United States
Department of
Agriculture

1989
Francis Marion National Forest
After Hurricane Hugo

2015
Francis Marion
National Forest

Draft
Environmental Impact Statement
for the Revised Land Management Plan

Forest Service | Region 8 | Francis Marion National Forest | R8-MB 146 B | August 2015

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Francis Marion National Forest
Draft Environmental Impact Statement
for the
Revised Land Management Plan

Berkeley and Charleston Counties, South Carolina

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

It is important that reviewers provide their comments at such times and in such a way that the Forest Service can use them to prepare 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, would be part of the public record for this proposed action (40 CFR 1502.10).

Send comments to: Francis Marion and Sumter National Forests
Attn: Francis Marion Forest Plan Revision
4931 Broad River Road
Columbia, SC 29212

The comment period will end 90 days after the notice of availability of the DEIS is published in the *Federal Register*. Please visit our website at http://bit.do/FMPlan for more information.

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Summary

This Draft Environmental Impact Statement (DEIS), prepared by the U.S. Forest Service describes and analyzes in detail three alternatives for managing the land and resources of the Francis Marion National Forest (Francis Marion). It describes the affected environment and discloses environmental effects of the alternatives. The process record is available on our public website at: http://www.fs.usda.gov/goto/scnfs/fmplan. Maps can be viewed on-line through the Collaborative Talking Points Mapping Tool.

1.1 Proposed Action

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

1.2 Issues Addressed

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

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

1.3 Alternatives

Three alternatives are described, compared and analyzed in detail in this DEIS. Alternative 1 represents the current forest plan and is also referred to as the 1996 plan. Alternative 2 is the alternative preferred by the Forest Service and is the foundation for the draft plan that is available for public review during a 90-day comment period. Alternative 3 is a variation of Alternative 2 developed to address concerns about the impacts to human health and safety from prescribed burning on the national forest.

1.4 Summary of Effects Analysis

Ecological Sustainability. All native ecosystems and native species, including at-risk species, would be protected in all alternatives. The long-term effects of ecosystem restoration would be expected to result in sustainable native communities and associated species. Each alternative includes management strategies and appropriate forest plan components for each group. Over time, associated species of regional and local viability concern should remain sustainable. Each alternative includes the forest plan components for ecosystem diversity necessary to provide the ecological conditions to conserve threatened and endangered species.

Each alternative is based on an overall strategy for achieving ecosystem restoration using a combination of vegetation management practices and prescribed burning to restore and maintain resilient native ecosystems. Alternative 2 emphasizes the following:

1. Converting loblolly pine stands that are not on appropriate sites to longleaf pine forests;
2. Improving hydrologic function of wetlands; and
3. Restoring rare communities and old growth.

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

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

- Implementation of best management practices and proper mitigation measures would result in minimal soil and water effects. Analysis indicates that, at the forest level, the expected intensity of management activities planned would not result in measurable changes either beneficial or detrimental to overall watershed condition.
- The air quality program for the Francis Marion provides guidance for conducting forest management activities in a manner that complies with state and federal standards, protects human health, promotes safety and does not degrade air quality. Prescribed burning is the activity that would most likely contribute air emissions.

Social and Economic Sustainability. Outdoor recreation opportunities enhance the quality of life not only for people who live within the administrative boundary, but for people across the entire USA. No alternative proposes any new developed recreation opportunity; however, Alternatives 2 and 3 place an increased emphasis on disperse recreation opportunities. Alternative 3 proposes expanding the forest's four existing wilderness areas.

Predicted urban development adjacent to national forest land would affect forest personnel's ability to complete prescribed burning on a landscape level. The alternatives propose different strategies to reduce hazardous fuel levels in areas of the forest that border highways and human communities.

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

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

1.5 Scope of the Decision

Based upon the effects of the alternatives, the responsible official would decide:

- Establishment of desired conditions and objectives;
- Establishment of forest-wide design criteria (standards and guidelines);
- Establishment of management areas and geographic areas;

- Determination of suitability of land;
- Determination of the maximum amount of timber that might be removed;
- Areas recommended for inclusion in the National Wilderness Preservation System (36 CFR 219.7(c)(2)(v)); and
- Identification of Eligible Wild and Scenic Rivers (36 CFR 219.7(c)(2)(vi)).

Chapter 1. Purpose and Need

1.1 Document Structure

This DEIS was prepared in compliance with the National Environmental Policy Act (NEPA) and other relevant federal and state laws and regulations. This DEIS discloses the direct, indirect and cumulative environmental impacts that would result from the proposed action and alternatives. This document is organized into four chapters:

- **Chapter 1. Purpose and Need for Action:** This chapter includes information on the history of the project proposal, the purpose and need for the project and the Forest Service's proposal for achieving the purpose and need. This section also details how the Forest Service informed the public of the proposal and how the public responded.
- **Chapter 2. Alternatives, including the Proposed Action:** This chapter provides a more detailed description of the Forest Service's proposed action as well as alternative methods for achieving the stated purpose. These alternatives are based on significant issues raised by the public and other agencies. This discussion also includes any mitigation measures associated with the proposed action or alternatives. Finally, this section provides a summary table of the environmental consequences associated with each alternative.
- **Chapter 3. Affected Environmental and Environmental Consequences:** This chapter describes the environmental effects of implementing the proposed action and other alternatives. The analysis is organized by themes developed from public involvement. Major themes include: Ecological sustainability, social and economic sustainability and resource integration.
- **Chapter 4. Consultation and Coordination:** This chapter provides a list of preparers and agencies consulted during the development of the DEIS.
- **Appendices:** The appendices provide more detailed information to support the analyses presented in the DEIS.

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

1.2 Background

The Francis Marion National Forest is located within Berkeley and Charleston counties in southeastern South Carolina and contains 258,942 acres. The land the forest occupies is a triangle formed by the Santee River to the north, the Intracoastal Waterway to the east and Lake Moultrie and the Cooper River to the west. The forest comprises about 12 percent of the public lands in the state. Major highways into the forest include U.S. highways 17, 17A and 52 as well as state highways 41 and 45. The forest is within a 60-minute drive north of the Charleston metropolitan area (see Figure 1-1).

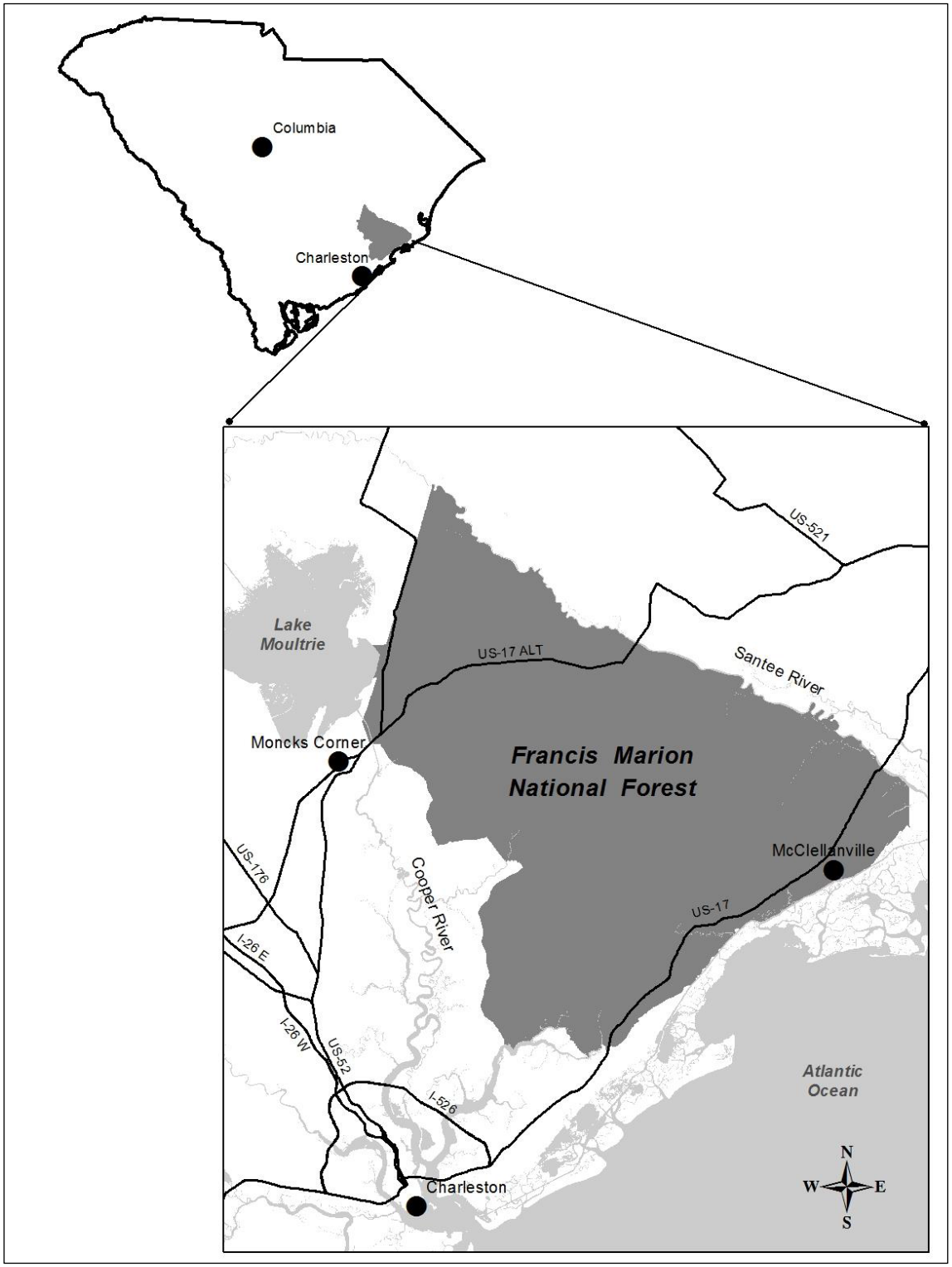

Figure 1-1. Vicinity map of the Francis Marion National Forest

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

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

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

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

Figure 1-2. Damage from Hurricane Hugo in 1989

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

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

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

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

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

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

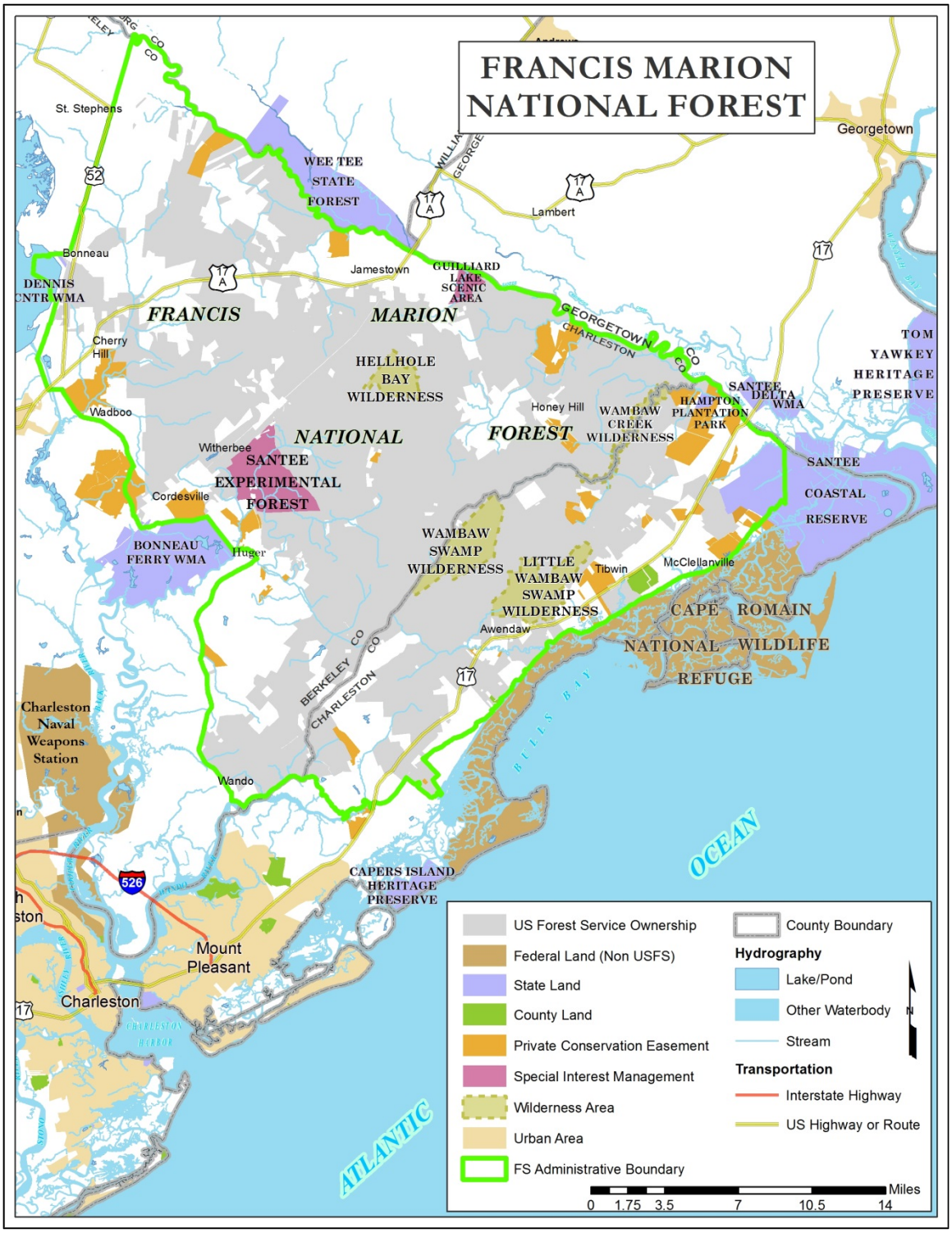

Figure 1-3. Map of the Francis Marion National Forest and surrounding area

1.3 Purpose and Need for Action

The need to revise the current forest plan includes: (1) the existing forest plan is more than 15 years old; (2) since the forest plan was approved in December 1995, there have been changes in economic, social, and ecological conditions, new policies and priorities, and new information based on monitoring and scientific research; and (3) extensive public and employee involvement, along with science-based evaluations, have helped to further identify the areas of the existing forest plan that need to be changed.

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

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

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

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

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

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

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

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

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

1.4 Proposed Action

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

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

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

Physical Environment (watersheds and soil, water and air quality). Provide desired conditions and objectives for maintaining, restoring and monitoring the soil, water and air resources on the Francis Marion. National Forest lands on the Francis Marion encompass only a small percentage of the streams and associated drainage areas within the coastal plain of the state.

In addition, much of the impacts to air and water resources are due to activities outside of the area that the Forest Service manages. Therefore, the focus will be on sustaining and improving watershed areas within national forest control while working cooperatively with other agencies and landowners to improve statewide watershed health and water, soil and air quality.

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

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

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

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

1.5 Decision Framework

The Revised Land Management Plan for the Francis Marion National Forest (hereafter referred to as the Forest Plan or Plan) will guide management of National Forest System (NFS) lands so that they are ecologically sustainable and contribute to social and economic sustainability; consist of ecosystems and watersheds with ecological integrity and diverse plant and animal communities; and have the capacity to provide people and communities with ecosystem services and multiple uses that provide a range of social, economic, and ecological benefits for the present and into the future. These benefits include clean air and water; habitat for fish, wildlife, and plant communities; and opportunities for recreational, spiritual, educational, and cultural benefits (36 CFR 219.1(c)).

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

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

Forest plans are strategic in nature and do not compel the agency to undertake any site-specific projects. Rather plans establish overall desired conditions and objectives that the individual national forest strives to meet. Forest plans also establish limitations on what actions would be authorized and what conditions would be met during project level decision-making.

The elements of a Forest Plan include the following:

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

Desired Conditions: A narrative description of the characteristics of the plan area toward which management should be directed (36 CFR 219.7(e)(1)(i)); FSH 1909.12, chapter 20, section 22.11).

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

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

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

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

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

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

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

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

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

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

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

1.6 Public Involvement

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

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

Based on comments from Forest Service personnel, public, other agencies and non-governmental organizations, the planning interdisciplinary (ID) team developed a list of issues to address in this DEIS.

1.7 Issues

The planning ID team separated the issues into two groups: non-significant and significant. The Council on Environmental Quality's (CEQ) NEPA regulations explain this delineation in Sec. 1501.7, "identify and eliminate from detailed study the issues which are not significant or which have been covered by prior environmental review (Sec. 1506.3)."

A list of non-significant issues and reasons regarding their categorization as non-significant may be found in the process record. Additional information is available on our public website at: http://www.fs.usda.gov/goto/scnfs/fmplan.

1.7.1 Significant Issues

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

1.7.1.1 Significant Issue 1

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

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

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

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

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

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

    Unit of Measure: Estimated acres of hydrologic function improvements.

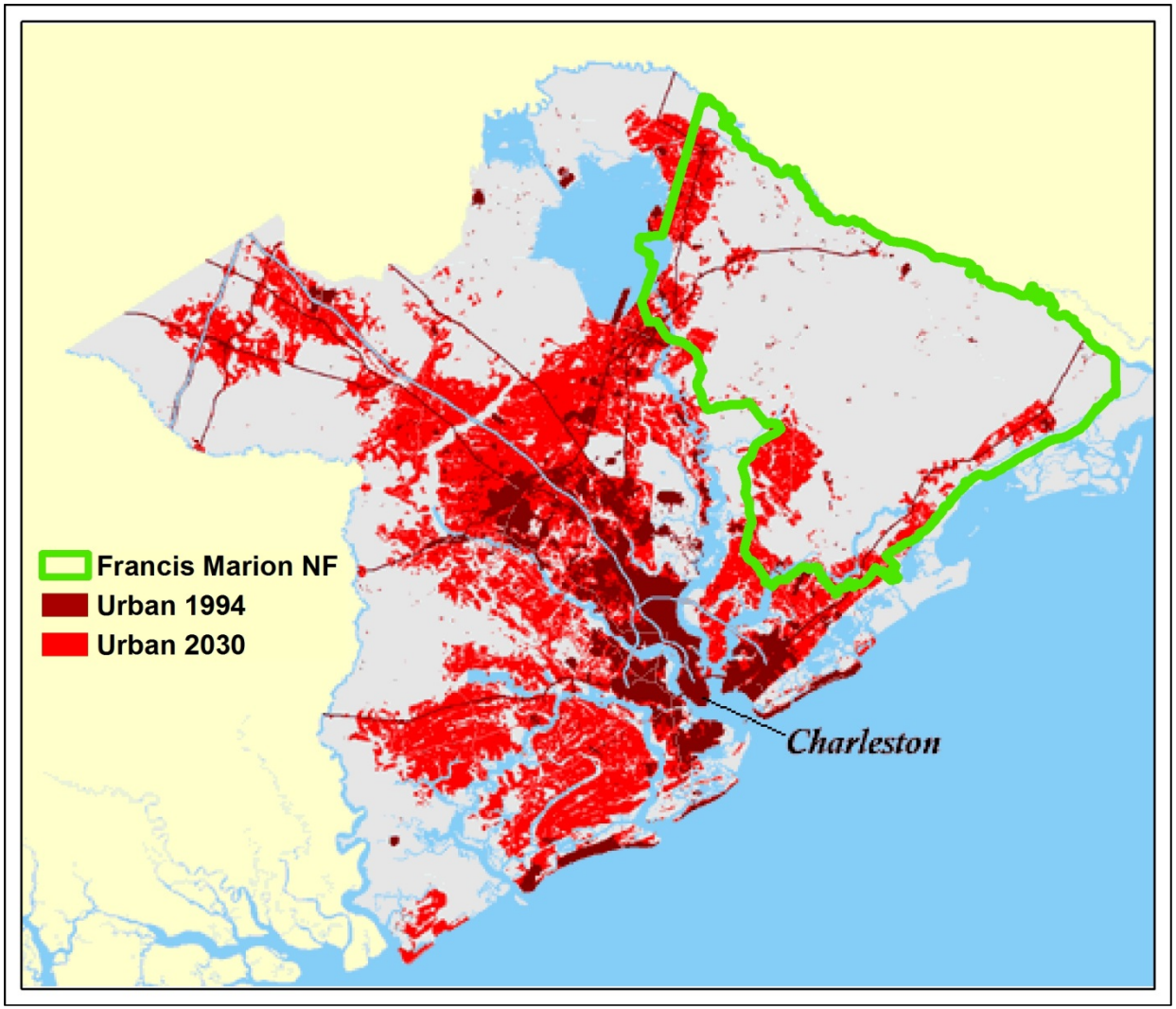

Figure 1-4. Projected urban development near the Francis Marion National Forest

1.7.1.2 Significant Issue 2

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

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

    Unit of Measure: Acres in Management Areas 1 and 2; acres in Fire Regime Condition Class 2 and 3.

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

    Unit of Measure: Acres in Management Areas 1 and 2; Acres in Fire Regime Condition Class 2 and 3.

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

    Unit of Measure: Acres in Management Area 1; Acres managed for at risk species.

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

    Unit of Measure: Acres of recommended wilderness

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

1.8 Relationship to Other Documents

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

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

1.9 Other Related Efforts

Other ongoing efforts influence the decision to be made:

- Transportation Analysis Planning
- Watershed Condition Framework
- Landownership Adjustment Strategy

Chapter 2. Alternatives

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

2.1 Alternatives Considered in Detail

In response to issues raised by the public, the Forest Service developed three alternatives, including the Alternative 1 No Action (1996 forest plan), Alternative 2 Proposed Action (Preferred Alternative) and Alternative 3. The tables at the end of this chapter summarize the responses to the significant issues described in chapter 1.

2.1.1 Alternative 1. No Action (1996 Forest Plan)

Under Alternative 1, the 1996 Forest Plan would continue to guide management of the plan area.

2.1.2 Alternative 2. Proposed Action (Preferred Alternative)

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

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

Opportunities to improve to hydrologic function are considered during project-level planning. Management activities may include plugging ditches to re-isolate depressional wetlands and adding culverts under dikes to restore water flows. Existing dikes may be used to limit saltwater influx where hydrologic modifications are causing salt water entry beyond historic conditions (e.g., lower Santee River). Hydrologic restoration would improve habitats for aquatic species and at-risk amphibians.

Plan direction under Alternative 2 includes four integrated resource management zones: Coastal, Wando, Wambaw and Santee. These zones are geographic areas that not only define and focus recreation opportunities in existing settings, but also include social/cultural components and multiple uses. These four zones would help frame the discussion about how the forest is connecting people to nature. No new developed recreation areas are proposed, but an emphasis is placed on increasing interconnected trail systems and connecting existing forest trails to the East Coast Greenway and the Palmetto Trail in the Coastal and Wando Zones. No additional areas are recommended for wilderness. Wilderness character is improved by emphasizing primitive, motorized conditions near Hellhole Swamp, Little Wambaw and Wambaw Creek Wildernesses.

outstandingly remarkable values (ORVs) of four eligible wild & scenic rivers are maintained on national forest lands.

2.1.3 Alternative 3

This alternative is a modification of Alternative 2. It emphasizes alternative methods to frequent landscape-level prescribed burning in smoke sensitive areas where human health and safety can be impacted. This reduction in landscape -level prescribed burning would result in a smaller Management Area 1. Use of treatments, such as mastication, herbicides or smaller burn blocks would address smoke management and human health concerns along the Hwy. 17 corridor, west of Hwy. 41 to Hwy. 402, and north of Hwy. 17A in Management Area 2. In addition, fewer growing season burns would occur within Management Area 1. This would result in less emphasis on restoration of fire-maintained ecosystems. Expansions to the four existing wilderness areas are proposed to enhance the wilderness experience. ORVs of four eligible wild and scenic rivers would be maintained on national forest lands. Three integrated resource management zones are identified.

2.2 Alternatives Considered but Eliminated from Detailed Study

NEPA requires federal agencies to rigorously explore and objectively evaluate all reasonable alternatives and to briefly discuss the reasons for eliminating any alternatives that were not developed in detail (40 CFR 1502.14). Public comments received in response to the proposed action provided suggestions for alternative methods of achieving the purpose and need. Some of these alternatives may have been outside the scope of the Francis Marion forest plan, duplicative of the alternatives considered in detail or determined to be components that would cause unnecessary environmental harm. Therefore, a number of alternatives were considered, but dismissed from detailed consideration for reasons summarized below.

- Custodial (no timber management, prescribed burning, mining, fishing or hunting). This alternative was not considered in detail because it does not meet law or policy requirements to provide multiple uses. Restoration of native ecosystems would not be possible under this alternative.
- Restoration of all lands suitable for longleaf pine. This alternative was not considered in detail because of potential impacts to human health and safety from prescribed burning in high-risk areas, particularly along major highways and near communities.
- Recommending for wilderness all areas inventoried as “may be suitable for wilderness consideration.” This alternative was not considered in detail for the following reasons:
    - It lacks public interest for wilderness designation for all the inventoried areas;
    - The areas contain ecological conditions that need to be restored;
    - It includes foraging clusters for red-cockaded woodpeckers; and,
    - People would still like to have access to these areas.

2.3 Comparison of Alternatives

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

2.3.1 Alternative 1. No Action (1996 Forest Plan)

2.3.1.1 Response to Issue 1

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

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

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

1d. Management Area 2 Wilderness in the 1996 plan includes direction on managing four congressionally designated wilderness areas totaling more than 13,000 acres (see Figure 2-3). No areas were recommended for wilderness in the 1996 forest plan.

