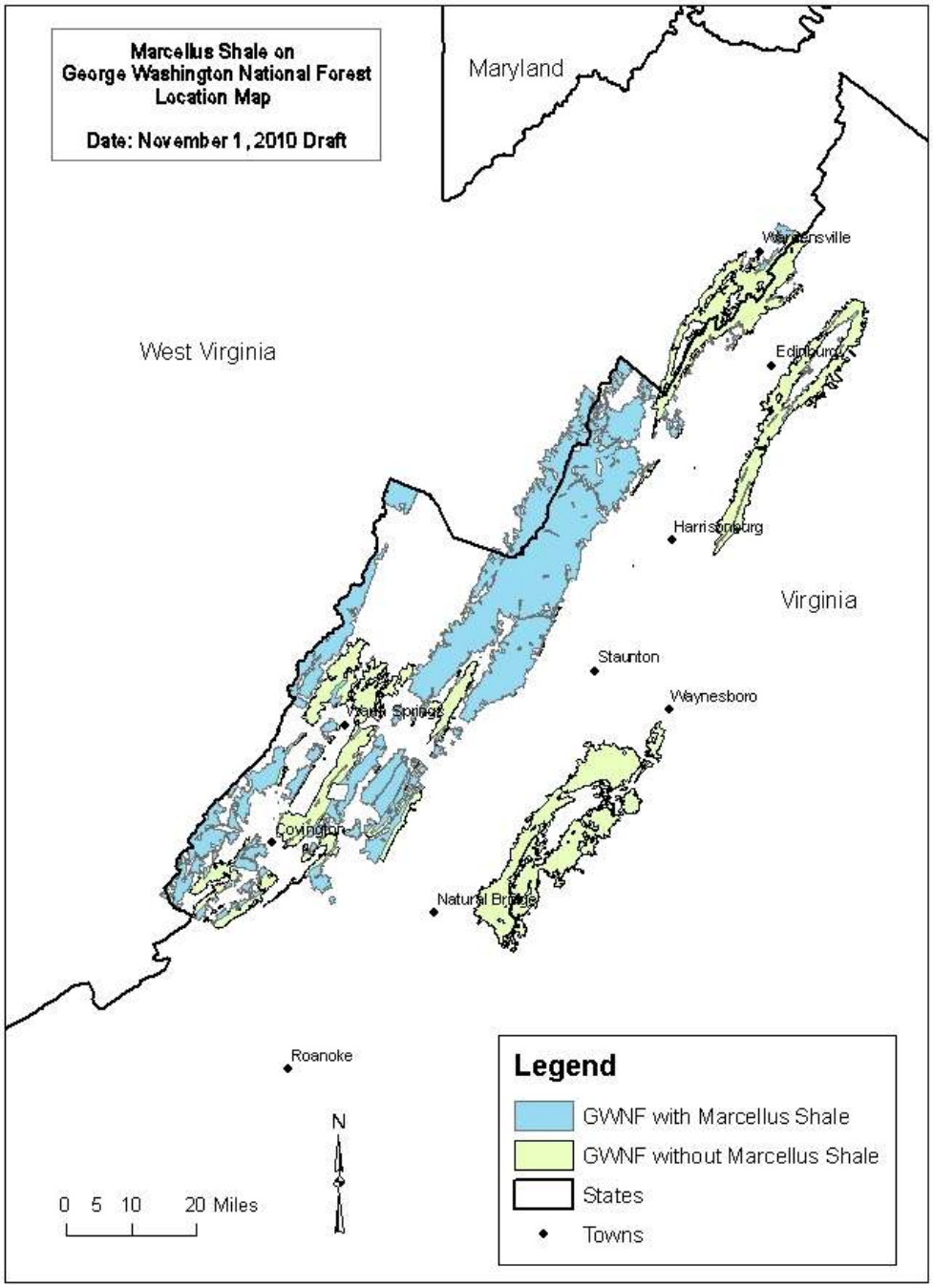

Figure D3 – Marcellus Shale on GWNF in Virginia and West Virginia.

Table D4– GWNF Mineral Status and Marcellus Shale

Mineral Status	Acres	Percent of GWNF (%)	Marcellus Shale Acres	Percent of Land Status in Marcellus Shale (%)
Total GWNF Acres	1,065,499	100.0%	592,300	55.6%
Withdrawn from mineral leasing by law	50,727	4.8%	22,537	44.4%
Not withdrawn from mineral leasing by law	1,014,772	95.2%	569,763	56.1%
Outstanding or reserved mineral rights - Partial or complete private mineral interest (subtotal of "not withdrawn" acres)	167,206	15.7%	97,615	58.4%
100% federal mineral ownership (subtotal of "not withdrawn" acres)	847,566	79.5%	472,148	55.7%
Existing federal oil & gas leases	12,412	1.2%	12,412	100.0%

OIL & GAS ACTIVITY BY ALTERNATIVE

The potential federal oil and gas activity on 100% federal mineral ownership for each alternative is shown in Table D5-GWNF Federal Oil & Gas Lease Activity by Alternative on 100% federal mineral ownership.

Table D5 GWNF federal oil & gas lease activity by Alternative on 100% federal mineral ownership

	Federal 100% Mineral Ownership Baseline RFD				Alt A				Alt B			
	Explor/ Eval wells (vertical)	Develop wells (vertical)	Develop wells (horizontal)	Total	Explor/ Eval wells (vertical)	Develop wells (vertical)	Develop wells (horizontal)	Total	Explor/ Eval wells (vertical)	Develop wells (vertical)	Develop wells (horizontal)	Total
Number of wells	17	42	207	265	16	39	198	253	12	30	153	195
Roads (miles)	30	50	166	246	24	39	132	195	18	30	102	150
Roads (acres)	109	182	604	895	86	143	479	708	66	111	370	547
Well Pads (acres)	34	86	476	596	33	81	378	492	25	63	292	380
Road & Well Pads (acres)	143	268	1,080	1,491	118	224	857	1,200	92	174	662	927
Well pads initial reclamation (acres)	31	76	433	540	29	72	344	445	22	56	266	344
Well pads in production (acres)	4	10	36	49	4	9	34	47	3	7	26	36
Pipelines (miles)	33	55	183	271	26	43	145	214	20	33	112	166
Pipelines (acres)	96	160	531	787	76	126	422	623	58	97	326	482
Off Site Production Facilities (acres)	0	0	0	21	0	0	0	24	0	0	0	19
Production reclamation (acres)	209	351	1,171	1,767	165	278	935	1,378	128	215	722	1,065
Total reclamation (total disturbance) (acres)	239	428	1,604	2,307	194	350	1,279	1,823	150	271	988	1,409
Water use for drilling (1,000s of gallons)	332	830	20,667	21,829	315	787	19,767	20,868	244	609	15,267	16,119
Water use for hydraulic fracturing (1,000s of gallons)	6,640	16,600	1,033,350	1,056,590	6,292	15,731	988,350	1,010,373	4,871	12,177	763,350	780,397

	Alt C				Alt D				Alt E			
	Explor/ Eval wells (vertical)	Develop wells (vertical)	Develop wells (horizontal)	Total	Explor/ Eval wells (vertical)	Develop wells (vertical)	Develop wells (horizontal)	Total	Explor/ Eval wells (vertical)	Develop wells (vertical)	Develop wells (horizontal)	Total
Number of wells	0	0	0	0	12	30	153	195	11	27	0	37
Roads (miles)	0	0	0	0	18	30	102	150	16	27	0	43
Roads (acres)	0	0	0	0	66	111	370	547	58	97	0	155
Well Pads (acres)	0	0	0	0	25	63	292	380	22	55	0	77
Road & Well Pads (acres)	0	0	0	0	91	173	662	927	80	152	0	233
Well pads initial reclamation (acres)	0	0	0	0	22	56	266	344	20	49	0	69
Well pads in production (acres)	0	0	0	0	3	7	26	36	2	6	0	9
Pipelines (miles)	0	0	0	0	20	33	112	165	18	29	0	47
Pipelines (acres)	0	0	0	0	58	97	326	481	51	85	0	137
Off Site Production Facilities (acres)	0	0	0	4	0	0	0	19	0	0	0	18
Production reclamation (acres)	0	0	0	0	127	215	722	1,065	112	189	0	301
Total reclamation (total disturbance) (acres)	0	0	0	0	150	271	988	1,408	132	238	0	369
Water use for drilling (1,000s of gallons)	0	0	0	0	243	608	15,267	16,118	214	534	0	747
Water use for hydraulic fracturing (1,000s of gallons)	0	0	0	0	4,863	12,158	763,350	780,372	4,271	10,676	0	14,947

	Alt F				Alt G			
	Explor/ Eval wells (vertical)	Develop wells (vertical)	Develop wells (horizontal)	Total	Explor/ Eval wells (vertical)	Develop wells (vertical)	Develop wells (horizontal)	Total
Number of wells	9	22	114	144	11	27	0	38
Roads (miles)	13	22	76	111	16	27	0	44
Roads (acres)	48	79	276	402	60	100	0	160
Well Pads (acres)	18	45	217	281	23	57	0	79
Road & Well Pads (acres)	66	124	493	683	83	157	0	239
Well pads initial reclamation (acres)	16	40	198	254	20	51	0	71
Well pads in production (acres)	2	5	20	27	3	6	0	9
Pipelines (miles)	14	24	83	122	18	30	0	48
Pipelines (acres)	42	70	242	354	53	88	0	141
Off Site Production Facilities (acres)	0	0	0	15	0	0	0	18
Production reclamation (acres)	91	154	538	783	115	194	0	309
Total reclamation (total disturbance) (acres)	107	194	736	1,037	135	245	0	380
Water use for drilling (1,000s of gallons)	174	436	11,367	11,978	220	550	0	769
Water use for hydraulic fracturing (1,000s of gallons)	3,489	8,722	568,350	580,561	4,397	10,992	0	15,389

CUMULATIVE OIL & GAS ACTIVITY ON GWNF BY ALTERNATIVE

The cumulative oil and gas activity from projected federal and private oil & gas lease activity on GWNF for each Alternative is shown in Table D6-GWNF cumulative oil & gas activity (projected federal and private oil & gas lease activity on GWNF).

Table D6 GWNF cumulative oil & gas activity (projected federal and private oil & gas lease activity on GWNF) Table

	GWNF (federal and private mineral ownerships) Baseline RFD				Alt A				Alt B			
	Explor/ Eval wells (vertical)	Develop wells (vertical)	Develop wells (horizontal)	Total	Explor/ Eval wells (vertical)	Develop wells (vertical)	Develop wells (horizontal)	Total	Explor/ Eval wells (vertical)	Develop wells (vertical)	Develop wells (horizontal)	Total
Number of wells	20	50	249	319	19	48	240	307	16	39	195	250
Roads (miles)	30	50	166	246	29	48	160	237	23	39	130	192
Roads (acres)	109	182	604	895	104	174	582	860	85	142	473	699
Well Pads (acres)	41	103	476	621	40	99	459	597	32	80	373	486
Road & Well Pads (acres)	150	285	1080	1516	144	273	1041	1458	117	222	846	1185
Well pads initial reclamation (acres)	37	92	433	562	35	88	418	541	29	72	339	440
Well pads in production (acres)	5	12	43	59	4	11	42	57	4	9	34	46
Pipelines (miles)	33	55	183	271	32	53	176	260	26	43	143	212
Pipelines (acres)	96	160	531	787	92	153	512	757	75	125	416	615
Off Site Production Facilities (acres)	0	0	0	25	0	0	0	24	0	0	0	19
Production reclamation (acres)	210	353	1178	1766	201	338	1135	1698	163	275	923	1380
Total reclamation (total disturbance) (acres)	246	445	1611	2328	236	426	1553	2239	192	347	1262	1820
Water use for drilling (1,000s of gallons)	400	1,000	24,900	26,300	383	957	24,000	25,339	312	779	19,500	20,590
Water use for hydraulic fracturing (1,000s of gallons)	8,000	20,000	1,245,000	1,273,000	7,652	19,131	1,200,000	1,226,783	6,231	15,577	975,000	996,807

	Alt C				Alt D				Alt E			
	Explor/ Eval wells (vertical)	Develop wells (vertical)	Develop wells (horizontal)	Total	Explor/ Eval wells (vertical)	Develop wells (vertical)	Develop wells (horizontal)	Total	Explor/ Eval wells (vertical)	Develop wells (vertical)	Develop wells (horizontal)	Total
Number of wells	3	9	42	54	16	39	195	249	14	35	42	92
Roads (miles)	5	9	28	42	23	39	130	192	21	35	28	85
Roads (acres)	19	31	103	152	85	141	473	699	77	128	103	307
Well Pads (acres)	7	18	81	106	32	80	373	486	29	73	81	183
Road & Well Pads (acres)	26	48	184	258	117	222	846	1185	106	201	184	490
Well pads initial reclamation (acres)	6	16	74	96	29	72	339	439	26	65	74	164
Well pads in production (acres)	1	2	7	10	4	9	34	46	3	8	7	19
Pipelines (miles)	6	9	31	46	26	43	143	211	23	39	31	93
Pipelines (acres)	16	27	90	134	75	124	416	615	68	113	90	270
Off Site Production Facilities (acres)	0	0	0	4	0	0	0	19	0	0	0	18
Production reclamation (acres)	36	60	200	300	163	275	923	1380	148	249	200	614
Total reclamation (total disturbance) (acres)	42	76	274	396	192	346	1262	1819	173	313	274	778
Water use for drilling (1,000s of gallons)	68	170	4,233	4,471	311	778	19,500	20,589	282	704	4,233	5,218
Water use for hydraulic fracturing (1,000s of gallons)	1,360	3,400	211,650	216,410	6,223	15,558	975,000	996,782	5,631	14,076	211,650	231,357

	Alt F				Alt G			
	Explor/ Eval wells (vertical)	Develop wells (vertical)	Develop wells (horizontal)	Total	Explor/ Eval wells (vertical)	Develop wells (vertical)	Develop wells (horizontal)	Total
Number of wells	12	30	156	198	14	36	42	93
Roads (miles)	18	30	104	152	22	36	28	86
Roads (acres)	66	110	378	555	79	131	103	312
Well Pads (acres)	25	63	298	386	30	74	81	185
Road & Well Pads (acres)	91	173	677	941	108	205	184	497
Well pads initial reclamation (acres)	22	56	271	350	26	66	74	166
Well pads in production (acres)	3	7	27	37	3	8	7	19
Pipelines (miles)	20	33	114	168	24	40	31	94
Pipelines (acres)	58	97	333	488	69	115	90	275
Off Site Production Facilities (acres)	0	0	0	15	0	0	0	18
Production reclamation (acres)	127	214	738	1094	151	254	200	623
Total reclamation (total disturbance) (acres)	149	270	1009	1444	177	320	274	790
Water use for drilling (1,000s of gallons)	242	606	15,600	16,449	288	720	4,233	5,240
Water use for hydraulic fracturing (1,000s of gallons)	4,849	12,122	780,000	796,971	5,757	14,392	211,650	231,799

The oil & gas investments and outputs for future federal oil & gas leases on GWNF 100% Federal Mineral Ownership are shown in Table D7-Oil & Gas Investment and Outputs on Future Federal Oil & Gas Leases on GWNF 100% Federal Mineral Ownership.

Table D7 Oil & Gas Investment and Outputs on Future Federal Oil & Gas Leases on GWNF 100% Federal Mineral Ownership Table

	RFD	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Oil & Gas Investment ($)	$1,653,775,017	$1,580,840,846	$1,221,128,967	$0	$1,221,014,744	$66,728,073	$907,038,955	$68,701,959
Natural gas production (MCF)	661,510,017	632,336,348	488,451,594	0	488,405,905	26,691,236	362,815,587	27,480,790
Wellhead MCF value based on 10 yr average of $5.34/MCF ($)	$3,532,463,489	$3,376,676,097	$2,608,331,512	$0	$2,608,087,532	$142,531,199	$1,937,435,236	$146,747,420
Federal royalty ($)	$441,557,936	$422,084,512	$326,041,439	$0	$326,010,941	$17,816,400	$242,179,405	$18,343,427
25% share of federal royalty to States for distribution to counties for schools and roads	$110,389,484	$105,521,128	$81,510,360	$0	$81,502,735	$4,454,100	$60,544,851	$4,585,857

DIRECT, INDIRECT AND CUMULATIVE EFFECTS OF FEDERAL OIL AND GAS LEASING AVAILABILITY

GEOLOGIC RESOURCES

Federal oil and gas activities that involve ground disturbance, such as construction of roads, well pads, and pipeline corridors, have the potential to adversely affect geologic resources. All the Alternatives with federal oil and gas leasing have the environmental protection requirements contained in federal oil and gas leases, BLM oil and gas regulations, Forest Service oil and gas regulations, State oil and gas regulations, federal laws applicable to NFS lands, and Forest Plan standards. The environmental protection requirements would avoid or reduce potential effects on the Forest's geologic resources, such as groundwater, groundwater-dependent ecosystems, springs, caves, sinkholes, karst, unusual landforms, and paleontological resources. The Forest Plan standards to protect geologic resources are in various sections of the Forest Plan, including Geologic Resources, Geologic Hazards, Water, Soil, Caves and Karstlands, and Indiana Bat Management. Standards under all Alternatives provide that the location and design of management activities, including oil and gas activities, will evaluate measures to avoid, minimize, or mitigate adverse effects on geologic resources with identified values (scientific, scenic, paleontological, ecological, recreation, drinking water, groundwater and groundwater dependent ecosystems).

The potential ground-disturbing activities associated with oil and gas activity will be used as an indicator of potential impact on geologic resources (Table D4). Using this indicator, Alternative C has the lowest potential for impact on geologic resources; Alternatives E, G, F, D and B have increasing levels of potential impact; and Alternative A has the most potential for impact on geologic resources.

In regard to karst, geologic map units indicate 11% of the Forest (about 119,000 acres) with geologic formations containing karst (Figure A.1). These geologic map units containing karst (carbonate bedrock) are estimated to encompass 109,308 acres in Virginia and 9,906 acres in West Virginia. Karst areas may be less than 100% of the geologic map unit because other types of bedrock may be present. The Marcellus Shale occurs on about 56% of the Forest (about 592,300 acres) (Figure D2). The geologic map units containing karst (11% of Forest) generally do not overlap with the Marcellus Shale (56% of Forest). The relatively small areas of overlap as well as the environmental protection requirements relating to karst would reduce potential for karst impact. Using potential ground-disturbing activities associated with oil and gas activity as an indicator of potential impact on karst, Alternative C has the lowest potential for impact; Alternatives E, G, F, D and B have increasing levels of potential impact; and Alternative A has the most potential for impact on karst.

In regard to groundwater, using horizontal wells as one indicator of potential impact on groundwater, Alternative C, E, and G would have no horizontals wells on future federal oil and gas leases, and so, would have the least impact on groundwater. Alternatives F, B and D would have horizontal wells, and so, an increase in potential impact; and Alternative A would have the most horizontal wells and the most potential for impact on groundwater.