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

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

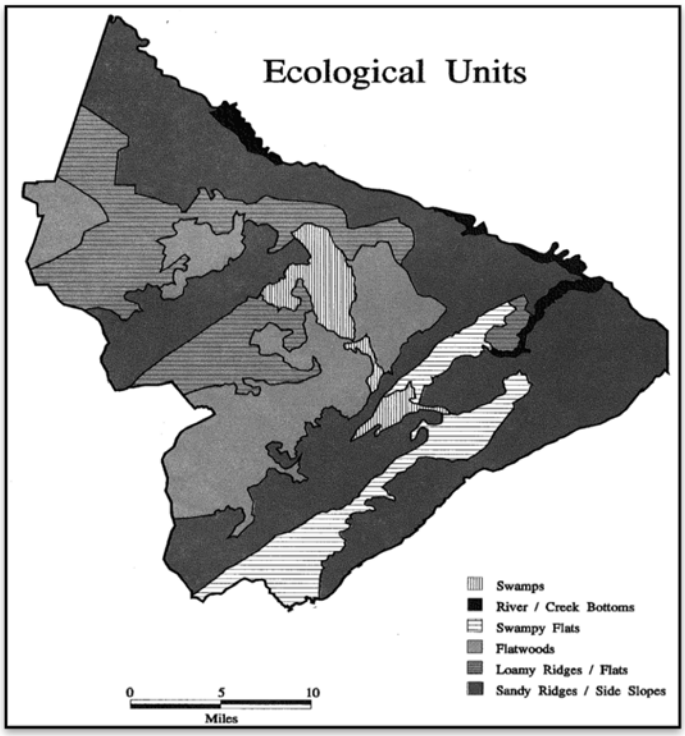

Figure 2-1. Ecological units in the 1996 Francis Marion Forest Plan

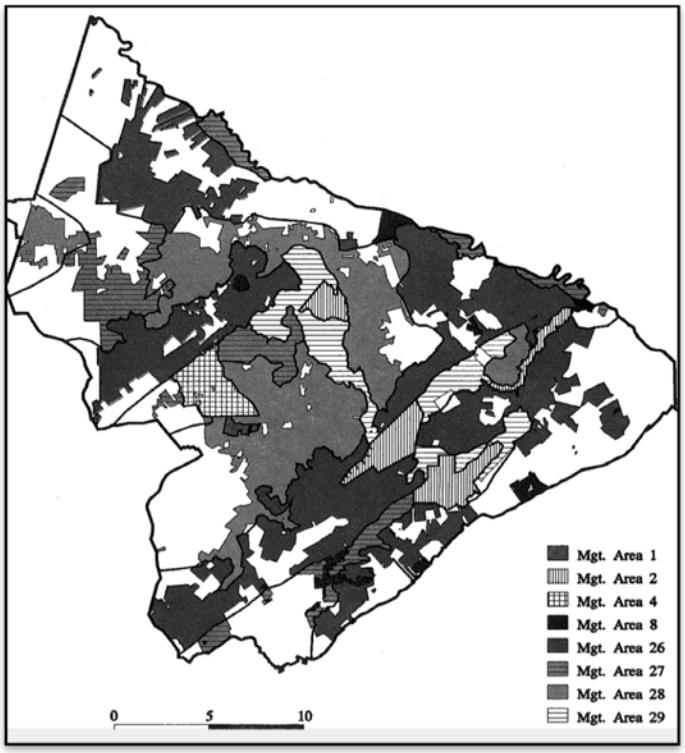

Figure 2-2. Management areas in the 1996 Forest Plan

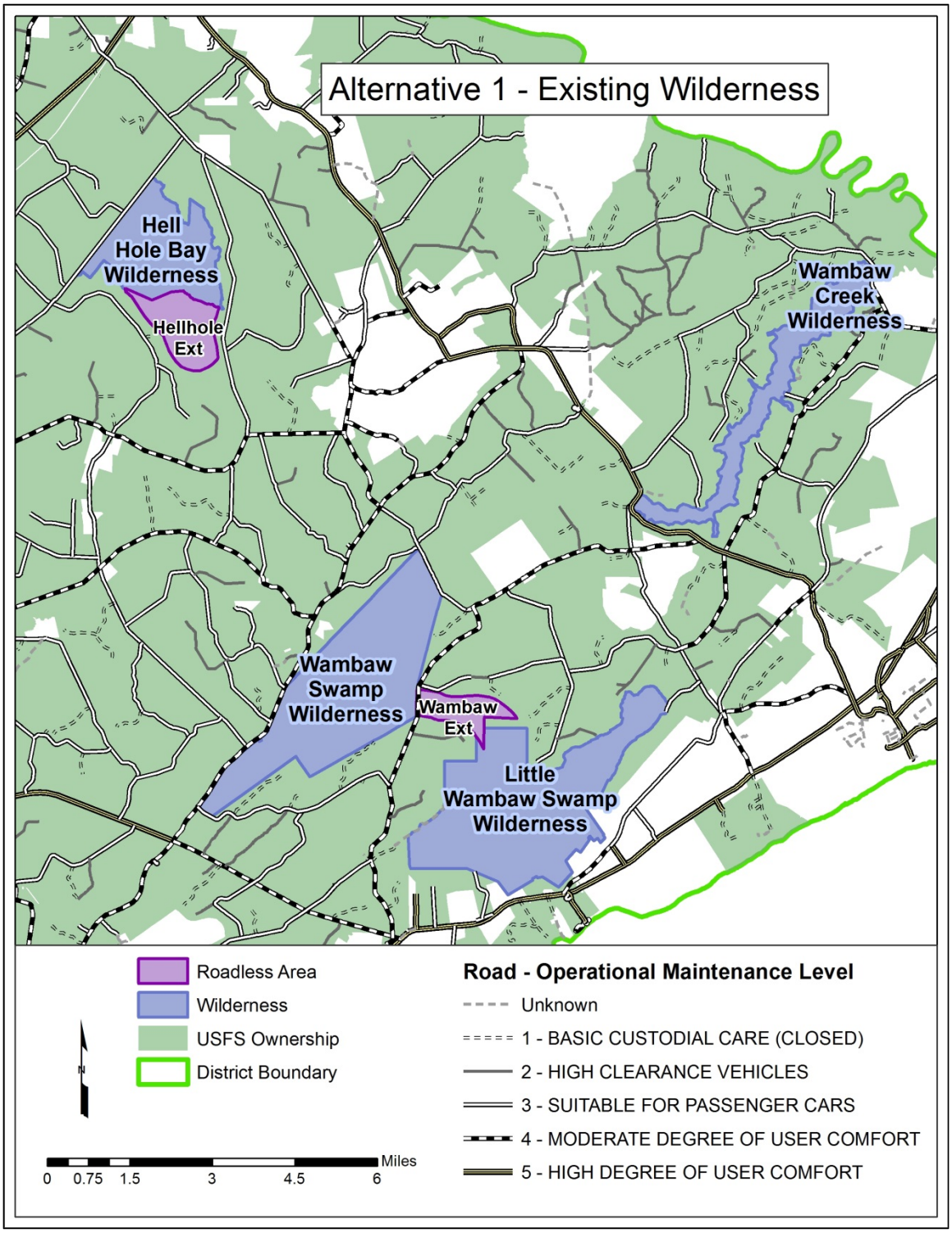

Figure 2-3. Wilderness areas in the 1996 forest plan

2.3.1.2 Response to Issue 2

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

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

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

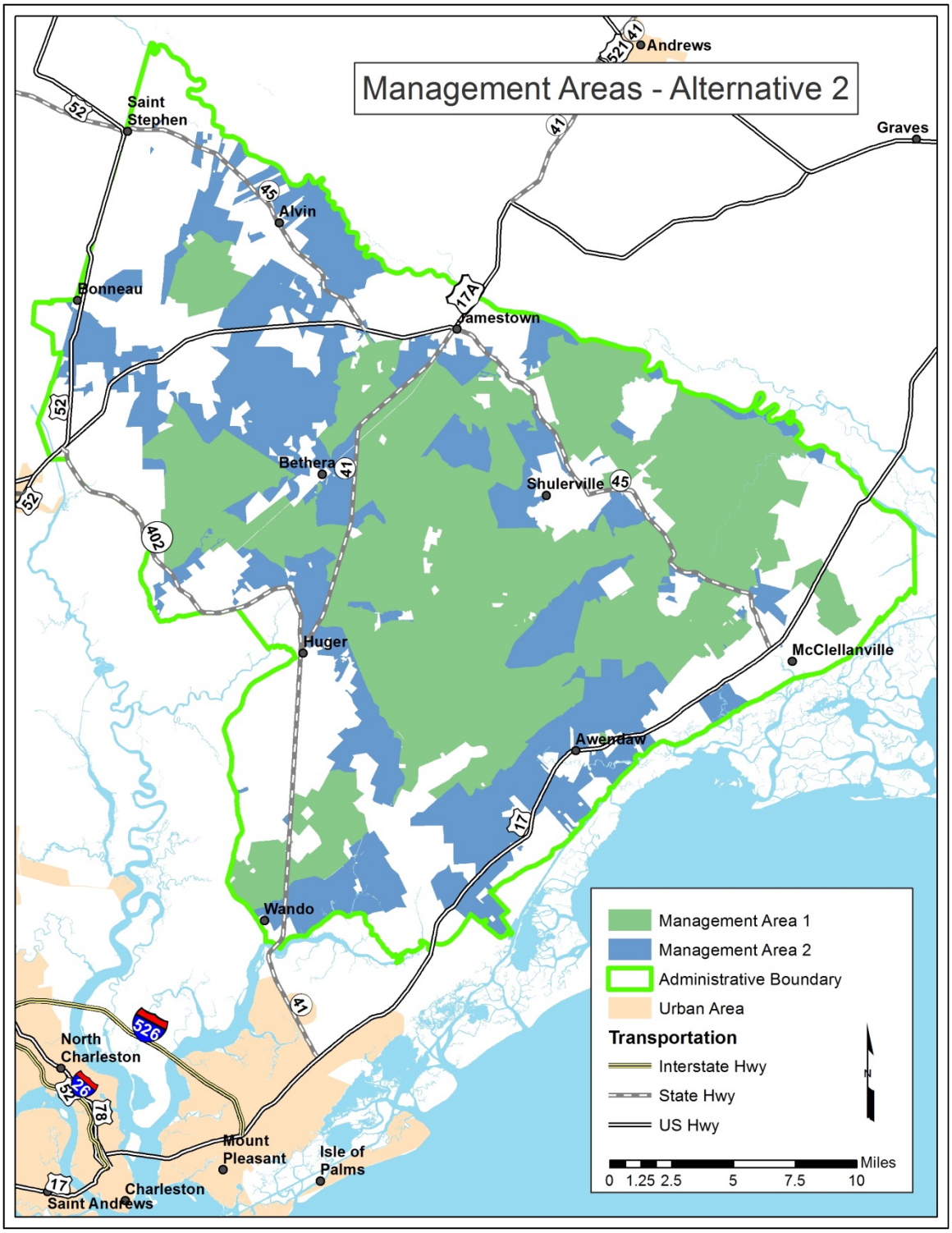

Figure 2-4. Proposed management areas in Alternative 2

2.3.2 Alternative 2. (Proposed Action)

2.3.2.1 Response to Issue 1

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

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

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

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

1d. Alternative 2 increases opportunities for remoteness by emphasizing a semi-primitive, motorized desired condition on national forest land adjacent to three existing wilderness areas. Four existing wilderness and two inventoried roadless areas are maintained. Three of those wildernesses have additional acres that emphasize a remote experience totaling more than 11,000 acres, but do not restrict mechanical activities in the turquoise colored area in the map below. Over time, site-specific road closures would improve wilderness character and lower open road density in the turquoise area. Roads that would need to be gated and used only for administrative access are highlighted in red. This road closure would require a site-specific NEPA decision (see Figure 2-6).

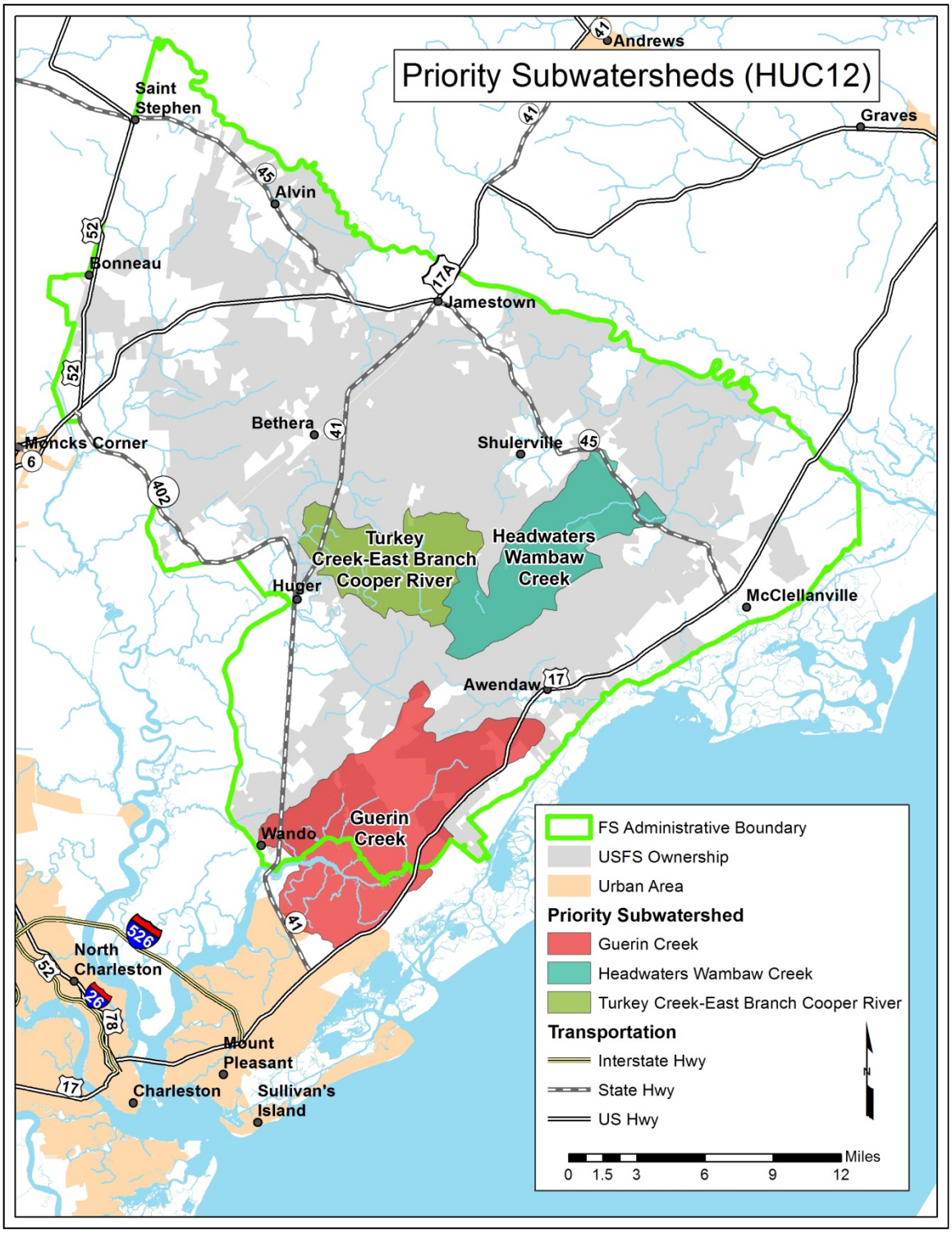

Figure 2-5. Priority watersheds identified in Alternative 2

2.3.2.2 Response to Issue 2

2a. Four resource integrated zones (RIZ) established are established in Alternative 2 would highlight unique areas and focus management direction. Changes in private lands uses within the Wando and Coastal integrated resources zones would increase the number of homes and businesses adjacent to national forests. Many tracts of national forest land adjacent to developments and major road have not been burned recently due to smoke management and human health concerns leading to build-up of fuels near homes and businesses (see Figure 2-7).

2b. In Alternative 2, the Francis Marion would use an “all lands” management strategy to address concerns that cross national forest boundaries. As part of this “all lands” approach, the Forest would use partnerships and collaboration to create fire-adapted human communities through community wildfire protection planning, including Firewise education.

2c. The proposed Wando RIZ would have the highest density of rare plants and animals on the Francis Marion National Forest. Many of these species are not only dependent on wetlands, but also on frequent, low-intensity fire. The increasing urban development and human use would constrain our ability to maintain these habitats (see Figure 2-8).

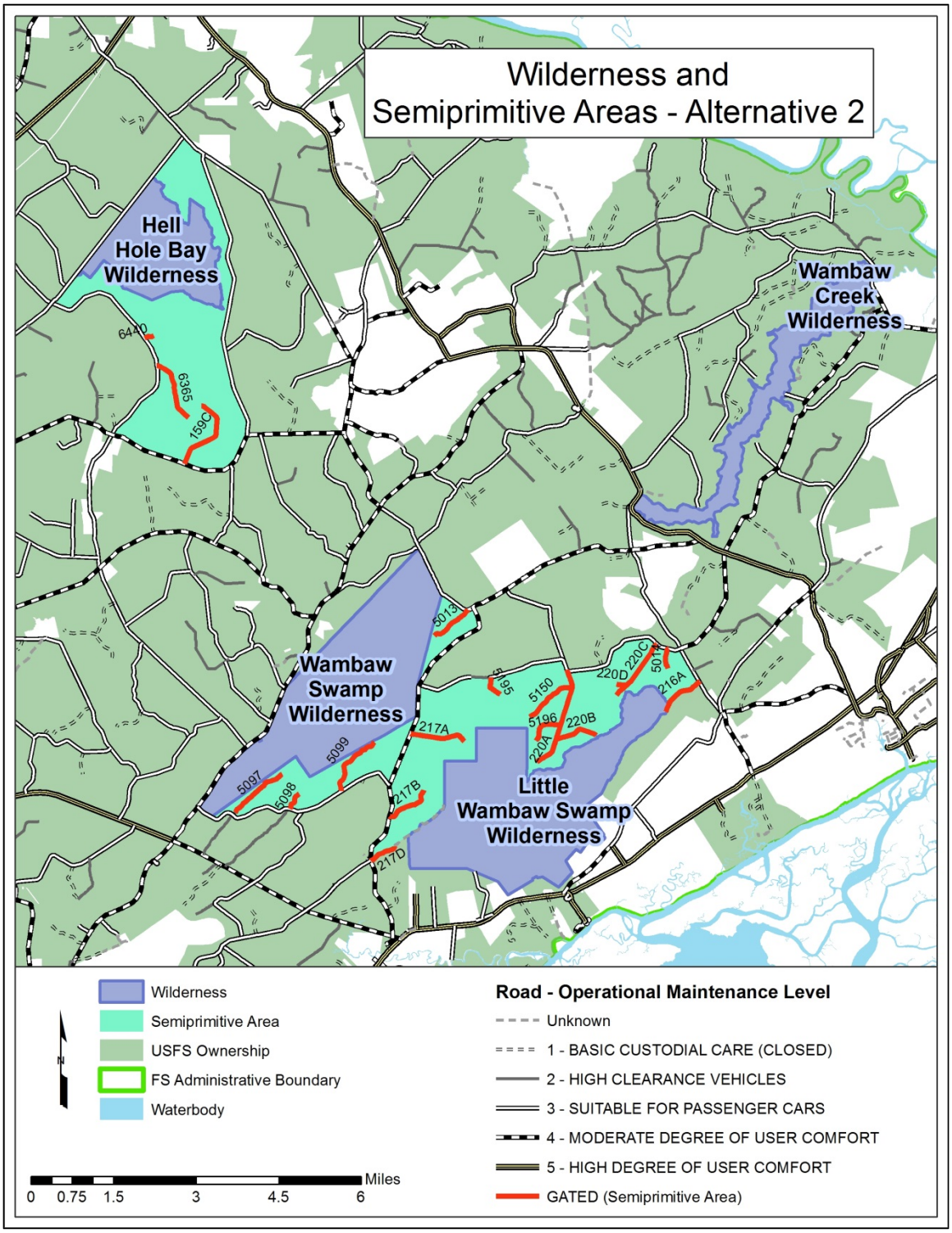

Figure 2-6. Proposed semi-primitive areas in Alternative 2

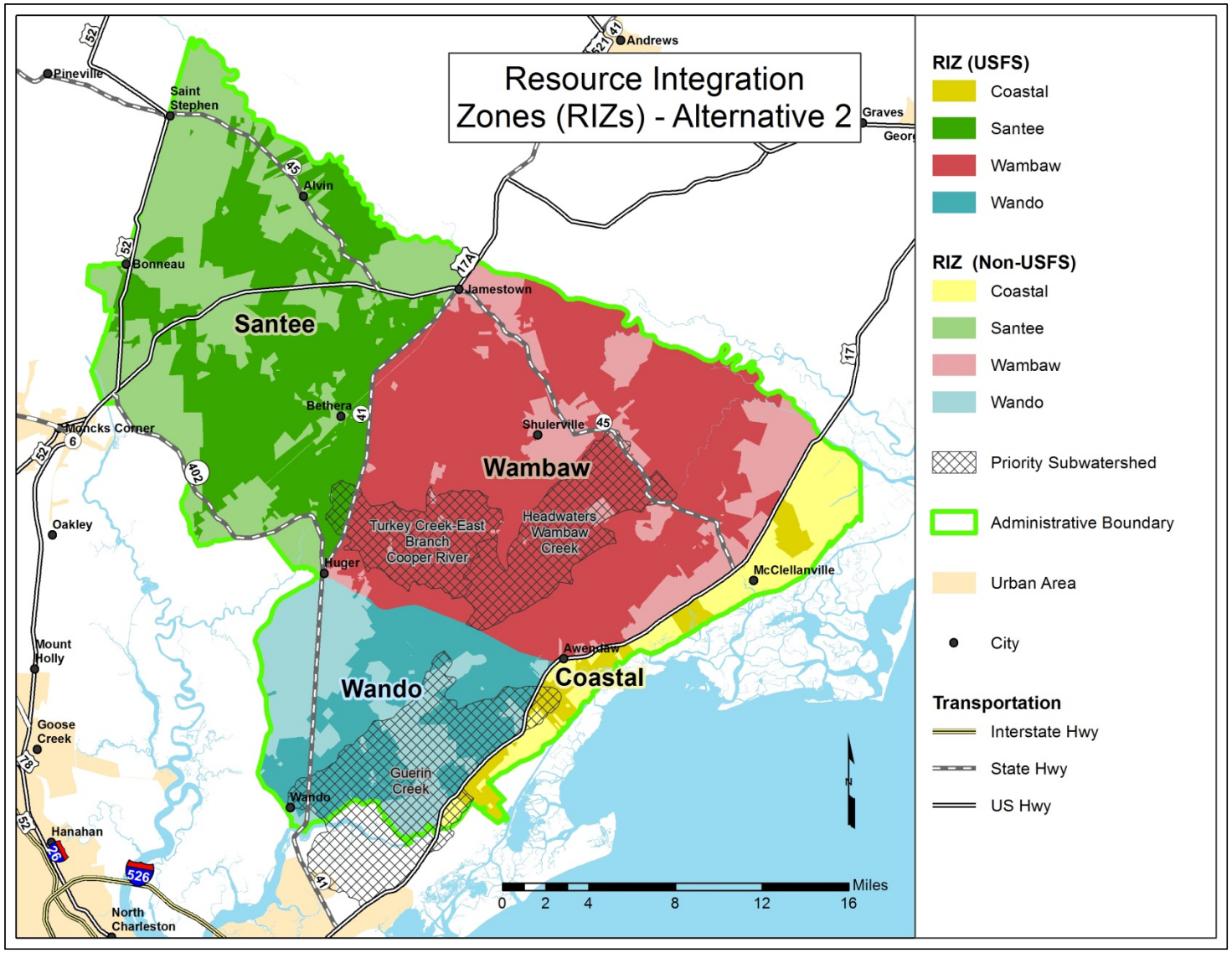

Figure 2-7. Proposed resource integration zones in Alternative 2

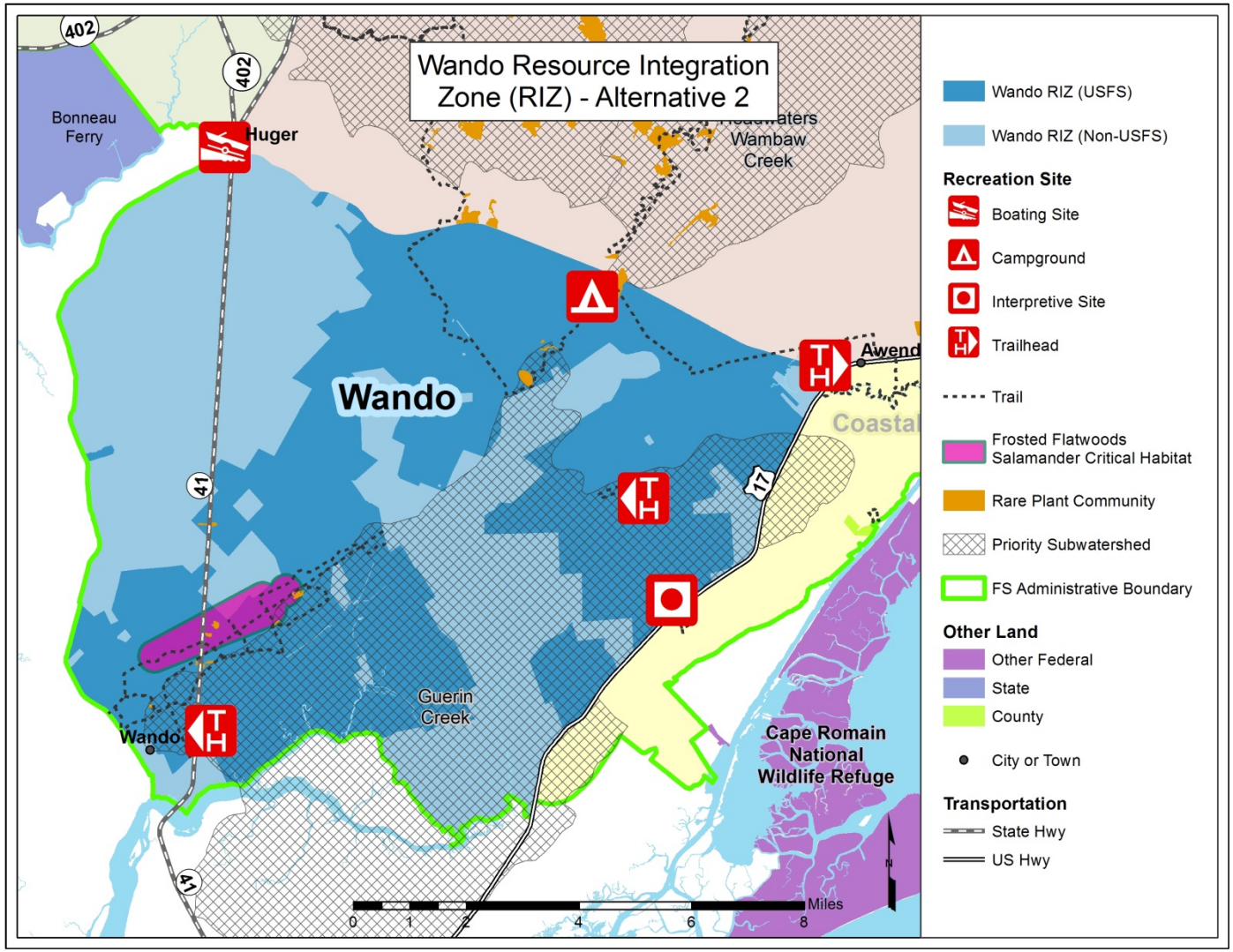

Figure 2-8. Proposed resource integration zones in Alternative 2

2.3.3 Alternative 3

2.3.3.1 Response to Issue 1

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

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

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

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

1d. In Alternative 3, four existing wilderness areas are expanded with four additions totaling more than 16,000 acres (including two roadless areas). Over time, additional road closures would improve wilderness character and lower open road density in the tan-colored area in the map.

Two inventoried roadless areas are proposed within the wilderness. Roads that would be closed and obliterated are highlighted in red. This road closure would require a site-specific NEPA decision (see Figure 2-10).

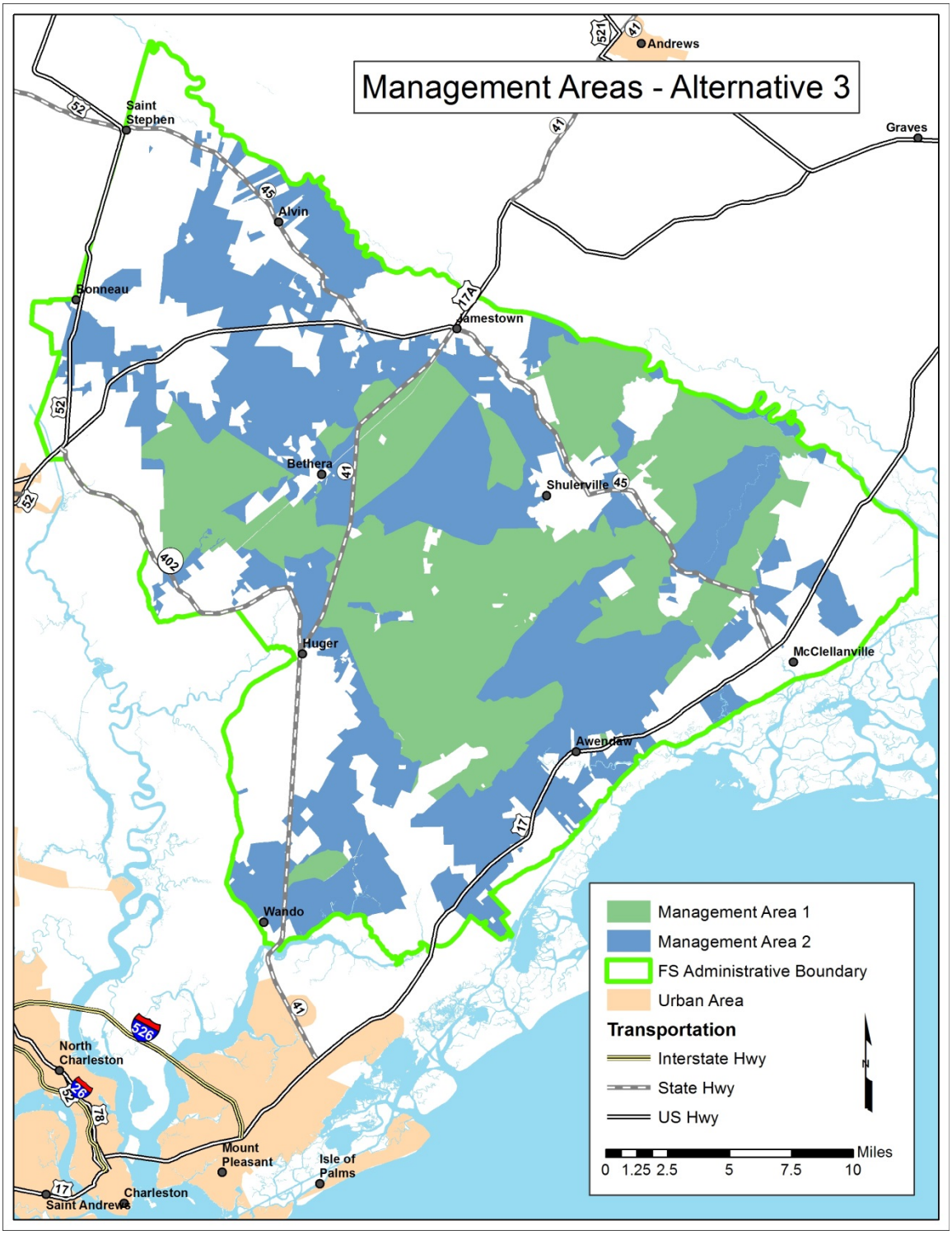

Figure 2-9. Management areas in Alternative 3

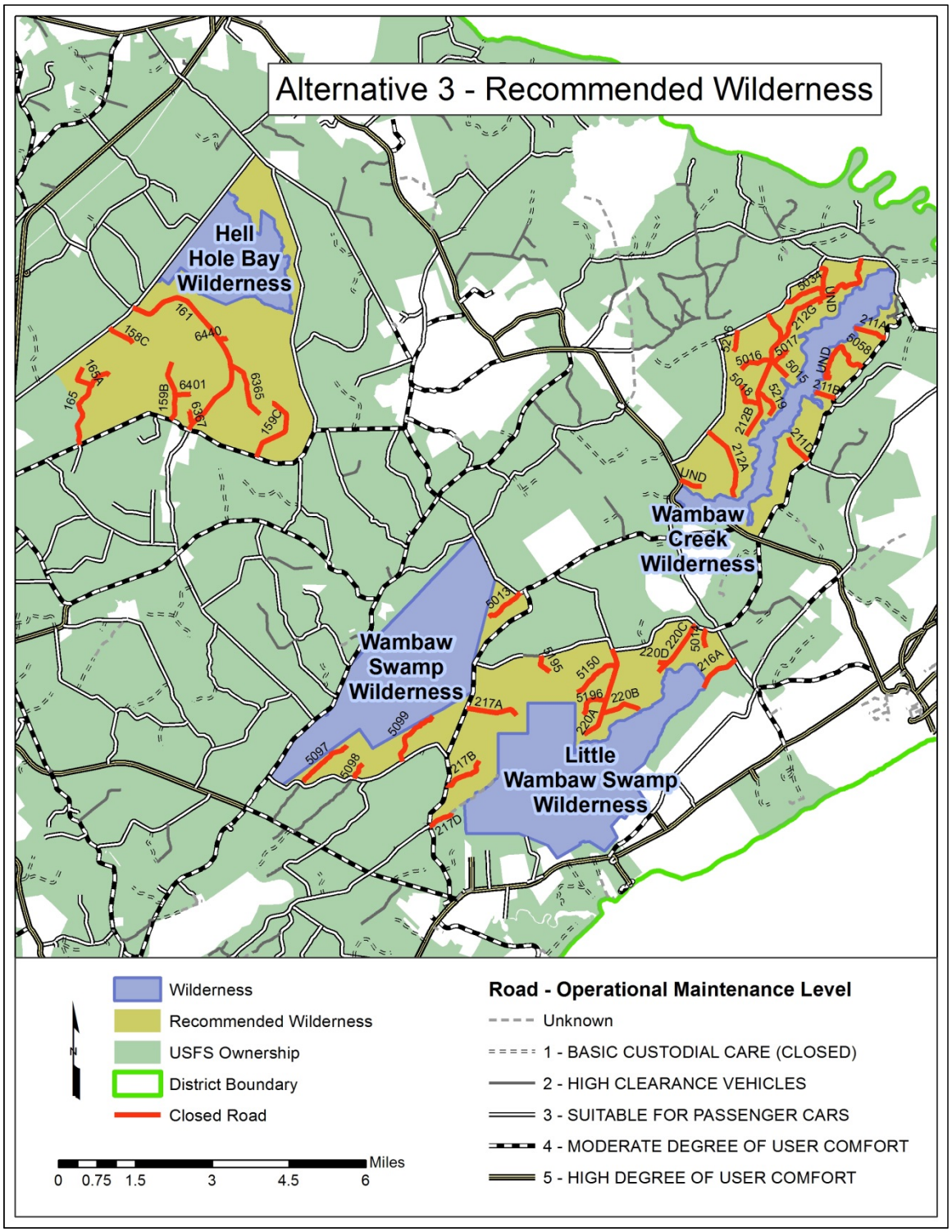

Figure 2-10. Recommended wildernesses in Alternative 3

2.3.3.2 Response to Issue 2

2a. Three resource integration zones highlight unique areas and focus management activities (see Figure 2-11). These three zones reflect an emphasis on using landscape-level frequent fire to reduce the risk of catastrophic wildfire in smoke-sensitive areas. Alternate methods include smaller burn blocks ignited by drip torches, mechanical chipping or mastication, use of herbicides or grazing on national forest lands along Hwy. 17, west of Hwy. 41 up to Hwy. 402 and north of Hwy. 17A (see Management Area 2 under 1a.). Prescribed burning may still be used in these smoke-sensitive areas, but it would not be on a one-three year fire return interval on a landscape scale.

2b. In Alternative 3, the “all lands” management strategy would be used to address concerns that cross national forest boundaries. Partnerships and collaboration would be critical to creating fire-adapted human communities through community wildfire protection planning, including Firewise education.

2c. The use of frequent, low-intensity fire and growing season burns would be emphasized less in the new Coastal Zone in Alternative 3. Alternative methods described in Response 2a would be needed to maintain habitats for at-risk plants and animals that occur on national forest land near the Town of Wando. Tradeoffs on the quality of habitat for at-risk plants and animals are discussed in Chapter 3 (see Figure 2-11).

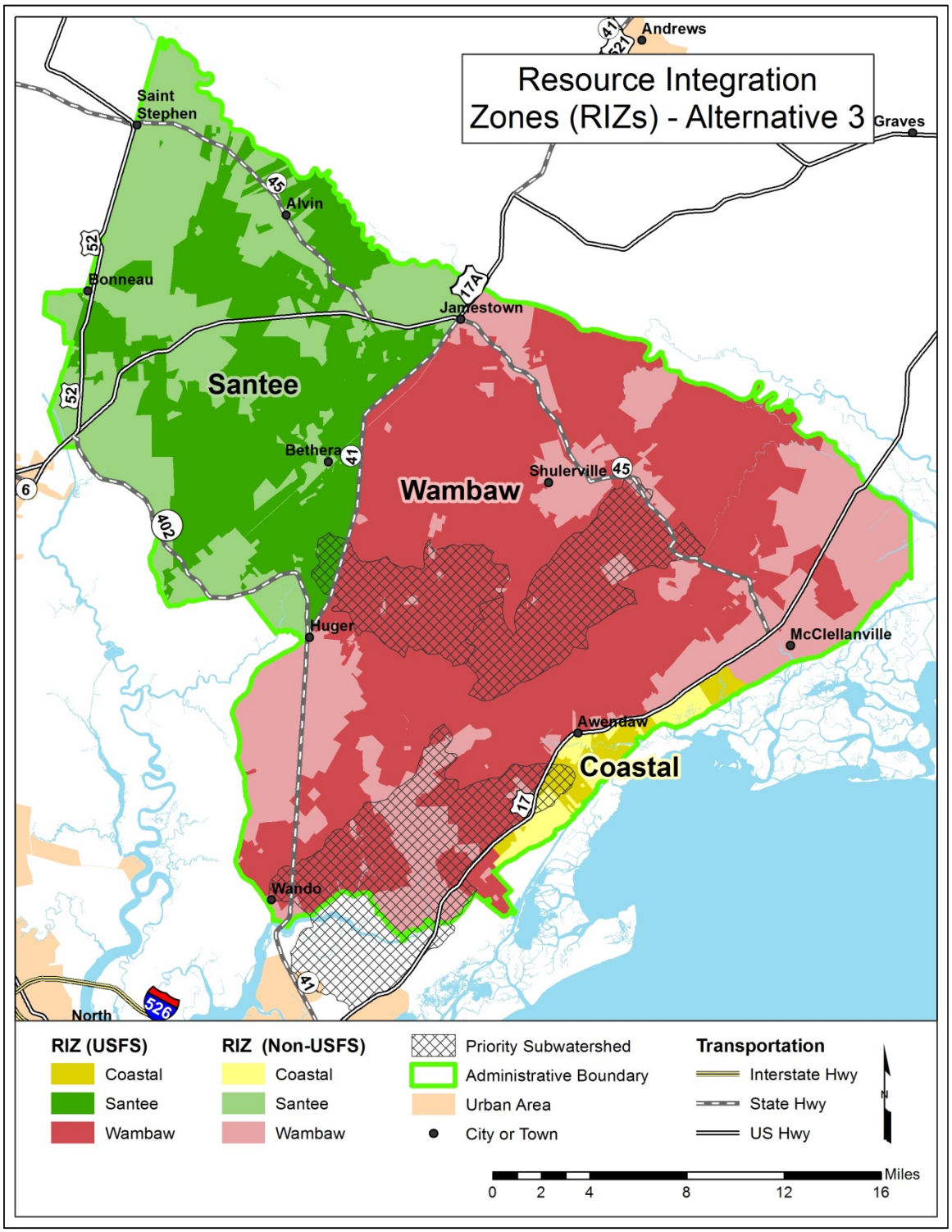

Figure 2-11. Alternative 3 resource integration zones

Table 2-1. Comparison of each alternative's response to the issues

Issue	Alternative 1 1996 Forest Plan	Alternative 2 Proposed Action	Alternative 3
Dormant Season Prescribed Burning (acres per decade)	260,000	195,000–325,000	167,000–280,000
Growing Season Prescribed Burning (acres per decade)	40,000	105,000–175,000	90,000–150,000
Upland Longleaf Ecosystem Acres Maintained or Restored (acres)	73.6% = 37,900	64.3% = 33,100	45.4% = 23,400
Wet Pine Savanna Ecosystem Acres Maintained or Restored (acres)	30% = 25,600	67% = 57,300	48% = 41,000
High Risk Prescribed Burn Areas (acres)	95,000	75,000	95,000
Fire Region Condition Class2 and 3 (acres)	115,000	95,000	115,000
Priority Watersheds (number)	0	3	3
Loblolly Pine Converted to Longleaf Pine (acres)	4,500	26,200	18,000
Projected Timber Sale Quantity (MMCF per decade)	95	98	100
Wild and Scenic Rivers (number of eligible)	1	5	5
Proposed Historic Districts (number)	0	4	4
Management Areas 1 (acres)	N/A	156,256	110,015
Management Area 2 (acres)	N/A	103,160	149,400

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

Alternative	1	2	3
Land Classified as Suitable for Timber Production (acres)	184,343	194,023	177,307
Percent of Land Ownership Classified as Suitable for Timber Production	71%	75%	68%
	MMCF		
Sustained Yield Limit			113.8
Projected Wood Sale Quantity, 1st decade	98.6	98.6	100.4
Projected Wood Sale Quantity, 5th decade	87.7	96.2	97.3

MMCF = Million cubic feet

Table 2-3. Projected wood sale quantity (PWSQ) for all products by decade (MCF/decade)

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

Table 2-4. Summary of proposed wilderness by alternative[1]

Existing Area	Alternative 1 1996 Plan	Alternative 2 Proposed Action	Alternative 3
Wilderness Expansion (acres)			16,351
Inventoried Roadless Area (acres)	1420	1420	0
Semi Primitive, Motorized (acres)	0	11,139	0
Grand Total Wilderness (acres)	13,812	13,812 acres	36,927 acres

[1] GIS acres are approximate.

Table 2-5. Draft wilderness recommendations by alternative*

Existing Area	Recommended	Alternative 1 1996 Plan (acres)	Alternative 2 Proposed Action (acres)	Alternative 3 (acres)
Wambaw Creek Wilderness		1,825	1,825	1,825
	Wilderness Expansion	0	0	5,747
	Semi-primitive, Motorized	0	0	0
Total Wilderness		**1,825**	**1,825**	**7,572**
Wambaw Swamp Wilderness		4,815	4,815	4,815
	Wilderness Expansion	0	0	1,745
	Semi-primitive, Motorized	0	1,745	0
Total Wilderness		**4,814**	**4,815**	**7,560**
Little Wambaw Swamp		5,047	5,047	5,047
Inventoried Roadless Area		530	530	0
	Wilderness Expansion	0	0	4,854
	Semi-primitive Motorized	0	4,324	0
Total Wilderness		**5,047**	**5,047**	**9,901**
Hellhole Bay Wilderness		2,125	2,125	2,125
Inventoried Roadless Area		890	890	0
	Expansion	0	0	4,540
	Semi-primitive Motorized	0	3,650	0
Total Wilderness		**2125**	**2125**	**9,080**
	Area A	0	0	0
	Area B	0	0	3,814
Total Wilderness		**0**	**0**	**3,814**

Chapter 3. Affected Environment and Environmental Consequences

3.1 Introduction

Chapter 3 describes the existing environment of the Francis Marion National Forest followed by the environmental consequences from the 3 alternatives. This Chapter is organized into 4 major sections broken down into subsections focused on different resource areas.

3.2 Physical

3.2.1 Soils
3.2.2 Geology
3.2.3 Air Quality
3.2.4 Climate Change
3.2.5 Watershed and Water Resources

3.3 Biological

3.3.1 Ecological Systems
3.3.2 Threatened and Endangered Species
3.3.3 Species Diversity (Species of Conservation Concern)
3.3.4 Forest Health and Protection

3.4 Economic and Social Environment

3.4.1 Forest Products/Timber Harvesting
3.4.2 Community Wildfire Protection Planning
3.4.3 Infrastructure
3.4.4 Special Uses, Energy, Minerals
3.4.5 Land Use and Ownership
3.4.6 Outdoor Recreation
3.4.7 National Wild and Scenic Rivers
3.4.8 Wilderness and Inventoried Roadless Areas
3.4.9 Scenery
3.4.10 Cultural Resources
3.4.11 Tribal
3.4.12 Recreational Fisheries Management
3.4.13 Huntable and Fishable Species
3.4.14 Social Demographics

3.5 Other Effects

3.5.1 Environmental Justice
3.5.2 Relationship of Short-Term Use and Long-Term Productivity
3.5.3 Irreversible and Irretrievable Commitment of Resources
3.5.4 Effects on Wetlands and Floodplains
3.5.5 Unavailable or Incomplete Information

3.2 Physical

3.2.1 Soils

3.2.1.1 Summary

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

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

3.2.1.2 Affected Environment

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

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

A second order soil survey has been used to delineate and identify specific soil series and their boundaries within the FMNF. At this level the minimum mapping unit typically ranges from 2 to 8 acres, so local inclusions of other soil types within a mapping unit may be found. Currently, there are 77 map units identified on the FMNF (SSURGO, 2013). Landforms in which these map units occur include ridges, marine terraces, Carolina Bays, swamps, pocosins, depressions, flats and floodplains. Elevations of these landforms range from -5 to 81 feet above sea level. Drainage class of these soils range from excessively well drained to very poorly drained (see Figure 3-1).

Soil function is ecosystem specific and must be assessed in the context of desired ecological conditions (Burger et.al, 2010). Eighteen ecological systems have been identified for the FMNF Plan Revision (Simon and Hayden, 2013). Due to the lack of soil quality data for each of these ecological systems and since soil types, their properties and processes vary greatly, a comprehensive assessment of soil quality has not been possible and contributes uncertainty. Also,

some management goals may not be completely complementary with respect to soil quality; 1 goal may, in fact, reduce soil quality for another goal. Therefore, an assessment of soil quality and current conditions are discussed in general.

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

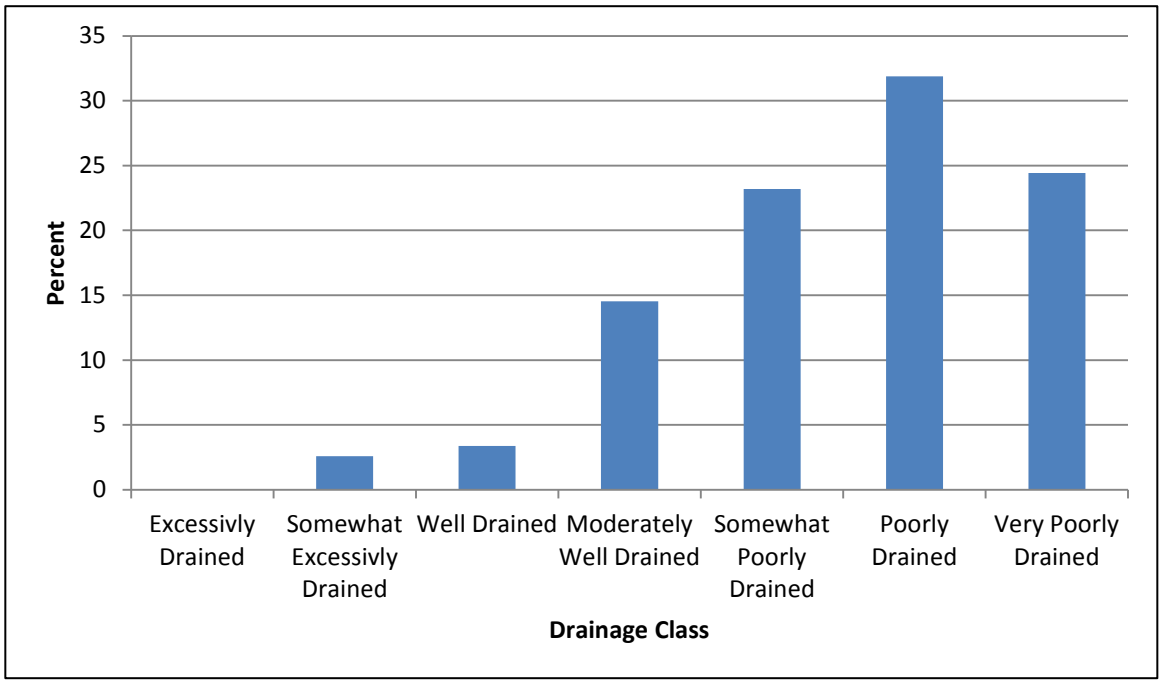

Figure 3-1. Drainage class distribution for soils within the Francis Marion National Forest

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

In general, soils have not changed very much since the 1996 forest plan revision. There are localized changes due to management activities that disturb the soil surface, but generally changes in soil properties are more static. Occasionally, during dry weather patterns, wildfires and some prescribed fires enter into areas that are normally wet and burn several inches of accumulated organic material. Depending on the degree of change, soils in those areas function

differently than before the fire and may also be taxonomically different. These changes are not regularly monitored or documented except in some wildfire instances where a damage assessment associated with a Burned Area Emergency Response Report was completed. Overall, most soils are adequately fertile; however, the poorly drained soils have low fertility levels and hydrous oxides of iron and aluminum that cause some restrictions on pine tree growth. Soils within the FMNF are stable with little erosion occurring across the area. Soils are intact and serve as a medium for root growth and soil organisms. Soil organisms are vital to decomposition and cycling of plant and animal materials in soils; however, the exact role of soil biological communities in maintaining soil quality is unclear (Levi, 2007). The rapid carbon assessment done by the Natural Resources Conservation Service (NRCS) shows soil organic carbon stocks are considered to be between 1001-1200 mg/ha to a depth of 100cm (soil survey staff, RaCA project, 2013). In forest soils, nutrient supply and biological activity are intimately tied to organic matter and nutrient cycling processes, including rates of input, decomposition and mineralization, storage and release or uptake. Protection of these processes from soil surface disturbances, displacement of soil organic matter layers and severe burns should maintain function in a given soil of a certain ecosystem.

3.2.1.3 Environmental Consequences

Vegetative management (including timber removal and cultural treatments), recreation developed sites and other intensive land use (i.e. administrative sites), and road and trail construction or reconstruction are the land management activities most likely to cause rutting, compaction, soil displacement, erosion, and removal of the organic surface. Mechanically pushed and plowed fire breaks associated with prescribed burn management activities are likely to result in displaced soil surface and accelerated soil erosion. Road and trail construction or reconstruction, developed recreation and other intensive land use, associated temporary roads and skid trails used for vegetative management, and artificially constructed fire breaks are the activities most likely to reduce long term soil productivity.. Other activities proposed in the alternatives would affect the soil resources minimally and are not discussed in detail.

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

Compaction is the increase in soil bulk density due to an external force. Any activity requiring the use of heavy equipment can cause some degree of compaction, but excessive compaction is often related to certain soil types and moisture levels. Compaction can result in alteration of soil chemical and physical properties. Compacted soils have altered structure which results in a decrease of macro pore space and soil porosity. This reduces productivity by retarding root growth as well as air and water/nutrient transfer in the soil. When soils are moist and/or wet, highly compacted soil can be a significant problem, especially if natural regeneration methods are planned. Surface soil recovery from compaction is relatively rapid on sandy soils, but may take

decades to recover on soils with clay near the surface unless some form of mitigation is used. Periodic freezing, thawing and fertilization can increase the rate of recovery. In the normal implementation of forest management activities, heavy equipment operation would be suspended, when conditions are conducive to excessive compaction. During periods of high soil moisture levels low ground pressure equipment, designated activity routes or other soil protection measures such as mats, bridges, woody fill, etc., would limit the extent of compaction when management activities cannot be avoided. Conducting management activities only during periods of dry soil conditions would prevent or minimize the extent of compaction. Mitigation of soil compaction would reduce the long-term effects to soils affected by compaction.

Soil displacement is the movement of soil material from its original position on the landscape. The displacement typically is small, perhaps a few inches to a few yards and often has a vertical and horizontal component from the original location. Displacement can alter the rich organic and mineral surface soil layer from 1 place to another through mechanical means (e.g., skidding of logs, blade construction of skid roads, fire line construction, landings, temporary and system roads, ATV trails, etc.). This can also accelerate erosion and reduce nutrient supplies, which are all important to plant growth. Soil displacement, depending on the vertical extent, can locally disrupt the normal surface and subsurface hydrologic flow particularly in areas where the water table is close to the soil surface. Rehabilitation of areas where soil has been displaced would limit the extent of the effects and reduce the long-term effects.

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

Erosion is a natural process that dislodges soil particles and moves them. Soil exposure can be a result of natural and human-induced conditions. Exposed surface soil particles move during events with external forces such as rainfall, stormflow and wind events. Forested soil is an excellent filtering mechanism that may absorb contaminants, preventing their entry into streams. However, when eroded, soil particles may include contaminants and may add to stream pollution upon delivery. Erosion that reaches the stream ne2rk is moved as a portion of the total dissolved solids or precipitates out temporarily to semi-permanently as sediment. Erosion is generally not a concern on the Francis Marion National Forest due to the flat terrain. Most erosion is found along roads and road ditches. Careful design, use of Best Management Practices (BMPs) and mitigation measures can reduce both erosion and sedimentation.

Removal of the organic surface can result in disruption to nutrient recycling in the soil and reduced nutrient availability for trees and other plants. Nutrient removal varies with the intensity of the activities and degree those organic materials that are removed. Removal of the surface materials can occur from mechanical operations but the greater extent occurs from fire. Prescribed burning could increase potential of nutrient loss. Adverse effects from a single light to moderate burn are minimal. Frequent burning (less than 3-year return interval) can reduce soil organic matter which subsequently reduces nitrogen mineralization and plant uptake. Return intervals greater than 3 years cause very little change soil organic matter, temporarily enhance

plant nutrient availability and reduce soil acidity. Three-year prescribed burn intervals allows the litter-duff biota to recover between burns and results in minimal nutrient loss because nutrients are quickly immobilized through plant uptake and sorption to soil particle. Light and moderate burns do not heat soil enough to significantly affect soil biota. Litter biota would be reduced but should quickly recover. The risk of affecting the soil productivity is minimal unless sites are burned more often than every 3 years or during high burn severity. Organic surface removal can also temporarily increase erosion potential and sedimentation.

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

Vegetation Management

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

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

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

Timber harvest practices occur at infrequent intervals and will generally maintain soil productivity with close attention to BMPs. Timber harvesting can increase the following: organic material in localized areas from tree limbs and tops; sunlight on the forest floor; soil temperatures; and decomposition rates. Areas that are maintained as or converted into savannas or woodlands would increase sunlight to the forest floor. Soil temperatures and decompositions rates would increase which would lead to a decrease in surface organic matter.

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

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

Areas that are maintained as or converted into savannas or woodlands would lead to an increase in sunlight to the forest floor. Soil temperatures would increase as well as decomposition rates which would lead in a decrease in surface organic matter. These areas would be burned on fairly frequent cycles. Burning coupled timber harvesting would increase sunlight to the forest floor and, therefore increase the densities of native plants and grasses in the understory. Once developed, native grasses have dense root ne2rks that help to increase soil development, organic content and productivity. Native grasses would help provide erosion control.

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

measures to control concentrated flow and reduce soil exposure through revegetation efforts. Firelines needed for frequent or regular burning cycles are designed and maintained for long-term use through control of concentrated waterflow to limit soil erosion.

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

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

Forest standards have been developed to ensure that herbicides would be applied correctly and pose no greater than minimal risk to soils and soils biota and do not accidentally contaminate surface waters. No herbicide would be mixed or used within 100 feet of perennial streams, lakes or ponds, or within 30 feet of other streams with defined channels. Herbicides, carefully directed and foliar sprayed during late spring to summer at the minimum recommended application rate, should result in no detrimental effects to long-term soil productivity or impacts to water quality. With these forest standards in effect, all alternatives show acceptably low risk with respect to potential herbicide use.

Wildlife Habitat Improvements (Wildlife Fields or Openings)

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

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

Recreation Management

Trails. Recreational trails impact soil resources to various degrees depending on location, types of users, maintenance methods, maintenance rotation and amount of use. Findings include rutting, soil compaction, erosion, sedimentation and loss of vegetation. Surface soil layers and vegetation would be removed in the tread path of new trails which would increase the potential for erosion to occur within the trail tread. Erosion potential would be greater on sections located in steeper slopes, in areas with coarse or silty soil material and in areas void of overstory vegetation. Trails should be designed so that the trail contours with the terrain; this would decrease erosion potential. The trail tread degrades more rapidly if traveled when soil moisture levels are high. Silty and sandy soils are more erodible and rutting can become a problem if traveled while wet. Rutting over time can accelerate erosion by entrenching the trail and concentrating water which would increase maintenance needs. The trail tread would also become compacted as use increases. Proper maintenance is essential to decrease the effects to the soil resource. Horses and Off-highway vehicles (OHVs. would cause more soil compaction, rutting and displacement than hikers and bikers. Horse and OHV trails usually degrade more rapidly than hiking and biking trails.

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

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

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

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

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

Roads

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

Road maintenance operations such as blading the road surface and pulling the ditches can lead to increases in soil erosion and increases in sediment production. During road maintenance activities, soil may be displaced and exposed. However, mitigation measures designed to stabilize the road surface, such as adding aggregate surfacing by armoring the soil or limiting distance and amount of concentrated flow by installing water diversion devices (dips, reverse grades, outslopes, leadoff ditches, culverts) would reduce adverse effects. The detachment and distance that soil particles move would be reduced by limiting water concentration and movement on disturbed surfaces and/or fill materials.

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

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

All Alternatives

All alternatives provide a balance of resource management which favors prescribed fire and selective methods of herbicide, plus mechanical methods that cause low to moderate soil disturbances. Most of soil productivity losses are generally associated with areas with greater soil disturbance such as firelines, trails, roads, landings, primary skid trails, and temporary roads. The smaller the percent area highly disturbed activities, the less impacts (compaction and erosion) there will be to the site. Highly disturbed areas typically averaged less than 10 percent of the forest. Trails, roads, and firelines are re-used more frequently.

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

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

Implementation of the best management practices, proper mitigation measures, and monitoring by the Sale Administrator would result in minimal soil effects for all the action alternatives. The cumulative effects of all management actions over time are not expected to reduce soil productivity. Mitigation measures for past, present and reasonably foreseeable management

activities (timber harvesting, site preparation and prescribed burning) are designed to keep the litter layer in place, or to replace the litter layer on exposed soils by seeding and fertilization; therefore, impacts associated with any 1 treatment would be completely recovered within 3 years. Upon completion of these treatments, timber harvesting activities would not occur in this analysis area for about 20-30 years, thus providing more than adequate time for the soil to recover. An exception to this could be an insect outbreak or other salvage events.

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

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

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

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

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

Cumulative Effects

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

Impacts on soils resulting from timber harvests normally recover before a new cycle of harvesting begins and as a result, cumulative impacts relative to compaction and displacement from successive harvesting operations would be expected to be minimal for the majority of harvested areas. Areas that are repeatedly used for logging decks and skid trails in stands that have more frequent entries have the potential to suffer more continuous periods of decreased soil productivity and decreased water infiltration. Although rehabilitation of these sites decreases the duration of the recovery period for soils and lessens the potential for cumulative degradation of soil conditions, the re-opening and use of these areas during successive harvest operations

generally results in some decreased soil quality on these sites. Areas having temporary productivity losses would be dispersed across timber harvests and would be a small fraction of the overall area. Coarse sandy soils show limited effects from compaction. Clay soils tend to hold water and displace rather than compact. However, silt-dominated soils tend to be affected the most. Where affected areas are not adequately restored following compaction, soil density will slowly revert to normal levels based on the frequency of freeze-thaw cycles, plant root penetration, soil microorganisms, earthworms, moles, etc. Effects from compaction can be expected to linger for decades if treatments are not employed to mitigate compaction.

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

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

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

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

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

3.2.2 Geology

The Francis Marion National Forest (FMNF) lies within South Carolina’s Lower Coastal Plain, the surface of which consists of unconsolidated marine and fluvial sand and clay deposited during the Quaternary Period. Elevations on the Francis Marion range from 5 below to 81 feet above sea level. The surface of the exposed Coastal Plain below 100 feet in elevation is characterized mainly by marine features, such as shorelines, bars and spits that formed during older warm interglacial periods when sea levels were higher than today. Today, landforms include ridges and

marine terraces, as well as many younger features such as Carolina bays, swamps, pocosins, depressions, flats and floodplains.

Generalized geology for Berkeley and Charleston counties includes 3 broad formations: Sand, clay and shell (see Figure 3-2) (Johnson, 1964):

- Along the Atlantic coast, sand, clay and shell are relatively younger deposits that form Silver Bluff. Within this zone, estuaries and wetlands provide habitat for hundreds of wildlife species. As rivers meet the sea at the coast, they deposit silts in estuaries that mingle with the saltier ocean water to provide an environment abundant in nutrients capable of supporting large amounts of sea life and waterfowl (Murphy, 1995). On the northeastern edge of the Francis Marion is the Santee River Delta, which provides habitat for hundreds of wildlife species, including the northern extent of the swallow-tailed kite. Geologically, the state continues miles out to sea onto the continental shelf, but geographically it ends at the coast (Murphy, 1995).
- Inland from the coastal zone to the western forest boundary are repeating packages of unconsolidated sand and clay that compose the shallow-lying Pleistocene-age geologic deposits. Moving westward these are the Princess Anne, Pamlico, Ten Mile Hill, Ladson, Penholoway and Wicomico formations (Doar and Kendall, 2014). These formations are a thin cover for the Eocene-age Santee Formation (Santee Limestone) in the northern part of the property along the Santee River. As seas transgressed and regressed, deposits of limestone made on the continental shelf created the Santee Formation. It is nearly pure white to creamy-yellow fossiliferous and partly glauconitic limestone and lime sediment. In northwestern and northeastern Berkeley County and in southwestern Georgetown County, limestone is mined for crushed stone aggregate.
- To the south phosphate-rich Oligocene and Miocene-age deposits are found overlying the Santee Formation and underlying the Pleistocene formations. While phosphate was never mined on the Francis Marion, it was mined in the Charleston and Beaufort areas. Once an important mineral commodity, it was used for agricultural fertilizer. The phosphate industry is no longer active in the state.