In regard to groundwater, using vertical and horizontal wells as another indicator of potential impact on groundwater, Alternative C would have no wells on future federal oil and gas leases, and so, would have the least impact on groundwater. Alternatives E, G, F, B and D would have increasing numbers of wells, and so, an increase in potential impact; and Alternative A would have the most wells and most potential for impact on groundwater. More analysis on potential effects on groundwater is in Water and Aquatics section.

GEOLOGIC HAZARDS

Geologic hazards are geologic processes or conditions (naturally occurring or altered by humans) that present a risk or potential danger to public safety, infrastructure, and property. Geologic hazards may affect or be affected by oil and gas activities, such as construction of roads, well pads, and pipeline corridors. Oil and gas activities have potential for two types of effects relating to geologic hazards:

Type 1) Oil and gas activities have the potential to increase risk to public safety and infrastructure by not considering natural geologic hazards in the location, design, and maintenance of oil and gas activities. For example, a natural landslide may damage or destroy an access road or a gas pipeline, and injure or kill people.

Different geologic settings have different geologic hazards. In karst areas, there are karst geologic hazards, including potential for ground collapse (sinkholes). If siting, design, and maintenance of oil and gas activities do not consider the geologic setting and potential geologic hazards, then public safety and infrastructure may be inadvertently and unnecessarily put at risk.

Type 2) Oil and gas activities have the potential to increase risk to public safety and infrastructure by not considering human-induced geologic hazards in the location, design, and maintenance of oil and gas activities. Oil and gas activities have the potential to 1) create human-induced geologic hazards, or 2) trigger or aggravate natural geologic hazards. For example, in karst areas, oil and gas activities have the potential to contaminate groundwater and to trigger or aggravate karst geologic hazards, including potential for ground collapse (sinkholes). Another example, excavation for oil and gas access road on a steep slope can undercut and remove some support from the hillside. In some geologic settings (adverse bedrock structures or weak surficial materials), this undercut and removal of support may lead to failure of the road cut-slope and hillside upslope. Or, construction of a road fill or well pad fill on a steep, geologically unstable slope may lead to a failure of the fill-slope. Such fill failures can transform into a debris flow and travel hundreds or thousands of feet down slope, endangering people and infrastructure far away from the fill failure. If siting, design, and maintenance of oil and gas activities do not consider the geologic setting and potential geologic hazards, then public safety and infrastructure may be inadvertently and unnecessarily put at risk.

Mitigation of these potential impacts under each Alternative is a challenge because there is no federal law with specific requirements that federal agencies consider the effects of ground disturbing activities on geologic hazards and associated risks to public safety. There are federal laws with specific requirements for federal agencies to consider and to protect plants, animals, artifacts, and fossils. But there is no federal law with specific requirements for federal agencies to consider and to protect public safety in regard to the wide range of geologic hazards on this Forest and other National Forests Systems lands.

To address the wide range of geologic hazards and to reduce the potential for impacts from oil and gas activities, the Alternatives have Forest-wide Standards that provide:

- Locate, design, and maintain trails, roads, other facilities, and management activities to avoid, minimize, or mitigate geologic hazards and potential impact on infrastructure and public safety.
- For ground-disturbing projects on slope gradients of 50% or greater located upslope and within one-half mile of Forest external boundary, conduct a geologic hazard and risk assessment of off-Forest public safety for landslides, including debris flows.

The potential ground-disturbing activities associated with oil and gas activity will be used as an indicator of potential impact on geologic hazards. Using this indicator, Alternative C has the lowest potential for impact on geologic hazards; Alternatives E, G, F, D and B have increasing levels of potential impact; and Alternative A has the most potential for impact on geologic hazards.

CUMULATIVE EFFECTS

In the past (1970-2000), five oil and gas wells were drilled on the Forest, but all wells were dry holes. The Forest does not have any active oil and gas wells. The cumulative impacts from oil and gas activity would be mostly due to potential future oil and gas activity under each Alternative. In addition to the effects from future federal oil and gas leases, discussed above, there are also potential impacts from 1) existing federal leases and 2) private mineral rights (outstanding or reserved mineral rights).

As of September 2010, federal oil and gas leases were in effect on about 1% of the Forest (12,412 acres). Existing leases are valid existing rights in place before the Revised Forest Plan is approved. Existing leases would be managed under the existing leases terms and conditions until the leases expire, terminate or are relinquished, at which time the availability of the lands for federal oil and gas leasing would be determined by the Forest Plan direction in effect at that time. Oil and gas exploration and development on existing federal oil and gas leases can occur regardless of which Alternative is chosen. Assuming 1% of the GWNF Baseline RFD is due to existing leases, the projected oil and gas activity for existing leases is included in the Table D2.

The federal government owns 100% mineral rights on about 84% of the Forest. Private parties own mineral rights on about 16% of the Forest. These outstanding or reserved mineral rights are partial or complete mineral interests. Oil and gas exploration and development on private mineral rights on NFS lands can occur regardless of which Alternative is chosen. Assuming 16% of the GWNF Baseline RFD is due to exercise of private mineral rights on the Forest, the projected oil and gas activity for private mineral rights is included in the Table D2.

Adding the Forest's potential future oil and gas activities from existing federal leases and private mineral rights (Table D2) to the Forest's potential future oil and gas activities from future federal leases (Table D4) gives the Forest's potential cumulative future oil and gas activities (Table D5).

The potential future oil and gas activities from existing federal leases and private mineral rights are the same for each Alternative, and so, the added potential effects on geologic resources and geologic hazards are the same for each Alternative. Adding these effects to the effects from future oil and gas activities from future federal leases gives the total effects from the Forest's future oil and gas activities, as follows. Using potential ground-disturbing activities associated with oil and gas activity as an indicator of potential effects on geologic resources including karst resources and on geologic hazards, Alternative C has the lowest potential for impact; Alternatives E, G, F, D and B have increasing levels of potential impact; and Alternative A has the most potential for impact. In regard to effects on groundwater from oil and gas activities, using horizontal wells as one indicator of potential impact on groundwater, Alternative C, E, and G would have the least impact; Alternatives F, B and D would more potential impact; and Alternative A would have the most potential for impact on groundwater. Using vertical and horizontal wells as another indicator of potential impact on groundwater, Alternative C would have the least impact on groundwater; Alternatives E, G, F, B and D would have more potential impact; and Alternative A would have the most potential for impact on groundwater. Using potential ground-disturbing activities associated with oil and gas activity as an indicator of potential impact on geologic hazards.

Considering the oil and gas activities along with other Forest management activities (timber, recreation, etc.), the cumulative impact on geologic resources and geologic hazards is the combination of the impacts discussed in Section A with the impacts discussed above.

SOILS

Oil and gas lease development is likely to affect soils with displacement and compaction. Disturbed soils are prone to erosion when vegetation is removed. Soils could also be affected by localized spills of fluids used during the drilling process, which could sterilize the soil and affect soil productivity.

We will estimate the effects to long term soil productivity and how extensive they could be. A threshold for a significant impact to soil productivity will be a fifteen percent reduction in productivity across the areas on the Forest that could be affected by oil and gas lease development. When long term soil productivity is reduced on fifteen percent or more of the activity area by any alternative, then this would be a significant impact to the soil resource and would not be in compliance with the laws guiding FS policy on protecting soil productivity. By identifying impacts to soil productivity and minimizing these impacts to small areas, we can protect the soil's ability to function as an important part of the surrounding ecosystem.

Activity areas are the areas on the Forest where oil and gas exploration and development could occur. Each alternative has a different sized activity area because alternatives vary by emphasis and prescription. The size of the different management areas on the forest changes by alternative. In each alternative we have subtracted the acres on the Forest that will not impacted by oil and gas development. These are: Designated Wilderness Areas, Recommended Wilderness Study Areas, Eligible Wild and Scenic River Areas, Appalachian Trail Corridor, Mt Pleasant National Scenic Area, Recommended National Scenic Areas, Indiana Bat Primary Areas and Remote Back Country Areas. The Activity Area for each alternative is used to compare with the total acres of long term effect to soil productivity and therefore determine the extent of the effects to soil productivity for each alternative. This way we can see the effects to the soil resource from oil and gas lease development across the Forest.

Table D8 Oil and Gas Activity Areas by Alternative

	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Total Forest acres	1,065,918	1,065,918	1,065,918	1,065,918	1,065,918	1,065,918	1,065,918
Acres with no development	265,742	276,426	563,577	278,092	353,263	450,802	339,726
Total Activity Area, acres	800,176	789,492	502,341	787,826	712,655	615,116	726,192

The table below displays the long-term effects to soil productivity in the areas where leasing and development will occur. Long-term effects will be due to well site construction and road building.

Table D9 Estimated Long Term Effects to Soil Productivity from RFD Oil and Gas Lease Development by Alternative

	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Acres of Long Term Productivity Affected	1458	1185	258	1,185	490	941	497
Activity Area, acres	800,176	789,492	502,341	787,826	712,655	615,116	726,192
Percent of Area Affected Long Term	0.18%	0.15%	0.05%	0.15%	0.07%	0.15%	0.07%

Cumulative effects add in wells and roads already constructed on the Forest for oil and gas development.

As of September 2010, federal oil and gas leases were in effect on about 1% of the Forest (12,412 acres). Oil and gas exploration and development on existing federal oil and gas leases can occur regardless of which alternative is chosen.

The estimated cumulative oil and gas development from projected federal and private oil & gas lease activity on GWNF for each Alternative is shown below along with cumulative effects to soils from other management activity, by alternative.

Table D10 Total Cumulative Long Term Effects to Soil Productivity from Oil and Gas Lease Development and Proposed Forest Plan Alternatives, acres

	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Existing Impacts from Oil and Gas Development**	10	10	10	10	10	10	10
RFD Oil and Gas Lease Development Effects **	1458	1185	258	1,185	490	941	497

	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Total Cumulative Effects from All Other Plan Activity	6913	6733-7063	6118	7293-7813	6693-6973	6553-6793	6773-7103
Total Cumulative Effect on Forest Long Term Soil Productivity	8381	7928-8258	6386	8488-9008	7193-7473	7504-7744	7280-7610
Percentage of Activity Area*	1.1% of 800,176	1.0-1.1% of 789,492	1.3% of 502,341	1.1-1.1% of 787,826	1.0-1.1% of 712,655	1.2-1.3% of 615,116	1.1-1.1% of 726,192

*Activity Area is the area on the Forest where oil and gas can be developed.
**Roads and Well pads.
***Existing oil and gas long term effects result from 5 existing well sites.

Existing roads for oil and gas development are included in the effects of FS system roads. Exploration/Evaluation Well Pad (vertical well) - (300'x300' pad): 2.07 acres per pad used for the five existing wells.

Estimated cumulative effects from RFD oil and gas development and proposed Forest Plan management activity are similar for all alternatives. At least 98% of the Forest's soil productivity will be maintained.

Short-term effects from compaction and erosion will be minimized through implementation of the site-specific erosion and sediment control plans developed for all construction areas. A Spill Prevention Control and Countermeasures Plan are prepared for each site to minimize the possibility and impacts from spills. Overall, cumulative long-term effects to soil productivity from RFD of oil and gas on the George Washington NF is less than one percent of the activity area are considered for each alternative. Alternative C has the least acres impacted, with Alternative D having the most.

AIR QUALITY

The George Washington National Forest is assessing the environmental consequences of leasing natural gas exploration and production rights on the Forest, under a variety of Alternatives. The primary criteria pollutant emissions from development of natural gas wells are nitrogen oxides (NO_x) and volatile organic compounds (VOC). These pollutants combine in the presence of sunlight to form ozone, a regulated pollutant that affects human health, and vegetation. The purpose of this analysis is to examine potential air quality impacts of emissions from the proposed activities.

Air quality impacts from development of a natural gas field can be divided into two categories: construction of well sites and production/operation of the wells. These activities differ in that the construction phase is relatively short, while the production phase will persist as long as the well continues to produce gas.

Construction Emissions: Construction emissions include the pollutant emissions from well pad development, which involves three separate, sequential activities: 1) Clearing, grading and construction of the road that connects the existing access road to the well pad site. These activities are sources of fugitive dust emissions from the construction traffic over unpaved roads, and tailpipe emissions from the construction traffic. 2) Rig-up, drilling and rig-down. These activities consist of bringing equipment and supplies by truck to the well site, drilling a hole to the desired depth, and removing the drilling equipment. Pollutant emissions from this phase of activity include particulates from the traffic on unpaved roads, tailpipe emissions from trucks, and exhaust emissions from the diesel powered drilling engines. 3) Completion and testing involves running pipe into the borehole and flaring small quantities of gas at the surface to evaluate productivity of the well. Pollutant emissions that occur during completion and testing include road dust from truck traffic, tailpipe emissions

from the trucks, and products of combustion from flaring natural gas. It was assumed that each well would require construction of a separate well pad.

Production Emissions: Gas produced from leased wells on the Forest will be collected and piped to a compressor station located on private land. The main source of emissions from the production phase will be from fugitive equipment emissions. Lesser emissions come from the heater-separator that is designed to separate liquids from the gas stream. Heat comes from burning some of the methane produced from the well.

The emission rates for construction and production activities have been taken from a Bureau of Land Management report "Environmental Assessment: Cooper Reservoir Natural Gas Development Project - Cumulative Air Quality Impact Analysis, May 1998". The Cooper Reservoir Project activities were similar to what would occur in gas field development in southwestern Virginia, which made it possible to use the pre-calculated, construction phase emissions for this analysis. Activities were of similar duration, similar equipment was used, and both projects involved "sweet" gas. Sweet gas wells do not produce hydrogen sulfide gas during flaring.

Analysis: Although the Reasonably Foreseeable Development report by BLM indicates that only a portion of the total wells will be constructed each year, this analysis assumed that construction and production for all wells would occur in one year. This approach provides a “worst case” assessment of potential impacts on air quality. In reality, all development scenarios would produce impacts less than presented here.

Each Alternative has a specified maximum number of wells that could be put into production over the next 15 years. Nitrogen oxide and volatile organic compound emissions from construction and production are calculated and compared between Alternatives for the “Direct/Indirect Effects” analysis. Future emissions from private wells on national forest system lands are added to the emissions from the Direct/Indirect effects analysis to assess "Cumulative Effects". Projected emissions are then compared to the current emission inventory (existing area and point sources of pollution, EPA 2005) for a ten-county analysis area to estimate the future potential effect on air quality. The analysis area includes counties with underlying Marcellus shale: Alleghany, Augusta, Bath, Botetourt, Highland, Rockbridge and Rockingham in Virginia; and Hampshire, Hardy and Pendleton in West Virginia.

Direct/Indirect Effects: The direct effect on air quality of leasing national forest land for gas development will be to increase volatile organic compounds and nitrogen oxides in the atmosphere by a very small amount (Table D11). Maximum annual emissions from “leased wells” would contribute 99 tons per year of VOC; less than 0.4% of current emissions in the analysis area (20,316 tons). Nitrogen oxide emissions are similar; maximum of 89 tons per year which is only 0.39% of current emissions (22,838 tons).

Table D11 Maximum estimated annual air pollution emissions from projected gas well development on the GWNF, tons

Alternative	Direct Effects		Cumulative Effects	
	Volatile Organic Compounds	Nitrogen Oxide	Volatile Organic Compounds	Nitrogen Oxide
A	81	89	99	108
B	63	69	80	88
C	0	0	17	19
D	63	69	80	88
E	12	13	29	32
F	46	51	64	70
G	12	13	30	32
BLM RFD	85	93	102	112
Current Emissions in Tons (EPA 2005 Emissions Inventory)			20,316	22,838

There are differences in air pollution emissions between some of the Alternatives, but in all cases emissions are such a small portion of the overall pollution load that all Alternatives would have very little effect on air quality.

Cumulative Effects: The cumulative effects air analysis included emissions from 1) wells that will be developed from existing leasing rights on national forest land, 2) private-rights wells developed on national forest land, and 3) wells projected for the various Alternatives. Projected emissions from all wells that could be developed in the ten-county area are displayed in Table D9 under "Cumulative Effects". Emissions from all projected development would equal less than 1% of current inventory of VOC and NOx emissions. Both of these pollutants contribute to the formation of ozone, a criteria pollutant monitored by state air regulators. It is unlikely that the emissions from any of the projected Alternatives would affect ozone attainment status at monitors in the region because the additional emissions are such a small component of overall emissions.

For general information on air quality regulations and current air quality on the Forest see the Affected Environment: Air section of the EIS.

WATER RESOURCES AND AQUATIC SPECIES

The Reasonably Foreseeable Development (RFD) of federal oil and gas on the GWNF is concentrated in the Marcellus shale formation, thus, this analysis will concentrate on potential development of that formation. This includes both vertical and horizontal well development. Horizontal well development has not yet been utilized on the GWNF. To evaluate and develop the Marcellus Shale for natural gas production, horizontal wells will undergo a stimulation process known as hydraulic fracturing (hydrofracking), which functions to release gas embedded in shale deep below the surface. It is estimated that it takes up to 3-5 million gallons of water per fracking event for each well (Harper 2008) and one drilling site could contain several wells. Some references suggest that up to 8 million gallons of water may be needed per treatment. Flowback water is the fluid that is recovered from the well following fracking. Gelling agents, surfactants and chlorides are identified as the flowback water components of greatest environmental concern. Other flow back components can include other dissolved solids, metals, biocides, lubricants, organics and radionuclides. The RFD estimated 3 wells could be drilled per pad. The following are issues related to water resources and aquatic species and habitat:

- Water withdrawals
- Surface water and groundwater contamination
- Non-point source pollution from ground disturbing activities

The following indicators will be used to reflect the potential risk to watershed, riparian and aquatic resources and the differences between alternatives.

- Percent Marcellus shale on GWNF and private land by watershed, associated with TESLR (Threatened, Endangered, Sensitive and Locally Rare)/MIS (Management Indicator Species)/SMC (Species of Management Concern) aquatic species
- Miles of perennial, intermittent, and trout streams on the GWNF underlain by Marcellus shale
- Percent Marcellus shale by public water supply watershed
- Percent Marcellus shale by source water watershed (applicable to Alternative C)
- Number of potential wells, acres of disturbed areas, and water use by alternative

There are 592,300 acres of Marcellus shale under the Forest land (55.6% of land status). About 16% of the Forest is in outstanding or reserved mineral rights, with 58% of that in Marcellus shale. Only 1.2% of the Forest (12,412 acres) is under existing federal oil and gas lease, all of which is within the Marcellus shale formation. Table D12 lists the percent Marcellus shale found in each 5th level HUC watershed, along with the number of aquatic TESLR/MIS/SMC species by watershed. Columns 5-6 indicate the acres or percent of private subsurface ownership on the GWNF, while column 7 includes private land, since those are areas of limited or no Forest Service control. See Appendix J for a table of the complete list of species by watershed.