3.2.2.1 Affected Environment

Groundwater in the Coastal Plain. Groundwater in the coastal plain is stored in permeable rock and sediment called aquifers which are made up of sand and limestone. Limestone formations have enough interconnected voids to allow groundwater to pass through readily; therefore, water can be withdrawn using wells. Whereas most of the groundwater resources of the lower coastal plain consist of moderate to large quantities of freshwater, some coastal areas are subject to brackish water encroachment.

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

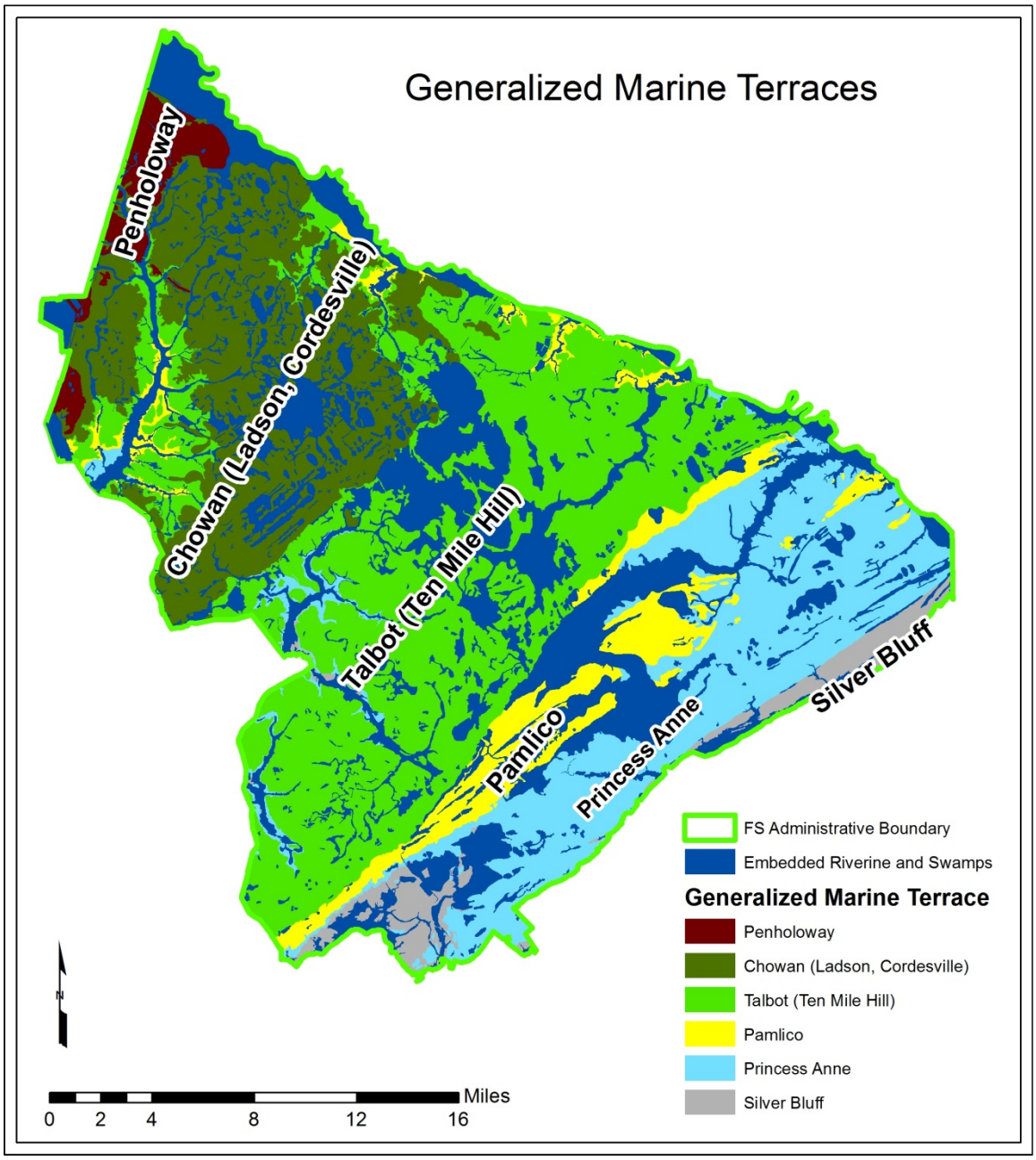

Figure 3-2. Geologic formations on the Francis Marion National Forest

A literature research revealed no specific references to cave and karst features in South Carolina, including for the FMNF, other than in the Santee, Lake Marion and Eutawville areas (Edwards et al., 2014). However, the Honey Hill lime sinks in the Guilliard Lake Research Natural Area clearly show pronounced karstic solution holes. Additionally, a recent field survey in May 2010 within the FMNF suggests that the area likely has karst features. The survey was conducted on the FMNF with four other pilot national forest sites for field training for Level I and II inventory of groundwater dependent ecosystems (GDE). A large spring called Blue Spring on the FMNF was reported by Hansen (2010) (see Figure 3-3). Wider-spread karst may be further supported by the fact that Santee Limestone is blanketed by the Upper Duplin Formation, a combination of clay and quartz pebble beds with sinkholes scattered among the modern alluvium and swamp deposits throughout the region (Willoughby, 2002). The Santee Limestone is part of the northern end of the multi-state Floridan aquifer system and is a major groundwater aquifer in coastal South Carolina for industrial, agricultural and public purposes (Hockensmith, 2009).

Figure 3-3. Blue Spring (May 2010)

Minerals. Removal of mineral materials is the only management activity that has the potential to affect the geology of the area, including groundwater supplies. Currently the Francis Marion has no mineral activity for the following reasons:

- No known potential for oil, coal or natural gas development exists on the forest, due in part to no Triassic basin, or its associated hydrocarbon resources, being identified; and
- No known deposits of gold, silver, or copper occur on the forest; therefore, there are no known outstanding mineral rights

Potential exists for 2 salable mineral products: limestone and sand.

- **Limestone.** The Santee Formation has high enough quality limestone that mining is occurring on private lands near the northern edge of the Francis Marion. Currently Martin Marietta is mining limestone near Jamestown. The company is producing products for road base and agricultural fertilization, which are considerable salable mineral products. In the past, the forest has received proposals for mining limestone. Each proposal was

turned down for various reasons. Since the agency could only give a five-year minerals material contract, and the area of interest contains a variety of rare or at-risk species, the inquirers have not pursued it further. While the Gulliard Lake Scenic Area has limestone, it is protected from mining as a forest-designated scenic area.

- **Sand.** There is questionable potential for dredging sand from rivers, but whether a special use permit from the Forest Service would be needed or not is determined by the actual ownership of the river bed. On larger rivers, the state owns the river bed and the South Carolina Department of Health and Environmental Control (SCDHEC) would process the sand dredging permit, typically with a public notice and comment period. On smaller rivers, where the river bed is national forest land, the permit would have to be approved by the Forest Service. The agency has not received any requests to develop sand dredging operations.

By law, certain lands, such as those withdrawn by an act of Congress (e.g., through the Wilderness Act of 1964 or the Wild and Scenic Rivers Act of 1968) or lands withdrawn by an order of the Secretary of the Interior, are withdrawn from mining claim location. Other lands, such as the Santee Experimental Forest, Honey Hill Research Natural Area, red-cockaded woodpecker clusters, developed recreation sites, botanical areas and critical habitat for frosted Flatwoods salamander, are not suitable for salable mineral development.

Paleontological Resources. Sedimentary units ranging in age from late Precambrian age to Quaternary have the potential to contain paleontological resources; all Francis Marion rocks and sediments are much younger than Precambrian and thus may contain fossils. Notable fossils from the Santee Formation are *Ostrea sellaformis*, *Ostrea carolinensis* (first collected from the old Santee Canal) and *Protoscutlla conradi*. Many of the species that produced Pleistocene fossils are extant and can be found in modern deposits on beaches today. Several examples of these are *Oliva sayana* (lettered olive) large *Mercenaria mercenaria* and *Mercenaria campechiensis* (northern and southern quahog), and various echinoderms (sand dollar, sea urchin, sea biscuit). Due to the area's geological history, the chance exists for pockets of preserved Oligocene and Miocene fossils on top of the Santee Formation and beneath the Pleistocene deposits. If these deposits exist, the notable fossils would be teeth from various species of shark.

Francis Marion has scattered postglacial freshwater sediment deposits that are already known or strongly suspected to contain microfossil records that can reveal the nature of past environments, including the development and fluctuations (e.g., changing fire regimes) of the modern pinewoods-and-wetland vegetational mosaic. Any future peat or muck mining would be the main threat in destroying these scattered deposits, though artificial drainage could do so also.

Geologic Hazards. Geologically, the Francis Marion National Forest falls in one of the most seismically active zones in the eastern United States. This seismicity (occurrence or frequency of earthquakes) clusters around the cities of Summerville and Bowman, known as the Middleton Place-Summerville Seismic Zone (MPSSZ) (SCDNR, 2013). This seismic activity is believed to be caused by 2 faults: Woodstock and Ashley River. The Woodstock Fault, which runs through this zone, has been active for thousands of years and will likely be active for thousands more.

Potential secondary effects of an earthquake include landslides, soil liquefaction and fire (SCDNR 2013).

- Landslides are not a concern on the Francis Marion due to the flat topography;
- Some potential liquefaction areas on the Francis Marion National are noted on the geologic hazard map for SC located at at http://www.dnr.sc.gov/geology/ggms5.htm

(SCDNR Geological Survey, 2012). This risk of soil liquefaction varies with the magnitude and epicenter of the earthquake and cannot be predicted for the Francis Marion. Soil liquefaction primarily affects buildings.

- The movement from earthquakes can rupture gasoline and natural gas pipes or damage electrical lines, which can cause fire and groundwater pollution. Where a fire may occur cannot be predicted, but management activities to reduce hazardous fuel buildup can reduce wildfire intensity and spread.
- Over limestone, groundwater drainage—especially mining and construction dewatering—and probably earthquakes, and sometimes simply unknown factors, can cause the sudden or slow local collapse of the ground, forming sinkholes. This is not unusual in recent decades in several areas outside Francis Marion; in addition, the older sinkholes within the Francis Marion indicate that sinkholes can occur there too.

3.2.2.2 Environmental Consequences

Groundwater in the Coastal Plain. None of the forest management activities proposed in Alternatives 1, 2 and 3 would include toxic pollutants or overuse of groundwater and no direct or indirect impacts to groundwater are anticipated. One exception is the mining of minerals, particularly limestone mining, has the potential to impact groundwater and is discussed below in more detail. More analysis on potential effects on groundwater is in section 3.2.5 Watershed and Water Resources.

Mineral Operations

All Alternatives

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

Mining does remove resources from the site, and therefore has the potential to impact ecological sustainability. Any mineral operations on national forest land would go through the special use review process. If a mining operation is approved, then the permit would require a site plan that would limit impacts to the environment and limit impacts to ecological sustainability to the immediate area.

Alternative 1

There is limited direction in the 1996 Forest Plan on where it is suitable to mine limestone on the Francis Marion. As noted earlier, existing laws withdraw some lands from mining activities, such as wilderness areas, RCW foraging clusters. The special use review process and state laws provide further protection of the resources, so direct and indirect effects to groundwater should meet the requirements of laws and policy.

Alternatives 2 and 3

Similar to Alternative 1, adherence to federal and state laws and policy should ensure compliance with meeting requirements to protect certain resources and designated areas. Suitablity determinations outlines areas on the Francis Marion that are suitable or not suitable for mineral development. The suitability analysis is designed to limit impacts to natural resources and address policies and laws. Under Alternative 3, more of the forest would be wilderness and fall under the protection of the Wilderness Act. Therefore, effects to minerals would likely be less in Alternative 3, although projects in this alternative would be subject to site plans that would limit effects.

Paleontological Resources

All Alternatives

Any alternative that allows surface disturbance of bedrock or sediments with the potential to contain paleontological resources may negatively impact such resources. In Alternatives 1, 2 and 3, surface disturbing activities in areas with fossils would include, as part of the project-specific NEPA evaluation, an analysis and disclosure of potential effects on paleontological resources and discussion of potential mitigation of adverse impacts that may be identified. Therefore, effects would be limited in all 3 alternatives. However, under Alternative 3, more of the forest would be wilderness meaning more acres would fall under the protection of the Wilderness Act. Therefore, effects to paleontological resources would likely be less in Alternative 3.

Geologic Hazards

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

Effects of Geological Hazards on the Forest. Overall, management activities on the Francis Marion in Alternatives 1, 2 and 3 would not affect the potential effects of geologic hazards (earthquakes, landslides, soil liquefaction, sinkholes, etc.) on the forest. However, the prescribed fire regime outlined in Alternatives 1 and 2 would reduce hazardous fuel buildup more than in Alternative 3. As a result, implementing Alternatives 1 or 2 would be more likely to reduce the intensity and spread of wildfires potentially resulting from geological hazards than Alternative 3.

Effects of Alternatives on Geologic Hazards. Implementation of Alternatives 1, 2 or 3 would be unlikely to directly or indirectly geological hazards on the forest.

Cumulative Effects

Many forest conditions and resources are influenced by geology in various ways, but proposed activity would consider and have little if any effect on geology. Some of the past activities on the forest and adjacent areas may have a degree of effects on geologic resources, such as hydrologic modifications, mining of materials, dams and diversion of rivers, use of groundwater. Most of these are difficult to quantify and explain, and have little or no bearing on the proposed actions being considered to manage the national forest. However, mining and special use proposals are among those activities that are unpredictable and/or information about where they may exist is limited for plan level analysis.

Management activities on the Francis Marion should not affect geological or paleontological resources off the national forest. As noted, mining for saleable minerals could impact the quality and recharge of groundwater. Proposals for mining must go through a site-specific analysis and additional mitigation measures may be required if impacts to resources including groundwater are anticipated.

Mining for limestone is occurring on private land near Dutart Creek within the proclamation boundary for the Francis Marion. SC DHEC monitors for potential groundwater impacts. If any impacts to groundwater occur, it could potentially impact groundwater dependent ecosystems, but no known impacts have been reported.

Off-forest instream dredging of channel and sand materials could impact channel stability on national forest lands. Sand materials acquired in the past are typically upland borrow sites of suitable materials both on the national forest or sometimes adjacent areas. The effects for these are more localized, but may impact groundwater, hydrologic patterns and/or indirectly affect other sensitive habitats.

3.2.3 Air Quality

3.2.3.1 Affected Environment

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

Air Pollution Emissions and Standards. Congress directed the U.S. Environmental Protection Agency (EPA) to set national ambient air quality standards (NAAQS) at for six criteria air pollutants: lead, sulfur dioxide (SO2), carbon monoxide (CO), nitrogen oxides (NOx), ozone (O3) and particulate matter (PM). As documented in the annual Forest Plan Monitoring Report as well as in EPA's GreenBook (http://www.epa.gov/airquality/greenbook/), ozone and particulate matter levels across the state of South Carolina have remained below the NAAQS standards.

This write up analyzes these six criteria pollutants relative to the 3 proposed alternatives.

Lead and SO2: The lead and sulfur contents of forest fuels is negligible; therefore, the effects of emissions from these pollutants from prescribed burning are not considered.

Carbon Monoxide: CO2 is the most abundant pollutant emitted from prescribed fire. It concerns human health because it binds to hemoglobin in place of oxygen. This leads to oxygen deprivation and all of the associated symptoms—from diminished work capacity to nausea, headaches and loss of mental acuity. CO2 concentrations can be quite high adjacent to a burn unit, but they decrease rapidly as they move away from the burn unit toward cleaner air. The effects of CO2 can be significant for those working the line on a prescribed fire, but due to rapid dilution, carbon monoxide is not a concern to urban and rural areas even a short distance downwind. Fortunately, most of the CO2 effects on human health are reversible because CO2 is rapidly removed from the body once the person is in cleaner air.

Nitrogen Oxide and Ozone: NOx emissions from prescribed fires are very small; alone they minimally affect human health. However, when combined with hydrocarbons (which are also moderately emitted from prescribed fire), they become precursors to the criteria pollutant

ozone. Ozone is formed in the atmosphere when nitrogen oxides and hydrocarbons combine in the presence of sunlight. Fire-related NOx and hydrocarbon emissions become more important to ozone levels only when other persistent and much larger pollution sources already present a substantial base load of precursors. To a limited degree, additional intermittent emissions of NOx and hudrocarbons may aggravate an already bad situation. Increased ozone concentrations are a concern to both human health as well as the environment.

Particulate Matter: The most important pollutant from prescribed fire emissions is particulate matter, specifically the very small particles that are less than 2.5 microns in diameter (PM2.5), due to the large amount emitted from prescribed fires and their negative effects on human health and visibility.

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

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

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

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

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

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

and takes appropriate mitigations to avoid these situations. Smoke management planning has been successful in protecting health and safety.

3.2.3.2 Environmental Consequences

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

Alternative 1: Direct, Indirect and Cumulative Effects

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

Alternative 2: Direct, Indirect and Cumulative Effects

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

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

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

Alternative 3: Direct, Indirect and Cumulative Effects

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

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

The cumulative effects of this alternative would result from indirect effects over time from forest vegetation and litter (fuel loadings) and the resulting effect on wildfires. In the absence of

prescribed burns, brushy species replace grasses causing fuel loading to increase. Wildfires occurring in areas with increased fuel loadings produce more smoke and are more difficult to contain; therefore they often burn for a longer duration. Wildfires may occur at times when wind carries smoke into sensitive areas and when smoke dispersal is poor. On a short-term basis, air quality could degrade under this alternative.

3.2.4 Climate Change

3.2.4.1 Introduction

All federal agencies must consider the effects of greenhouse gas (GHG) emissions (e.g., carbon, methane, nitrous oxide and fluorinated gases) and climate change in the evaluation of all proposed federal actions, including revising forest plans. Agencies should consider the following when addressing climate change:

1. The potential effects of management actions on climate change as indicated by a quantitative analysis of GHG emissions from the vehicles used by forest employees in completing their work and potential changes in carbon sequestration and storage for all 3 alternatives; and
2. The potential impacts of climate change on the Francis Marion National Forest (FMNF or Francis Marion) as indicated by a qualitative discussion of climate change impacts on natural resources.

Climate change is a particularly complex challenge given its global nature and inherent interrelationships among its sources, causes, mechanisms of action and impacts. The effects of climate change observed to date and projected to occur in the future include more frequent and intense heat waves, more severe wildfires, degraded air quality, more heavy downpours and flooding, increased drought, greater sea-level rise, more intense storms and harm to water resources, agriculture, wildlife and ecosystems. This section includes a summary of potential effects (for a detailed discussion on potential changes to the climate, see the Climate Change section of the Francis Marion National Forest Plan Assessment).

3.2.4.2 Affected Environment

Carbon. Forests represent the largest sink of terrestrial carbon. Maintaining forests as forests is one of the best methods to store carbon and help reduce GHG. In addition the wood products store carbon and keep it out of the atmosphere.

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

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

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

The most recent inventories indicate that the Francis Marion National Forest is a carbon sink, with most recent five-year accumulations at the rate of about 14 percent. Although this increase is within the sampling error for the inventory, the trends reflect that a continued increase at this rate is likely. The 2011 estimates for the Francis Marion National Forest total 18.5 teragrams (Tg or million metric tonnes) ± 2.8 Tg of carbon, which represents about 0.04 percent of the total of approximately 45,278 Tg of carbon in forests of the coterminous United States (EPA 2012). The average density of forest carbon is about 71.5 metric tonnes per acre.

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

Carbon Storage. The February 10, 2015 Baseline Estimates of Carbon Stocks in Forests and Harvested Wood Products for National Forest System Units, provided by the USDA Forest Service Climate Change Advisor's Office indicates that the total forest ecosystem carbon stocks and density have steadily increased for at least the past 20 years on the Francis Marion and Sumter National Forests[1] The highest percent change in carbon storage occurred in the above-ground carbon pool, due to net growth of the forest, and the lowest was in the understory pool, probably due to near equilibrium between new additions and emissions due to fire and decomposition. Most of the carbon is concentrated in the above-ground and soil organic carbon pools.

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

Most recent Forest Inventory and Analysis (FIA) inventories and trends from prior inventories also indicate that the Francis Marion National Forest is a carbon sink, with most recent 5-year accumulations at the rate of about 14 percent. Although this increase is within the sampling error for the inventory and not statistically significant, these trends reflect that an increase carbon stocks is likely to continue unless there is a major disturbance event. This trend includes the effects of current management, including annual timber harvests averaging about 33,000 ccf (Forest Service Cut and Sold Reports 2008–2012) and annual average prescribed burning on 35,000 acres. The 2014 ecosystem carbon stock estimates for the Francis Marion National Forest

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

total 19.8 teragrams (Tg or million metric tons) ± 1.6 Tg of carbon. The average density of forest carbon is about 71.5 metric tons per acre. On average 22 thousand metric tons of carbon, 0.12 percent of the standing total stocks of carbon, have been harvested each year. Approximately 30 percent of harvested wood remains sequestered in durable wood products and landfills after 50 years. 0.149 Tg of CO2 has been emitted annually by prescribed fire. Annual prescribed burning emits carbon at the rate of about 8.4 percent of the carbon in down wood and litter, but only 0.8 percent of the total standing carbon stocks. Additional annual emissions of GHGs from prescribed burning are estimated to be 0.010 Tg metric ton CO2 equivalent of Methane (CH4) and 0.006 Tg CO2 equivalent of Nitrogen-dioxide (N2O).

Historic and Current Climate. In evaluating historic climate, 2 estimates are made for temperature and precipitation. One is based on observed historic data (Gibson et al., 2002; Parameter-elevation Relationships on Independent Slopes Model (PRISM)), the other is based on predictive models (global climate models or GCMs). The intent of providing multiple representations of current climate is to establish a chain of logic-enabling analysis of future projections at coarser scales (about 12 kilometers) with respect to historic reference conditions that are observationally based and available at finer scales (about four kilometers). Having both representations of current climate available supports an understanding of the strengths and weaknesses of current and future projections and limitations related to scale. The Girvetz et al. (2009) representation of current climate serves as the baseline for comparison with future climate projections in subsequent sections of this report.

Long-term monitoring on the Santee Experimental Forest found:

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

GCM and PRISM models estimate:

- Annual average temperature estimates from 1980 to 2009 differ by 0.8°F with PRISM estimating 64.7°F and the median GCM estimating 65.0°F (see Table 3-3). GCM and PRISM seasonal average estimates temperature over the same time period are quite similar in the summer, winter and fall (less than 0.2°F difference) and most different in the spring (differ by 0.8°F).
- Annual average precipitation estimates for the time period 1980 to 2009 differ by 0.5 inches with PRISM estimating 50.6 inches and the median GCM estimating 51.1 inches (see Table 3-4). GCM and PRISM historic estimates of seasonal average estimates precipitation over the same time period are most similar in the winter and spring (differ by less than 0.3 inches) and most different in the summer and fall (0.6 inches and 1.1 inches, respectively).

Future Climate. Accounting for uncertainty is an essential step when considering future climate projections. Uncertainty comes from model uncertainty, uncertainty about future rates of greenhouse gas emissions and uncertainty related to the spatial and temporal scales of analysis. Considering multiple climate models and evaluating model agreement is one approach for

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

- Annual average temperatures indicate warming with increases of 1.2°F from 2010 to 2039. Even the most conservative ensemble considered (25th percentile) estimates 1.1°F of warming during the same time period, which is greater than the range of uncertainty considered (25 to 75th percentile) of 0.5°F. All seasonal averages show warming, with the greatest change occurring in the fall and the least change occurring in the winter (increase of 1.0°F) for 2010 to 2039. In all cases the projected changes are greater than the 25th to 75th percentile range, which represent the level of model uncertainty
- Precipitation projections seem to indicate a generally wetter future, with a median increase of 2.8 percent for 2010 to 2039. However, this change is well within the range of uncertainty considered (25th to 75th percentile) of 4.0 inches for 2010 to 2039. Seasonal precipitation projections seem to indicate a trend toward a wetter fall with less pronounced changes in other seasons. However, this change is well within the range of uncertainty considered (25th to 75th percentile) of 2.3 inches for 2010 to 2039.

3.2.4.3 Environmental Consequences

Assessing the Potential Effects of Management Actions on Climate Change

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

Land management practices such as prescribed burning, timber stand improvements, fuel load reductions, scheduled harvesting and grazing land management can result in both carbon emissions and carbon sequestration. A prescribed burn of forest or grasslands conducted to limit ecosystem destruction through wildfires or insect infestations may result in short-term GHG emissions and loss of stored carbon at the same time that a restored, healthy ecosystem provides long-term carbon sequestration through enhanced regrowth and biological sequestration. The Council on Environmental Quality (CEQ) is providing a reference point of 25,000 metric tons of CO2-e emissions on an annual basis below which a GHG emissions quantitative analysis is not warranted.

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

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

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

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

Most recent Forest Inventory and Analysis (FIA) inventories and trends from prior inventories also indicate that the Francis Marion National Forest is a carbon sink, with most recent 5-year accumulations at the rate of about 14 percent. Although this increase is within the sampling error for the inventory and not statistically significant, these trends reflect that an increase carbon stocks is likely to continue unless there is a major disturbance event. This trend includes the effects of current management, including annual timber harvests averaging about 33,000 ccf (Forest Service Cut and Sold Reports 2008–2012) and annual average prescribed burning on 35,000 acres. The 2014 ecosystem carbon stock estimates for the Francis Marion National Forest total 19.8 teragrams (Tg or million metric tons) ± 1.6 Tg of carbon. The average density of forest carbon is about 71.5 metric tons per acre. On average 22 thousand metric tons of carbon, 0.12 percent of the standing total stocks of carbon, have been harvested each year. Approximately 30 percent of harvested wood remains sequestered in durable wood products and landfills after 50 years. 0.149 Tg of CO2 has been emitted annually by prescribed fire. Annual prescribed burning emits carbon at the rate of about 8.4 percent of the carbon in down wood and litter, but only 0.8 percent of the total standing carbon stocks. Additional annual emissions of GHGs from prescribed burning are estimated to be 0.010 Tg metric ton CO2 equivalent of Methane (CH4) and 0.006 Tg CO2 equivalent of Nitrogen-dioxide (N2O).

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

Alternative 1 (Current Management)

Conditions of Carbon stocks and emission resulted from this alternative would continue ate the rates described in the Affected Environment. Based on forest management effects and background natural disturbance of the past 20 years, rates of forest growth and reductions due to timber harvest removals and mortality would be expected to continue for at least the next 20 years at the rates for the past 20 years, resulting in continued net gains in forest ecosystem carbon stocks. Prescribed burning will continue to create emissions, but a neutral net growth in the understory carbon pool would be expected due to continue near equilibrium levels between new additions from wood and leaf fall and reductions due to fire and decomposition. The Francis Marion National Forest is expected to remain a carbon sink for the foreseeable future, unless uncontrolled catastrophic events occur that cause significant forest mortality.

Alternative 2 (Proposed Action)

Conditions of Carbon stocks and emission would increase under this alternative. Carbon mass in annual timber harvests would increase to about 65 thousand metric tons, based on annual harvests of 98,000 ccf. Prescribed fire and other fuel reduction (such as mastication), projected at 50,000 acres per year, would emit 0.21 Tg of carbon (CO2), 0.015 Tg CO2 equivalent of Methane (CH4) and 0.008 Tg CO2 equivalent of Nitrogen-dioxide (N2O).

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

Alternative 3

Conditions of Carbon stocks and emission would increase under this alternative. Carbon mass in annual timber harvests would increase to about 65 thousand metric tons, based on annual harvests of 98,000 ccf. Prescribed fire and other fuel reduction (such as mastication), projected at 43,000 acres per year, would emit 0.18 Tg of carbon (CO2), 0.013 Tg CO2 equivalent of Methane (CH4) and 0.008 Tg CO2 equivalent of Nitrogen-dioxide (N2O).

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

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

The Francis Marion National Forest is experiencing increased threats from fire, insect and plant invasions, disease, extreme weather and drought. Scientists project increases in temperature and

changes in rainfall patterns that can make these threats occur more often, with more intensity and/or for longer durations.

Air Quality. Climate change may affect the distribution patterns and concentrations of air pollutants through changing wind and precipitation patterns (Bytnerowicz et al., 2007) as well as increased temperatures (Bedsworth, 2011). Increases in summer temperatures can increase the severity and duration of air pollution episodes potentially offsetting any future reductions in emissions (Wu et al., 2008). Airborne particulate matter is expected to decrease as precipitation increases; however, a climate-driven increase in wildfires could potentially increase both particulate and ozone concentrations (Jacob and Winner, 2009). An increase in nitrogen deposition is also predicted (Civerolo et al., 2008), which could lead to acid loading in forest streams (McNuly and Boggs, 2010).

Biological Diversity. At-risk plants and animals will respond to environmental changes by adapting, moving or declining (Aitken et al., 2008). Species with high genetic variation will be better able to survive new conditions. Higher temperatures will cause many species to shift ranges, generally moving to track their suitable habit (e.g., northward or higheer in elevation) (McKenney et al., 2007; Heller and Zavaleta, 2009). However, in some cases, the rate of warming combined with land-use changes will restrict the ability of plants and animals to move into suitable habitat (Hitch and Leberg, 2007; Pickles et al., 2012). The species most likely to be negatively impacted by climate change will be highly specialized and habitat restricted (Rodenhouse et al., 2009).

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

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

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

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

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

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

Aquatic Ecosystems. Increases in temperature and changes in precipitation patterns leading to lower baseflows and altered hydrology in streams and lakes will affect both plant and animal species in aquatic environments (Mulholland et al., 1997). Increased drought frequency can lead to poor water quality and habitat squeezes (Ficke et al., 2007), reducing diversity and increasing the incidence of waterborne diseases (Rahel and Oden, 2008). Higher temperatures will negatively affect coolwater-adapted fishes, including striped bass (Coutant, 1990) and Atlantic and shortnose sturgeons (Waldman, 2011), while warmwater-adapted species may expand in range (Meyer et al., 1999). Fish kills due to high summertime temperatures are likely to become more common in shallow waters of the Southeast (Stefan et al., 2001; Fang et al., 2004). Freshwater mussel species already declining in the region may be most at risk with future changes as impacts from landuse changes in combination with drought-induced low water levels and high summer temperatures may potentially extirpate thermally sensitive mussel populations (Galbraith et al., 2010; Golladay et al., 2004).

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

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

3.2.4.4 Management Implications

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

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

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

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

in the short term, they focus growth and storage for the future on trees that are at lower risk and/or more resilient to disturbance.

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

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

Table 3-3. Stand approaches to building and maintaining resistance and resilience to disturbance

Disturbance	Indicator	Desired Conditions	Building and Maintaining Resistance	Building and Maintaining Resilience
			Influence of composition and structure on the disturbance at the stand-level	**Influence of disturbance on subsequent composition and structure within a stand**
Wildfire	Severity of wildfire behavior	Fire-resilient forests are capable of absorbing fires without changing the system at the landscape scale	Use methods to reduce fuel build-up and reduce ladder fuels Maintain appropriate fire return intervals	Thinning, prescribed burning and other fuel reduction treatments redistribute or remove fuels.
Southern Pine Beetle	Risk of outbreak	The composition and structure of pine stands decrease the probability of that a large number of beetles can develop within and spread from a pine stand	Favor Longleaf pine over loblolly pine, since longleaf pine is more resistant to SPB Maintain basal areas of less than 100 square feet in pine stands	Maintain mature Longleaf pine to provide a seed source for natural regeneration
Hurricanes or tornados	Amount of Storm damage (windthrow and breakage) within a stand	The composition and structure of stands reduce the impacts of high winds associated with hurricanes	Favor Longleaf pine over loblolly since LL pine is more adapted to high winds. Manage for lower basal areas, so trees are more resistant to windthrow	Maintain mature Longleaf pine to provide a seed source for natural regeneration Plant seedlings grown from suitable seed sources to reforest area
Flooding	Amount of flood damage within a stand	The composition and structure of stands reduce the downstream impacts of flooding	Match culverts, crossings and bridge to anticipated stormflows Maintain roads and trails so that storm flows can move across the landscape.	Match native species to the appropriate site in restoration efforts
Drought	Water Stress to plants	The composition and structure of stands increase water yields during the growing season	Thin stands to lower basal areas to increase water yields during the summer months	Favor Longleaf pine in restoration efforts, since Longleaf pine are more resistant to drought than Loblolly pine.

Table 3-4. Landscape-level approaches to building and maintaining resistance and resilience to disturbance

Disturbance	Indicator	Desired Conditions	Building and Maintaining Resistance	Building and Maintaining Resilience
			Influence of multi-stand structure and function on the spread of disturbance.	**Influence of disturbance on subsequent multi-stand composition and structure**
Wildfire	Risk of spread	Fuel treatments do not eliminate wild fire, but modify fire behavior, which increases fire suppression effectiveness and reduces mortality in the overstory	Use Strategic placement of fuel treatments within the wildland urban interface to reduce the spread of wildfires to nearby homes and communities	Manage for a fire-resilient landscapes by using landscape level, low-intensity, frequent prescribed fire. Favor fire-adapted species to reduce mortality
Southern Pine Beetle	Risk of spread	Landscape composition and structure reduce the probability that a SPB population will go from endemic to epidemic.	Manage for up to 10% of the longleaf pine ecosystems in young (0-10 age group) vigorous pine stands	Plant longleaf pine seedlings from suitable seed sources
Hurricanes or tornados	Extent of storm damage	Landscape composition and structure reduce the extent of wind damage across the Francis Marion	Manage for a mix of age classes and species across the national forest	Manage for highly diverse ecosystems that are functioning across public lands and private lands
Flooding	Extent of flood damage	Landscape composition and structure reduce the extent of flood damage across the Francis Marion	Restoring access to the historic floodplain will slow stormwaters and dissipate the waters over a larger area Minimize the amount of impervious surface on the landscape	Favor functioning diverse ecosystems, that can withstand the impacts of standing floodwater within the 100-year floodplains.
Drought	Recharge of groundwater	Landscape composition and structure reduce the extent of drought across the Francis Marion	Restoring hydrologic function will slow the movement of water in floodplains, riparian areas and wetlands and help recharge groundwater	Longleaf pine ecosystems are managed at lower basal areas, which increase available water during the growing season.

3.2.5 Watershed and Water Resources

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

3.2.5.1 Watersheds: Affected Environment

Watershed boundaries are classified and defined by Hydrologic Unit Codes (HUCs) (Eidson et al. 2005). The unit code numbering system developed by the U.S Geological Survey (U.S.G.S) classifies watershed by size from region to sub-watersheds. The Francis Marion falls within the Middle Atlantic Coastal Plan Eco-region in the hydrologic boundaries of the Santee River, Cooper River, and the associated Coastal Sub-basins, (HUC) 03050112, 03050201, and 03050209 (Eidson et al, 2005).

Figure 3-4 outlines waters flowing to the Cooper River, Santee and Coastal Waters. Color changes indicate elevation differences (high to low of gray, brown, yellow, green and blue) with abrupt curvilinear coastal features demarking the marine terrace scarps and riverine systems eroded into and embedded within them.

Twenty-one 6th level sub-watersheds were evaluated by a Forest interdisciplinary team under the Watershed Condition Framework but only 16 were carried forward in the analysis to select priority watersheds. While twenty-seven 6th level sub-watersheds occur within the administrative boundary with national forest land, the team evaluated sub-watersheds with 20% or more in national forest lands. All watersheds were rated as fair based on moderate geomorphic, hydrologic and biotic integrity relative to their natural condition. The Watershed Condition Framework uses watershed attributes and indicators to determine watershed condition across the forest.

3.2.5.2 Watersheds: Environmental Consequences of Alternatives

For water resources, effects are typically disclosed on an individual watershed basis, with distinct spatial, and temporal bounds that encompass a project or proposed action planned by the forest. Direct, indirect, and cumulative effects are disclosed for water resources within the watersheds, I.E stream flow, water quality, riparian areas etc. For planning purposes, rather than disclosing effects for watersheds as a whole, they are discussed individually for each resource area.

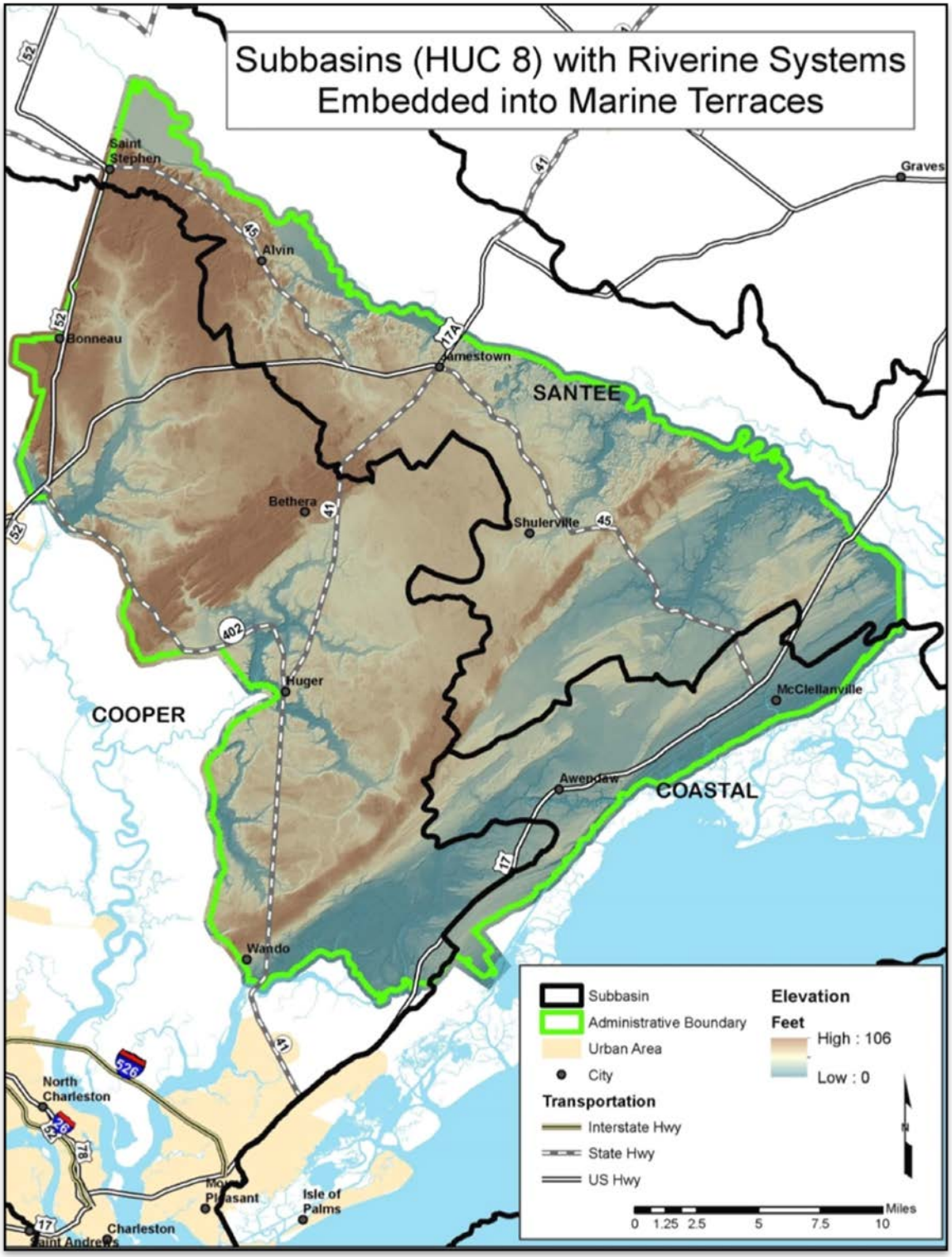

Figure 3-4. Three major sub-basins within the Francis Marion National Forest

3.2.5.3 Rivers and Streams: Affected Environment

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

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

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

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

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

The Santee Dam hinders the migrations of native anadromous fish to their historic spawning grounds in the Piedmont. These include shad, striped bass, and sturgeon. In addition to the large dam on the Santee River, there are numerous smaller dams and dikes throughout Forest watersheds that are barriers to fish movement. These smaller dams also create impoundments in natural stream systems. This results in a loss of habitat through the conversion of lotic habitat to lentic habitat, which favors competitive and often predacious species like largemouth bass and other centrarchids (Palmer et al. 2005).

Mercury from coal burning in power generation is an air pollutant that can have a negative impact on rivers and streams. Mercury is problematic in black water streams that extend across the state, coastal, and gulf region, and northeast. Wetlands, which are found throughout the Francis Marion National Forest, are important sinks for mercury, as well as sources of methyl mercury. Once

mercury deposition occurs, it may be transformed through sulfate reduction by wetlands into methyl mercury (MeHg), which bio-accumulates in the food chain and concentrates in fish. Due to the abundance of wetland areas, conversion, and accumulation of mercury may begin on the national forest and continue downstream through the biological food chain. Fish consumption advisories due to methyl mercury are common throughout coastal South Carolina; including rivers and streams on the Francis Marion.

Tidal Influenced Streams. SC Department of Natural Resources generally uses US Highway 17 as the dividing line separating freshwater from saltwater. Approximately 179 miles of intermittent and perennial streams on the forest are estimated to have tidal influence with another 25 miles (mostly along the Santee River and the intra-coastal waterway) that border or are just outside the forest proclamation boundary. There are approximately 6,546 acres of Tidal waters on the Francis Marion, located in the Salt Marsh and Maritime Ecosystems (Hansen, 2013). The State typically manages tidal lands and waters. They are classified for: recreation, crabbing, fishing, shellfish harvesting, human consumption, and have anti-degradation limits set by the state.

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

3.2.5.4 Rivers and Streams: Environmental Consequences

All Alternatives

Direct effects are caused by an action and occur at the same time and place, whereas indirect effects are caused by the action but manifested later in time or farther removed in distance but are generally foreseeable (CEQ regulations Sec 1508.8). At the Forest Plan level, desired actions are proposed to meet forest land management objectives, and effects are disclosed in general terms with estimations of “probable” effects. Direct and Indirect effects at the project level, (where implementation occurs), are specific for an action where data related to that action and forest monitoring is more available and site specific. For all alternatives, management activities on national forest land, and continued growth and development on private land have the potential for direct and indirect impacts to rivers and streams.

On national forest land, timber harvesting, recreation (campgrounds and trails) fire management, and roads all result in land disturbance (direct effect) and potential erosion and sedimentation (indirect effect) to rivers and streams (Swank, W.T., L.W. Swift, Jr and J.E. Douglas. 1988). Effects from private land activities can generally be projected on the basis of historical impacts, and population growth or known future development. The Federal Clean Water Act (CWA) objectives of “restoring and maintaining the chemical, physical and biological integrity of the Nation’s Waters” are being carried out voluntarily with Best Management Practices (BMP) on private lands. National forests have developed standards and guidelines for the protection of rivers and streams. For example, in Alternatives 2 and 3, streams are protected with specific riparian management zones that minimize pollution and maintain riparian areas and aquatic

habitat. Furthermore, the Forest Service has recently published guidelines for National Best Management Practices (USDA, 2012) as guidance in developing protective measures to maintain and improve water quality. All national forests are instructed to follow the published guidelines.

Riparian area direction has been developed at a regional level and implemented for all national forests in the Southern Region. On state and private forest lands, BMPs have been developed toprotect water resources and control nonpoint source pollution, (typically sediment and pollutants, such as oil drips, brake dust, etc that are washed from roads, landings, and skid trails), as opposed to point sources from discrete outflow on industrial or urban sites. Although voluntary, State monitoring programs have shown BMPs practices are effective in minimizing and preventing sedimentation and degradation of streams (Aust, M, and Blinn, C. 2004).

Given the effectiveness of these BMP programs, all alternatives should not have long-term direct and indirect impacts to rivers and streams. Most importantly, future impacts will be mitigated by project specific BMPs, and Forest Plan implementation of standards and guidelines. Most research indicates that water quality recovers within 2 to 5 years from forestry operations. (Aust, Michael and Blinn, Charles., 2004).

Alternative 1

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

Alternatives 2 and 3

Alternatives 2 and 3 are similar regarding improvement of hydrologic function and watershed health. The proactive approach of identifying watershed improvement needs and correcting Hydrologic problems caused by past management activities (i.e. construction of roads) will result in overall improvement of streams and rivers. Additionally, these alternatives have identified priority watersheds for improvement following completion of the Watershed Condition Framework. With a specific focus on watershed health, and improvement of hydrologic function, indirect and direct effects will be minimized and all management activities will meet State requirements for water quality standards. Cooperative programs and continued research on management impacts will facilitate and augment watershed restoration.

Cumulative Effects for All Alternatives

Cumulative effects result from incremental impacts when added to other past, present and reasonably foreseeable future actions. Again, cumulative effects are difficult to estimate at the Forest Plan level where no specific project decisions are proposed. Estimates of effects are general and used to compare alternatives. At the project level, cumulative watershed effects are

refined using current information, existing data, past practices, known project effects, and more refined predictions of effects from private land.

The watershed serves as the spatial unit for analyzing cumulative effects. Rivers and streams will be somewhat impacted in the future due to private land activities, and actions implemented under the forest plan. The general predictions of those effects are based on historical information, existing condition from past actions, and trends. As in direct/indirect effects, the implementation of State and Federal regulations, BMPs, Forest Plan Standards and Guidelines, should minimize cumulative effects on rivers and streams on national forest land. Private land cumulative effects may or may not follow existing trends of development and population growth. Climate change may have synergistic effects as rivers and streams respond to man-caused, and climate induced changes. Cumulative effects under Alternatives 2 and 3 will be lessened with the focus on improving hydrologic function and watershed health.

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

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

Freshwater wetlands have been modified since European settlement. Many forested wetlands on the Francis Marion were ditched and drained for rice fields prior to the end of the Revolutionary War (Porcher and Rayner 2001). Channeling and ditching for roads, infrastructure, and industrial logging from forested wetlands, were common practices at the turn of the century (Hester 1997; Conner et al. 2011). At the time of European settlement, it is estimated that approximately 80 million hectares of forested freshwater wetlands existed in the coterminous United States. Draining and clearing of forested wetlands for agriculture beginning in the mid-1800s, accounts for at least 87 percent of wetland loss (Journal of the Society of Wetland Scientists 1989). The Francis Marion National Forest has much evidence of Soil disturbance that causes sediments to streams; wetlands and riparian areas. See the Francis Marion Forest Plan assessment.

Geographic Information System (GIS) estimated the extent of riparian areas, wetlands, stream, lake, and tidal margins. In 1996, 143,000 acres of wetlands were identified. Currently embedded streams, riparian, and wetland types make up approximately 153,000 acres. Riparian areas were not identified in the 1996 Forest plan but a riparian management plan was developed with specific standards to protect riparian areas. See a description of Riparian guidelines and maps in the Francis Marion Forest Plan Assessment previously cited. The 1996 plan recognized that about 50,000 acres of pine forests have hydric soils and met classification criteria as wetlands. Forested wetlands additionally include black water stream floodplains, and floodplain forest. Large river floodplain forests, tidal wooded swamp forests, non-riverine swamp, wet hardwood forests, and non-riverine basin swamp forests also define forested wetlands.

On the Francis Marion National Forest, forested wetlands conservatively occupy 118,730 acres or 45.8 percent of forested acres (based on ecological modeling). See Nature serve (Ecological Systems of Francis Marion National Forest 1 November 2012).

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

Direct and Indirect Effects for All Alternatives

From erosion estimates based on land uses and forest activities, sediment delivery for the coastal plain is estimated at 10 percent of erosion (Roehl, 1962; Lu et al., 2003). Sedimentation is related to logging, roads, trail crossings, and other management activities (Hansen et al. 1994).

Impacts from sediment to streams inhibit the movement of aquatic organisms and impair aquatic habitat. Erosion and sedimentation estimates, (Table 3-5) indicate that increased sedimentation over the next decade by each alternative is insignificant with only a 4.6 to 4.9 percent increase per decade (Hansen, 2015 unpublished technical report). All alternatives would emphasize protection and improvement of riparian areas, wetlands and floodplains. Management activities consistent with BMPs and other protective measures will be implemented as described under rivers and streams.

Watershed improvement varies by alternative. Alternatives 2 and 3 emphasize the restoration of wetlands critical to at-risk amphibian species and benefits to habitat for at risk species are anticipated. However, Alternative 2 may have greater benefits than Alternative 3 with the emphasis on prescribed burning programs that improve overall habitat. In Alternative 1, the forest plan would not preclude restoration, but provides no specific direction for improvement.

Alternative 1

Alternative 1 continues forest management under the 1996 Forest Plan. As with other resource areas, the 1996 plan does not emphasize nor provides direction for restoration of hydrologic function and management would continue under current standards and guidelines but provide protection for riparian areas and wetlands. There is little focus or a priority in alternative 1 to improve watershed condition or improve aquatic habitat. The effects of a non-action approach to watershed improvement would result in greater potential detrimental impacts to Rivers and Streams than Alternatives 2 and 3. Without a proactive approach to improving hydrologic function and connectivity the impacts or effects from Alternative 1 would continue at present levels.

Alternatives 2 and 3

Alternatives 2 and 3would restore and monitor water resources on the Francis Marion and would have a beneficial effect lacking in Alternative 1. Much of the impact to water resources is due to activities off national forest land. The focus of Alternatives 2 and 3 is on sustaining and improving watershed areas within national forest control while working cooperatively with other agencies and landowners to improve statewide watershed health, water, soil, and air quality. Restoration of fire-maintained ecosystems and hydrologic function of wetlands is the foundation Alternatives 2 and 3. For projects proposed under these 2 alternatives, management activities would improve hydrologic function, and water quality. Planned watershed restoration would improve riparian areas, wetlands, and habitats for aquatic species, as well as at-risk amphibians. Three priority watersheds selected for improvement from the WCF analysis are examples of planned improvements over the next decade.

Cumulative Effects

As previously stated, at the project level, cumulative watershed effects are predicted using current information, existing data, past practices, known project effects, and more refined predictions

from private land actions. Cumulative effects for all three alternatives arenot be considerably different nor result in long term impacts. Past and present management activities on the Francis Marion and private lands have contributed sediment, changed the hydrologic regime, affected riparian areas, and impaired aquatic habitat. However watershed health remains fair and water quality meets State water quality standards (Francis Marion Forest Plan Assessment). The exception is 303D listed streams where impairments are not generally due to forest management but off site contamination (air pollution, animal waste, sewage etc.) from mercury and fecal coliform. 303D streams will be discussed in a later section.

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

3.2.5.7 Water Quality: Affected Environment

A comprehensive assessment of Coastal, Cooper, and Santee river sub-watersheds provides an overall assessment of watershed condition, historical land use, water impacts from management activities, and physical descriptions of imbedded watersheds. A detailed description of each watershed is provided in this process paper, titled Template-Ecological Sustainability Evaluation (ESE) Tool Preliminary Assessment-Coastal Cooper and Santee River sub-watersheds (Hansen et al 2013).

Most of the State's water is suitable for public-supply, industrial, and irrigation use, and Aquatic life is supported in most of the State's lakes, estuaries, and rivers. However, water quality and habitat is generally poor. An EPA study that analyzed the Macro Invertebrate Multimetric Index MMI shows that 71% of river and stream length in the Coastal Plains eco-region is in poor condition compared to least-disturbed conditions, 17% is in fair condition, and 12% is in good condition. The Macro invertebrate Observed/Expected O/E Taxa Loss results show that 19% of river and stream length has lost more than 50% of the taxa (EPA, 2013). This assessment shows that most widespread indicators of stress in the Coastal Plains eco-region are phosphorous, in stream habitat, riparian vegetation cover, riparian disturbance, and streambed sediment. Phosphorous is at high levels in 36% of river and stream length, medium in 31%, and low in 33%.

In-stream habitat is in poor condition in 24% of river and stream length, fair in 30%, and good in 45%. Riparian vegetative cover is in poor condition in 18% of river and stream length, fair in 13%, and good in 69%. Riparian disturbance, or evidence of human influence in the riparian zone, is at high levels in 13% of river and stream length, fair in 40%, and good in 47%. Streambed sediments are rated poor in 13% of river and stream length, fair in 34%, and good in 51%. Figure 3-5 provides a graphical view of the biological, chemical and physical causes of impairment.

Primary impacts on the forest from pollution are associated with fecal coliform, methyl mercury, and sedimentation. The following are listed 303 D stream segments in or near the Francis Marion. The primary listings are fecal coliform that affect recreational and shellfish gathering waters. These include: Awendaw Creek, Guerin Creek, Wando River, Turkey Creek, Cane Gully Branch, Wadboo Swamp, and Echaw Creek (SC DHEC 2012). Listings for mercury include East Fork Cooper River near Quinby Creek, Wadboo Creek, Santee River below Wilson Dam, diversion and rediversion canals, and Wambaw Creek. The entire coastal marine and estuary areas have been identified as a water quality advisory for fish consumption (SC DHEC). Lakes Marion and Moultrie and other major streams are also impaired with fecal coliform.

Many streams in the coastal plains area are listed as impaired due to methyl mercury and fecal contamination. These impaired streams are on the EPA 303D list and requires the development of TMDLs. Water pollution from sediment on the Francis Marion National Forest is associated with: prescribed burning; timber harvesting; road maintenance and agriculture. Private land development and urban expansion is another source of sediment. High suspended sediment loads and contaminants such as trace elements are typically associated with urban areas (White and Tittlebaum 1985). Elevated fecal coliform include many natural sources such as from wildlife, septic systems, sewage, and wastewater transmission and treatment facilities.

Direct and Indirect Effects for All Alternatives on Water Quality

Research and studies have shown that correcting water quality problems is a major issue for the State and Francis Marion National Forest (Bard et. al, 2004). Water quality should be improved over the next decade on the Francis Marion National Forest. Land clearing, timber harvesting, recreation use, prescribed burning, and road construction will continue under all alternatives but there is a greater interest in improving water quality on National Forest lands. There are also research opportunities and partnerships with the Santee Experimental Forest, U.S. Geologic Survey, Clemson University, and the College of Charleston that should add to the knowledge base on improving water quality over the next decade.

The implementation of Best Management Practices will serve to minimize non-point pollution from National Forest and private forest lands. Most pollution control BMPs focus on techniques to exclude sediment from streams. These include controlling erosion at its source, trapping sediment in natural barriers such as Streamside Management Zones (Verry, Elon S et al. 2000.) Streams that are impaired with methyl mercury, fecal coliform and other chemical contaminants must be controlled through interagency cooperation and control of contributing sources. Planned Total Maximum Daily Loads (TMDLs) will be a useful instrument to deal with mercury and fecal coliform. Reducing these effects will by necessity have to happen under South Carolina water quality programs and cooperative programs with other agencies that control air pollution. Forest management activities do not contribute methyl mercury and fecal coliform is controlled at recreation areas, and other areas that potentially cause fecal coliform.

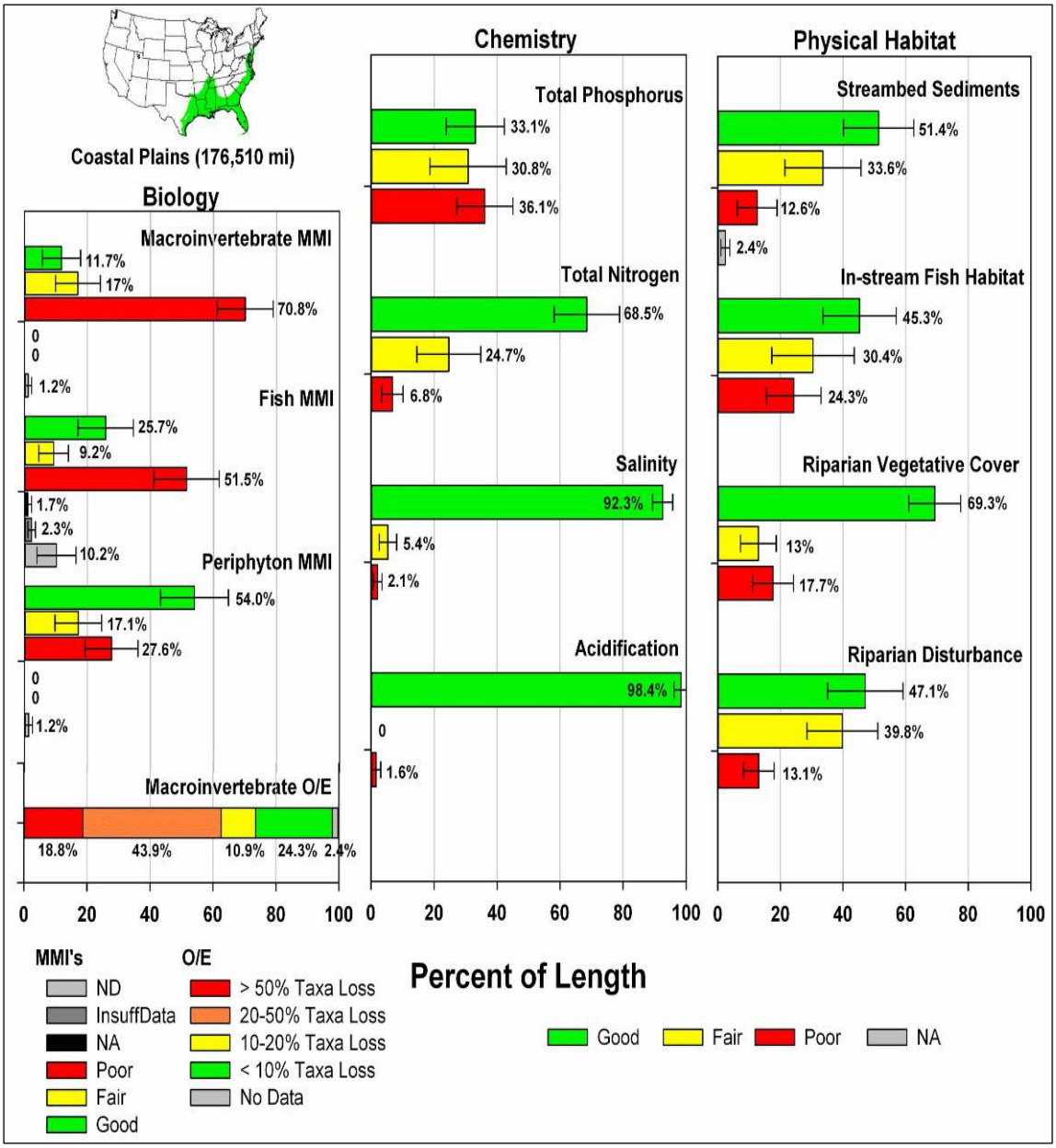

Figure 3-5. Graphs showing good, fair and poor ratings for Biologic, Chemistry and Physical Habitat

Source: Biological condition coastal plains (national rivers and streams assessment 2008-2009, a collaborative survey (Draft) EPA /841/D-13/001).