Table D12 Marcellus shale and Number of Aquatic TESLR/MIS/SMC by Watershed*

Watershed	Marcellus Acres on GWNF	Marcellus % of watershed on GWNF	Marcellus % of watershed on NF & Private land	Acres of Marcellus in private sub-surface on GWNF	% of watershed, Marcellus in private sub-surface on GWNF	Marcellus % of watershed: private, plus private sub-surface on GWNF	Number of aquatic TESLR/MIS /SMC
North Fk South Br Potomac R	10,384	5.1%	71.3%			66.2%	21
South Fk South Br Potomac R	55,525	30.1%	90.5%	12,393	6.7%	67.1%	2
Cacapon River	5,484	2.1%	66.9%	3,964	1.5%	66.3%	3
Middle River	22,543	9.4%	11.0%	2,777	1.2%	2.8%	1
Dry River-North River	110,980	58.9%	67.8%	32,557	17.3%	26.2%	4
Naked Cr-South Fk Shenandoah R	1,331	0.6%	0.9%	1,026	0.5%	0.8%	5
Shoemaker R-N Fk Shenandoah R	61,945	46.5%	87.8%	26,382	19.8%	61.1%	3
Smith Cr-North Fk Shenandoah R	333	0.2%	5.4%			5.2%	4
Stony Cr-North Fk Shenandoah R	4,906	2.2%	20.2%	1,394	0.6%	18.6%	7
Cedar Creek	422	0.4%	32.7%			32.3%	3
Dunlap Creek	37,679	34.8%	73.6%	707	0.7%	39.5%	2
Potts Creek	12,529	11.3%	47.8%			36.5%	7
Back Creek-Jackson River	55,586	25.2%	45.0%	3,999	1.8%	21.6%	5
Wilson Creek-Jackson River	22,436	16.2%	44.7%	1,152	0.8%	29.3%	8
Cowpasture River	95,086	42.0%	71.9%	10,077	4.5%	34.4%	11
Catawba Creek-James River	6,955	3.3%	22.1%	1,298	0.6%	19.4%	7
Craig Creek	1,259	0.5%	62.1%			61.6%	11
Calfpasture River	69,850	46.3%	72.5%	1,539	1.0%	27.2%	7
Little Calfpasture River	14,974	28.0%	65.2%			37.2%	1

*Birds and non-TE plants were not included in this analysis because species occurrence locations were not readily available in GIS format.

Looking at stream type underlain by Marcellus shale on the GWNF; there are 792 miles of perennial streams, 1,596 miles of intermittent streams, and 426 miles of trout water (VDGIF 2010a).

Table D13 lists the acres and percentages of Marcellus shale in public water supply watersheds, by ownership pattern. Table D14 shows the acres and percentages of Marcellus shale in the source water watersheds used in Alternative.

Table D13 Marcellus shale by Public Water Supply Watershed

Public Water Supply Watershed	Acres of Marcellus on GWNF	Marcellus % of watershed on GWNF	Marcellus % of watershed on GWNF & Private land	Acres of Marcellus in private sub-surface on GWNF	% of watershed, Marcellus in private sub-surface on GWNF	Marcellus % of watershed: private, plus private sub-surface on GWNF
North Fork Shenandoah R-Cedar Cr	402	0.4%	32.0%			31.5%
Dry River and Skidmore Fork	19,959	91.8%	100.0%	7623	35.1%	43.3%
North River	16,699	100.0%	100.0%	2270	13.6%	13.6%
Smith Creek	457	5.1%	5.7%	64	0.7%	1.3%
Jackson River	17	0.4%	69.4%			68.9%

Table D14 Private Marcellus shale by Source Water Watersheds used in Alternative C (applicable to Alternative C)

Source Water Watershed	Acres of Marcellus in private sub-surface on GWNF	% of watershed, Marcellus in private sub-surface on GWNF	Marcellus % of watershed: private, plus private sub-surface on GWNF
Painter Run-Stony Creek	41	0.1%	3.5%
Crab Run	2722	14.9%	82.6%
Runion Creek-North Fork Shenandoah River	938	4.6%	62.6%
German River	6083	30.5%	81.5%
Riles Run-Stony Creek	574	1.7%	56.8%
Little Dry River	6251	31.1%	51.7%
Capon Run-North Fork Shenandoah River	1812	5.8%	39.3%
Yellow Spring Run-Stony Creek	762	6.9%	32.1%
Shoemaker River	8548	36.5%	66.5%
Honey Run-Dry River	68	0.7%	16.1%
Skidmore Fork-Dry River	10273	41.3%	56.5%
Thorny Branch-North River	3362	11.8%	26.2%
Black Run-Dry River	10121	46.3%	53.5%
Little River	2573	15.8%	18.4%
Briery Branch	659	2.1%	11.7%
Skidmore Fork-North River	4559	18.0%	18.4%
Muddy Creek	951	4.7%	17.5%
Chair Draft-Calfpasture River	1341	9.3%	24.4%
Hamilton Branch	192	1.6%	19.5%

The RFD estimates a total of 319 wells within the Marcellus formation (20 vertical exploration wells, 50 vertical development wells, and 249 horizontal development wells). Associated activities include: 246 miles of roads, 621 acres of well pads, 271 miles of pipeline, 26,300,000 gallons of water for drilling, and 1,273,000,000 gallons of water for fracturing. As previously stated, water withdrawals, ground and surface water

contamination, and non-point source pollution from ground disturbing activities are issues of concern in relation to water resources and aquatic species.

General Effects from Water Withdrawals

Water for hydraulic fracturing will need to be trucked in, or withdrawn from nearby streams or aquifers. Without proper controls on the rate, timing and location of withdrawals, stream flow modifications could result in negative impacts to a stream's best uses, including but not limited to the aquatic ecosystem, downstream riverine and riparian resources, wetlands, and aquifer supplies.

Impacts to Aquatic Ecosystems

Aquatic ecosystems could be adversely impacted by:

- changes to water quality or quantity;
- insufficient stream flow for aquatic biota or to maintain stream habitat; or
- the actual water withdrawal infrastructure.

Many small headwater streams on the Forest undergo severe flow reductions during the summer and early fall, making them very susceptible to further water reductions. Drawing production water from these streams could cause reductions in fish and other aquatic organism populations or damage them permanently (Vokoun and Kanno 2009). Similarly, massive withdrawals of groundwater in these headwater watersheds could adversely affect surface water flow (PSU 2009; NYDEC 2009).

Seasonally, unmitigated withdrawals could adversely impact fish and wildlife health due to exposure to unsuitable water temperature and dissolved oxygen concentrations. It could also affect downstream dischargers whose effluent limits are controlled by the stream's flow rate. Water quality could be degraded and exert greater impacts on natural aquatic habitat if existing pollutants from point sources (e.g. discharge pipes) and non-point sources (e.g. runoff from farms and paved surfaces) are not sufficiently diluted or become concentrated.

Improperly installed water withdrawal structures can result in the entrainment of aquatic organisms, which can remove any/all life stages of fish and macroinvertebrates from their natural habitats as they are withdrawn with water. To avoid adverse impacts to aquatic biota from entrainment, intake pipes can be screened to prevent entry into the pipe. Additionally, the loss of biota that becomes trapped on intake screens, referred to as impingement, can be minimized by properly sizing the intake to reduce the flow velocity through the screens. Transporting water from the water withdrawal location for use off-site, can transfer invasive species from one waterbody to another via trucks, hoses, pipelines, and other equipment. Screening of the intakes can minimize this transfer; however additional site-specific mitigation considerations may be necessary.

Impacts to Downstream Wetlands

The existence and sustainability of wetland habitats directly depend on the presence of water at or near the surface of the soil. The functioning of a wetland is driven by the inflow and outflow of surface water and/or groundwater. As a result, withdrawal of surface water or groundwater for high volume hydraulic fracturing could impact wetland resources. These potential impacts depend on the amount of water within the wetland, the amount of water withdrawn from the catchment area of the wetland, and the dynamics of water flowing into and out of the wetland. Even small changes in the hydrology of the wetland can have significant impacts on the wetland plant community and on the animals that depend on the wetland. It is important to preserve the hydrologic conditions and to understand the surface water and groundwater interaction to protect wetland areas.

Aquifer Depletion

The primary concern regarding groundwater withdrawal is aquifer depletion that could affect other uses, including nearby public and private water supply wells. This includes cumulative impacts from numerous groundwater withdrawals and potential aquifer depletion from the incremental increase in withdrawals if groundwater supplies are used for hydraulic fracturing. Aquifer depletion may also result in aquifer compaction which can result in localized ground subsidence. Aquifer depletion can occur in both confined and unconfined aquifers.

The depletion of an aquifer and a corresponding decline in the groundwater level can occur when a well, or wells in an aquifer are pumped at a rate in excess of the recharge rate to the aquifer. Essentially, surface water and groundwater are one continuous resource; therefore, it also is possible that aquifer depletion can occur if an excessive volume of water is removed from a surface water body that recharges an aquifer. Such an action would result in a reduction of recharge which could potentially deplete an aquifer.

Aquifer depletion can lead to reduced discharge of groundwater to streams and lakes, reduced water availability in wetland areas, and corresponding impacts to aquatic organisms that depend on these habitats. Flowing rivers and streams are merely a surface manifestation of what is flowing through the shallow soils and rocks. Groundwater wells impact surface water flows by intercepting groundwater that otherwise would enter a stream. In fact, many headwater streams rely entirely on groundwater to provide flows in the hot summer months. It is therefore important to understand the hydrologic relationship between surface water, groundwater, and wetlands within a watershed to appropriately manage rates and quantities of water withdrawal.

Depletion of both groundwater and surface water can occur when water withdrawals are transported out of the basin from which they originated. These transfers break the natural hydrologic cycle, since the transported water never makes it downstream nor returns to the original watershed to help recharge the aquifer. Without the natural flow regime, including seasonal high flows, stream channel and riparian habitats critical for maintaining the aquatic biota of the stream may be adversely impacted. Surface and subsurface sources of public and private water supply may be reduced.

General Effects from Surface Water and Groundwater Contamination

Surface Spills and Releases at the Well Pad

Contamination of surface water bodies and groundwater resources during well drilling could occur as a result of failure to maintain stormwater controls, ineffective site management and surface and subsurface fluid containment practices, poor casing construction, or accidental spills and releases. Surface spills would involve materials and fluids present at the site during the drilling phase. Spills or releases can occur as a result of tank ruptures, equipment or surface impoundment failures, overfills, vandalism, accidents (including vehicle collisions), ground fires, or improper operations. Spilled, leaked or released fluids could flow to a surface water body or infiltrate the ground, reaching subsurface soils and aquifers. Pit leakage or failure could also involve well fluids. The greater intensity and duration of surface activities associated with well pads with multiple wells increases the odds of an accidental spill, pit leak or pit failure if mitigation measures are not sufficiently durable. Concerns are heightened if on-site pits for handling drilling fluids are located in primary and principal aquifer areas, or are constructed on the filled portion of a cut-and-filled well pad.

Hydraulic Fracturing Additives and Flowback water

As with the drilling phase, contamination of surface water bodies and groundwater resources during well stimulation could occur as a result of failure to maintain stormwater controls, ineffective site management and surface and subsurface fluid containment practices, poor well construction and grouting, or accidental spills and releases. These issues are acknowledged here because of the larger volumes of fluids and materials to be managed for high-volume hydraulic fracturing.

Flowback water is the fluid that is recovered from the well following fracking. Gelling agents, surfactants and chlorides are identified as the flowback water components of greatest environmental concern. Other flow back components can include other dissolved solids, metals, biocides, lubricants, organics and radionuclides. The exact characteristics and quantities of components in flowback water will vary by location. The additives are proprietary information and unavailable for analysis.

Opportunities for spills, leaks, operational errors, and pit or surface impoundment failures during the flowback water recovery stage are the same as they are during the prior stages with the additional potential of releases from:

- hoses or pipes used to convey flowback water to tanks, an on-site pit, a centralized surface impoundment, or a tanker truck for transportation to a treatment or disposal site; and
- tank leakage or failure of a pit or surface impoundment to effectively contain fluid.

As much as 60 – 80% of the hydrofracking water can return to the surface (Staaf and Masur 2009) contaminated with tens of thousands of pounds of chemicals, salt, and sand. This wastewater is stored in holding ponds, potentially adjacent to perennial or intermittent stream channels and is subject to overflow, leakage, or spillage. Contact with adjacent waterways could cause fish kills or affect entire food webs and could contaminate drinking water sources. All of these streams have floodplains and, often, a complex series of dry flood channels that are sensitive to disturbances in these areas. The majority of incidents that lead to surface water contamination result from spills and leakage during the transfer and draining of these pits (NYDEC 2009).

Contaminated flowback water that is trucked off the drilling site to local wastewater treatment plants may not be able to be effectively treated (Soeder and Kappel 2009; Levy and Smith 2010) and, in fact, might render the plant useless (by killing off active media). Sand, salt, and a mixture of biocides, surfactants, lubricants, and solvents may pass through these treatment plants directly into larger rivers. Many of these rivers are already under stress from other contaminants and this would potentially add to pollution troubles (VDGIF 2010).

Land application of contaminated flowback water and solids have been known to sterilize soils and kill forest plots. At the very least, flowback water is known to contain high levels of chloride; chlorides have a number of biological and non-biological effects. Chloride ions pass readily through soil and will eventually enter surface water. Because chloride moves through soil at the same rate as water it shares the same hydrologic cycle as water. This means chloride deposited on soil's surface can also enter ground water (Environment Canada 2001). Sodium chloride is inhibiting to soil bacteria at about 50 mg/l. High concentrations of chloride will damage or kill leaves or buds when delivered as a spray. Concentrations first will affect sensitive vegetation and trees. High enough concentrations will sterilize soil and prohibit any growth (Siegal 2007).

Millions of gallons of contaminated flowback water can remain in the ground during and after production. Extra steel and concrete casing is required in wells to protect groundwater; however, corrosive agents used in slickwater frac could erode casings and contaminate entire aquifers. Many of these shale deposits are adjacent to limestone geology, thus residual frac water under pressure could find its way into groundwater supplies.

Fuel oil, surfactants, and biocides are also used in slickwater frac and this gelatinous mixture has the potential to fill fissures underground and create pollution issues. Although it is surmised that these compounds comprise only a small fraction of the fracturing fluid, it becomes additive when millions of gallons of water are pumped into the ground. This could add up to hundreds of pounds of chemicals over the production life of a well (Soeder and Kappel 2009).

Concentrated solids, contaminated with radioactive waste (i.e. radium) are often extracted from the ground after being used to fracture the shale. Some frac water in New York State exceeded the EPA safety standards for radioactivity. However, more study is needed to determine the potential impacts of radioactive materials on aquatic organisms (Sumi 2008; Rabb 2010).

Centralized Flowback Water Surface Impoundments

Use of centralized surface impoundments and flowback water pipelines as part of a flowback water dilution and reuse system has environmental benefits, including reduced demand for fresh water, reduced truck traffic and reduced need for flowback water treatment and disposal. However, any proposal for their use requires that the potential impacts be recognized and mitigated through proper design, construction, operation, closure and regulatory oversight.

- Potential soil, wetland, surface water and groundwater contamination from spills, leaks or other failure of the impoundment to effectively contain fluid. This includes problems associated with liner or construction defects, unstable ballast or operations-related liner damage.
- Potential soil, wetland, surface water and groundwater contamination from spills or leaks of hoses or pipes used to convey flowback water to or from the centralized surface impoundment.
- Potential for personal injury, property damage or natural resource damage similar to that from dam failure if a breach occurs.
- Transfer of invasive plant species by machinery and equipment used to remove vegetation and soil.
- Consumption by waterfowl and other wildlife of contaminated plant material on the inside slopes of the impoundment.

General Effects from Non-point source pollution from ground disturbing activities

All phases of natural gas well development, from initial land clearing for access roads, equipment staging areas and well pads, to drilling and fracturing operations, production and final reclamation, have the potential to cause water resource impacts during rain and snow melt events if stormwater is not properly managed.

Initial land clearing exposes soil to erosion and more rapid runoff. Construction equipment is a potential source of contamination from such things as hydraulic, fuel and lubricating fluids. Equipment and any materials that are spilled, including additive chemicals and fuel, are exposed to rainfall, so that contaminants may be conveyed off-site during rain events if they are not properly contained. Steep access roads, well pads on hill slopes, and well pads constructed by cut-and-fill operations pose particular challenges, especially if an on-site drilling pit is proposed.

A production site, including access roads, is also a potential source of stormwater runoff impacts because its hydrological characteristics may be substantially different from the pre-developed condition. There is a greater potential for stormwater impacts from a larger well pad during the production phase, compared with a smaller well pad for a single vertical well.

Each drilling pad occupies 1 – 5 acres of ground, not including roads and stream crossings. Several pads can occupy one site, creating the potential for a significant volume of non-point runoff (NYDEC 2009). Fugitive dust may be problematic for adjacent waterways.

Cumulative Impacts

Cumulative impacts are the effects of two or more single projects considered together. Adverse cumulative impacts can result from individually minor but collectively significant projects taking place over a period of time. Cumulative impacts will be discussed from two perspectives:

1) Site-Specific cumulative impacts beyond those previously discussed resulting from multi-well pads and

2) Regional impacts which may be experienced as a result of gas development.

Site-Specific Cumulative Impacts

The potential for site-specific cumulative impacts as a result of multi-well pads, while real, is easily quantified and can be adequately addressed during the application review process (NYDEC 2009). General areas of

concern with regard to water use, ground disturbance, and contamination issues are the same as those of individual well pads. While the pads may be slightly larger than those used for single wells, the significant impacts are due to the cumulative time and trucking necessary to drill and stimulate each individual well.

In relation to non-point source pollution and surface water contamination, maintenance of the roads and accidental vehicular spills is a concern because of the number and size of the trucks used to transport and deliver equipment and supplies. A horizontal well takes four to five weeks of 24-hour-per-day drilling with an additional three to five days for the hydraulic fracture. This duration will be required for each well, with industry indicating that it is common for three wells to be drilled on a multi-well pad. Typically, one or two wells are drilled and stimulated and then the equipment is removed. If the well(s) are economically viable, the equipment is brought back and the remaining wells drilled and stimulated. Current regulations require that all wells on a multi-well pad be drilled within three years of starting the first well. As industry gains confidence in the production of the play, there is the possibility that all wells on a pad would be drilled, stimulated and completed consecutively.

The trucking requirements for rigging and equipment will not be significantly greater than for a single well pad, especially if all wells are drilled consecutively. Water and materials requirements, however, will greatly increase the amount of trucking to a multi-well pad compared to a single well pad. The NYDEC estimated truck trips per an eight well multi-well pad; those estimates were scaled back to 3 wells per pad and are as follows:

- Drill Pad and Road Construction Equipment 10 – 25 Truckloads
- Drilling Rig 20 Truckloads
- Drilling Fluid and Materials 100-200 Truckloads
- Drilling Equipment (casing, drill pipe, etc.) 100-200 Truckloads
- Completion Rig 15 Truckloads
- Completion Fluid and Materials 40-80 Truckloads
- Completion Equipment – (pipe, wellhead) 5 Truckloads
- Hydraulic Fracture Equipment (pump trucks, tanks) 150-200 Truckloads
- Hydraulic Fracture Water 1,600 – 2,400 Tanker Trucks
- Hydraulic Fracture Sand 80 – 100 Trucks
- Flow Back Water Removal 800 – 1,200 Tanker Trucks

Total estimates are 2,920 – 4,445 truck trips per 3 well pad. As can be seen, the vast majority of trucking is involved in delivering water and removing flow back. Multiple wells in the same location provide the potential to reduce this amount of trucking by reusing flow back water for the stimulation of other wells on the same pad. The centralized location of water impoundments may also make it economically viable to transport water via pipeline or rail in certain instances.

In the production phase, the operations at multi-well pads include a small amount of equipment, including valves, meters, dehydrators and tanks remaining on site, which may be slightly larger than what is used for single wells but is still minor. The reclamation procedures are the same as for single well pads, however, there will be more area left for production equipment and activities. It is anticipated that a multi-well pad will require up to three acres compared to one acre or less for a single well pad.

Regional Cumulative Impacts

The level of impact on a regional basis will be determined by the amount of development and the rate at which it occurs. Accurately estimating this is inherently difficult due to the wide and variable range of the resource, rig, equipment and crew availability, permitting and oversight capacity, leasing, and most importantly, economic factors. This holds true regardless of the type of drilling and stimulation utilized. In other plays around the country, development has occurred in a sequential manner over years with development activity concentrated in one area then moving on with previously drilled sites fully or partially reclaimed as new sites are drilled. Once drilling and stimulation activities are completed and the sites have been reclaimed, the long

term impact at the sites will consist of widely spaced and partially re-vegetated production sites and fully reclaimed plugged and abandoned well sites. However, for aquatic resources, there are areas of concern for cumulative impacts with regard to water use, ground disturbance, and contamination issues. The discussions below are examples of regional effects from these areas of concern.

Evaluation of cumulative impacts of multiple water withdrawals must consider the existing water usage, the non-continuous nature of withdrawals and the natural replenishment of water resources. Concerns over decreased streamflow from regional water withdrawals and the potential effect this has on aquatic habitat, water quality, and recreational use of rivers has prompted recent research in the East. In Massachusetts, cumulative withdrawal of ground water substantially decreased low flows in the Ipswich River (USGS 2001); while research in this and other rivers documented measurable alterations in fish communities following water withdrawal induced habitat changes (Armstrong et al. 2001; Freeman 2005; Vokoun and Kanno 2009). In addition to stream effects, the USGS reports that land subsidence due to the pumping of ground water occurs in nearly every State (USGS 1995).

Regional cumulative effects of water contamination and sedimentation to aquatic organisms have been documented for many species. The adverse modification and destruction of aquatic habitats, water pollution, and the introduction of non-indigenous species, have been the major causes of mussel declines and extinctions during this century (Stein et al. 2000). Of all the factors contributing to the jeopardized status of Southeastern native freshwater fishes, non-point source pollution (primarily siltation) and alteration of flow regimes (primarily impoundment) are the largest contributors to fish imperilment. Etnier (1997) points out that these two anthropogenic factors are responsible for 72% of imperilment problems.

Freshwater mussel and fish populations have been reduced and, in some cases, completely extirpated from lakes and streams by pollutants from municipal, industrial, and agricultural sources. Effluents impacting aquatic organisms include industrial discharges, fly ash and sulfuric acid spills, acid mine drainage, organic wastes, insecticides, and chlorinated sewage (U.S.D.I. Fish and Wildlife Service 1990). In addition, sub-lethal bioaccumulation of toxins can reduce overall health and fitness of an individual or population. Fish advisory warnings are currently in place on five river reaches in Virginia (for mercury, PCB's, and kepone) (FORVA 2001).

Alternative Comparison

Common to all alternatives are 1) private mineral rights on NFS lands, and 2) existing federal oil and gas leases. The potential federal oil and gas activity on 100% federal mineral ownership will vary by alternative. See the Federal Oil and Gas Leasing Availability Decision by Alternative discussion in the EIS for more detail regarding federal and private ownership, current leases, and proposed stipulations. For alternative comparison in light of water resources and aquatic species, Table D5 shows projected activity for both federal and private oil and gas leases.

Because the only drilling that would be done in Alternative C is that under private ownership, Alternative C has the lowest potential for ground-disturbing activities, and least amount of water use. Those numbers are slightly higher in Alternatives E and G, because although they allow vertical wells, these alternatives exclude horizontal drilling, significantly decreasing the amount of water use and potential for contamination. Alternative F has the next highest numbers, followed by D and B, which are almost identical. Lastly, Alternative A most closely corresponds to the RFD and has the highest potential for ground disturbance and uses the most amount of water.

Aquatic Viability Determinations for Oil and Gas Leasing

Within the Forest Plan Revision analysis, separate viability determinations were made for each watershed where a species occurs, because in many cases watersheds support separate populations, and because factors affecting viability can vary considerably from watershed to watershed. Viability outcomes from each species by watershed were determined by incorporating elements of species distribution, abundance, and sensitivities to environmental factors; watershed condition relative to the species' environmental sensitivities; and the national forest role in the watershed. To include the effects from oil and gas leasing, the amount of Marcellus shale by species and watershed was determined, as well as whether or not the species occurrence was on federally or privately owned mineral rights (see Table J1 Appendix J). Only those species found in

watersheds with Marcellus shale were included. Viability outcomes by watershed that were determined in the EIS based on stressors were then evaluated in light of the additional stressor of horizontal drilling in Marcellus shale. Viability outcomes by species, by watershed with the potential for drilling in the Marcellus shale formation and Forest Plan Alternatives are found in Table J2, Appendix J. Viability outcomes are:

Outcome A. Species is well distributed and abundant within watershed. Forest Service may influence conditions in the watershed to keep it well distributed. Likelihood of maintaining viability is high.

Outcome B. Species is potentially at risk in the watershed; however, the extent and location of NFS lands with respect to the species is conducive to positively influence the sustainability of the species within this watershed. Therefore, likelihood of maintaining viability is moderate.

Outcome C. Species is potentially at risk within the watershed; however, the extent and location of NFS lands with respect to the species is NOT conducive to positively influence the sustainability of the species within this watershed. Therefore, species viability in the watershed may be at risk.

Outcome D. The species is so rare within the watershed (population is at very low density and/or at only a few local sites) that stochastic events (accidents, weather events, etc.) may place persistence of the species within the watershed at risk; however, the extent and location of NFS lands with respect to the species is conducive to positively influence the sustainability of the species within this watershed. Therefore, likelihood of maintaining viability is moderate.

Outcome E. The species is so rare within the watershed (population is at very low density and/or at only a few local sites) that stochastic events (accidents, weather events, etc.) may place persistence of the species within the watershed at risk. Forest Service ability to influence the species is limited. Therefore species viability in the watershed may be at risk.

A summary of the changes by alternative is below.

Table D15 Viability Outcomes by Alternative based on Marcellus Shale Potential Development

Viability Outcome	Number of Species/Watershed Combinations with the Specified Outcome							
	EIS viability outcome	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
A (Low Risk)	7	2	2	6	2	6	2	6
B (Moderate Risk, FS May Positively Influence)	30	10	10	20	10	20	10	20
C (Potential High Risk, Little Opportunity for FS Influence)	43	68	68	54	68	54	68	54
D (Moderate Risk, FS May Positively Influence)	22	17	17	21	17	21	17	21
E (Potential Very High Risk, Little Opportunity for FS Influence)	13	18	18	14	18	14	18	14

Changes to aquatic species viability based on the additional stressor of horizontal drilling in Marcellus shale were similar in Alternatives C, E and G because none of the alternatives allow horizontal drilling. The species viability changed from low or moderate risk to potential high or very high risk in those watersheds where the species occurrence was on Marcellus shale in National Forest, but with privately owned mineral rights.

Changes to aquatic species viability were similar in Alternatives A, B, D, and F because all of those alternatives allow horizontal drilling in Marcellus shale to some extent. The species viability changed from low or moderate risk to potential high or very high risk in those watersheds where the species occurrence was on Marcellus shale in National Forest. The exception was in the North Fork South Branch Potomac River watershed (includes the Laurel Fork area), where although the area is underlain by Marcellus shale in Federal ownership, mineral leasing of the area will not be allowed in all alternatives.

SPECIAL BIOLOGICAL AREAS, CAVES, RARE COMMUNITIES

The majority of the Reasonably Foreseeable Development for oil and gas will occur on the Lee, North River, Warm Springs, and James River Ranger Districts. A number of rare communities, caves, and Special Biological Areas occur on the Forest and they act as a “coarse filter” for the protection of biological diversity. According to SAMAB (1996) about 66% of TES species are associated with rare communities, and the percentage increases even further when riparian areas are included. By protecting rare communities, including caves, a very large number of TES plant and animal species also receive protection. Added to this are Special Biological Areas where single occurrences or assemblages of TES species are recognized and protected.

Applicable Standards for Rare Communities/Caves/Special Biological Areas from the Forest Plan:

FW-62: Maintain records of rare community locations and conditions across the forest. Survey project areas for rare communities prior to implementing projects that have the potential to negatively affect them.

FW-63: A minimum of 200 foot buffers are maintained around cave entrances, sinkholes, and cave collapse areas known to open into a cave's drainage system. There are no soil-disturbing activities or harvest of trees within this buffer. Wider buffers are identified through site-specific analysis when necessary to protect caves from potential subterranean and surface impacts. Perennial, intermittent, channeled ephemeral stream standards will apply beyond the first 200 feet.

FW-64: The use of caves for disposal sites or the alteration of cave entrances is prohibited except for the construction of cave gates or similar structures to ensure closure.

FW-65: Management activities within any area draining into a cave are limited if they may affect the cave ecosystem through sedimentation, soil sterilization, the addition of nutrients or other chemicals (including pesticides and fertilizers), or if they change the cave's natural hydrology or micro-climate.

FW-69: The specific location of a Significant Cave cannot be made available to the public unless it is determined that disclosure of this information would not create a substantial risk of harm, theft, or destruction of the cave. Significant and potentially significant caves on the Forest are managed in accordance with the Cave Resources Protection Act of 1988 (16 U.S.C. 4301-4309) to protect them through regulating their use, requiring permits for removal of their resources, and prohibiting destructive acts.

4D-005 Eradicate non-native invasive plants when the infestations are isolated. Use hand-applied chemicals, with Forest Supervisor approval, when necessary.

4D-006a (9F-008) Control non-native invasive species (plants, animals, insects, and diseases) where they are causing negative effects to rare communities. Do not introduce non-native species in or near rare communities, unless it is a natural enemy of a non-native pest.

4D-014 These areas are available for federal oil and gas leasing with controlled surface use to protect threatened, endangered, sensitive, and locally rare species. Other Federal minerals may be available on a case-by-case basis after full consideration of effects on threatened, endangered, sensitive, and locally rare species.

4D-015 Permit mineral materials for commercial, personal, free, and administrative use purposes with conditions to protect threatened, endangered, sensitive, and locally rare species habitat.

4D-016 Federal oil and gas leases exist in some of these areas. Roads, wells, and other necessary infrastructure associated with these leases are allowed. Existing lease stipulations are used to minimize disturbance to threatened, endangered, sensitive, and locally rare species habitat.

4D-017 Private mineral rights exist in some of these areas. Roads, wells, and other necessary infrastructure associated with these rights are allowed. Requests for access to a non-Federal interest in lands pursuant to a reserved or outstanding right are recognized, and reasonable access is granted. Encourage such interests to minimize disturbance to threatened, endangered, sensitive, and locally rare species habitat.

4D-019a (9F-027) Only permit road construction to access valid existing rights and mineral leases, or if entering the rare community to access an adjacent area results in less environmental impact. Road reconstruction and minor relocation are permitted after full consideration of effects on the rare community and associated species.

4D-019b (9F-028) New roads are engineered to minimize impacts to the rare community and managed as closed to public motorized travel.

4D-020 These areas are unsuitable for designation of new utility corridors, utility rights-of-way, communication sites or wind energy development. Existing uses may continue unless removal is necessary to protect threatened, endangered, sensitive, and locally rare species.

The possible effects of oil and gas development on rare communities, caves, and Special Biological Areas include removal of tree species, ground disturbance, changes in hydrology, changes in soil temperature, and possible invasion by non-native species. Even though there may be activities associated with oil and gas development, the Plan Standards provide protection for threatened, endangered, and sensitive species that occur within rare communities, caves, and Special Biological Areas. The areas may receive some disturbance, but project and site-specific analysis will include mitigation to prevent damage to the integrity of these areas and the species that depend on them.

Forest Plan direction for rare communities, caves, and Special Biological Areas is to protect the natural resource values associated with them. They are generally not actively managed, except where necessary for their restoration and maintenance.

MANAGEMENT INDICATOR SPECIES

Concerns regarding overall biodiversity of the areas proposed for federal oil and gas development are best addressed through the use of Management Indicator Species (MIS) as designated by the Forest Plan (Table B2.8). Wildlife resources on the Forest are located in Virginia and West Virginia and are managed in cooperation with the Virginia Department of Game and Inland Fisheries (VDGIF) and the West Virginia Department of Natural Resources (WVDNR). State wildlife agencies set policy for hunting and fishing regulations and associated law enforcement programs. The Forest Service manages the habitat conditions for wildlife. The following discussion focuses on the habitat conditions that support wildlife populations in the area.

Under the National Forest Management Act (NFMA) the Forest Service is charged with providing for a diversity of plant and animal communities consistent with overall multiple use objectives. Management Indicator Species (MIS) are a planning tool used to accomplish this requirement (36 CFR 219.19). They are selected during forest planning "because their population changes are believed to indicate the effects of management activities" (36 CFR 219.19(a)(1)) on important elements of plant and animal diversity.

The Reasonably Foreseeable Development (RFD) for federal oil and gas (particularly in the Marcellus shale) on the George Washington National Forest is concentrated on the Lee, North River, Warm Springs, and James River Ranger Districts.

Cow Knob Salamander. This salamander is a species with a restricted range. It is endemic to the higher elevations of Shenandoah Mountain along the VA/WV border. It is a terrestrial salamander that occurs

primarily above 2500 feet in elevation and mainly occurs in rocky talus areas on north to northeast aspects. It forages openly on cool to warm, dark, humid/rainy nights consuming small insects and other invertebrates. The Cow Knob salamander is an MIS because it is a Sensitive species and a narrow endemic that occurs almost entirely on the George Washington National Forest (North River Ranger District). The 1993 GW Forest Plan created the Shenandoah Crest Special Management Zone (SC-SMZ) to protect the habitat of this salamander. The range of the Cow Knob salamander overlaps with the location of Marcellus shale on the Forest. Under an agreement with the U.S. Fish and Wildlife Service (1994) no road construction is permitted on the Forest within the SC-SMZ. This would greatly inhibit gas well development. The agreement also states, that while the SC-SMZ is available for oil and gas leasing, controlled surface use stipulations will be used to protect the salamander's habitat and populations. These controlled surface use stipulations are subject to approval by the Cow Knob salamander Conservation Team.

Pileated Woodpecker. The Pileated Woodpecker generally prefers mature deciduous forests ranging from bottomlands to uplands. Key habitat requirements include older mature forests with dead trees (snags) for nesting. Pileated woodpeckers will also nest in large dead limbs on live trees. Nests are large cavities they construct usually over 30 feet above the ground. They feed on ants, insects, and insect larvae (mainly carpenter ants and wood-boring beetles) found by probing under the bark of standing trees and in stumps or fallen logs. Some fruits and berries are taken in fall and winter (Hamel, 1992). These woodpeckers are year-round residents. The pileated woodpecker is an MIS for snag dependent wildlife.

Ovenbird. Preferring mature, dry, deciduous hardwoods with a closed canopy, the ovenbird is an area sensitive MIS requiring relatively large undisturbed tracts. As ground nesters, they are especially vulnerable to predators. Breeding habitat is deciduous or mixed forest (rarely pure pine woods) with moderate understory, preferably in uplands. Since the ovenbird is a neotropical migrant, arriving in spring and departing the Forest in the fall, declines in populations may be caused by events happening on the wintering areas, not the Forest.

Chestnut-sided Warbler. The habitat of this common warbler is typically second-growth hardwoods and overgrown fields in the Appalachian Mountains over 3,500 feet. On the Forest it's therefore found in the Blue Ridge, Ridge and Valley, and Cumberland mountains. It's most numerous in abandoned fields with scattered saplings, along woodland edges, and in open park-like deciduous woods. It nests 1 to 4 feet above the ground in saplings and shrubs and feeds on insects gleaned from leaves and twigs in deciduous vegetation (Hamel, 1992). The chestnut-sided warbler is an MIS for high elevation early-successional habitats because of its strong association with these habitats, and because its populations should be responsive to forest management efforts that create and sustain such habitats. Also, the chestnut-sided warbler is effectively monitored using established breeding bird survey protocols. Since the chestnut-sided warbler is a neotropical migrant, arriving in spring and departing the Forest in the fall, declines in populations may be caused by events happening on the wintering areas, not the Forest.

Acadian Flycatcher. This common flycatcher is found mainly in moist deciduous forests with a moderate understory near streams. Nests are found on horizontal or down-hanging branches of deciduous trees, usually over a stream. This arboreal hawking insectivore generally sits on a branch 10 to 40 feet high near a stream where it will sally after flying insects (Hamel, 1992). The Acadian flycatcher is deemed an appropriate species to indicate management-induced changes to mature riparian forests. It is highly associated with mature deciduous forests along streams and bottomland hardwoods throughout the Forest. This species is selected to help indicate the effects of management activities on mature riparian habitats. Since the Acadian flycatcher is a neotropical migrant, arriving in spring and departing the Forest in the fall, declines in populations may be caused by events happening on the wintering areas, not the Forest.

Eastern Towhee. Also called the Rufous-sided towhee, this widespread bird is found most commonly in upland brushy habitats, woodland margins, thickets, cut-over woods, and overgrown fields. Key habitat requirements are shrubs, saplings, and understory trees where a thicket is present. Nests are most often located in thickets and brushy places on the ground or in shrubs and saplings up to 5 feet off the ground. Towhees forage on the ground and in low shrubs where they scratch in leaf litter to expose insects, seeds, and fruits that they glean (Hamel, 1992). Towhees are year-round residents although individuals will migrate short distances. The Eastern towhee was selected as an MIS to indicate the effects of management activities on early seral habitats.