Mercury from coal burning used in power generation is an air pollutant that can have a negative impact on water quality. Mercury is a problematic in black water streams that extend across the state, coastal, gulf region, and northeast. Wetlands, found throughout the Francis Marion National Forest, are important sinks for mercury, as well as sources of methyl mercury. Once mercury deposition occurs, it may be transformed through sulfate reduction by wetlands into methyl mercury (MeHg), which bio accumulates in the food chain and concentrates in fish. Due to the abundance of wetland areas, conversion and accumulation of mercury may begin on the national forest and continue downstream through the biological food chain. Fish consumption advisories due to methyl mercury are common throughout coastal South Carolina; including rivers and streams on the Francis Marion.

Alternative 1

As discussed previously, this alternative will follow the 1996 Forest Plan that mandates the implementation of Standards and Guidelines and BMPs but does not focus on improvement of watersheds as a priority. The reduction of impacts to water quality would not be a priority and effects of sedimentation form forest activities would be greater in watersheds that require restoration.

Alternatives 2 and 3

At the planning level, erosion and sediment estimates that impact water quality are meant for comparison purposes only. Riparian management zones for perennial and intermittent streams, and Forest Wide Standards (Chapter 3, S19 and S20) specific to ephemeral channels will prevent or lessen any direct and indirect effects from erosion and sediment. Actual implementation of an alternative will quantify and predict effects at the project level. For planning purposes sediment modeling was used to calculate sediment production from management activities over the next decade. (Hansen, technical report unpublished, 2015)

Table 3-5. Estimated sediment delivery to streams from NFS and private lands based on land use activities over the next decade[1]

6th Level Sub-watershed	Total Sediment Delivered (tons per decade)	Sediment Sources from NFS Lands (acres [%])	Sediment Sources from Private Lands (Acres [%])
Awendaw Creek	1,964	21,954 [85]	3,722 [15]
Cane Pond Branch	1,029	7,424 [69]	3,325 [31]
Dutart Creek-Santee River	3,874	10,763 [37]	18,436 [63]
Echaw Creek	3,439	19,684 [69]	8,716 [31]
French Quarter Creek	3,276	4,953 [26]	14,391 [74]
Gough Creek	1,294	6,336 [51]	6,117 [49]
Guerin Creek	5,557	16,895 [42]	23,110 [58]
Headwaters of Wambaw Creek	1,656	20,441 [95]	1,081 [05]
Nicholson Creek	1,802	28,457 [97]	783 [03]
Outlet Wambaw Creek	2,551	21,293 [87]	3,287 [13]
Quinby Creek	2,673	14,066 [62]	8,616 [38]
Savanna Creek	1,877	12,883 [74]	4,405 [26]
Turkey Creek-East Branch Cooper River	1,776	16,159 [98]	350 [02]
Wadboo Creek	3,734	20,840 [61]	13,573 [39]
Walker Swamp	11,244	8,836 [24]	28,346 [76]
Wedboo Creek	2,809	8,424 [54]	7,067 [46]

[1] Information presented is for sub-watersheds with 20 Percent or greater National Forest System (NFS lands).

Results of the predicted sediment loads over the next decade show insignificant increases from national and private forest land activities by alternative. Table 3-5 presents the predicted increases in sediment by alternative for the next decade by alternative and includes all sources of sediment, including private land actions. As shown in Table 3-6, the percentage of increase over the next 10 years is statistically insignificant and should have no detrimental effects on water resources.

Table 3-6. Predicted sediment increases in tons per decade

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

With the concern and focus on improving water quality on the national and state forest lands, there should be no impairment to water quality under any of the alternatives. Effects will be determined and controlled at the project level. The Clean Water Act requires protection of the nations waters through required discharge requirements, development of BMPs and dredge and fill limits.

The Clean Water Act (CWA) (33 U. S. C. § 1251 et seq.) establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters. NPDES permits are required for discharges to the nations waters and impaired waters are identified and prioritized to meet Total Maximum Daily Loads (TMDLS). Water quality reports are prepared by the States and submitted to EPA. (SC DHEC 303(d)/305(b) reports SC DHEC 2012c, 2012d). The 303d report identifies impaired waters for various water quality attributes or conditions. The 305b report describes the State's water quality programs and reports the conditions of the State's waters. See State of South Carolina, Integrated Report for 2012, Part I: Section 303(d) for a List of Impaired Streams.

The CWA amendments of 1987 required the control of pollution in stormwater. EPA developed the NPDES permit system to regulate stormwater quality from publicly owned storm drain systems or point sources. NPDES permits are generally delegated to the States. Non-point sources are regulated under section 319 that requires development of BMPs and monitoring to determine effectiveness.

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

3.2.5.8 Groundwater and Water Quantity: Affected Environment

Groundwater

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

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

The Francis Marion has a number of groundwater withdrawals on national forest land. Table 3-7 shows the withdrawal by Site numbers, stations, and period of years for the withdrawals. Figure 3-6 provides a map showing the withdrawal sites.

Table 3-7. Francis Marion groundwater withdrawals

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

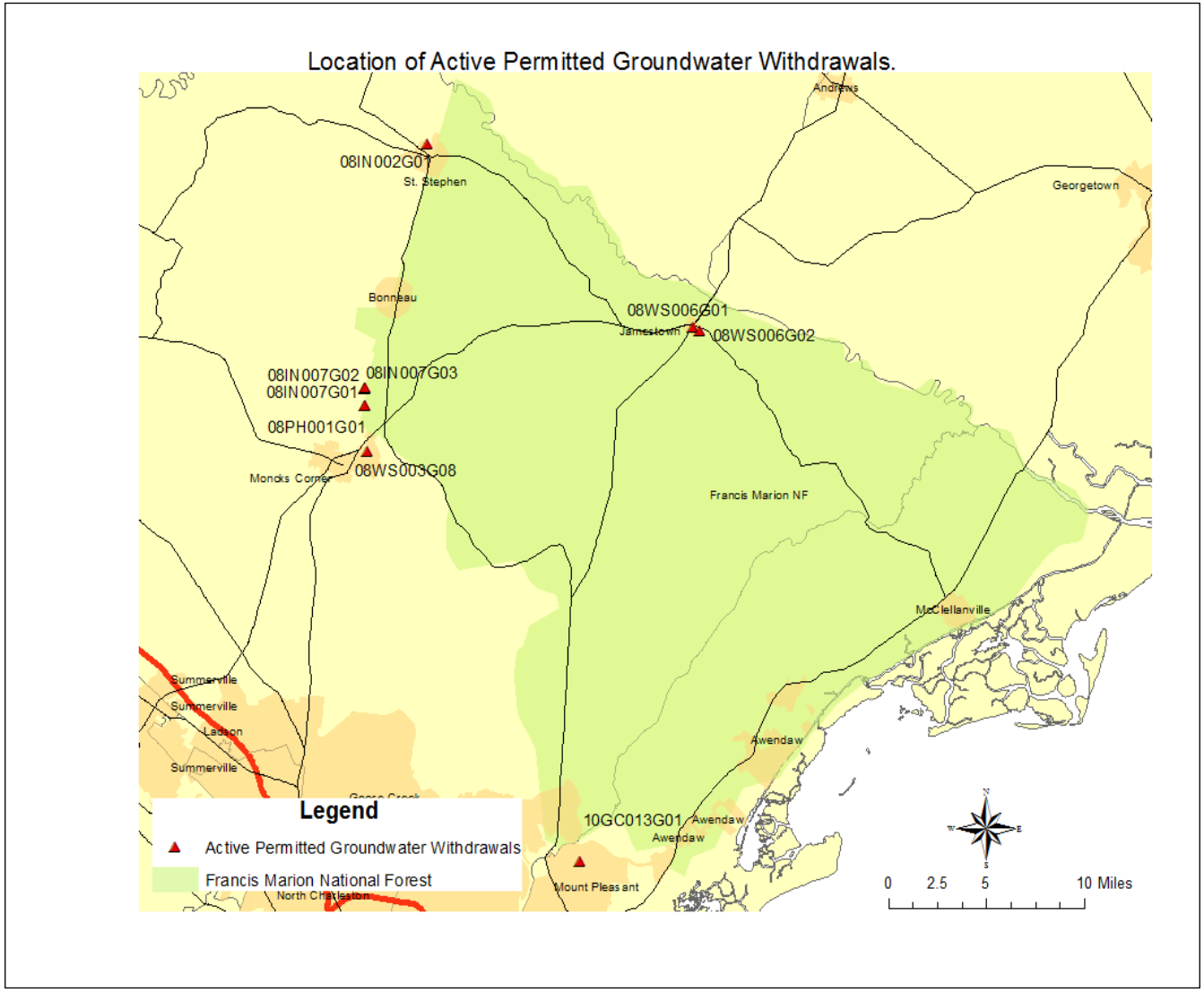

Figure 3-6. Groundwater withdrawal stations on the Francis Marion National Forest

There are currently 19 wells on the official system within the Francis Marion National Forest. Five of these are not being used at this time and are currently considered excess. Four wells are inactive at this time. Ten wells are actively being used. There are five administrative wells on the Forest that currently supply water to recreational facilities. There are two wells used at Tibwin Plantation site. There is one flowing (artesian) well available for public and emergency use. The administrative sites with current use wells include the Seed Orchard, Helibase and Work Center. From water sources outside of the Francis Marion National Forest, there are two recreational facilities and one at the District Office that are served by municipal water sources. The water quantities needed for consumptive drinking and associated water uses are not currently available at this time.

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

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

Water Quantity

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

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

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

3.2.5.9 Groundwater and Water Quantity: Direct and Indirect Effects

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

Groundwater

Previous discussions indicated that Groundwater withdrawals have resulted in a drop in water tables. South Carolina lists the regulation of groundwater as a top priority, given the demands on water, and effects of droughts. Additionally, predicted population growth will create greater demand. (Badr, A.W. et al, 2004) Forest Management under all alternatives should not have a measureable effect on groundwater. Forests serve as recharge areas, especially in depressions, riparian areas and wetlands. Current and future Land disturbance caused by timber sales, road construction, recreation, and other planned actions should not have direct, indirect effects or cumulative impacts on groundwater. There a number of groundwater withdrawals on the Francis Marion but these permitted uses will not be impacted by any of the proposed alternatives (Table 3-7). Groundwater effects are a concern on private land due to population growth and increased demand for water. Wells will be protected under all alternatives.

Water Quantity

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

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

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

3.2.5.10 Watershed Health: Watershed Condition Framework

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

There are 27 6th level sub-watersheds on the Francis Marion National Forest. Of the 27 watersheds, 21 were selected for WCF evaluation- those with watershed area greater than 5% National Forest ownership. A forest interdisciplinary team then evaluated sub-watersheds that contained 20% or greater National Forest lands to develop a list of priority watersheds that were candidates for restoration (Table 3-8). All watersheds were rated as fair based on moderate geomorphic, hydrologic and biotic integrity relative to their natural condition.

Table 3-8. Watersheds with greater than 20% National Forest ownership

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

3.2.5.11 Priority Watersheds

Three priority watersheds were identified under the watershed condition framework ranking system: the Headwaters of Wambaw Creek; Turkey Creek/East Branch of Cooper River, and Guerin Creek (Figure 3-7). A detailed description of each watershed is provided in a process paper, titled Template-ESE tool preliminary assessment-Coastal Cooper and Santee River sub-watersheds (Hansen et al 2013). There is additional information in “The Assessment”.

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

Turkey Creek–East Fork Cooper River (98 percent National Forest). Turkey Creek is a 16,508-acre watershed with 95 miles of streams. There are funding opportunities from a number of planned timber management projects. Ongoing hydrological and ecological and opportunities for partnerships with the Santee Experimental Forest, U.S. Geologic Survey, Clemson University, and, the College of Charleston make Turkey Creek an excellent candidate for successful restoration. Santee Experimental Forest has several long-duration climate and hydrologic research studies in this watershed, and the Santee Experimental Forest serves as the Atlantic Coastal Plain reference for hydrologic studies. The studies are within a core burning area with

endangered, threatened, and sensitive species including red-cockaded woodpecker. Restoration therefore benefits water resources and habitat for a number of biological species.

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

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

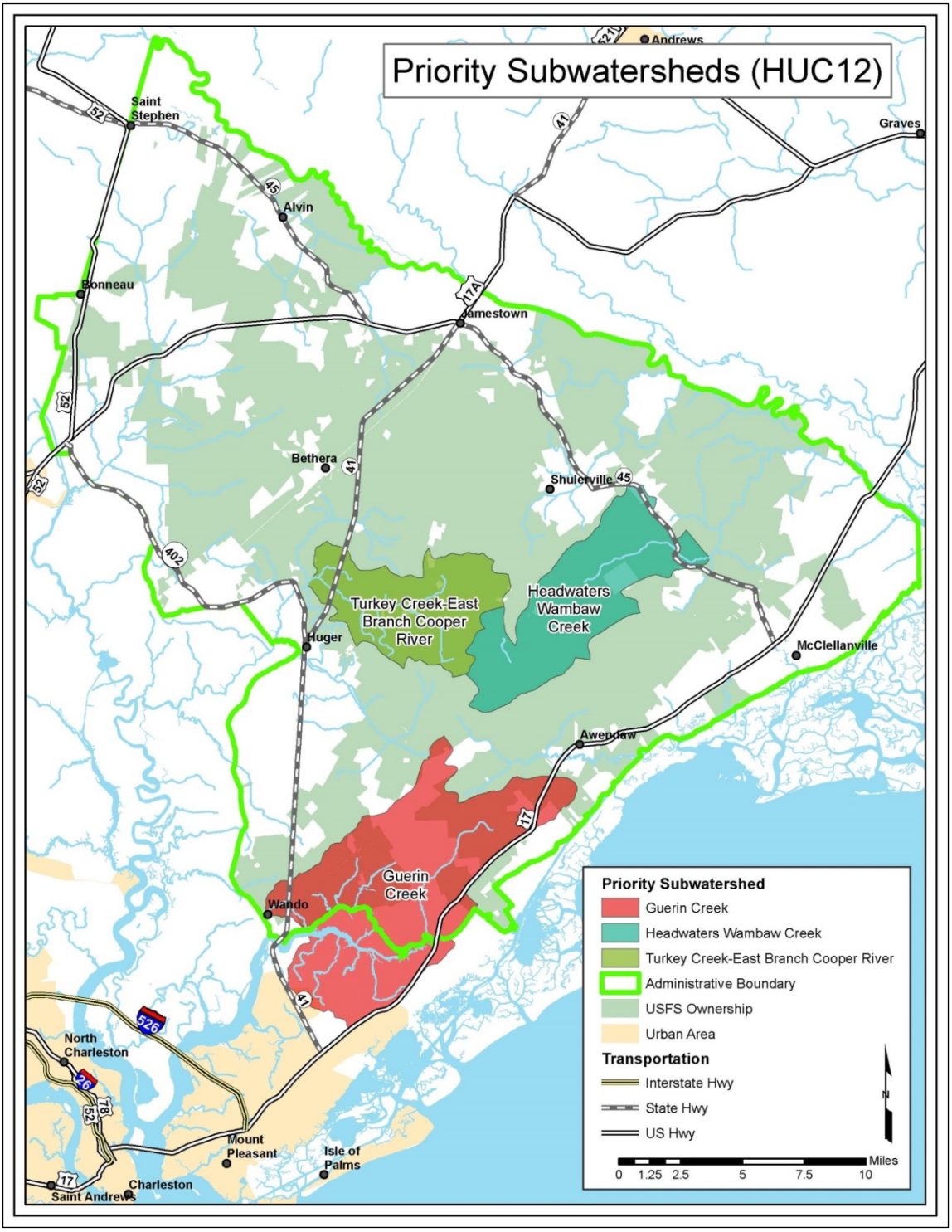

Figure 3-7. Three Priority Sixth level Sub-watersheds on the Francis Marion

3.3 Biological Environment

3.3.1 Ecological Systems

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

Digital LiDAR mapping sampled soils, geology and native vegetation at more than 1000 points. Classification units followed NatureServe (2012), and considered land-use history, ecosystem drivers, stressors and natural disturbance regimes. Simon and Hayden, working with the Forest Service and NatureServe, identified and mapped 21 ecological systems on the Francis Marion National Forest, which were then grouped into nine ecosystem groups; these ecosystem groups formed the foundation for developing restoration activities. The ecosystems and ecosystem groups represent common and rare community types, both of which are important for sustaining ecological and species diversity.

Table 3-5 and Figure 3-4 show the ecosystem groups identified for the Francis Marion National Forest. These groups formed the basis for maintenance and restoration activities, for evaluating forest plan effects on ecosystem and species diversity and for interpretation of the natural range of variability (NRV). Desired conditions in the forest plan for ecosystem maintenance and restoration consider related biophysical setting descriptions from LANDFIRE (www.landfire.gov), ecosystem descriptions from NatureServe (2012) and ecozone descriptions from Simon and Hayden (2014). Associated documents in the process record and in Appendix E can be consulted for more detailed information on the composition, structure and function of both ecosystems and ecosystem groups.

Table 3-9. Ecosystem groups and acreages on the Francis Marion National Forest and surrounding areas, shown for lands within the administrative and proclamation boundaries

Ecosystem Groups	Administrative Boundary	Proclamation Boundary
Upland Longleaf and Loblolly Pine Woodlands and Forests	51,500	100,400
Wet Pine Savannas and Flatwoods	85,500	128,400
Depressional Wetlands and Carolina Bays	8,500	11,800
Pocosins	9,300	11,000
Narrow Forested Swamps and Blackwater Stream Floodplain Forests	43,900	75,200
Broad Forested Swamps and Large River Floodplain Forests	49,200	68,100
Oak Forests and Mesic Hardwood Forests	5,800	10,000
Maritime Forests and Salt Marsh	4,000	11,400
Streams and Rivers	2,499 miles	1,460 miles
TOTAL	257,700	416,300

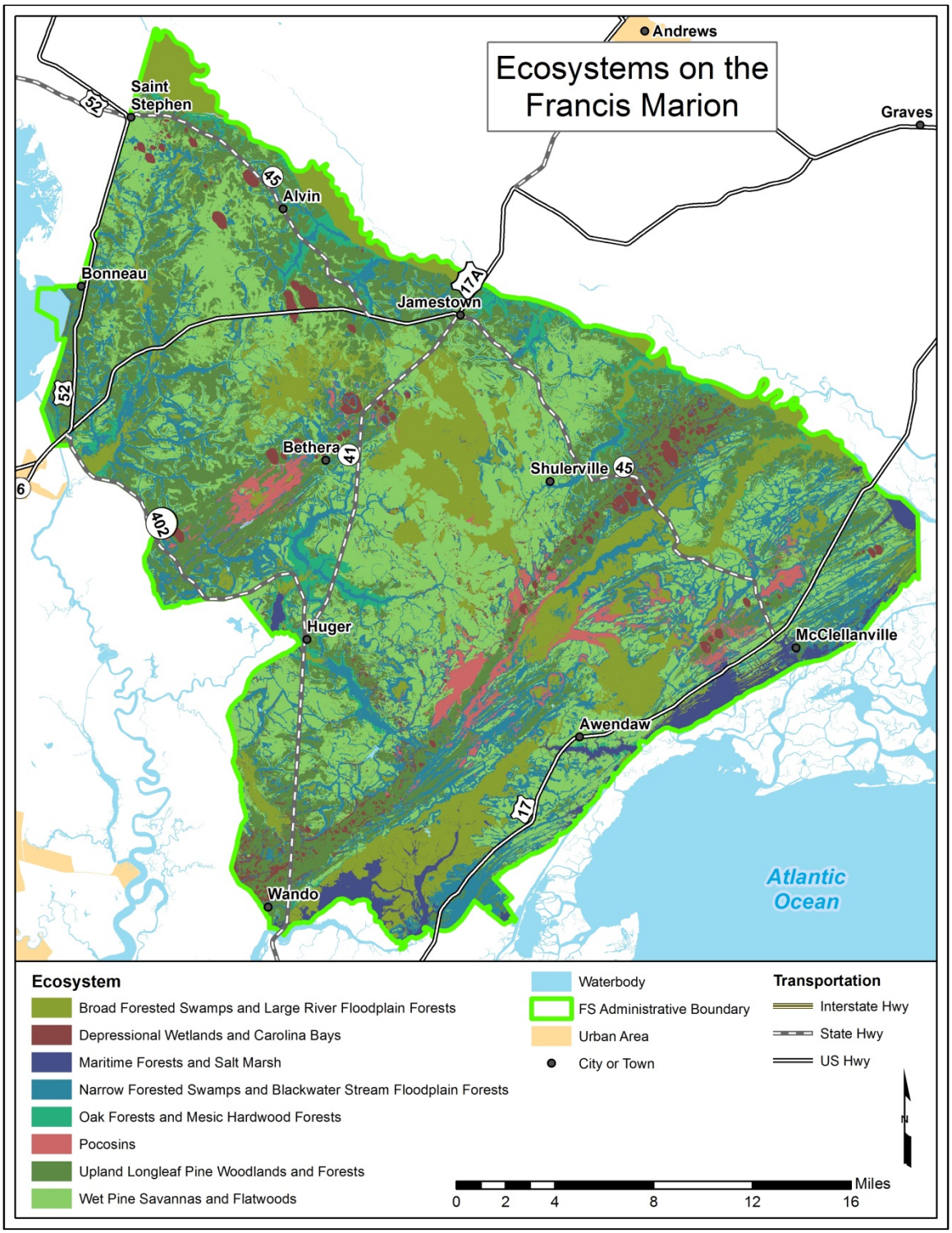

Figure 3-8. Ecosystem groups on the Francis Marion (note streams and rivers are not displayed in this map)

Embedded Rare Communities

High-quality plant communities or plant associations occur within ecosystems which contribute towards botanical biodiversity at a smaller scale than ecosystems but at a larger scale than plant populations. These areas are often imbedded within the larger ecosystem-level direction, and are compatible with the desired composition, structure, function and processes of the associated native ecosystems. The 1996 Francis Marion National Forest Revised Land and Resource Management Plan includes a ne2rk of 2,056 acres in designated botanical areas, comprised of a combination of rare plant populations, rare and high quality plant communities and areas of high public interest. This information was evaluated and a rare community coverage (including existing and documented high-quality plant communities only) was created in 2014 consisting of 99 areas and 3,176 acres. Numerous rare plant associations have been documented from the forest by NatureServe (2012).

Distribution, Extent and Trends of Fire-Adapted Ecosystems

Longleaf pine ecosystems once covered 90 million acres from Virginia to Texas (see Figure 3-5) and would have dominated the landscape occupied by the Francis Marion National Forest. By 1900, it was evident that longleaf pine replaced itself only sporadically in a tiny percentage of its' former landscape; by 1967, loblolly pine plantations had been established on 12,460,000 acres throughout the southeast (Frost, 1993). The near elimination of once dominant longleaf pine ecosystems was perhaps the greatest ecosystem alteration resulting from intensive forest management and land use conversion in the South (Wear and Greis, 2012).

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

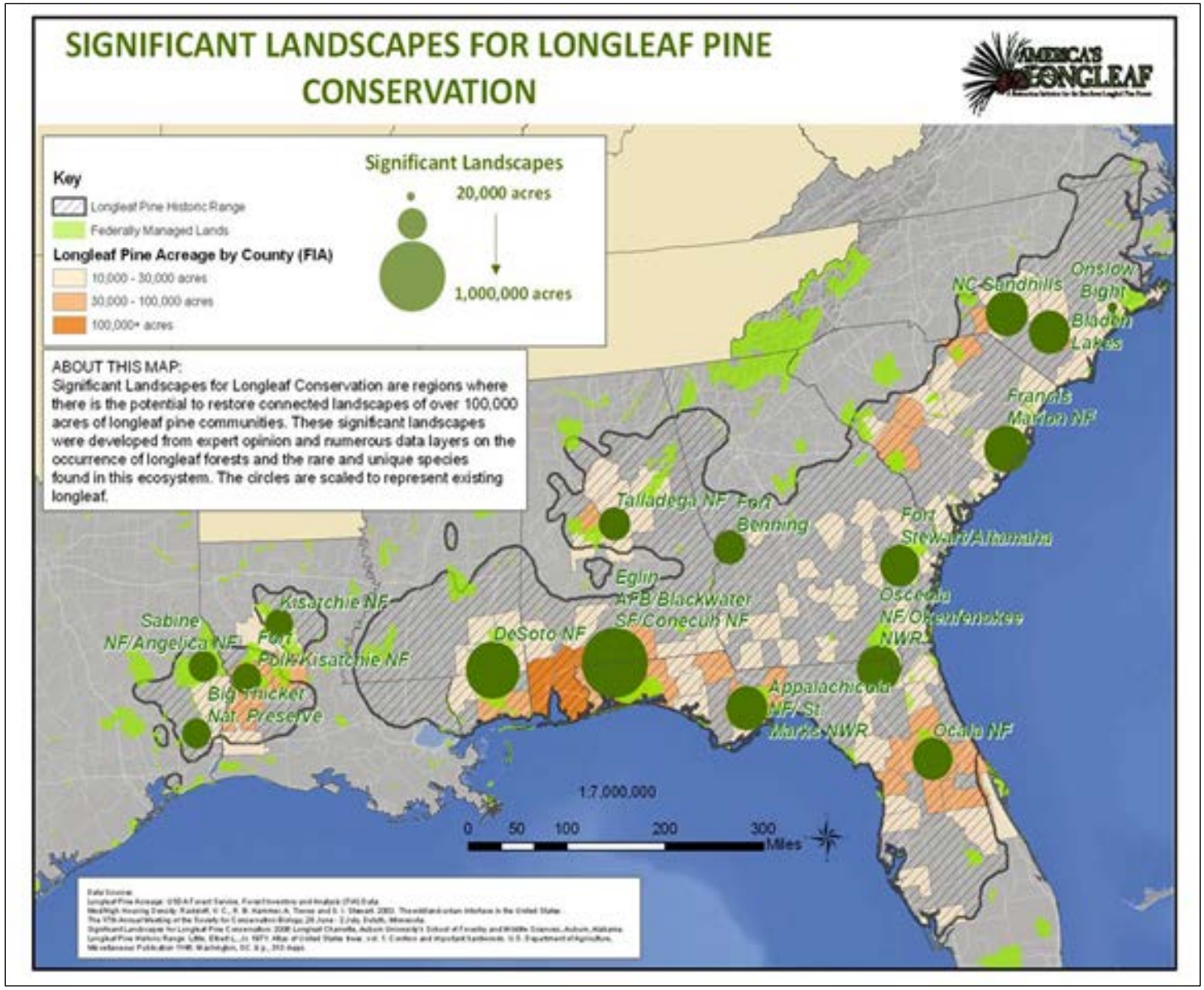

Figure 3-9. Significant landscape for longleaf pine conservation (America's Longleaf Restoration Initiative)

Ecological Systems and Existing Forest Types

Within ecosystems, existing vegetation reflects a combination of land-use practices which have altered the native vegetation; it also provides us with an indication of native ecosystem restoration opportunities (see Table 3-6). Both longleaf pine and fire were discouraged by turn-of-the-century forest management practices and according to historic records, the percentage of loblolly pine dominated forest has increased by upwards of 16 percent since the FMNF was established in 1936. Table 3-6 shows existing vegetation on the forest occurring within each ecosystem group using forest type groups from Field Sampled Vegetation or FSVeg.

Process for Evaluating Effects to Ecosystem Integrity and Sustainability

Steps used to build an ecological sustainability framework are documented within the ecological sustainability evaluation tool and described in Appendix E. The ecological sustainability evaluation database serves as the source for evaluating ecosystem diversity on the FMNF and developing plan components for the 2015 revised forest plan. The Forest Service developed a relational database, the ecological sustainability evaluation tool, based on the structure of the ecological planning tool designed by The Nature Conservancy.

To evaluate ecological sustainability, the planning team identified key characteristics for each ecosystem, identified measurable indicators for each key characteristic, weighted them in importance and defined ranges of acceptability for each ecosystem across each alternative, both at 10- and 50-year timeframes. This process is further described in Appendix E and within the ecological sustainability tool.

Table 3-10. Existing forest type groups by Native Ecological System Acres (expressed as a percentage of Total Ecosystem Group Acres)

	Bottomland Hardwood (incl. Oak) or Mixed Hardwood/ Yellow Pine or Sweetgum	**Loblolly Pine and Mixtures w/Hardwood (no oak listed)**	**Longleaf Pine and Mixtures w/Loblolly or Slash Pine**	**Pond Cypress and/or Bald Cypress**	**Pond Pine, Pond Pine/Hardwood, Brush Species, Undrained Flatwoods, Sweetbay, Swamp tupelo, Red Maple**	**Upland Hardwood (incl. Oak) or Mixed Hard-wood/Yellow Pine or Shortleaf Pine**
Forest Type	46, 61, 62, 63, 64	13, 31	21, 22, 27, 29	23, 24, 67	18, 36, 40, 68, 98, 99	10, 11, 44, 47, 48, 49, 53, 57, 58, 77
Upland Longleaf and Loblolly Pine Woodlands and Forests	**4.2**	**51.3**	**36.1**	**12.9**	**4.6**	**1.2**
Wet Pine Savannas and Flatwoods	**6.7**	**53.4**	**24.7**	**5.9**	**8.1**	**9.0**
Depressional Wetlands and Carolina Bays	**6.6**	**31.8**	**21.2**	**16.0**	**21.0**	**1.3**
Pocosins	**2.3**	**7.4**	**11.2**	**11.1**	**67.0**	**0.6**
Narrow Forested Swamps and Blackwater Stream Floodplain Forests	**17.0**	**29.3**	**13.3**	**15.0**	**23.3**	**1.9**
Oak Forests and Mesic Hardwood Forests	**22.0**	**63.3**	**1.3**	**3.8**	**1.0**	**6.2**
Maritime Forests and Salt Marsh	**11.0**	**21.2**	**2.9**	**0.6**	**28.3**	**3.3**
Broad Forested Swamps and Large River Floodplain Forests	**16.9**	**23.5**	**0.9**	**36.4**	**17.2**	**0.5**

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

The Francis Marion National Forest is dominated by 2 longleaf-dominated ecosystem groups, upland longleaf pine woodlands and wet pine savannas and Flatwoods. Upland longleaf ecosystems occur on sandy ridges and are typically dominated by longleaf pine, whereas wet pine savanna and Flatwoods ecosystems occur on wet, seasonally saturated mineral soils and can be dominated by longleaf pine, pond pine or loblolly pine on wetter sites. Three upland longleaf variants and 2 wet pine savanna variants were mapped ecologically on the forest based on subtle differences in soil moisture and topography. Plant communities within each type differ in structure, in associated understory and woody species, and in moisture regime associated with soils and subtle changes in landform.