Black Bear. The black bear is an opportunistic species that can thrive in a wide variety of habitats. The black bear's most important habitat need is considered to be freedom from constant human disturbance. Remote habitat free from the regular presence of humans is an important component of bear habitat quality. Access management does not refer to the prohibition of building or upgrading existing roads, but rather to their subsequent management after construction such as whether they're open or closed and the timing of closure. Roads in and of themselves are not detrimental; it's the use of these roads by the public that affects black bear. At least five percent of the area should be in an age class of older trees and these should be well dispersed over the area. Mature forests with large diameter trees are needed to provide hard mast and hollow den trees.

Eastern Wild Turkey. Wild Turkeys prefer mature forests (mid- to late successional) with open understories, temporary and permanent clearings well dispersed, and freedom from disturbance during nesting and brood rearing seasons. The key components of wild turkey habitat in oak-hickory forests are brood habitat, nesting and fall/winter habitat, and freedom from disturbance. Brood habitat is the most limiting factor to eastern turkey population in the central Appalachians (Pack, personnel communication). Hens with broods use a wide variety of habitats. These include pastures with hay fields, utility rights-of-way, wildlife clearings, burned areas, and natural glades or savannas; however, the structure of vegetation is as important as vegetation types (Healy 1981). In mature forests, ideal brood habitat includes at least 5% of the area in well-dispersed, permanent grass/herbaceous openings. Ground cover should consist of patchy vegetation that does not impede poult movements, yet provides good horizontal cover from predators, and produces abundant insects for food. Partially canopied (<60%) savannahs that are open and park-like with moderate herbaceous/shrubby understory with little midstory vegetation provide optimal brood habitat. Nesting and fall/winter habitat may include uncut hay fields, areas harvested for timber, and burned forests. Nesting habitat should be near brood habitat. Preferred and most successful nest sites seem to be on the edge of extensive stands of brush and herbaceous vegetation. Hard mast (usually acorns) is the most important fall food of the eastern turkey in the central Appalachians. Because of the variation in mast production between oak groups, a variety of oak species best provides sustained mast production. Ideal habitat includes at least 60% of the area in mast bearing age (50 years+). Human disturbance to hens and broods during the nesting and brood rearing season should be minimized. No more than one mile of open road per 1,000 acres will minimize this disturbance.

White-Tailed Deer. White-tailed deer use a variety of habitat types. White-tailed deer prefer early successional forest areas, woodland edge, and a mosaic of various forest age classes. A mixture of habitat types and resulting edge insures an abundant food source is available throughout the year. White-tailed deer heavily use hard mast in the fall (usually acorns) to accumulate sustaining fat reserves for the winter. During the winter woody browse makes up the majority of a deer's diet in the central Appalachians. In the spring and summer they consume young growing herbaceous plants, fruits, and woody shoots and leaves. Early successional habitat, generally no larger than 25 acres in size, well dispersed with approximately 10% of the area in the 0-10 age class provides forage and escape cover throughout the year. Well-dispersed forest openings 1/2 to 1 acre in size occupying up to 5% of the area and shrub-grass habitats provide necessary spring/summer foods. In extensive forested areas a minimum of 60% of the area maintained in mast bearing age (40 years +) provides suitable fall hard and soft mast for white-tailed deer.

Hooded Warbler. Habitat of this common warbler is moist deciduous and mixed forests with a dense understory, typically found in rich woods, ravines, and bottomlands. Key habitat requirements are forests (usually deciduous) with a thick, rich understory layer. The hooded warbler is rarely associated with moist deciduous forests above 4,000 feet (Hamel, 1992). Nests are built 2 to 5 feet above the ground in shrubs and saplings where they are poorly concealed. These warblers forage primarily in shrubs within 15 feet of the ground by gleaning and hawking insect prey. The hooded warbler is an MIS for mid- to late-successional oak and oak-pine forests. Since the hooded warbler is a neotropical migrant, arriving in spring and departing the Forest in the fall, declines in populations may be caused by events happening on the wintering areas south of the U.S. and not on the Forest.

Scarlet Tanager. This common woodland bird is typically found in upland mature deciduous (usually oak) forests for which it was selected as an MIS. It's most common in lower and middle elevations in the mountains up to 4,000 feet and is rarely found over 5,000 feet. The key habitat feature is mature deciduous forests. Nests are located 20 to 50 feet above the ground in a hardwood tree. The scarlet tanager feeds on insects that

it gleans from twigs and leaves (Hamel, 1992). In the fall it often will feed on berries. Since the scarlet tanager is a neotropical migrant, arriving in spring and departing in the fall, declines in populations may be caused by events happening on the wintering areas south of the U.S. and not on the Forest.

Pine Warbler. The pine warbler is closely associated with middle-aged to mature pine and pine-oak forests, generally occurring only where some pine component is present. While not among the common warblers, it is considered the most appropriate MIS for the yellow pine habitat component. Nests are built in pines and foraging for insects occurs in the crowns of pines where they glean insects from needles and twigs (Hamel, 1992). Since the pine warbler is a neotropical migrant, arriving in spring and departing the Forest in the fall, declines in populations may be caused by events happening on the wintering areas south of the U.S. and not on the Forest.

Wild Brook Trout. These trout are cold-water species that require water temperature less than 69 degrees Fahrenheit, dissolved oxygen values greater than 7.0 parts per million, and sedimentation rates that are in equilibrium with the watershed. To be considered "wild" they must be a reproducing population that is not dependent on stocking. Positive activities within watersheds that support wild trout are those that stabilize or improve the physical and biological conditions of the stream. For a complete discussion of effects on wild trout as an MIS in relation to this project see "AQUATIC VIABILITY DETERMINATIONS FOR OIL AND GAS LEASING"

Beaver (***Castor canadensis***). Beavers were selected as an MIS because they are a keystone species that create wetland habitat with many physical and biological benefits. Beavers alter ecosystem hydrology, biogeochemistry, vegetation, and productivity with consequent positive effects on the plant, vertebrate, and invertebrate populations that occupy beaver-modified landscapes. Their impoundments trap fine textured sediments that act as water storage reservoirs, resulting in slow, sustained discharge that maintains streamflows during dry periods; afford protection from flooding of downstream areas; and produce a raised water table that enhances riparian zones. Additionally, beaver habitat modifications can reduce pollution and improve water quality in aquatic ecosystems, by trapping sediment and nutrients; reducing downstream turbidity; and purifying water from acidification and other non-point source pollutants. The capability of beavers to store water, trap sediment, reduce erosion, and enhance riparian vegetation can be used as a management tool to restore degraded aquatic and riparian ecosystems. Beavers are a habitat-modifying species and play a pivotal role in influencing community structure in many riparian and wetland systems. Restoring beaver populations to their maximum viability on public lands is desirable because of the beaver's capability to restore and maintain healthy riparian ecosystems. Key conservation elements for the beaver on National Forest System lands are, therefore, protection and enhancement of aquatic and riparian habitats by management of water resources and riparian vegetation, beaver population enhancement by natural recolonization and transplants where necessary, and proactive management of beaver damage issues.

The physical effects of oil and gas leasing upon wildlife include elimination of individual animals and their associated habitat by construction or reconstruction of access roads, clearing and leveling of drill pad sites, and construction of pipelines and off-site facilities, and reduction of availability and quality of water and wetland habitat (see aquatic viability determinations for oil and gas leasing).. There is no anticipated gas well development in the next two decades on the Pedlar Ranger District. The potential impacts from new gas well development on the Lee, North River, Warm Springs, and James River Ranger Districts would vary by Alternative:

Currently there are no leases for Marcellus Shale gas wells on the Lee, North River, Warm Springs, and James River Ranger Districts.

Forest fragmentation can affect wildlife by encouraging species that use early successional and forest edge habitats, such as the MIS eastern towhee and wild turkey, and discouraging animals that use interior forest habitats, such as the ovenbird and hooded warbler. Under all alternatives, road, pipeline, facility, and drill pad construction would reduce existing mature forest habitat and increase the amount of edge in the project area. However, these hard mast/mature forest/old age forest habitat conditions will remain well connected over the 15-year period and forested travel corridors free from constant disturbance are maintained by road access closure. Forest fragmentation would be minimal given the narrow clearing widths for roads and pipelines and the small acreage disturbed when compared to the extensive surrounding unfragmented forests. Given the

Lee, North River, Warm Springs, and James River Ranger Districts are in a generally forested landscape, the expected negative impacts of edge are not considered significant.

Early seral habitat would be increased in all alternatives where roads and/or well pads are not allowed to redevelop into forest conditions. The increase in grass/forbs under all alternatives would provide food source for such MIS as whitetail deer, wild turkey, and indirectly for such species as the eastern towhee. While hard mast is reduced under all alternatives due to reduction of forested acres, hard mast production capability is still retained on adjacent acreage. It is likely that soft mast production (fruits and berries) will increase under all alternatives with plants such as blackberry, raspberry, and pokeweed occurring where land is cleared.

Numbers of snags will be reduced in all alternatives due to the number of acres of forest that will be cleared. Snag development generally takes 80 to 100+ years; therefore, even if cleared land is allowed to return to forest, it will take many decades for snags to develop once trees achieve a mature size and then die. However it is likely this loss of snags will be offset over time by increased tree mortality resulting from insect infestations such as gypsy moth and pine bark beetles.

Because of lease stipulations or conditions of approval on plans of operation, development activities would be excluded from riparian areas. This habitat would be maintained and riparian species, such as the Acadian flycatcher and beaver, should have little to no change. However, impacts from water withdrawal on wetland and riparian habitat could have impacts on riparian MIS such as Acadian flycatcher and beaver (see aquatic viability determinations for oil and gas leasing)

A summary of expected effects to MIS are shown in Table D16 below.

Table D16 Expected Effects to Management Indicator Species by Alternative

Common Name	Management Effects Indicated	A	B	C	D	E	F	G
Cow Knob Salamander	TES species dependent on mature, moist hardwood forest	=/=	=/=	=/=	=/=	=/=	=/=	=/=
Pileated Woodpecker	Snag-dependent wildlife species	=/-	=/-	=/-	=/-	=/-	=/-	=/-
Ovenbird	Mature forest interior species	=/-	=/-	=/-	=/-	=/-	=/-	=/-
Chestnut-sided Warbler	High-elevation early successional species	=/=	=/=	=/=	=/=	=/=	=/=	=/=
Acadian Flycatcher	Mature riparian forest dependent species	=/=	=/=	=/=	=/=	=/=	=/=	=/=
Hooded Warbler	Mid- and late successional deciduous forest species, inc. mixed mesophytic, oak & oak-pine forests	=/-	=/-	=/-	=/-	=/-	=/-	=/-
Scarlet Tanager	Upland oak forest species	=/-	=/-	=/-	=/-	=/-	=/-	=/-
Pine Warbler	Mid- and late successional pine and pine-oak forests	=/-	=/-	=/-	=/-	=/-	=/-	=/-
Deer	Cold-water streams and meeting fishing demand for these species	=/+	=/+	=/+	=/+	=/+	=/+	=/+
Eastern Wild Turkey	Meeting hunting demand for this species	=/+	=/+	=/+	=/+	=/+	=/+	=/+
Black Bear	Meeting hunting demand for this species	=/=	=/=	=/=	=/=	=/=	=/=	=/=
Wild Brook Trout	Meeting hunting demand for this species	See discussion under “Aquatic Species”						

Population trend expressed as expected change from current levels following implementation of proposed action: “++” relatively large increase, “+” increase,“=” little to no change, “-“ decrease, “- -“ relatively large decrease.

THREATENED, ENDANGERED, AND SENSITIVE (TES) SPECIES

The majority of the Reasonably Foreseeable Development for oil and gas will occur on the Lee, North River, Warm Springs, and James River Ranger Districts which provide habitat for 6 federally threatened and endangered terrestrial species, which include 3 plants, 2 mammals and one mussel. Two federally listed species, Virginia sneezeweed and swamp pink occur only on the Pedlar Ranger District where there is no Marcellus Shale and, therefore, are not considered further. There are 70 terrestrial species designated by the Regional Forester as sensitive on the Lee, North River, Warm Springs, and James River Ranger Districts. Sensitive species include species occurring on the Forest with range-wide viability concerns, but which are not included on lists of endangered, threatened, proposed, or candidate species. Sensitive species receive special management emphasis in order to ensure their viability and to preclude trends toward federal listing or endangerment. Forest terrestrial threatened, endangered, and sensitive species that might be affected by the oil and gas leases occur in two ecological sections: the Northern Ridge and Valley, and the Allegheny Front. Each of these sections contains distinct geologies and landforms, which give rise to a variety of unique habitats such as boreal forests, caves, wetlands, shale barrens, fire-adapted communities, glades, sinkholes, and springs. These unique habitats, in turn, support assemblages of rare plant and animal species. In addition to the habitat diversity found in the ecological sections, the Forest encompasses a wide range of latitude. Many plant and animal species more typically associated with northern or southern biomes reach the limit of their range on the Forest. For the oil and gas leasing analysis, species that could potentially be affected are shown below:

Table D17 TES Species Potentially Affected by Oil and Gas Leasing on the GWNF

Species Name	Common Name	Range on or near GWJNFs	Habitat - Detail	TES	G Rank	VA SRank	WV SRank
			VERTEBRATES				
Fish							
Notropis semperasper	Roughhead shiner	Upper James R watershed above Buchanan	Aquatic-rivers	S	G2G3	S2S3	-
Noturus gilberti	Orangefin madtom	S Fk Roanoke R watershed, Roanoke R above Salem, Craig Ck, Johns Ck, Cowpasture R	Aquatic-streams	S	G2	S2	-
Amphibian							
Plethodon punctatus	Cow Knob salamander	Shenandoah Mtn, VA & WV	Mixed oak, late successional with loose rocks and logs, >2500'	S	G3	S2	S1
Birds							
Falco peregrinus	Peregrine Falcon	Hack sites late 80s & early 90s No nests, current migrant.	Nests on ledges or cliffs, buildings, bridges, quarry walls. Non-breeding sites, farmland, open country, lakeshores, broad river valleys, airports.	S	G4	S1B/S2N	S1B/S2N
Haliaeetus leucocephalus	Bald Eagle	Potomac R, James R watershed	Feeds and nests on or near large lakes and rivers	S	G5	S2S3B/S3N	S2B/S3N
Lanius ludovicianus migrans	Migrant Loggerhead Shrike	Ridge & Valley (Shenandoah Valley)	Open grasslands with trees and shrubs, fencerows	S	G4	S2B/S3N	S1B/S2N
Thryomanes bewickii altus	Appalachian Bewick's wren	Historical records in Botetourt, Giles, Highland Washington Cos	Thickets, old fields, fencerows, old home sites	S	G5T2Q	S1B/SZN	S1B/S1N
Mammals							

Species Name	Common Name	Range on or near GWJNFs	Habitat - Detail	TES	G Rank	VA SRank	WV SRank
Corynorhinus townsendii virginianus	Virginia big-eared bat	Summer: VA - Highland Co. (1 cave), WV - Pendleton Co. (4 caves); Winter: Highland, Rockingham, Pendleton Co. (6 caves), largest WV population in Pendleton Co. Small #'s of bats (usually <10) in a few other widely scattered caves during summer months. Bath & Pulaski County records are historic, no occupied caves currently known.	Resides in caves winter and summer. Short distance migrant (<40 miles) between winter and summer caves. Forages primarily on moths and foraging habitat is common (fields, forests, meadows, etc.). Forages within 6 miles of summer caves. USFWS Critical Habitat is 5 caves in WV (4 Pendleton Co. & 1 Tucker Co.). Closest Critical Habitat cave to GWJNF is ~3 miles in Pendleton Co., WV.	E	G4T2	S1	S2
Glaucomys sabrinus fuscus	Virginia northern flying squirrel	Laurel Fork area, Highland Co	Spruce-fir forests and adjacent northern hardwoods	S	G5T2	S1	S2
Microtus chrotorrhinus carolinensis	Southern rock vole	Alleghany Mtn, Bath Co	Cool, moist, mossy talus under oaks/northern hardwoods	S	G4T3	S1	S2
Myotis leibii	Eastern small-footed bat	Ridge & Valley	Hibernates in caves during winter, roosts in crevices of large rock outcrops, cliffs, & under large rocks in talus & boulder-fields during summer, forages widely in all forested and open habitat types over both ridges and valleys.	S	G3	S1	S1
Myotis sodalis	Indiana bat	Blue Ridge, Ridge & Valley, Cumberland Mtns	Caves winter, upland hardwoods summer, forages widely along riparian areas and open woodlands	E	G2	S1	S1
Sorex palustris punctulatus	Southern water shrew	Alleghany Mtn, Bath Co; & Laurel Fork, Highland Co	Riparian areas w/in spruce-fir forests and northern hardwoods	S	G5T3	S1S2	S1
INVERTEBRATES							
Snail (Mollusk, Class Gastropoda)							
Glyphyalinia raderi	Maryland glyph	Alleghany, Montgomery Cos	Calciphile, edge of seeps within leaf litter	S	G2	S1S2	S2
Helicodiscus diadema	Shaggy coil	Alleghany Co	Calciphile, limestone rubble and talus	S	G1	S1	-
Helicodiscus lirellus	Rubble coil	Rockbridge Co	Calciphile, limestone rubble and talus	S	G1	S1	-
Helicodiscus triodus	Talus coil	Alleghany, Botetourt, Rockbridge Cos	Calciphile, limestone rubble on wooded hillsides and caves	S	G2	S1S2	SH
Clam and Mussel (Mollusk, Class Bivalvia)							
Alasmidonta varicosa	Brook floater	Potomac drainage	Aquatic-rivers	S	G3	S1	S1
Elliptio lanceolata	Yellow lance	Roanoke R, James R	Aquatic-rivers	S	G2G3	S2S3	-
Lasmigona subviridis	Green floater	Widely distributed in N & S Fk Shenandoah R, Pedlar R, James R	Aquatic-rivers	S	G3	S2	S2
Pleurobema collina	James spinymussel	Potts Ck, Craig Ck, Johns Ck, Patterson Run, Pedlar R, Cowpasture R, Mill Ck (Deerfield)	Aquatic-rivers	E	G1	S1	S1
Amphipod (Crustacean, Order Amphipoda)							
Stygobromus gracilipes	Shenandoah Valley cave	Frederick, Rockingham, Shenandoah, Warren Cos	Caves	S	G3G4	S2S3	S1

Species Name	Common Name	Range on or near GWJNFs	Habitat - Detail	TES	G Rank	VA SRank	WV SRank
	amphipod						
Stygobromus hoffmani	Alleghany County cave amphipod	Low Moor cave, Alleghany Co	Caves	S	G1	S1	-
Stygobromus mundus	Bath County cave amphipod	Alleghany, Bath Cos	Caves	S	G2G3	S1S2	-
Isopod (Crustacean, Order Isopoda)							
Miktoniscus racovitzai	Racovitza's terrestrial cave isopod	Alleghany, Botetourt, Page, Rockbridge, Shenandoah Cos	Caves	S	G3G4	S2	-
Millipede (Class Diplopoda)							
Nannaria shenandoah	Shenandoah Mountain Xystodesmid millipede	One site: along Long Run Road, Rockingham Co	Leaf litter, mixed oak forest	S	G1	S1	-
Pseudotremia alecto	a millipede	Griffith Knob, Alleghany Co; near Mountain Grove saltpetre cave, Bath Co	Leaf litter, deciduous forests	S	G1	S1	-
Centipede (Insect, Order Chilopoda)							
Nampabius turbator	a cave centipede	One known site: Low Moor cave, Alleghany Co	Caves	S	G1G2	S1	-
Springtail (Insect, Order Collembola)							
Arrhopalites carolynae	A cave springtail	Augusta, Highland, Bath, Lee, Wise Cos	Caves	S	G2G4	S1	-
Arrhopalites sacer	A cave springtail	Bath Co	Caves	S	G1G2	S1	-
Dragonfly and Damselfly (Insect, Order Odonata)							
Gomphus viridifrons	Green-faced clubtail	New R, Craig Ck, Pound R, Locust Spring	Aquatic-rivers	S	G3	S2	S2
Beetle (Insect, Order Cloeoptera)							
Cicindela ancocisconensis	Appalachian tiger beetle	Alleghany, Bath, Highland, Lee, Rockbridge, Washington, Wise Cos	Riparian – sandy/silty edges of streams and rivers	S	G3	S2	S3
Cicindela patruela	Northern barrens tiger beetle	Blue Ridge, Ridge & Valley	Eroded slopes of exposed sandstone and conglomerate	S	G3	S2	S2S3
Hydraena maureenae	Maureen's shale stream beetle	Alleghany, Bath, Botetourt, Bland, Craig, Cos	Interstitial water in riparian-shale substrate along stream edge	S	G1G3	S1S3	-
Butterfly and Moth (Insect, Order Lepidoptera)							
Callophrys irus	Frosted elfin	Frederick, Montgomery, Page, Roanoke Cos	Dry, open woods, clearings, and road/powerline ROWs w/ abundant wild indigo (*Baptisia tinctoria*)	S	G3	S2?	S1
Erynnis persius persius	Persius duskywing	Blue Ridge, Ridge & Valley	Bogs, wet meadows, open seepages in boreal forests	S	G5T1T3	S1	-
Pyrgus centaureae wyandot	Appalachian grizzled skipper	Ridge & Valley	Shale barrens, open shaley oak woodlands	S	G5T1T2	S1S2	S1
Speyeria diana	Diana fritillary	Blue Ridge, Ridge & Valley	Grasslands-shrublands, near streams with thistles and milkweeds, larval host plant, violets	S	G3G4	S3	S2S3
Speyeria idalia idalia	Regal fritillary	Blue Ridge, Ridge & Valley	Riparian, grasslands-shrublands	S	G3T1Q	S1	S1

Species Name	Common Name	Range on or near GWJNFs	Habitat - Detail	TES	G Rank	VA SRank	WV SRank
Catocala herodias gerhardi	Herodias underwing	Bald Knob, Bath; Poverty Hollow, Montgomery Co; Sand Mtn, Wythe Co (non FS property)	Pitch pine/bear oak scrub woodlands, >3000'	S	G3T3	S2S3	SU
Erythroecia hebardi	Hebard's noctuid moth	Bath Co	Rich, mesic hardwood forest. Larvae host plant is Canada horse-balm (*Collinsonia canadensis*).	S	GU	SH	-
Euchlaena milnei	Milne's euchlaena moth	Edinburg Gap, Shenandoah Co	Moist, forested slopes of mixed pine hardwoods. Acidic oak woods.	S	G2G4	S2	S2
NON-VASCULAR PLANTS							
Lichen							
Hydrothyria venosa	Waterfan	Amherst, Alleghany, Bedford, Botetourt, Giles, Madison, Nelson, Rockbridge, Shenandoah Cos	Aquatic – in streams/springs/cascades	S	G3G5	S1	-
Liverwort							
Nardia lescurii	a liverwort	Blue Ridge, Ridge & Valley	Riparian – on peaty soil over rocks, usually in shade and associated w/ water, <3000'	S	G3?	SU	-
VASCULAR PLANTS							
Aconitum reclinatum	Trailing white monkshood	Blue Ridge, Ridge & Valley	Rich cove sites, streambanks, seepages all with high pH	S	G3	S3	S3
Allium oxyphilum	Nodding onion	Monroe, Summers, Mercer, Greenbrier Cos, WV	Shale barrens, sandstone glades	S	G2Q	-	S2
Arabis patens	Spreading rockcress	Frederick, Lee, Page, Shenandoah, Warren Cos	Shaded, calcareous cliffs, bluffs, and talus slopes	S	G3	S2	S2
Arabis serotina	Shale barren rockcress	Ridge & Valley N of New R watershed	Shale barrens and adjacent open oak woods	E	G2	S2	S2
Berberis canadensis	American barberry	Blue Ridge, Ridge & Valley	Calcareous open woods, bluffs, cliffs, and along fencerows	S	G3	S3S4	S1
Buckleya distichophylla	Piratebush	Blue Ridge S of Roanoke R, Ridge & Valley S of James R	Open oak and hemlock woods	S	G2	S2	-
Carex polymorpha	Variable sedge	Blue Ridge, Ridge & Valley, N of James R	Open acid soil, oak-heath woodlands, responds to fire	S	G3	S2	S1
Carex schweinitzii	Schweinitz's sedge	Bath, Montgomery, Pulaski, Washington Cos	Bogs, limestone fens, marl marshes	S	G3G4	S1	-
Clematis coactilis	Virginia white-haired leatherflower	Ridge & Valley, Rockbridge Co, S to Wythe Co	Shale barrens, rocky calcareous woodlands	S	G3	S3	-
Corallorhiza bentleyi	Bentley's coralroot	Alleghany, Bath, Giles Cos VA; Monroe, Pocahontas Cos WV	Dry, acid woods, along roadsides, well-shaded trails	S	G1G2	S1	S1
Delphinium exaltatum	Tall larkspur	Blue Ridge, Ridge & Valley	Dry calcareous soil in open grassy glades or thin woodlands	S	G3	S3	S2
Echinacea laevigata	Smooth coneflower	Alleghany, Montgomery Cos	Open woodlands and glades over limestone or dolomite	E	G2G3	S2	-
Euphorbia purpurea	Glade spurge	Blue Ridge, Ridge & Valley	Rich, swampy woods, seeps and thickets	S	G3	S2	S2
Heuchera alba	White alumroot	Shenandoah Mtn	High elevation rocky woods and bluffs	S	G2Q	S2?	S2
Hypericum mitchellianum	Blue Ridge St. John's-wort	Blue Ridge, Ridge & Valley	Grassy balds, forest seepages, moderate to high elevations	S	G3	S3	S1
Iliamna remota	Kankakee globe-mallow	Alleghany, Botetourt, Rockbridge, Bedford Cos	Open, disturbed riverbanks and roadsides	S	G1Q	S1	-

Species Name	Common Name	Range on or near GWJNFs	Habitat - Detail	TES	G Rank	VA SRank	WV SRank
Juglans cinerea	Butternut	Blue Ridge, Ridge & Valley	Well-drained bottomland and floodplain, rich mesophytic forests mostly along toeslopes	S	G4	S3?	S3
Liatris helleri	Turgid Gayfeather	Blue Ridge, Ridge & Valley	Shale barrens, mountain hillside openings	S	G3	S3	S2
Lycopodiella margueritae	Marguerite's clubmoss	Bath Co	Seasonally moist soils, wet acidic ditches, borrow pits	S	G2	NA	-
Monotropsis odorata	Sweet pinesap	Blue Ridge, Ridge & Valley	Dry oak-pine-heath woodlands, soil usually sandy	S	G3	S3	S1
Paxistima canbyi	Canby's mountain lover	Ridge & Valley	Calcareous cliffs and bluffs, usually undercut by stream	S	G2	S2	S2
Phlox buckleyi	Sword-leaf phlox	Blue Ridge, Ridge & Valley	Open, often dry oak woodlands and rocky slopes, usually over shale in humus rich soils, often along roadsides	S	G2	S2	S2
Poa paludigena	Bog bluegrass	Blue Ridge, Ridge & Valley	Shrub swamps and seeps, usually under shade	S	G3	S2	S1
Potamogeton hillii	Hill's pondweed	Bath Co	Clear, cold calcareous ponds	S	G3	S1	-
Potamogeton tennesseensis	Tennessee pondweed	Ridge & Valley	Ponds, back water of streams and rivers	S	G2	S1	S2
Pycnanthemum torrei	Torrey's mountain-mint	Bland, Bath, Giles, Rockbridge, Wythe Cos	Open, dry rocky woods, roadsides, and thickets near streams, heavy clay soil over calcareous rock	S	G2	S2?	S1
Scirpus ancistrochaetus	Northeastern bulrush	Ridge & Valley	Mountain ponds, sinkhole ponds in Shenandoah Valley.	E	G3	S2	S1
Scutellaria saxatilis	Rock skullcap	Blue Ridge, Ridge & Valley	Rich, dry to mesic ridgetop woods, 32 counties in VA, likely G4/S4	S	G3	S3	S2
Sida hermaphrodita	Virginia mallow	Ridge & Valley, James R watersheds	Riverbank glades with loose rock or sandy soil	S	G3	S1	S3
Trillium pusillum var. moniticulum	Mountain least trillium	Great North Mtn & Shenandoah Mtn, VA & WV	Open oak woodlands in well drained soil and margins of thickets	S	G3T2	S2	S1
Vitis rupestris	Sand grape	Ridge & Valley	Scoured banks of rivers and streams over calcareous bedrock	S	G3	S1?	S2

P=potentially affect by oil and gas leasing, E=endangered, T=threatened, S=sensitive

FEDERALLY LISTED SPECIES

Following is a brief description of each of the federally listed plant and animal species currently known to exist on the Lee, North River, Warm Springs, and James River Ranger Districts along with current management strategies for recovery.

Table D18 Federally Threatened and Endangered Species for the GWNF

Taxa	Species	Status
Mammal	Indiana Bat (Myotis sodalis)	Endangered
Mammal	Virginia Big-Eared Bat (Corynorhinus townsendii virginianus)	Endangered
Mussel	James Spiny Mussel (Pleurobema collina)	Endangered
Vascular Plant	Shale Barren Rock Cress (Arabis serotina)	Endangered
Vascular Plant	Smooth Cone Flower (Echinacea laevigata)	Endangered
Vascular Plant	Virginia Sneezeweed (Helenium virginicum)	Threatened
Vascular Plant	Swamp Pink (Helonius bullata)	Threatened
Vascular Plant	Northeastern Bulrush (Scirpus ancistrochaetus)	Endangered

Northeastern bulrush (*Scirpus ancistrochaetus*).

Unless otherwise noted, the information used in this analysis comes from NatureServe (accessed in 2010). Northeastern bulrush was listed as endangered under the Endangered Species Act in 1991. Populations are known from MA, MD, NH, NY (presumed extirpated), PA, VA, VT, and WV. The habitat seems to vary geographically, although there are not enough sites to allow generalizations to be made. However, one does observe that in the south, sinkhole ponds are the most common habitat for the plant, and in the north, other kinds of wetlands, including beaver-influenced wetlands, provide suitable habitat. When this species was listed as endangered there were 33 known populations. As of 2007, there were about 113 extant occurrences known in the Appalachians from southern Vermont and New Hampshire to western Virginia, with most occurrences in Pennsylvania. Most populations are in Pennsylvania (70) and Vermont (22) (USFWS 2008). The other populations are in Massachusetts (1), Maryland (1), New Hampshire (9), Virginia (7), and West Virginia (3) (USFWS 2008). There are about ten historical occurrences: New York (1), Pennsylvania (7), Virginia (1), Quebec (1). The plants are restricted to fairly specific wetland habitats that are infrequent, especially in the southern part of the range. Various threats are associated with the habitat, including drainage and development, agricultural runoff, and any developments that could alter the local hydrology. Additional, unsurveyed habitat does exist, and more populations of this species may be found in the future if the potential habitats remain intact. Long-term monitoring of known sites is needed before any conclusions can be drawn about the habitat needs of the plant, or about the stability of its populations in changing environments.

The implementation schedule for the northeastern bulrush recovery plan (USDI Fish and Wildlife Service 1993) includes five items that directly relate to Forest Service management:

- Secure permanent protection for known populations;
- Resurvey sites thought to have suitable habitat;
- Verify, monitor, and protect any additional populations;
- Identify potentially suitable habitat for additional surveys; and
- Survey potential sites.

Throughout its range, northeastern bulrush is found in open, tall herb-dominated wetlands. Often it grows at the water's edge, or in a few centimeters of water, but it may also be in fairly deep water (0.3-0.9 m) or away from standing water. In the southern part of its range, the most common habitat is sinkhole ponds, usually in sandstone. Water levels in these ponds tend to vary both with the season and from year to year. At least one site (in Massachusetts) is in a sand plain, where water level fluctuates as well. Two sites in Vermont are influenced to some extent by beaver activity as well as other hydrological factors.

With the information available it is difficult to compare sites throughout the plant's range. For example, lists of associated species may represent an entire wetland or the immediate vicinity of the plant, but this is not always possible to determine from available information. Nevertheless, examination of field reports indicates that there is considerable variety in associated species. A few species, however, are common to several of the sites. These are Dulichium arundinaceum, Scirpus cyperinus sens. lat., Glyceria canadensis, and Triadenum virginicum.

Virginia. There are seven extant northeastern bulrush sites in Virginia, with two ranked as A/AB, two ranked B/BC, and one ranked E. The status of most of these sites is unknown because they have not been surveyed since the 1980s or 1990s. Habitat includes emergent ridgetop shallow ponds, shallow sinkhole depressions and mountainside bench ponds. Four sites are located on private land, three are on public land, and ownership of one site is undetermined. In Virginia, the northeastern bulrush is listed as State endangered; however, no additional protection (e.g., buffers) is afforded to wetlands supporting the species. No upland buffers are regulated or protected around any wetlands in the State. The northeastern bulrush is protected under the Endangered Plant and Insect Species Act of 1979, which prohibits take without a permit, but individual landowners are exempt from these permitting requirements.

West Virginia. There are three northeastern bulrush populations in West Virginia, two of which are ranked B, and one of which is ranked D. These occurrences were surveyed and last observed in 2005. Habitat includes sinkhole ponds atop a low, flat sandstone ridge, and small seasonal ponds. Two of these sites are located on private lands, and one is located on National Forest land managed by the U.S. Forest Service (USFWS 2008). The northeastern bulrush has no official status in West Virginia, and this State does not have an endangered species law. No upland buffers are regulated or protected around any wetlands in the State.

Shale barren rockcress (*Arabis serotina*). Unless otherwise noted, the information used in this analysis comes from NatureServe (accessed in 2010).

Shale barren rockcress was listed as endangered under the Endangered Species Act on August 8, 1989. Shale barren rockcress is a narrow endemic known only from shale barren regions of Virginia and West Virginia; one of the most restricted shale barren endemics. According to NatureServe, approximately 56 occurrences are believed extant, 34 in Virginia and 22 in West Virginia, of these most made up of fewer than 50 individuals; there are perhaps fewer than 4,000 plants altogether. Most occurrences are on public lands, predominantly National Forests. Depending on the definition of an occurrence, there appear to be more occurrences than indicated in NatureServe. The following is from the Forest's Monitoring and Evaluation Report 2004:

> *"In 1993 there were 17 known occurrences of shale barren rockcress on the Forest. The Forest's focus since this species was listed has been to attempt to locate additional populations and further define its range on the Forest. From 1994 to 1998 agency personnel worked cooperatively with the*

Virginia Division of Natural Heritage and the USFWS to inventory shale barrens on the Forest (Belden, Ludwig, and Van Alstine 1999). The Virginia Division of Natural Heritage identified 809 potential shale barrens from aerial photographs. Of these, 188 were examined for rare species. The inventory resulted in 27 new occurrences of shale barren rockcress, bringing the total known sites on the Forest (in Virginia) to 37. This number does not include two sites where shale barren rockcress was known to occur recently, but could not be found in 1994. In 2004 the West Virginia Department of Natural Resources discovered a new population of shale barren rockcress at the Little Fork North Shale Barren bringing the total occurrences on the Forest from the 77 reported by the West Virginia Natural Heritage Program in 2000 to 78. This includes both Virginia and West Virginia information. Of the 78 occurrences, 17 were known in 1993 when the GWNF Plan took effect, so there has been an increase of 61 occurrences."

Because of the highly stressful nature of shale barrens environments, this species is not believed to be capable of tolerating much additional disturbance. Threats include road/trail construction and maintenance, erosion, inundation resulting from flood control measures, deer browsing, competition from exotic plants, and declines of its pollinators due to the spraying of Dimilin and BT insecticides for gypsy moth control. Shale barren rockcress is an endemic of shale deposits, occurring only on sparsely-vegetated xeric, south or west-facing shale slopes (barrens) at elevations from 400 to 600 meters. Populations are known from both the shale openings and shale woodlands adjacent to the shale openings. All extant occurrences are on shale of Devonian age (Ludwig pers. comm.); a single occurrence was known from the Martinsburg shale of Ordovician age, but it is no longer extant. The term "shale barren" is a general reference to certain mid-Appalachian slopes that possess the following features: 1) southern exposures, 2) slopes of 20-70 degrees and 3) a covering of lithologically hard and weather-resistant shale or siltstone fragments (Dix 1990). These barrens support sparse, scrubby growth; frequently-observed species include Quercus ilicifolia, Q. prinus, Q. rubra, Pinus virginiana, Juniperus virginiana, Prunus alleghaniensis, Rhus aromatica, Celtis tenuifolia, Kalmia latifolia, Bouteloua curtipendula, Andropogon scoparius, Phlox subulata var. brittonii, Silene caroliniana ssp. pensylvanica, Sedum telephoides, Antennaria spp., Aster spp., and Solidago spp. (Dix 1990). Local variations in associated flora may be considerable (Braunschweig et al 1999, Jarrett et al 1996, Keener 1970, Keener 1983, Wieboldt 1987). Although adequate moisture is available for most plants within the substrata of the shale layers, adverse surface conditions act to restrict germination and establishment success of plants (Platt 1951). It is primarily the effect of high surface temperatures that limits plant reproductive success in these habitats. Surface soil temperatures are often well above the physiological tolerance of most plant species, reaching maximum temperatures of 63 degrees Celsius (Dix 1990). Such temperatures are high enough to cause direct damage to seedlings. For additional detailed information pertaining to the shale-barren community, see Dix (1990).

Recovery tasks for the Forest identified in the shale barren rockcress Recovery Plan include:

- Implement and evaluate the monitoring program.

Smooth coneflower (*Echinacea laevigata*). Unless otherwise noted, the information used in this analysis comes from NatureServe (accessed in 2010).