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

The planning team evaluated the condition of existing and restorable longleaf in 2010 with the SC Nature Conservancy; looking at overstory, midstory and understory conditions, this work suggests that 13.6 percent of the forest's longleaf ecosystem is in very good to good condition (maintain condition class) including 15.2 percent of the forest's upland longleaf and 9.5 percent of the forest's wet pine savanna and Flatwoods ecosystems. Approximately 53 percent are in poor condition (restore all condition class), including 42.5 percent of the forest's upland longleaf woodland and 59.5 percent of the forest's wet pine savanna and Flatwoods ecosystems (see Table 3-7). Approximately 25 percent are in fair condition (improve condition class), including 29 percent of upland longleaf and 22 percent of wet pine savanna ecosystems. Condition classes are defined as follows (ALRI, 2009).

- **Maintain.** Forest canopy and understory conditions that currently will provide ecosystem functions, processes and assemblages of representative species of plants and animals. The maintain condition class is grouped to include maintain, improve ground only, improve mid-story only, improve canopy only and restore canopy only management classes.
- **Improve.** Longleaf pine may be present, but lack significant components of understory communities and fire regimes to support representative communities. Tree cover may be dense.
- **Restore.** Stands do not currently support a longleaf pine canopy nor understory but could be re-introduced based on ecological modeling or the presence of representative soils.

Table 3-11. Longleaf condition classes from 2010 Longleaf Assessment, acres by longleaf ecosystem type

Condition Class	Upland Longleaf	Wet Pine Savanna	Other1	Total
Improve	8,551	10,336	3,568	22,455
Maintain	8,213	8,639	2,811	19,663
Restore	12,458	28,159	6,469	47,086
No cond class	78	198	31	306
Total	29,299	47,331	12,879	89,510

[1] Represents other ecosystems included within stands inventoried as part of the longleaf assessment.

Lack of frequent prescribed fire is a primary threat to longleaf pine ecosystem integrity, particularly to herbaceous understory communities. The Forest Service recognized the importance of frequent prescribed fire in maintaining longleaf ecosystems in the 1996 forest plan and included a standard that Management Area 26 be prescribed burned on a 2-3 year rotation. However, from 2005 and 2012, 19,597 acres (36 percent) of potential and existing upland longleaf woodlands and 27,138 acres (15 percent) of the wet pine savanna and Flatwoods ecosystem were burned 3 or more times (2 to 6-year burning rotation). The total acres prescribed burned on the forest have remained fairly constant, but have not met the long-term objectives for total burning and growing season burning within longleaf pine forest types (see Section 3.4.2 Community WildFire Protection Planning). Prescribed burning practices in the wildland urban interface (WUI) have been particularly limited. Prescribed burning within the federally endangered red-cockaded woodpecker habitat management area has remained fairly constant at 50 percent, and the forest has burned approximately 30 percent of Management Area 26 on a 2-3 year rotation (USDA-FS, 2008).

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

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

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

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

Alternative 1

Direct and Indirect Effects. Objectives and probable activities in the 1996 Forest Plan are listed on pp. 2-2, S-3, S-4 and at the landscape level include prescribed burning, thinning and identifying and maintaining existing acreage in pine and pond cypress savanna, forested ponds, maritime forests, pocosins, calcareous mesic forests and longleaf woodlands. Longleaf restoration

activities would continue to emphasize maintenance and restoration of longleaf forest types on 53,500 acres, and dormant season and growing season burning on 260,000 acres and 40,000 acres for the next decade.

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

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

Cumulative Effects. The WUI between the forest and Charleston would continue to expand and challenge the agency's prescribed burning activities in the future, particularly in and around state highways. This growth would influence the ability to prescribed burn in Management Area 26. Between 2005 and 2012, only 36 percent of potential and existing upland longleaf woodlands and 15 percent of the wet pine savanna and Flatwoods ecosystems were burned at the desired fire frequency, affecting vegetation condition, herbaceous groundcover and structural diversity. The total acres prescribed burned on the forest would remain constant. Partnership initiatives, such as the Sewee Longleaf Landscape Cooperative, would continue to provide incentives to private landowners in the short-term to both prescribed burn and plant longleaf, but trends in the long-term on private lands would remain uncertain.

Determination of Effects (see Figure 3-6). In the next 10 to 50 years, it is anticipated that the direct, indirect and cumulative effects of this alternative on the sustainability of upland longleaf and loblolly pine woodlands would be fair to poor , givenlack of more frequent growing season fire, non-native invasive species prevention and control efforts, and greater connectivity..

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

1. Forty percent of the forest's wet pine savannas and Flatwoods would be maintained and restored in Management Area 26 (below the 50 percent threshold);
2. The higher basal areas required in the 1995 Record of Decision for red-cockaded woodpecker management; and
3. The lack of more aggressive desired conditions, as well as maintenance and restoration objectives for wet pine savannas and associated ground-cover communities.

Alternative 2

Direct and Indirect Effects. Objectives and desired conditions would address the maintenance and restoration of upland longleaf and wet pine savanna and Flatwoods ecosystem composition, structure, function and connectivity. Probable activities would include prescribed burning, thinning, hydrologic restoration and non-native invasive species control. Restoration of longleaf pine forest types would occur on suitable upland and wet pine sites. To supplement burning and reduce fuels away from Management Area 1, the agency would rely on mechanical and chemical means of woody treatment at wildland-urban interfaces, and selective treatments with herbicides. Recreational uses would continue to increase but would be maintained at a sustainable and a dispersed level.

Upland pine woodlands would be maintained and restored on 33,500 acres (64 percent of the total extent) and wet pine savannas and Flatwoods would be maintained, improved and restored on 58,100 acres (67 percent of the total extent) within Management Area 1. Canopies would be open with canopy closure typically less than 60 percent (40-70 ft.2 basal area) and as low as 10 ft.2 basal area in wet savannas. Groundcover would be predominantly native and herbaceous. Prescribed burning would mimic natural fire regimes within Management Area 1 and would include a one-3 year prescribed burning regime, as well as a growing season burn at least every third burn (approximately 360,000 acres of dormant season prescribed burning per decade and 100,000 acres of growing season burning).

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

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

Determination of Effects (see Figure 3-6)**.** In the next ten to fifty years, it is anticipated that the direct and indirect effects of Alternative 2 on sustainability of upland pine woodlands would be good.

In the next 10 years, it is anticipated that the direct and indirect effects of Alternative 2 on sustainability of wet pine savannas and Flatwoods would be fair for 2 reasons:

1. Restoration to sustainable levels would take years to achieve; and
2. The agency is limited in its ability to fund and implement the restoration of wet pine savannas and Flatwoods at this scale in the next ten years alone.

In the next 50 years, it is anticipated that the direct and indirect effects of Alternative 2 on sustainability of wet pine savannas and Flatwoods would be good since 67 percent of these ecosystems would be restored across the landscape under this alternative.

Alternative 3

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

Objectives and desired conditions would address maintenance and restoration of upland longleaf and wet pine savanna and Flatwoods ecosystem composition, structure, function and connectivity. Probable activities would include prescribed burning, thinning, hydrologic restoration and non-native invasive species control. Restoration of longleaf pine forest types would occur on suitable upland and wet pine sites. To supplement burning and reduce fuels away from Management Area 1, the agency would rely on mechanical and chemical means of woody treatment at wildland urban interfaces, as well as selective treatments with herbicides. Recreational uses would continue to increase but would be maintained at a sustainable and a dispersed level.

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

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

Determination of Effects (see Figure 3-6). In the next 10 to 50 years, it is anticipated that the direct and indirect effects of Alternative 3 on sustainability of upland pine woodlands would be fair since 45.4 percent of the ecosystem extent would be maintained and restored in this alternative.

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

Composite Alternative Sustainability Ranking for Upland Longleaf Woodlands

Figure 3-6 compares the sustainability of upland longleaf and loblolly pine woodland ecosystems across all 3 alternatives.

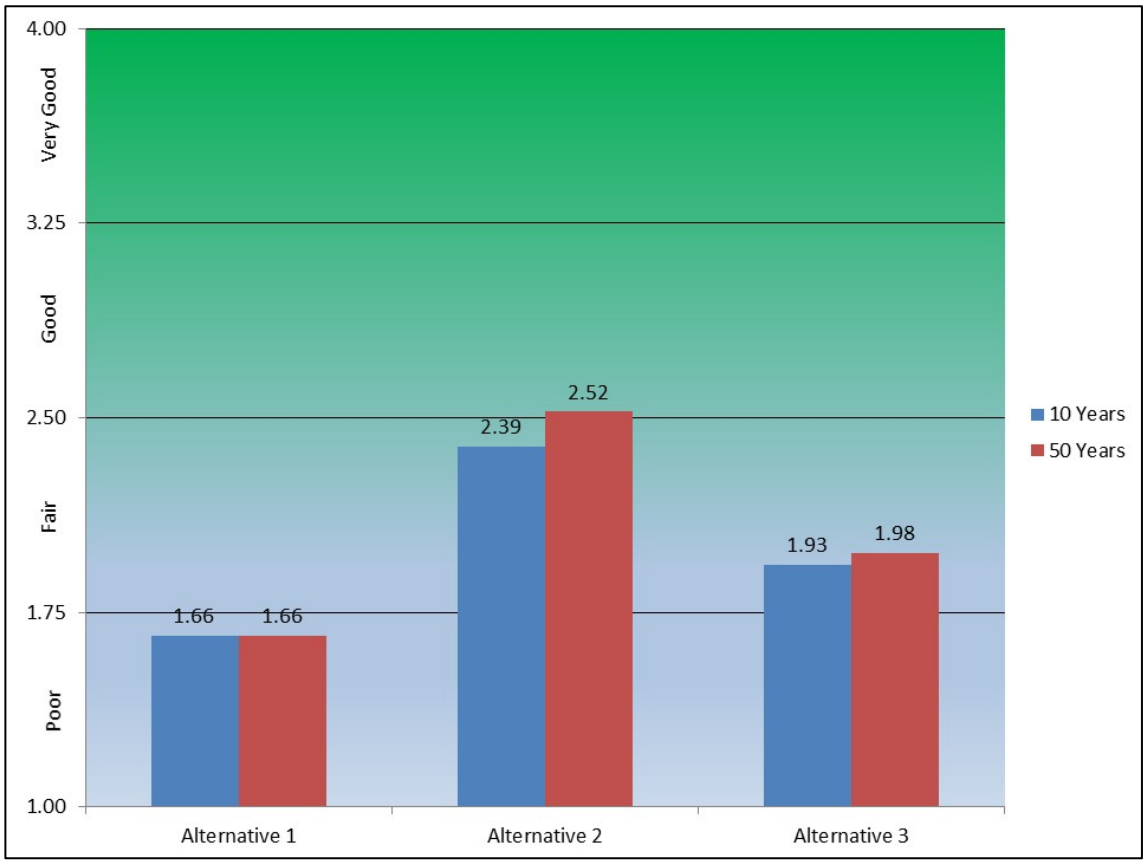

Figure 3-10. Forestwide Upland Longleaf Pine Woodland Ecological Sustainability Scores

Key characteristics and indicators for evaluating the sustainability of upland longleaf woodlands and wet pine savanna ecosystem groups are described in Appendix E and are outlined in Table 3-8.

The key characteristics and indicators in Table 3-9 were determined to be important, but were not used due to lack of data.

Table 3-12. Key characteristics and indicators for evaluating the sustainability of upland longleaf woodlands and wet pine savanna ecosystem groups

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

Table 3-13. Key characteristics and indicators for evaluating the sustainability of upland longleaf woodlands and wet pine savanna ecosystem groups that were determined to be important but were not used due to lack of data

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

The acreage that would be maintained and restored to upland longleaf pine ecosystem scores good only in Alternative 2. In Alternative 1, the key characteristics related to connectivity, fire regime, non-native invasive species, structural diversity and vegetation condition would be ranked poor to fair in terms of ecological sustainability across the landscape. All would increase to good levels after both 10 and 50 years based on management direction in Alternative 2. Alternative 2 would provide desired conditions for maintaining and restoring 64.3 percent of the total extent of upland longleaf ecosystems on the forest with prescribed fire and other tools, compared to 73.6 percent in Alternative 1 and 45.4 percent of the total extent in Alternative 3. The allocation of Management Area 1 in Alternative 2 would most closely match the agency’s ability to prescribed burn on the forest within the last decade, and would be anticipated to do so in the next 10-50 years of implementation.

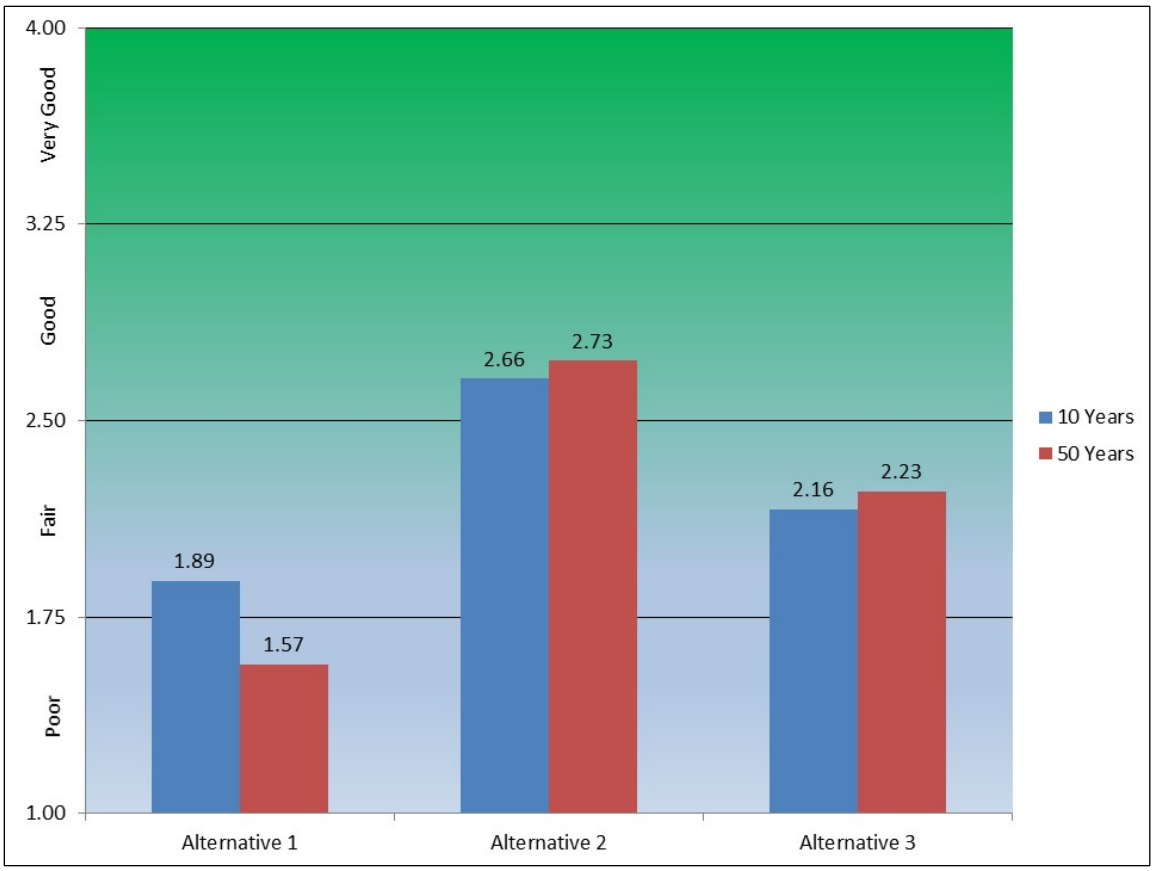

Figure 3-11. Forestwide Wet Pine Savanna and Flatwoods Ecological Sustainability Scores

The acreage that would be maintained and restored to wet pine savanna and Flatwoods ecosystems scores good only in Alternative 2. In Alternative 1, for the key characteristics related to connectivity, fire regime, non-native invasive species, old growth, structural diversity and vegetation condition, all would be ranked poor to fair in terms of ecological sustainability across the landscape. All would increase to good levels after both 10 and 50 years based on management direction in Alternative 2. Alternative 2 would provide desired conditions for maintaining and restoring 67 percent of the total extent of wet pine savanna and Flatwoods ecosystems on the forest with prescribed fire and other tools, compared to 30 percent in Alternative 1 and 48 percent of the total extent in Alternative 3. The allocation of Management Area 1 in Alternative 2 would most closely match the agency's ability to prescribed burn on the forest within the last decade, and would be anticipated to do so in the next 10 to 50 years of implementation.

3.3.1.3 Affected Environment: Depressional Wetlands and Carolina Bays

The 1996 Forest Plan contains an objective to, "[I]dentify and maintain existing acreage in.. pond cypress/swamp tupelo pond, and pond cypress and pine savannas." With the use of LiDAR Simon and Hayden (2013) identified 83 Carolina bays and 435 depression ponds within the forest proclamation boundary. The condition of select Carolina bays and depression ponds included as designated botanical areas, were monitored in 2012 (Everett, 2010). Many are threatened by successional vegetation, lack of frequent prescribed fire, feral hogs and poaching associated pitcher plants and orchids (Everett, 2012; Glitzenstein, 2012). Other threats to depression ponds and Carolina bays on the forest include illegal OHV use near Halfway Creek Road. On the

Francis Marion, 33.5 percent of depressional wetlands and Carolina bays are in grassland, savanna or woodland canopy cover based on analysis of 2009 LiDAR.

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

Frequent 1 to 3 year prescribed fire is an important process for maintaining and restoring an herbaceous component within Carolina bays and depression ponds and their ecotones (NatureServe, 2012; DeSteven and Toner, 2004),which provide habitat for a number of rare plant and animal species. Prescribed fire data for the forest suggests that 20 percent of Carolina bays and 38 percent of depression ponds are being prescribed burned at natural fire frequencies (3 or more times between 2005 and 2012).Numerous depressional wetlands and Carolina bays are imbedded within Pleistocene terraces where fire would have occurred frequently, burning into the ecotones and often through the pond. Isolated wetlands and Carolina bays were historically protected from fire; old firelines can still be seen, fragmenting and decreasing diversity in the ecotone. In the absence of frequent fire, particularly during periods of drought, isolated wetlands acquire an evergreen shrub component and both loblolly pine and swamp tupelo can become established, shading out the herbaceous understory.

Everett (2012) and Glitzenstein (2012) note feral hog damage in many of our depression ponds and Carolina bays associated with rare plants. Table 3-10 provides a list of non-native invasive plants that have been documented from depressional wetlands and Carolina bays on the forest.

Table 3-14. Non-native invasive plants documented in Depresssional Wetlands and Carolina Bays on the Francis Marion National Forest (2013)

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

3.3.1.4 Environmental Consequences: Depressional Wetlands and Carolina Bays

Alternative 1 – No Action (1996 Forest Plan)

Direct and Indirect Effects. Under this alternative pond cypress savanna and cypress tupelo pond vegetation occurring within depressional wetlands and Carolina bays, would be maintained, but not restored. Many would continue to be threatened by successional vegetation, lack of frequent prescribed fire and feral hogs. Directly and indirectly, depressional wetlands and Carolina bays would be maintained on the forest, but key characteristics of herbaceous groundcover and open canopy structure would be less likely to occur at sustainable levels.

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

Determination of Effects. In the next 10 and 50 years, it is anticipated that the direct, indirect and cumulative effects of this alternative on sustainability of depressional wetlands and Carolina bays would be fair at both 10- and 50- year intervals, given that there would be no forest plan direction to restore them, particularly using prescribed fire

Alternative 2 – Proposed Action

Direct and Indirect Effects. Under this alternative pond cypress savanna and cypress tupelo pond vegetation occurring within depressional wetlands and Carolina bays would be maintained, improved and restored, particularly within Management Area 1, where frequent and growing season natural fire regimes would be restored. Other activities within this ecosystem group could include mechanical or chemical selective control of unwanted or off-site woody vegetation, such as loblolly pine or red maple, and non-native invasive species control. Associated activities would be expected to directly and indirectly benefit the ecosystems in this ecosystem group.

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

Determination of Effects. In the next 10 and 50 years, it is anticipated that the direct, indirect and cumulative effects of this alternative on the sustainability of depressional wetlands and Carolina bays would be good . Alternative 2 would provide desired conditions for maintaining and restoring 73 percent of the total extent of Carolina bay and depressional wetland ecosystems on the forest with prescribed fire and other tools.

Alternative 3

Direct and Indirect Effects. Under this alternative pondcypress savanna and cypress tupelo pond vegetation occurring within depressional wetlands and Carolina bays would be maintained, improved and restored, particularly within Management Area 1, where natural fire regimes would

be restored. Associated activities would be expected to directly and indirectly benefit these ecosystems, but over a lesser area than Alternative 2. Depressional wetlands in the Wando Area would be threatened by lack of prescribed fire and successional vegetation since they would not occur in Management Area 1 in this alternative.

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

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

Composite Sustainability Ranking

Key characteristic and indicators for evaluating sustainability of the Carolina Bay and depression pond ecosystem group are described in Appendix E and are outlined in Table 3-11. The key characteristics and indicators in Table 3-12 were determined to be important, but were not used due to lack of data.

The acreage that would be maintained and restored in Carolina bay and depression pond ecosystems scores good in Alternative 2 and to a more limited extent in Alternative 3. Alternative 2 would provide desired conditions for maintaining and restoring 73 percent of the total extent of Carolina bay and depressional wetland ecosystems on the forest with prescribed fire and other tools, compared to 52 percent of the total extent in Alternative 3. The 1996 forest plan did not include direction (Alternative 1) to restore Carolina bays and depressional wetlands, though it did include direction to maintain them. In Alternative 1, key characteristics related to connectivity, fire regime, non-native invasive species, structural diversity and vegetation condition would all rank poor to fair. All would increase to good levels after both 10 and 50 years based on management direction in Alternatives 2 and 3.

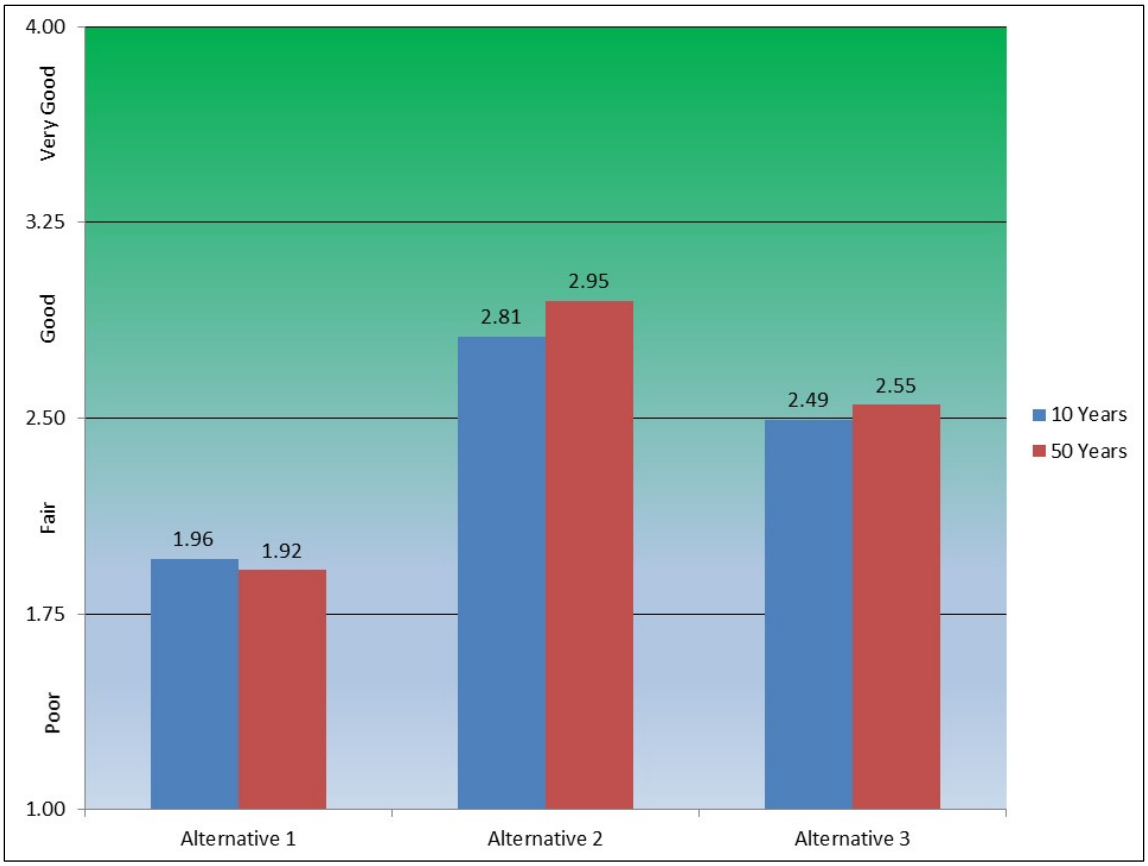

Figure 3-12. Forestwide Depressional Wetlands and Carolina Bay Ecological Sustainability Scores

Table 3-15. Key characteristic and indicators for evaluating sustainability of the Carolina Bay and depression pond ecosystem group

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

Table 3-16. Key characteristics and indicators that were determined to be important, but were not used due to lack of data

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

3.3.1.5 Affected Environment: Pocosins

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

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

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

3.3.1.6 Environmental Consequences: Pocosins

Alternative 1

Direct and Indirect Effects. The 1996 Forest Plan includes an objective to “[I]dentify and maintain existing acreage in ...bay swamp pocosin.” Based on LiDAR, Simon and Hayden (2014) predict relatively modest acreage in peatland pocosin and canebrakes, pocosin vegetation in Carolina bays and streamhead seepage swamp, pocosin and baygalls (9,322 acres).

Many pocosins and associated ecotones would continue to be threatened by successional vegetation, lack of frequent prescribed fire and feral hogs. Directly and indirectly, pocosins would

be maintained on the forest, but key characteristics in regard to vegetation composition, herbaceous groundcover, fire regime and open canopy structure would be less likely to occur.

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

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

Alternative 2 – Proposed Action

Direct and Indirect Effects. Under this alternative pocosins would be maintained, improved and restored, particularly within Management Area 1 where natural fire regimes would be restored. Few proposed activities are likely to occur in pocosins, other than dormant and growing season prescribed fire, and these activities would be expected to directly and indirectly benefit these ecosystems.

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

Determination of Effects. In the next 10 and 50 years, it is anticipated that the direct, indirect and cumulative effects of this alternative on sustainability of pocosins would be good. Alternative 2 would provides desired conditions for maintaining and restoring 79% percent of the total extent of pocosin group ecosystems on the forest with prescribed fire and other tools.

Alternative 3

Direct and Indirect Effects. Under this alternative, pocosins would be maintained, improved and restored, particularly within Management Area 1, where natural fire regimes would be restored. Few activities are likely to occur in pocosin ecosystems, other than frequent dormant and growing season prescribed fire. These activities would be expected to directly and indirectly benefit these ecosystems.

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

Determination of Effects. In the next 10 and 50 years, it is anticipated that the direct, indirect and cumulative effects of this alternative on sustainability of pocosins would be good. Alternative 3 would provide desired conditions for maintaining and restoring 63.4% percent of the total extent of pocosin group ecosystems on the forest with prescribed fire and other tools.