Smooth coneflower was listed as endangered under the Endangered Species Act on September 8, 1992 and is known from about 100 occurrences rangewide, a majority of which are of fair to poor viability in several southeastern states. Most historically known populations were destroyed by development and habitat alteration, especially the suppression of fire, and a number of remaining populations are primarily in marginal locations, where they are vulnerable to urbanization, the use of herbicides, repeated mowing, and potentially, collection for the medicinal trade. Small remote populations may suffer from loss of habitat due to succession.

There are two known populations of smooth coneflower on the Forest. One is along a roadside and mainly in the ditch, making management very difficult and dangerous. The other is five miles west in an open woodland that can be managed.

The Recovery Plan for smooth coneflower does not have any recovery tasks specific to the Forest. **Indiana bat (*Myotis sodalis*).** The distribution of Indiana bats is generally associated with limestone caves in the eastern

U.S. (Menzel et al. 2001). Within this range, the bats occupy two distinct types of habitat. During summer months, maternity colonies of more than 100 adult females roost under sloughing bark of dead and partially-dead trees of many species, often in forested settings (Callahan et al. 1997). Reproductive females may require multiple alternate roost trees to fulfill summer habitat needs. Adults forage on winged insects within three miles of the occupied maternity roost. Swarming of both males and females and subsequent mating activity occurs at cave entrances prior to hibernation (MacGregor et al. 1999). During this autumn period, bats roost under sloughing bark and in cracks of dead, partially-dead and live trees. Wintering colonies occupy very specific climatic regimes in cool, humid caves or mines primarily west of the Appalachian Mountains (Barbour and Davis 1969; Menzel et al. 2001). Few sites provide these conditions, and approximately 85% of the species inhabits only nine caves or mine shafts (Menzel et al. 2001; USDI FWS 1999).

Indiana Bat (Myotis sodalis). Although most hibernacula have been protected, the Indiana bat still appears to continue a 5% decline in range-wide population every two years (Cochran et al. 2000). Causes of decline are not known and have continued despite efforts to protect all known major hibernacula. Researchers are focusing studies on land use practices in summer habitat, heavy metals, pesticides and genetic variability in attempts to find causes for the declines.

Recommended habitat management includes protecting known significant hibernacula from human impacts, retaining forested condition around the entrances to significant hibernacula, and evaluating opportunities to protect Indiana bats through land acquisition (Menzel et al. 2001).

It is difficult to quantify summer roosting habitat for Indiana bat at a range-wide, regional or local level due to the variability of known roost sites and lack of knowledge about landscape scale habitat characteristics. Forest management practices that affect occupied roost trees may have local impacts on Indiana bat populations. However, the bats live in highly altered landscapes, depend on an ephemeral resource--dead and dying trees--and may be very adaptable. Anecdotal evidence suggests that these bats may respond positively to some degree of habitat disturbance (USDI FWS 1999).

Several caves on the Forest have been known to support Indiana bats, at least historically. Steps have been taken by the Forest to protect these caves for the Indiana bat. Both males and females hibernate in large caves and mine tunnels. In 1995, bat gates were installed in several caves on the Forest. These caves are Shire's Saltpetre Cave on the New Castle Ranger District, and Kelly Cave and Cave Springs Cave on the Clinch Ranger District. Shire's Saltpetre Cave and Kelly Cave are the only caves on the Forest known to have been hibernacula for Indiana bats, at least historically. Cave Springs Cave is not currently known to be a hibernaculum for any rare bat species, but it has the potential to serve as a hibernaculum. In addition, Cave Springs Cave is known to contain a variety of troglobitic amphipods and isopods. Both forest-wide standards and a specific management prescription surrounding Indiana bat hibernacula are designed to protect roosting and foraging habitat as well as the hibernacula for the Indiana bat. The primary cave protection area is administratively unavailable for Federal oil and gas leasing. The secondary cave protection area is available for leasing with controlled surface use stipulations to protect Indiana bat habitat.

Virginia big-eared bat (Corynorhinus townsendii virginianus). This bat has a very limited range in Virginia and on the Forest. It uses caves as both hibernation and maternity sites and none of the caves known to be currently used in Virginia or West Virginia are on the GWJNF. This bat is also called the Western big-eared bat and formerly was in the genus *Plecotus* (you may still see it referred to this way). This species is listed as endangered both at the federal (1979) and state (Virginia, 1987) level, and as of July 1, 2005 it is officially the Virginia state bat. This bat is unique in that it is one of two bats in Virginia that uses caves almost exclusively during both summer and fall (the other species with a similar life history is the gray bat - Myotis griscesens). In Virginia this bat is currently only known to occur in Tazewell County (3 caves) during the summer and 5 caves in three counties (Tazewell, Bland, & Highland) during the winter. There are historic records in Rockingham, Bath, and Pulaski (?) counties. The area in Virginia where this bat is concentrated, and of greatest concern, is in the Tazewell County area where there are relatively large (~1,500 to 2,000 individuals) and well known winter hibernacula and a summer maternity caves. Elsewhere in Virginia the bat is/was known to occur in caves with just a few individuals (usually <10), probably as transients. The Virginia big-eared bat forages almost exclusively on moths and will feed over a wide variety of habitats including hay fields, corn fields, meadows, forests, etc. - wherever moths are found. Therefore, caves (and only a very few) are the key habitat

element for this species. It forages widely over many different types of vegetation and foraging habitat is not critical, nor are moths in short supply. (Note: this is a species to closely consider in our gypsy moth related projects.)

James spinymussel (*Pleurobema collina*). The James spinymussel was federally listed as endangered in 1988. Historically, this species was apparently throughout the James River above Richmond, in the Rivanna River, and in ecologically suitable areas in all the major upstream tributaries (Clarke and Neves 1984). The species remained widespread through the mid-1960's, but now appears extirpated from 90% of the historic range. Extant populations and historical habitats on or near the National Forest are displayed in Table 3-75. This species is found in slow to moderate currents over stable sand and cobble substrates with or without boulders, pebbles, or silt (Clarke and Neves 1984). Hove and Neves (1994) found James spinymussels in 1.5 to 20 m wide second and third order streams at water depths of 0.3 to 2 m. Seven fish hosts, all in the family Cyprinidae, have been identified (Hove 1990): bluehead chub, rosyside dace, blacknose dace, mountain redbelly dace, rosefin shiner, satinfin shiner, and stoneroller. Freshwater mussels are filter feeders taking organic detritus, diatoms, phytoplankton, and zooplankton from the water column.

The following excerpt from Hove and Neves (1994) states the current thinking on threats: "There are several anthropogenic and natural threats to the James spinymussel's continued existence. Nearly all the riparian lands bordering streams with the James spinymussel are privately owned. With more intensive use of the land, it is probable that water quality and habitat suitability will deteriorate. At present, the most detrimental activities include road construction, cattle grazing, and feed lots that often introduce excessive silt and nutrients into the stream."

The introduced Asian clam is also considered to be a threat to the James spinymussel and is beginning to invade several sites (Hove and Neves 1994). Despite extensive searches on the Jefferson National Forest, the James spinymussel has been confirmed at only one site. This consisted on one live specimen found in 1990 (O'Connell and Neves 1991). A subsequent survey in 2001 failed to locate any live specimens at this site. Based on this information it is uncertain that the Forest supports a viable population of James spinymussel. The main avenues for the Forest to aid in this species recovery are through land acquisition, assisting in augmentation efforts, and working with landowners to protect streams and streamside habitat. See section titled "AQUATIC VIABILITY DETERMINATIONS FOR OIL AND GAS LEASING"

Exploration and production activity would have minimal, if any, effects to any TES species that may occur in the area. Most effects would be associated with exploration and development activities that disturb or destroy habitat that supports the occurrence of a TES species. All activities that involve leases will require the preparation of a Biological Assessment and/or Biological Evaluation that determines effects on the TES species and outlines appropriate mitigation measures. TES species, no matter where they occur within the lease area, will be protected to ensure viable populations and suitable associated habitat. Controlled surface use and timing stipulations along with application of forestwide and specific standards will reduce or eliminate most adverse impacts. Generally, specific locations of exploration and production activity is flexible, so impacts to TES species can be avoided by relocating the development and confining disturbance to previously disturbed areas. Federally listed species will require compliance with the Endangered Species Act with species protection and recovery objectives outlined in the Recovery Plan prepared for each species. All known occurrences of federally listed plants on the Forest site are protected within Special Biological Areas. These areas are available for Federal oil and gas leasing with controlled surface use stipulations to protect the plants and their habitat as well as other rare biological resources.

For state listed species, the Forest will cooperate fully with the protection and recovery objectives set forth by the state. All alternatives include the general goal of contributing towards the recovery of federally listed threatened and endangered species (T&E). Additionally, the following activities are common across all alternatives:

- Recovery plans (when available) will be followed for all T&E species;
- Forest-wide population objectives for threatened, endangered, and candidate
- plants will be followed;

- Forest-wide standards will be followed. For example, "sites supporting federally listed threatened and endangered species or individuals needed to maintain viability are protected from detrimental effects caused by management actions";
- Threatened, endangered, and sensitive species will be conserved through the site-specific biological evaluation process;
- Surveys for all TES and their habitats will continue to be conducted on the Forest, particularly as part of the biological evaluation process in conjunction with projects likely to affect habitat for the species (project-level surveys would be conducted in accordance with procedures outlined in the Region 8 supplement of Forest Service Manual 2672);
- Monitoring of known populations of threatened, endangered, and sensitive species will be conducted consistent with Forest Manual direction.

WILDLIFE

The physical effects of oil and gas leasing upon wildlife include elimination of individuals that cannot move out of existing habitats being impacted by construction or reconstruction of access roads, clearing and leveling of drill pad sites, and construction of pipelines and facilities. Site access is developed by building a new road or improving an existing one. The potential impacts from new gas well development on the Lee, North River, Warm Springs, and James River Ranger Districts would vary by Alternative:

Table D19 Wildlife Effects of Gas Well Development

Oil and gas activity for vertical and horizontal wells	GWNF Baseline RFD	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Number of wells	319	307	250	54	249	92	198	93
Total reclamation (total disturbance) (acres)	2,328	2,239	1,820	396	1,819	778	1,444	790

Currently, there are no leases for Marcellus Shale gas wells on the Lee, North River, Warm Springs, and James River Ranger Districts. Road and drilling pad construction would result in the creation of edge and a reduction of forest interior habitat. Creation of edge can result in an increase in cowbird parasitism and predation upon a variety of species. Given the Lee, North River, Warm Springs, and James River Ranger Districts are in a generally forested landscape, the expected negative impacts of edge are not considered significant. Forest interior habitat will be lost as a result of road construction and creation of drilling pads. This loss is considered to be similar for each alternative, thus habitat for the ovenbird, a forest interior management indicator species, will be reduced for all alternatives. Conversely, creation of edge and early seral habitat can benefit some species, such as white-tail deer and wild turkey. Early successional bird species, such as indigo buntings, eastern towhees, and field sparrows may benefit from the resulting open and brushy habitats created from RFD of oil and gas resources. Habitat for the eastern towhee, an early successional habitat management indicator species, will be improved under all alternatives. In addition, habitat for white-tailed deer and wild turkey will be improved.

NON-NATIVE INVASIVE PLANTS

The Chief of the U.S. Forest Service (USFS) has identified non-native invasive species as one of the four critical threats to USFS ecosystems. As defined in Executive Order 13112 issued February 3, 1999, an invasive species is one that meets the following two criteria: "1) it is nonnative to the ecosystem under consideration and, 2) its introduction causes or is likely to cause economic or environmental harm or harm to human health."

In the United States, invasive species are reported to be the second-most critical threat to conservation of biodiversity (Wilcove et al. 1998). Nonnative plants are known to occur across Southern and Central Appalachian forests, often accounting for 25% or more of the documented flora. While not all non-native

species are known to disrupt native ecosystems, of particular concern are those that are successful at invading and rapidly spreading through natural habitats. Invasive plants create a host of harmful environmental effects to native ecosystems including: displace native plants; degrade or eliminate habitat and forage for wildlife; threaten endangered species; impact recreation; affect fire frequency; alter soil properties; decrease biodiversity; and more. Invasive plants spread across landscapes, unimpeded by ownership boundaries. Infested areas represent potential seed sources for continuation of the invasion on neighboring lands.

The potential impacts from new gas well development on the Lee, North River, Warm Springs, and James River Ranger Districts would vary by Alternative:

Table D20 Non-Native Invasive Plants Effects of Gas Well Development

Oil and gas activity for vertical and horizontal wells	GWNF Baseline RFD	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Number of wells	319	307	250	54	249	92	198	93
Total reclamation (total disturbance) (acres)	2,328	2,239	1,820	396	1,819	778	1,444	790

Currently, there are no leases for Marcellus Shale gas wells on the Lee, North River, Warm Springs, and James River Ranger Districts.

Ground disturbance caused by activities associated with Marcellus gas development includes road construction, well pad construction, pipeline construction and maintenance, and off-site facility construction. Ground disturbance creates habitat suitable for NNIP infestations. Roads and pipelines are corridors for NNIP to move through the landscape. The potential for NNIP infestation and movement increases with the amount of ground disturbance. Alternative A has the most acres of potential ground disturbance and therefore has the greatest potential for NNIP establishment. Alternatives B, D, and F would have 23% to 55% less ground disturbance than Alternative A and consequently as proportionately reduced threat of NNIP infestation. Alternatives C, E, and G would have a 283% to 565% reduced threat of NNIP infestation versus Alternative A. The potential for NNIP infestations from ground disturbing activities could be offset by specifying aggressive NNIP treatments when authorizing special use permits.

POTENTIAL WILDERNESS AREAS AND INVENTORIED ROADLESS AREAS

Development of gas wells could affect Potential Wilderness Areas and Inventoried Roadless Areas on the North River, James River and Warm Springs Ranger Districts. In Alternatives B, C, D, E, F, and G areas allocated to the Remote Backcountry Management Prescription Area would be leased with a no surface occupancy stipulation so there would be no impacts to those areas. The only impacts would occur in the portions of the Potential Wilderness Areas or Inventoried Roadless Areas that are not allocated to Remote Backcountry. Table D21 displays the Inventoried Roadless Area acres potentially affected by gas development.

Table D21 Inventoried Roadless Areas Potentially Affected by Gas Development

Potential Wilderness Name	Potential Wilderness Area Acres	Inventoried Roadless Area Acres	Acres of Inventoried Roadless Area not protected by Backcountry Prescription						
			A	B	C	D	E	F	G
Archer Knob	7,100								
Beards Mountain	10,200	7,500	7,500						
Beech Lick Knob	14,100								
Crawford Knob	14,900	9,900	9,900	1,200		1,400			
Elliott Knob	11,100	9,400	9,400	200					
Galford Gap	6,700								
Gum Run	14,500	12,600	12,600						
High Knob	18,400	12,900	12,900	500					
Jerkemtight	27,300	16,800	16,800	800		800			
Laurel Fork	10,200	10,000	10,000						
Little Alleghany	15,400	10,200	10,200	700		1,000	1,000		
Little River	30,200	27,200	27,200	1000					
Oak Knob - Hone Quarry Ridge	16,300	10,800	10,800	800		1,200			
Oliver Mountain	13,000	13,000	13,000						
Paddy Knob	6,000								
Potts Mountain	7,000								
Ramseys Draft Addition	19,100	12,800	12,800						
Rich Hole Addition	12,200	10,900	10,900	1,500		1,500	1,500		
Rich Patch	900								
Rough Mountain Add	2,100	1,200	1,200						
Shaws Ridge	7,300								
Total	264,000	165,200	165,200	6,700	0	5,900	2,500	0	0

Table D22 displays those portions of the Potential Wilderness Areas potentially affected by gas development

Table D22 Potential Roadless Areas Potentially Affected by Gas Development

Potential Wilderness Name	Potential Wilderness Area Acres	Inventoried Roadless Area Acres	Acres of Potential Wilderness Area not Protected by Prescription (Backcountry, SBA, Shen Mtn)						
			A	B	C	D	E	F	G
Archer Knob	7,100		7,100	7,100		7,100		7,100	2,200
Beards Mountain	10,200	7,500	2,600			1,800		1,800	1,800
Beech Lick Knob	14,100		14,100	8,500		8,500			5,800
Crawford Knob	14,900	9,900	5,000	5,000		5,000	2,500	2,500	5,000
Elliott Knob	11,100	9,400	1,700	1,700		1,700	1,700		1,700
Galford Gap	6,700		6,700	6,700		6,700	6,700		6,700
Gum Run	14,500	12,600	1,900	1,900		1,400			
High Knob	18,400	12,900	5,600	5,600		5,300			4,100
Jerkemtight	27,300	16,800	10,500	10,500		10,400	4,300	4,300	3,600
Laurel Fork	10,200	10,000	200	200					
Little Alleghany	15,400	10,200	5,200	5,200		5,200	5,200		5,000
Little River	30,200	27,200	3,000	3,000		2,400		2,400	1,500
Oak Knob - Hone Quarry Ridge	16,300	10,800	5,500	5,500		4,400			
Oliver Mountain	13,000	13,000	0						
Paddy Knob	6,000		6,000	6,000		5,100	5,100		5,100
Potts Mountain	7,000		7,000	7,000		7,000			7,000
Ramseys Draft Addition	19,100	12,800	6,300	6,300		5,400	4,700		3,400
Rich Hole Addition	12,200	10,900	1,200	1,200		1,200	1,200		1,000
Rich Patch	900		900	900					
Rough Mountain Add	2,100	1,200	900	900		800			900
Shaws Ridge	7,300		7,300	7,300		7,200			
Total	264,000	165,200	98,700	90,500	0	86,600	31,400	18,100	54,800

RECREATION

The Reasonably Foreseeable Development (RFD) for federal oil and gas uses the assumption that the entire is George Washington National Forest is open to federal oil and gas leasing except areas withdrawn by law, specifically designated Wildernesses and the Mount Pleasant National Scenic Area. The recreation opportunity settings of the national forest are inventoried using the Recreation Opportunity Spectrum (1986 ROS Book, USDA Forest Service). The spectrum of settings ranges from primitive to urban. Settings inventoried on the George Washington National Forest include semi-primitive non-motorized (SPNM), semi-primitive motorized (SPM), roaded natural (RN), and rural (R). There are no areas on the Forest that meet the inventory criteria for the two extreme ends of the spectrum: primitive and urban.

The RN setting allows human-made structures such as wellheads but these are generally scattered and remain visually subordinate from sensitive travelways. In the RN setting, remoteness is of little relevance due to the expected proximity to roads and/or facilities. However the semi-primitive settings provide opportunities for remote, backcountry recreation where there is little evidence of human-made structures other than trails and

their associated signs and structures. Some vestiges from the past may be evident, but have been substantially reclaimed by nature. Examples include old narrow gauge railroad grades and logging roads.

There are approximately 995 miles of national forest system trails within the baseline RFD area, excluding trails in designated Wildernesses and the National Scenic Area. These trails are multiple-use, most allowing hiking, horseback riding and mountain biking. Three trails that total 65 miles allow motorized use. Hunting and some fishing are common dispersed recreation activities.

There are 59 developed recreation areas within the RFD area, and an additional 52 developed sites that support dispersed recreation.

Oil and natural gas development would affect recreation activities primarily in terms of the degree to which the settings and patterns of use are changed due to development operations. There are 847,566 acres, or 80% of the George Washington National Forest, in federal mineral ownership and not withdrawn from mineral leasing by law. Access road construction, gas well pad construction, gas pipeline construction and drilling operations could impact the developed and dispersed recreation visitors' experience and the recreation settings.

The sights and/or sounds of gas development activities may negatively impact the experience of recreationists using trails or recreating off-trail in the general forest area in the vicinity of lease activity, particularly during the drilling operation, pipeline construction and subsequent maintenance periods. A short-term result would be use pattern changes in the form of avoidance and displacement to other areas. A normal drilling operation would require about three months, beginning with site clearing and ending with site restoration. With production operations, the disturbance would normally be limited to the immediate area of the wellhead and the access road.

Within RN settings and given the latitude for well pad location contained in existing regulations, the negative impacts of leases can usually be mitigated during the production phase. Long-term, site restoration would allow the RN criteria to be met. Lease stipulations or Conditions of Approval on Surface Use Plans of Operations would ameliorate or eliminate impacts in some cases.

Within SPM and SPNM settings, a natural, unmodified environment should dominate. Areas of inventoried SPNM and SPM recreation settings that are allocated to prescription areas where federal oil and gas leasing is not available or would have a No Surface Occupation stipulation include Wilderness, recommended Wilderness, Appalachian Trail corridor, research natural area, designated National Scenic Area, recommended National Scenic Area and remote backcountry. These acres of semi—primitive settings are substantially protected and there would be little impacts to them.

In SPNM and SPM settings, there should be no permanent roads, on-site management controls should be subtle, and within SPNM areas there should be no motorized use. The construction, operations and maintenance of roads, wells, pipelines, their permanent presence in the setting, and the increased interactions between Forest visitors to these settings and lessees and contractors are not consistent with the experience characterization for SPM and SPNM. The table below shows acres of SPNM and SPM that are allocated to prescription areas that would be available for oil and gas leasing with either controlled surface occupancy, a timing stipulation or standard lease terms.

Table D23 Summary of Semi-Primitive Settings Available for Oil and Gas Leasing With Surface Occupancy by Alternative

Stipulations and Terms	ALT A	ALT B	ALT C	ALT D	ALT E*	ALT F	ALT G
Controlled Surface Occupancy Stipulation, SPNM+SPM acres	5,856	5,615	0	5,395	5,367	5,320	5,384
Timing Stipulation, SPNM+SPM acres	656	0	0	659	659	659	659
Standard Lease Terms, SPNM+SPM acres	183,863	167,512	0	177,968	125,643	107,763	134,355
Summary of SP Acres Available for Oil and Gas Leasing	190,375	173,127	0	184,022	131,670	113,742	140,398

*Under Alternative E, no horizontal drilling and associated hydraulic fracturing operations will be allowed. Source of Data: ROS Acres by Alternative generated by GIS, with leave availability options per the Suitable Uses by Alternative Table applied.

Based upon the baseline RFD, anticipated minerals activities and the resultant impacts from potential new gas well sites, associated roads, pipeline clearing and disturbance, following are the alternatives descending from greatest impacts to less impacts: Alternative A, Alternative D, Alternative B, Alternative G, Alternative E. Impacts may be mitigated by the Conditions of Approval on Surface Use Plans of Operations under all of the alternatives.

All of the developed recreation sites would be protected from direct affects of gas production by the Controlled Surface Use stipulations or Conditions of Approval on Surface Use Plans of Operations under all of the alternatives. However, there is some potential for recreationists to hear or see evidence of gas development activities taking place near the recreation site. These would normally be short- term impacts during production periods.

There is potential for roads and pipelines constructed to support oil and gas development and operations to impact trails and trail users. Direct impact to trails would occur in instances where access roads or pipelines cross them. Roads generate noise, dust, and safety concerns. Storm water runoff from roads and maintenance operations can potentially damage trails.

Alternative C would have the least impact on trails, followed by Alternatives E and G. The alternative that would likely have the most impacts on trails is Alternative A. It has the greatest potential for occurrences of crossings or close proximity to trails that would impact trails and trail users. The alternatives with the next greatest potential for impacts to trails are Alternatives B and D. These effects may be mitigated, to varying degrees, through rehabilitation, management controls, and/or trail relocation. Lease stipulations or Conditions of Approval on Surface Use Plans of Operations would ameliorate or eliminate impacts in some cases.

As of September 2010, existing federal oil and gas leases were in effect on 1.2% of the George Washington National Forest lands. Considering both potential federal leases and potential private minerals development on national forest land, and the resultant impacts from expected new gas well sites, associated roads, pipeline clearing and disturbance, Alternative A would have the greatest impacts on recreation resources, followed by Alternative D.

SCENERY

The scenic resource is affected by management activities altering 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, which result in visual alterations inconsistent with the assigned SIO, even with mitigation, affect scenery. Management activities that have the greatest potential of affecting scenery are road construction, vegetation management, insect and disease control, special use utility rights-of-ways, and mineral extraction.

Mineral management and development activities can involve major alteration to landform, as well as contrasts to form, line, color, and texture, causing substantially adverse scenic impacts. Natural gas drilling and production are not common on the George Washington National Forest. To date there have been only five exploration wells and no wells have gone to production. Currently, the activities associated with minerals involve shale pits, limestone extraction and surface collection of building rock. New activities associated with federal oil and gas leasing will impact scenery.

The most significant visual impacts from natural gas well development would occur during the drilling operation and subsequent maintenance periods. Drilling rigs and other equipment would give the area an industrial look that is out of character with the surrounding landscape. The negative visual impacts from drilling would include the construction of well pads, access roads and pipelines along with the operation and sight of the necessary drilling equipment. A normal drilling operation would require several months, beginning with site clearing and ending with site restoration. The areas are moderate to steeply slope and there may be some steep cut slopes that would likely be necessary in the construction of roads and well pads. The following table shows the potential development of roads, pipelines, and well pads by alternative.

Table D24 Federal Oil and Gas Leasing Activities by Alternative That Affect Scenery

SUMMARY	ALT A	ALT B	ALT C	ALT D	ALT E	ALT F	ALT G
Roads (miles)	195	150	0	150	43	111	44
Pipelines (miles)	214	166	0	165	47	122	48
Well pad acres	492	380	0	380	77	281	79

Based upon the Reasonably Foreseeable Development (RFD) scenario, potential minerals activities and the resultant impacts from expected new gas well sites, associated roads, pipeline clearing and disturbance to soils, the Alternatives rank, in descending order, from the greatest impacts to the least impacts as follows:

Alternative A, D, B, F, G, and E. Related to oil and gas leasing, Alternative C would have no impact on scenery.

Potential maximum direct, indirect and cumulative effects to scenery resources can be assessed according to the maximum extent within which the characteristic landscape is altered, including changes to line, color, texture and scale. Ground-disturbance, grading and vegetation clearing activities can potentially occur for all alternatives except Alternative C. The principal proposed activities that could alter the characteristic landscape include construction of roads, well pads and pipelines. Cumulatively, the repeated implementation of these project activities could, over time, result in the degradation of scenery.

CULTURAL RESOURCES

The George Washington National Forest contains a multitude of sites representing past human events. Beginning with Native American occupations dating as early as 8000 B.C., the variety of cultural resources is impressive. Prehistoric sites include multi-use base camps, transient camps, hunting and gathering stations, quarries, lithic reduction stations, and rock-shelter occupations. The most common site type is often referred to as a lithic scatter and represents a short-term occupation where stone tools were made and/or sharpened and may be associated with a plethora of ancillary activities. Native American sites are found throughout the Forest for all time periods with the exception of the Ice Age Paleoindians. Unknown Paleoindian sites may exist on the Forest but have yet to be located. Cultural resources are important resources that require inventory, evaluation, protection, and interpretation.

Direct and indirect affects to historic or cultural resources could result from both natural and human-caused events. These vary depending upon the type of resource, the fragility of the resource, and the type of disturbance, but could include soil disturbance to varying depths, vegetation removal, looting or vandalism, and land use changes.

Accordingly, five types of ground disturbing land management activities that vary in magnitude (acres or miles) have the greatest potential to affect cultural resources. These include: timber management, road construction, fire management, mineral management, and recreation use. To a lesser degree, other forms of land management, such as landownership adjustment (land exchange), special use permits, structures management, and wildlife management can also affect cultural resources.

Exploration and development of leasable minerals, oil, gas, and mineral materials may impact cultural resources through access road construction, pipeline construction, well pad placement, and actual removal and displacement of minerals and soil. Mineral extraction may produce severe, albeit localized, direct effects to significant cultural resources as the overburden containing historic resources are removed. Indirect effects could include damage to significant cultural resources located outside the area of immediate mining resulting from erosion, the installation of road accesses and equipment staging areas, and vandalism and looting resulting from increased access to these historic properties.

Apart from these common effects, potential maximum direct, indirect and cumulative effects to cultural resources can be assessed according to the maximum extent within which ground-disturbing activities can potentially occur for each alternative. The principal proposed ground-disturbing activities include construction of roads and well pads. Cumulatively, the repeated implementation of these project activities could, over time,

result in the degradation of sites, a potential reduction in the number of intact historic properties, and increased site vandalism.

Analysis of effects of minerals management to significant cultural resources is performed programmatically in compliance with existing laws and regulations (e.g., 36 CFR 296, 800, and the PA with the Virginia SHPO) and occurs on a case-by-case basis separate from alternatives. Therefore, effects to cultural resources resulting from minerals management are not affected by alternative.

CHAPTER 4 LIST OF PREPARERS

Name/Education/Experience	Role/Responsibility
Thomas Bailey BS Soil Science (1976); 27 years experience in the collection, evaluation, mapping and interpretation of soil resource information.	Interdisciplinary Team Member, Soil Resources
JoBeth Brown BA Sociology (1984); 20 years experience in public affairs.	Public Affairs Officer
Ted Coffman BLA Landscape Architecture and BS Horticulture (1980, 1979); 27 years of experience involving visual resources and the design and administration of recreation, Wilderness, and trails.	Recreation Staff Officer
Thomas K. Collins BA Geology (1965); Graduate Study in Geology; 35 years of experience in the inventory and evaluation of geologic resources.	Interdisciplinary Team Member, Geology
Carol Croy BS Wildlife and Fisheries (1987), MS Wildlife Ecology (1991), PhD Wildlife Ecology (2003); 23 years experience in inventorying, monitoring and management of plant and animal species, including rare, endangered and sensitive species; 7 years experience in research of prescribed fire effects on flora and fauna communities.	Interdisciplinary Team Member, Wildlife Resources
Steve Croy BS Wildlife Biology and Botany (1977); 30 years experience involving the inventory, management, and monitoring for threatened, endangered, and rare plant and animal species.	Interdisciplinary Team Member, Sensitive Plant and Animal Resources, Fire
Cindy M. Huber BS Forestry (1976); MS Entomology (1981); 11 years of experience in assessing the impacts of insect and disease pests on forest resources, 17 years experience in monitoring and evaluating the effects of air pollution on natural resources and visibility.	Interdisciplinary Team Member, Air Resources
Fred Huber BA Biology (1972); MS Botany (1976); Graduate Study in physiological ecology of alpine plant species; 21 years of experience in identifying and evaluation sensitive plant and animal resources and habitats.	Interdisciplinary Team Member, Sensitive Plant Resources

Name/Education/Experience	Role/Responsibility
Dawn Kirk BA Biology/Environmental Studies (1990); MS Fisheries (1992); Graduate Study in aquatic ecology and benthic macroinvertebrates, 18 years of experience in monitoring and evaluating aquatic habitats and fisheries management.	Interdisciplinary Team Member, Aquatic Resources
Ken Landgraf BS Water Resource Science and Biology (1978); 10 years experience in NEPA and Forest Planning, 21 years of experience in collecting, interpreting information on water, air and soils.	Interdisciplinary Team Member, Planning Staff Officer
Russ MacFarlane BSF Forest Resource Management (1985); 17 years experience in timber planning/silviculture, 8 years experience in pest management.	Interdisciplinary Team Member, Silviculture
Al McPherson BA Biology (1973); 17 years experience in the administration and monitoring of recreation, wilderness, and trails programs.	Interdisciplinary Team Member, Recreation (retired)
James O'Hear BS Geography (1986); 20 years in GIS and forest planning.	Geographic Information Systems
Karen Overcash BS Forest Resource Management (1985); MS Forest Biometrics (1988); 20 years of experience in land management planning.	Interdisciplinary Team Leader, Planning Analyst, NEPA
Richard Patton MS Forest Management/Hydrology (1980); 30 years experience in inventory and evaluation of water resources.	Interdisciplinary Team Member, Hydrology
Dave Plunkett Bachelor of Science, Forestry, Penn State University (1975); 26 years experience with U.S. Forest Service as forester and planner at Ranger District and Supervisor's Office level on 4 National Forests in 3 Forest Service Regions and Northeast Forest Experiment Station.	Interdisciplinary Team Member, Planning and NEPA (retired)
Scott Vandegrift BS Construction Engineering (1995); 19 years civil engineering experience including 15 years of facility and transportation management	Interdisciplinary Team Member, Engineering and Lands

Name/Education/Experience	Role/Responsibility
Ginny Williams BLA Landscape Architecture (1990); 20 years of experience involving visual resources, developed recreation, trails, Wilderness and design.	Interdisciplinary Team Member, Scenery and Recreation Resources

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CHAPTER 5 DEIS DISTRIBUTION LIST

Copies of the Draft Environmental Impact Statement were sent to the following federal agencies:

USDA, National Agricultural Library
Environmental Protection Agency
U.S. Department of the Interior, Office of Environmental Policy and Compliance
USDA Bureau of Land Management
USDI Fish & Wildlife Service

Notification that the Draft Environmental Impact Statement is available on the web was sent to the following federal agencies:

Advisory Council on Historic Preservation
Director, Office of Environmental Policy and Compliance
Environmental Protection Agency
Federal Aviation Administration
Federal Highway Administration
National Marine Fisheries Service
Natural Resources Conservation Service
NOAA Office of Policy and Strategic Planning
Ohio River Basins Commission
Rural Utilities Service (RUS)
U.S. Army Engr. Great Lakes and Ohio
U.S. Army Engr. North Atlantic Division
U.S. Coast Guard (USCG)
U.S. Department of Energy
USDA APHIS PPD/EAD
USDA Office of Civil Rights

On January 11, 2011 Forest Supervisor Maureen Hyzer sent a letter to about 1,000 people and organizations on our Forest Plan mailing list. The letter was also posted on the Forest web site. The letter explained that the DEIS would be available on the web, on a computer disk, or as a hard copy. Individuals who wanted a hard copy or a computer disk were asked to respond to the Forest by February 1. As a result of this letter, the following individuals or groups were sent a hard copy of the DEIS.

Shawn Head, West Virginia Division Of Natural Resources
Barbara Sargent, West Virginia Division Of Natural Resources
Chuck Waggy, West Virginia Division Of Natural Resources
Kieran O'Malley, West Virginia Division Of Natural Resources
Mike Eye, Shenandoah WMA
Charles Teets, West Virginia Division Of Natural Resources
Sherman Bamford
Randy Bush, Va. Forest Products Association
Sarah Francisco & David Carr Jr, Southern Environmental Law Center
John P Cone Jr, Citizens Task Force
Wade Evans
David Hannah, WILD VIRGINIA
John Hutchinson
Laura Neale, Virginia Wilderness Committee
Wade A. Neely
Archie Pugh, American Electric Power
Ernest Reed, HEARTWOOD

The following individuals or organizations were sent a computer disk.

Dr. Dan Downey, Trout Unlimited Massanutten Chapter
Jill Keihn, Northern Shenandoah Valley PDC
Sherry Ryder, Bath County Planning
William Fawcett
Suzette Molling, USDI Nps, Blue Ridge Parkway
Larry Smith, Va DCR, Division Of Natural Heritage
Susan Plank
Jim Mooney, Va. Loggers Association
Thomas Aurelio
Liz Belcher, Roanoke Valley Greenways
Charlie Huppuch
Steve Shipe
Carroll Kisling, Sr
James Bryan
Lynn Cameron
Lee Foerster
Donald Polhemus
John R. Sweet
Diane S. Hypes, Old Dominion 100 Mile Ride, Inc.
Lynn Williams
Martin P. Albert, Md
Pete Davis, Lexington News-Gazette
Pete & Lee Meyer
B.J. Summers
Roger Timbrook, Mead/Westvaco, Wood Dept
John Cunningham
Jim And Elizabeth Murray, Virginia Wilderness Committee
Albert Lewis, Rockbridge County Board Of Supervisors
Herbert Cooper
, Amherst County
Mark E. Barker, Blue Ridge Environ Defns Lea
Bo Beasley, Blue Ridge Land Rovers Club
Laura Belleville, Appalachian Trail Conservancy
Donald Blankenship
Ralph & Christina Bolgiano
Norman Bouchard
Michael Brill
Pete Bsumek
David Burns
Ken Caplinger, Wv State Parks
Betty Carver, Wv Div Of Tourism
Phillip Cobb
Patrick Coffield, Augusta County Administrator
Sam Crickenberger, Rockbridge County Planning
Archie Dean
John Dodd Ii
Dennis Dutterer
David Ede, Monongahela NF
Larry Endsley, Augusta Lumber
Alvin Estep, Western Va. Deer Hunters Association
Ray Fernald, Va Dept. Of Game And Inland Fisheries
Dan E. French, Amherst Co. Service Authority
Carl Garrison, Iii, Va Dept Of Forestry
John Hancock
Michell Hicks, Eastern Band Of Cherokee

Jerry Jacobsen
Thomas Jenkins, Shenandoah Mountain Bike Club
Derral Jones, Va Dept. Of Conservation And Recreation
Bill Jones
Emily Kimball, Va Dept. Of Conservation And Recreation
Gary Kirby
Sharon Link, Hampshire Co. Board Of Supervisors
James & Parke Loesel, Citizens Task Force
Carolyn Mauck
Carol Lena Miller, Virginia Wilderness Committee
Mark Miller, Virginia Wilderness Committee
Andy Morris, Town Of Clifton Forge
Russell J. Murphy
Charles Newton
Bill Novajosky
Joseph Paxton, Rockingham Co. Administrator
Robert Proudman, Atc-Dir. Of Con. Ops.
Bruce Ritchie
Alan Staimon, Va 4WD
Ron Sutton, Va Dept. Of Conservation And Recreation
Leslie D Trew, Va Dept. Of Conservation And Recreation
Amy McDonnell, Chesapeake Bay Foundation, Inc.

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