Composite Sustainability Ranking

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

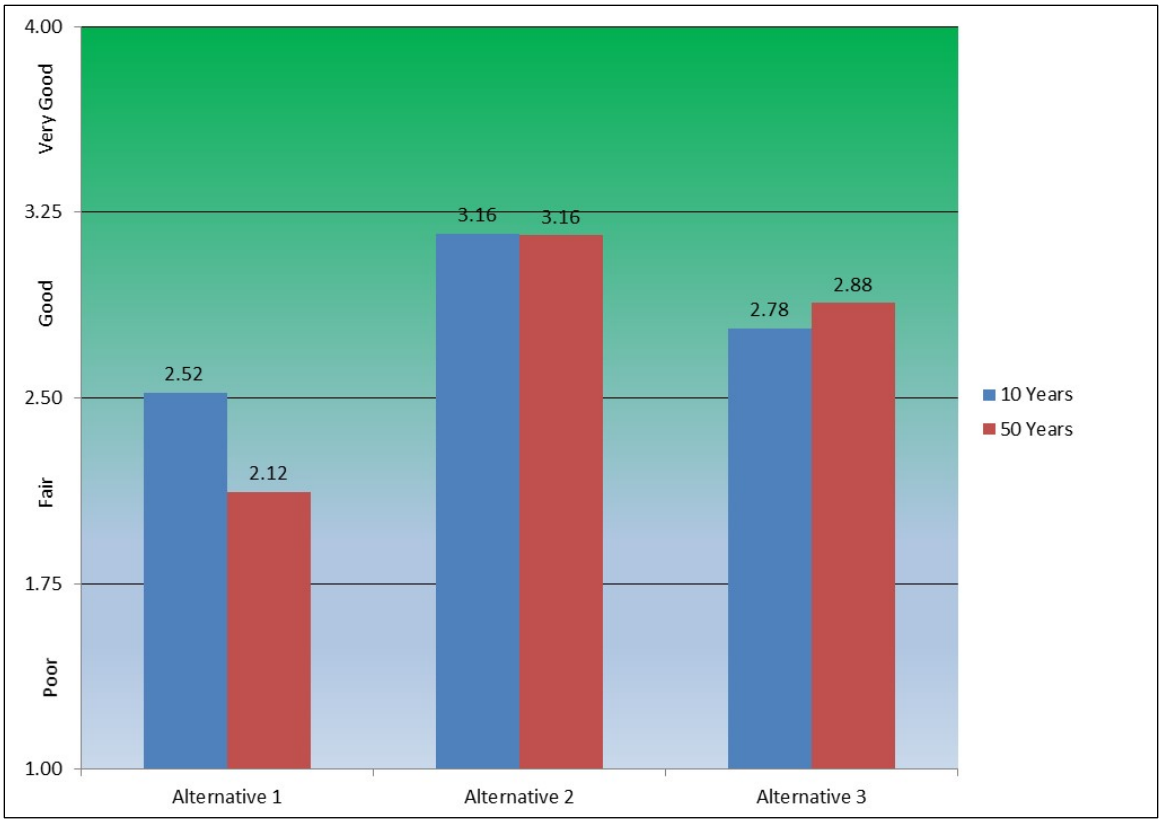

Figure 3-13. Forestwide Pocosin Ecological Sustainability Scores

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

Table 3-17. Key characteristics and indicators for evaluating sustainability of the ecosystems associated with the pocosin ecosystem group

Key Characteristic	Indicator
Connectivity	OHV Trail Density
Connectivity	Paved Open Road Density
Connectivity	Unpaved Open Road Density
Function	Percent of System Acres Burned at Desired Return Interval
Function	Percent of System Acres Burned During the Growing Season
Stressor	Percent of Ecosystem Extent Impacted by Invasive Plant Species
Composition	Percent of Ecosystem Extent dominated by characteristic Native Species

Table 3-18. Key characteristics and indicators that were determined to be important but were not used due to lack of data

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

The acreage that would be maintained and restored in ecosystems associated with the pocosin ecosystem group scores good in Alternatives 2 and 3. Alternative 2 would provide desired conditions for maintaining and restoring 79 percent of the total extent of pocosin group ecosystems on the forest with prescribed fire and other tools, compared to 63.4 percent of the total extent in Alternative 3. In Alternative 1, the current condition of key characteristics related to connectivity would all rank very good, though their condition would be expected to decline in the 50-year interval due to lack of forest plan direction to restore them.

3.3.1.7 Affected Environment: Oak Forests and Mesic Hardwood Forests

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

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

Natural fire regimes for oak and mesic hardwood forests would be relatively infrequent. Approximately 75 percent of the modeled dry and dry-mesic oak acres have been prescribed burned 3 or more times between 2005 and 2012 which is a higher frequency than one would predict under natural disturbance regimes (LANDFIRE predicts a 5-10 year return interval for dry mesic oak forests and a 35-year interval for mesic slope forests). Several mesic and calcareous hardwood forest communities are threatened by non-native invasive plants (Everett, 2012; McMillan et al., 2001). Structural departure analysis for the upland hardwood ecosystems suggests that the forest's upland hardwood forests and mesic slope forests are moderately departed in structure compared to reference conditions (LANDFIRE, 2006), with a relatively low percentage in late successional open conditions, and there are no stands qualifying as old growth.

3.3.1.8 Environmental Consequences: Oak Forests and Mesic Hardwood Forests

Alternative 1

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

Cumulative Effects. The Francis Marion National Forest plays a relatively small role in providing for oak and mesic hardwood ecosystems, which are relatively uncommon across the landscape.

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

Alternatives 2 and 3

Direct and Indirect Effects. Under both Alternatives 2 and 3, oak and mesic hardwood forests would be maintained, improved and restored on appropriate sites wherever they occur. In some cases, this could take decades to achieve. Activities such as less frequent fire, non-native invasive treatments and loblolly pine thinning or removal could indirectly benefit these ecosystems. The direct and indirect effects of these alternatives would be an improvement in the vegetation composition and the structure of oak and mesic hardwood forests on ecologically suitable sites across the landscape.

Cumulative Effects. The Francis Marion National Forest plays a relatively small role in providing for oak and mesic hardwood ecosystems, which are relatively uncommon across the landscape.

Determination of Effect. In the next 10 and 50 years, it is anticipated that the direct, indirect and cumulative effects of Alternatives 2 and 3 on the ecological sustainability and integrity of oak forests and mesic hardwood forests would be good, since associated ecosystems would be maintained and restored on appropriate sites wherever they occur.

Composite Sustainability Ranking

Key characteristics and indicators for evaluating sustainability of the ecosystems associated with the oak and mesic hardwood ecosystem group are described in Appendix E and outlined in Table 3-15. The key characteristics and indicators in Table 3-16 were determined to be important, but were not used due to lack of data.

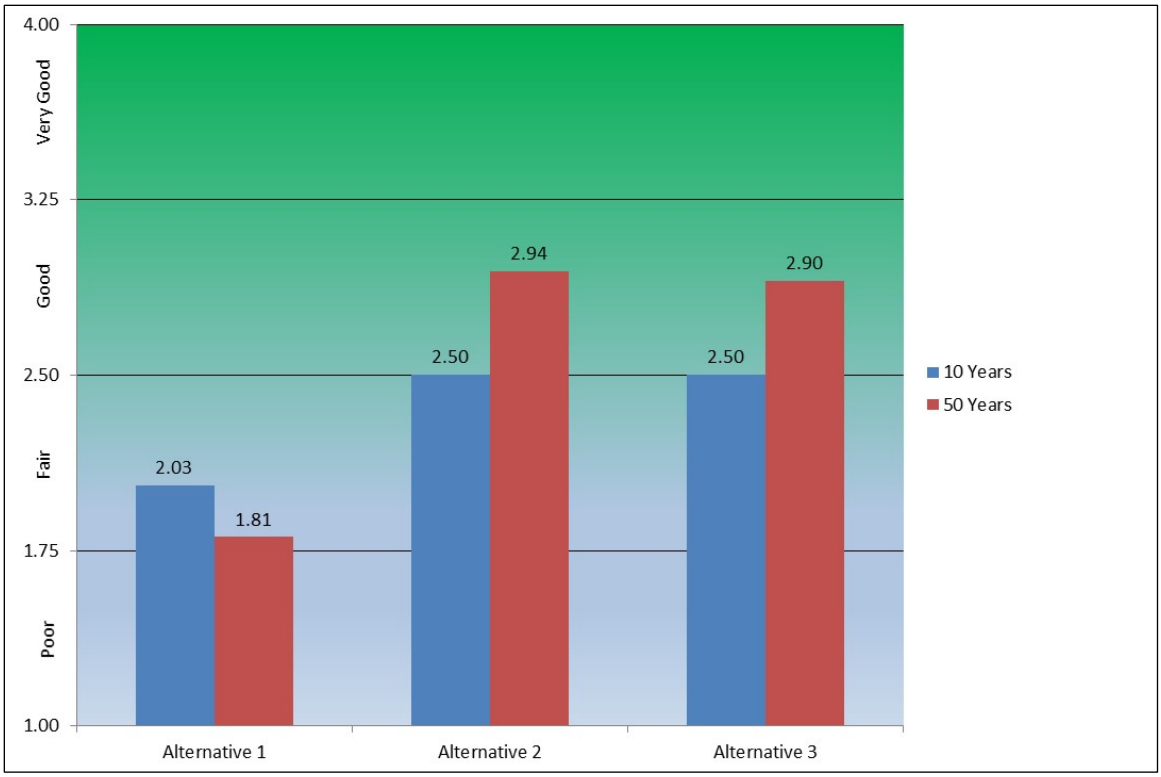

Figure 3-14. Forestwide Oak and Mesic Hardwood Ecological Sustainability

Table 3-19. Key characteristics and indicators for evaluating sustainability of the ecosystems associated with the oak and mesic hardwood ecosystem group

Key Characteristic	Indicator
Connectivity	OHV Trail Density
Connectivity	Paved Open Road Density
Connectivity	Unpaved Open Road Density
Function	Percent of System Acres Burned at Desired Return Interval
Stressor	Percent of Ecosystem Extent Impacted by Invasive Plant Species
Structure	Percent of Old Growth Forest
Composition	Percent of Ecosystem Extent dominated by characteristic Native Species
Structure	Ecological Departure Ranking (Structure)

Table 3-20. Key characteristics and indicators that were determined to be important, but were not used due to lack of data

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

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

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

Forested wetlands were grouped into 2 ecosystem groups based on similarities in disturbance regimes, landscape position and vegetation dynamics. Collectively, forested wetlands occupy 36 percent of the forest (93,100 acres), occurring predominantly as narrow (10 percent) or broad (15 percent) non-riverine swamps. The planning team grouped narrow forested swamps and blackwater stream floodplain forests to include small blackwater river and stream floodplain forests and narrow non-riverine swamp and wet hardwood forested ecosystems. It also grouped broad forested swamps and large river floodplain forests to include broad non-riverine swamp and wet hardwood forests, large river floodplain forests and tidal wooded swamps. Flooding is the most important ecological factor influencing associated ecosystems, though fire can vary from a minor to a significant influence on vegetation composition and structure. The original vegetation was likely a true shifting mosaic, where prescribed burning influenced peat build-up, hydrology and vegetation (Simon and Hayden, 2014).

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

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

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

Alternative 1 – No Action

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

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

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

Determination of Effect. In the next ten years, it is anticipated that the direct, indirect and cumulative effects of Alternative 1 on the ecological sustainability and integrity of forested wetlands would be good for broad forested swamps, large river floodplain forests, narrow forested swamps and blackwater steam floodplain forest; they would drop slightly to fair for narrow forested swamps and blackwater steam floodplain forests in the 50-year interval, given the lack of desired conditions, including prescribed fire.

Alternative 2

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

invasive species would be likely to increase in this alternative at 10- and to greater extent 50-year intervals.

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

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

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

Alternative 3

Direct and Indirect Effects. The restoration and maintenance of ecosystems associated with both broad and narrow forested groups would occur in both Management Areas 1 and 2, though prescribed fire would be used as a management tool only in Management Area 1, where 43 percent of ecosystems associated with the narrow forested ecosystem and 27 percent of the broad forested ecosystems occur. Direct and indirect effects could result from prescribed burning and limited harvest, but the influence on fire-adapted species occurring in the narrow forested ecosystem group would be less than in Alternative 2 but greater than Alternative 1. Harvesting in bottomland hardwood and cypress-tupelo forests to restore these ecosystems or their structure would occur at somewhat lower levels than Alternative 2, but higher than in Alternative 1. Although some treatment would occur to manageable levels, due to the remote nature of the broad forested wetland group, non-native invasive species would be likely to increase in this alternative at 10- and to greater extent 50-year intervals.

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

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

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

Composite Sustainability Ranking

Key characteristics and indicators for evaluating sustainability of the ecosystems associated with both narrow non-riverine swamp and blackwater stream and broad non-riverine swamp and large river floodplain ecological groups are outlined in Table 3-17. The key characteristics and indicators in Table 3-18 were determined to be important, but were not used due to lack of data.

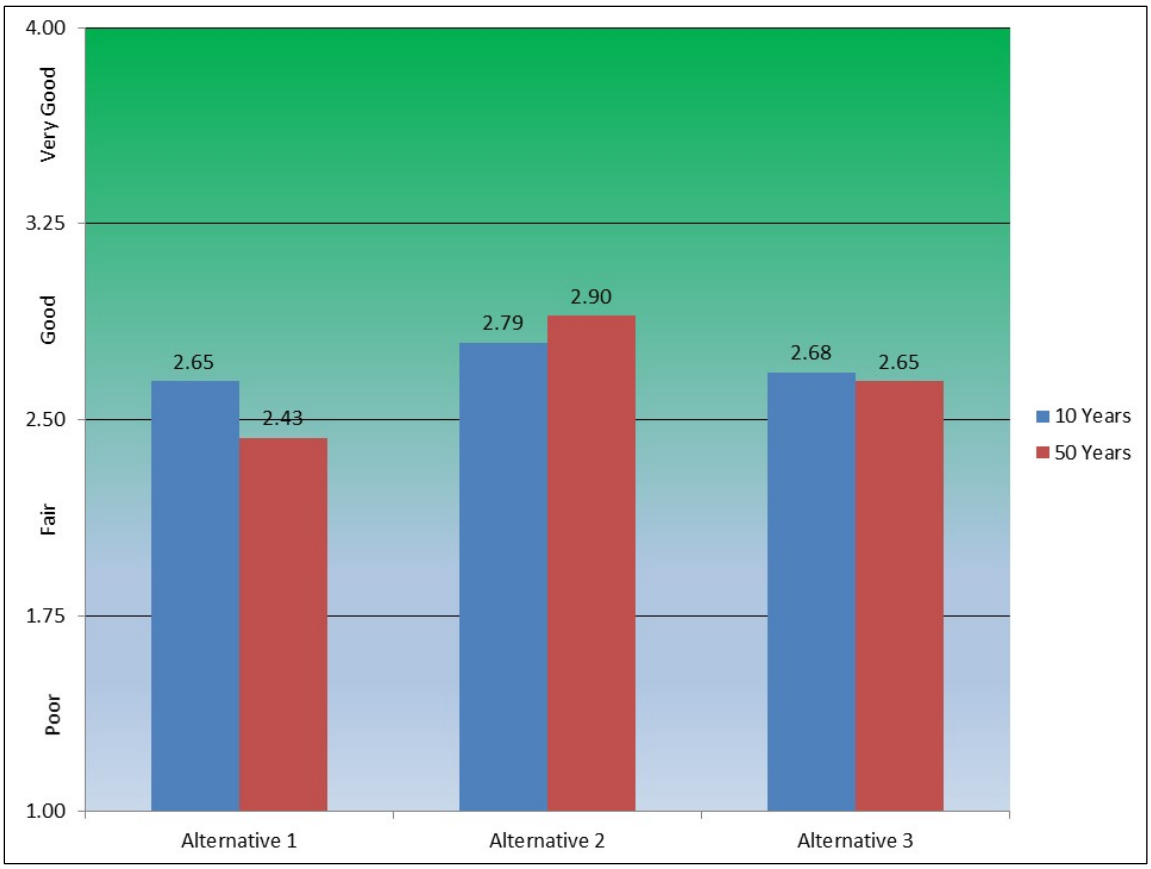

Figure 3-15. Forestwide Narrow Non-Riverine Swamp and Blackwater Stream ecological sustainability scores

Table 3-21. Key characteristics and indicators for evaluating sustainability of the ecosystems associated with both narrow non-riverine swamp and blackwater stream and broad non-riverine swamp and large river floodplain ecological groups

Key Characteristic	Indicator
Stressor	Sea-Level Rise, with saltwater overwash of terrestrial systems
Function	Percent of System Acres Burned at Desired Return Interval
Connectivity	OHV Trail Density
Connectivity	Paved Open Road Density
Connectivity	Unpaved Open Road Density
Stressor	Percent of Ecosystem Extent Impacted by Invasive Plant Species
Structure	Percent of Old Growth Forest
Structure	Ecological Departure Ranking (Structure)
Composition	Percent of Ecosystem Extent dominated by characteristic Native Species

Table 3-22. Key characteristics and indicators that were determined to be Important but were not used due to lack of data

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

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

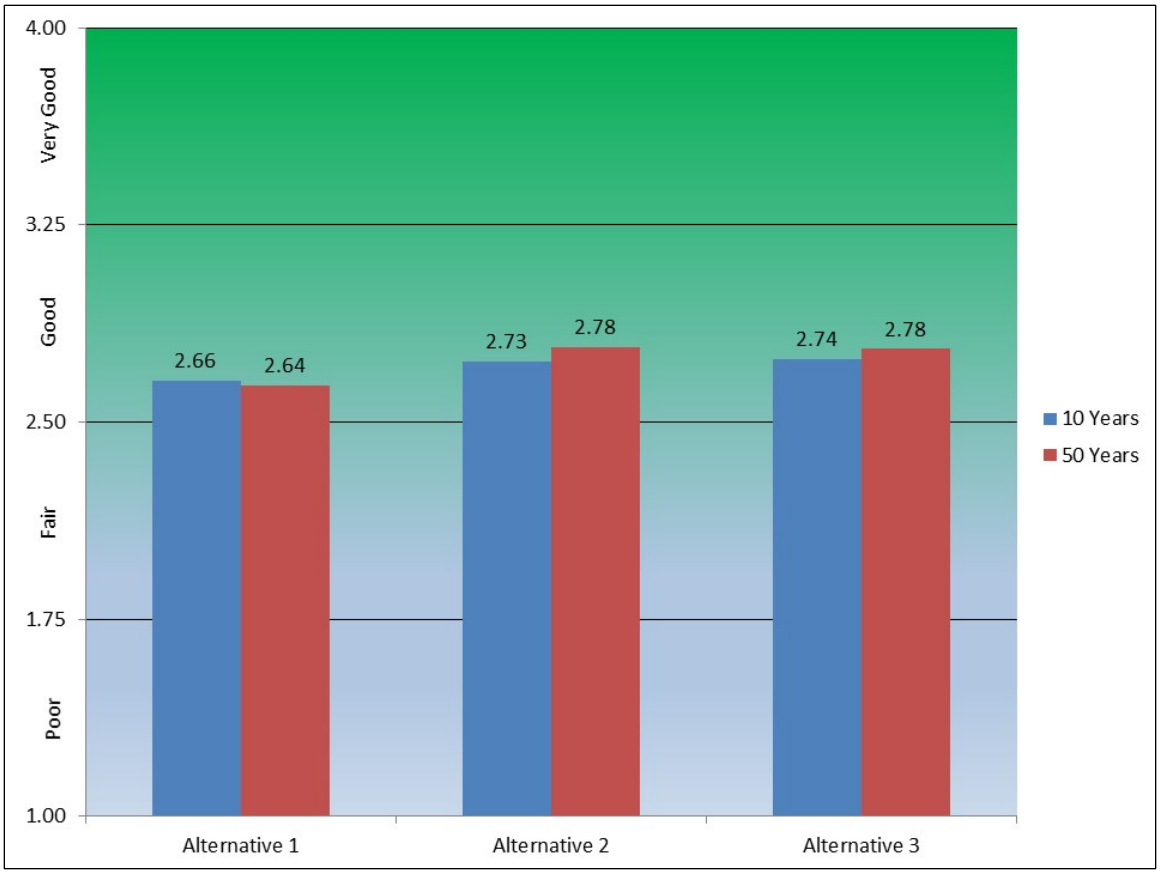

Figure 3-16. Forestwide Broad Non-Riverine Swamp and Large River Floodplain ecological sustainability scores

3.3.1.11 Affected Environment: Maritime Forests and Salt Marsh

The 1996 Forest Plan contains an objective to, "[I]dentify and maintain existing acreage in.. maritime forest". Several areas containing maritime fringe and salt marsh have been acquired by the forest since 1996 in the vicinity of Guerin Bridge Road, much in bedded loblolly pine (Porcher, 2005). Only a coastal fringe of maritime forest is identified through current mapping efforts (1200 acres) and both freshwater marsh and saltwater marsh in Forest Service ownership

are relatively uncommon (2800 acres). Many maritime fringe forests are threatened by past management practices which included ditching and diking for rice production (Porcher, 2005), planting of loblolly pine, non-native invasive species and hurricanes. Approximately 21 percent of our maritime forests are dominated by loblolly pine. In the future, they will be threatened by sea-level rise and climate change.

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

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

3.3.1.12 Environmental Consequences: Maritime Forests and Salt Marsh

Alternative 1

Direct and Indirect Effects. Ecosystems in this group would be maintained in Alternative 1 but not restored, and would continue to be impacted by non-native invasive species.

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

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

Alternative 2 – Proposed Action

Direct and Indirect Effects. All maritime forests and salt marsh ecosystems on the forest would be maintained and restored in Alternative 2. Probable activities could include non-native invasive species control, plugging of ditches or restoration of vegetation to species composition typical of maritime forests.

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

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

Alternative 3

Direct and Indirect Effects. All maritime forests and salt marsh ecosystems on the forest would be maintained and restored in Alternative 3. Probable activities could include non-native invasive species control, plugging of ditches or restoration of vegetation to species composition typical of maritime forests.

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

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

Composite Sustainability Ranking

Key characteristics and indicators for evaluating sustainability of the ecosystems associated with the maritime forest and salt marsh ecosystem group are described in Appendix E and are outlined in Table 3-20. The key characteristics and indicators in Table 3-19 were determined to be important, but were not used due to lack of data.

The acreage that would be maintained and restored in ecosystems associated with the maritime forest and salt marsh group score good in regard to ecological sustainability in Alternatives 2 and 3. Alternatives 2 and 3 would provide desired conditions for maintaining and restoring 100 percent of the total extent of this ecosystem group. In Alternative 1, maritime forests would be maintained but not restored and would be ranked poor or fair for non-native invasive species, landscape structural diversity and old growth. Negative direct, indirect and cumulative impacts to ecological sustainability associated with non-native invasive plant species, high road densities, and lack of direction to maintain old growth conditions would be likely to increase in the 50- year interval.

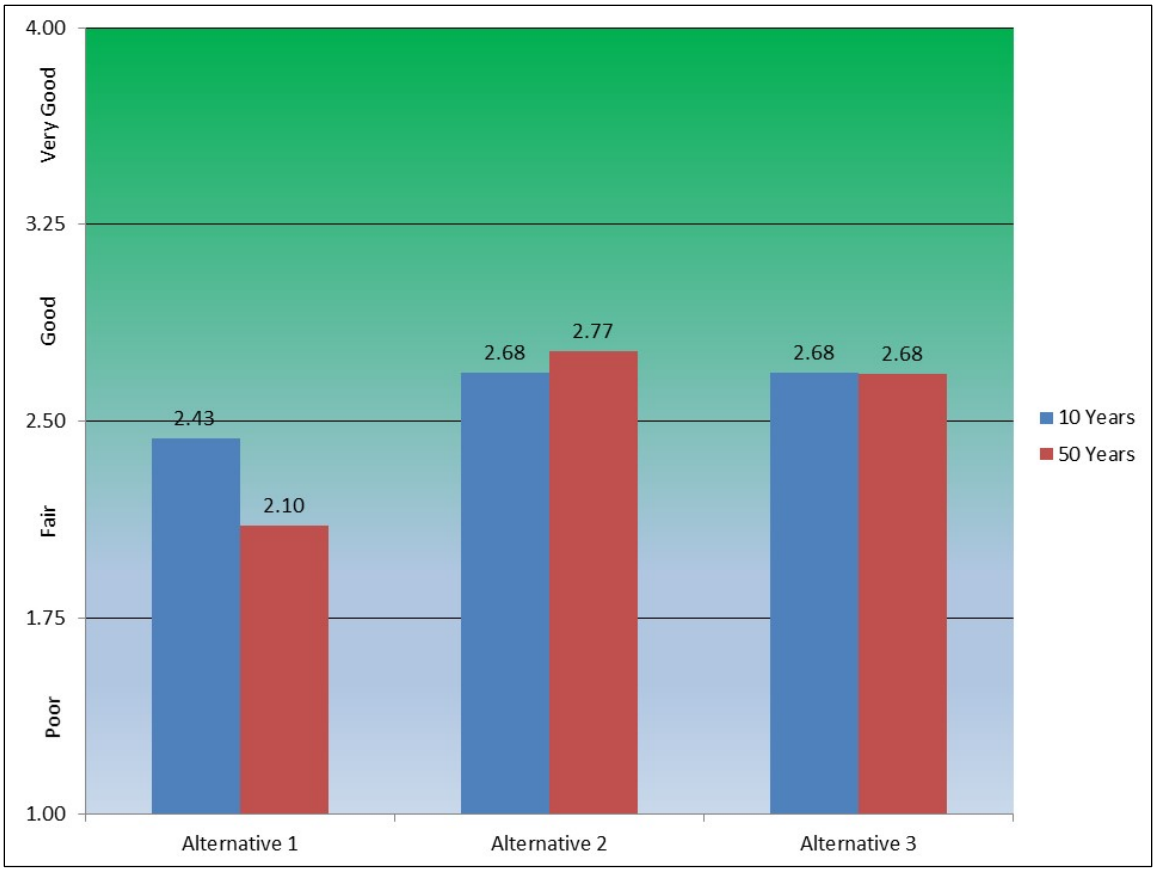

Figure 3-17. Forestwide Maritime Forest and Salt Marsh ecological sustainability scores

Table 3-23. Key characteristic and indicators for evaluating sustainability of the ecosystems associated with the maritime forest and salt marsh ecosystem group

Key Characteristic	Indicator
Stressor	Sea Level Rise, with saltwater overwash of terrestrial systems
Connectivity	OHV Trail Density
Connectivity	Paved Open Road Density
Connectivity	Unpaved Open Road Density
Stressor	Percent of Ecosystem Extent Impacted by Invasive Plant Species
Structure	Percent of Old Growth Forest
Structure	Ecological Departure Ranking (Structure)
Composition	Percent of Ecosystem Extent dominated by characteristic Native Species

Table 3-24. Key characteristics and indicators that were determined to be important, but were not used due to lack of data

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

3.3.1.13 Affected Environment: Rivers and Streams

The Francis Marion contains portions of 27 6th level watersheds that drain to the Atlantic Ocean. Forest Service ownership is greatest within the Nicholson Creek and Headwaters Wambaw Creek watersheds at 97 percent and 95 percent respectively. Ownership is disjunct with private inholdings throughout the watersheds.

Table 3-25. Summary of desired conditions for streams and rivers in management areas 1 and 2

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

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

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

Habitat Connectivity. The physical structure of aquatic habitats is a major factor in the continuity between and heterogeneity within aquatic habitats that supports the local diversity of fauna and flora. Dams, culverts and roads can act as barriers to aquatic organism movement

within and among streams, as well as movement into the respective floodplain. The physical configuration of streams and rivers provides a rich diversity of habitats such as undercut banks, riffles and deep pools where fish and other fauna feed, rest and breed. Alterations to the hydrologic and energy regimes of streams or rivers affect the physical structure of aquatic habitats (Palmer et al., 2005).

The entire forest has had various hydrological modifications (see stream channel morphology). These modifications to the streams have reduced habitat quality and connectivity to many aquatic species. The forest has more than 1,000 non-road hydrological modifications within the 27 sub-watersheds associated with forest streams.

Federally listed species that occur on or near the forest are listed in Table 3-22. These species have been addressed in the Aquatic Viability Analysis (Chapter 3).

Table 3-26. Federally listed species that occur on the Francis Marion National Forest

Scientific Name	Common Name	Status
Acipenser brevirostrum	shortnose sturgeon	E
Acipenser oxyrinchus	Atlantic sturgeon	E
Anguilla rostrata	American eel	Petitioned

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

As noted previously, the Francis Marion contains portions of 27 6th level watersheds that drain to the Atlantic Ocean. Forest Service ownership is greatest within the Nicholson Creek and Headwaters Wambaw Creek watersheds at 97 percent and 95 percent respectively. Ownership is disjunct with private inholdings throughout the watersheds.

3.3.1.14 Environmental Consequences: Rivers and Streams

Alternative 1

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

Prescribed fires naturally maintain many ecosystems on the forest. Theses activates would include fire lines that, if improperly placed could alter habitat. These fire activities would have the potential to enter the riparian area and crossing streams. During this activity the beneficial wood debris would potentially be consumed by fire if the intensity and severity are uncontrolled. With proper ignitions and controls fire would benefit the streams by maintaining native vegetation and introducing woody debris to the stream system. Intense fires that destroy much of the groundcover and increase sedimentation in small stream would cause negative effects to aquatic ecosystems.

Roads affect the timing and volume of stream discharges by: intercepting and concentrating surface and subsurface flows; expanding or decreasing the channel ne2rks; and reducing infiltration. The historic hydrological patterns within a watershed are altered affecting the functions and processes to which the riparian and its inclusive aquatic communities have adapted.

Migration and movement of aquatic species are primarily restricted at road crossings by hanging culverts, high water velocity, inadequate swimming depth or any combination of these 3 factors. Migration and movement barriers would potentially be desirable (in rare cases) to protect a native species and habitats from a non-native competitor or saltwater. During watershed level analysis, 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 electrofishing or replace the culvert to facilitate natural movement back into the area

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

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

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

Alternatives 2 & 3

Direct and Indirect Effects. Soil disturbance and loss of riparian vegetation would remain the largest threats to aquatic habitats in watersheds on the Francis Marion. Soil disturbance would add sediments to streams that were highly impacted by past farming and logging practices. Road and trail crossings would continue to contribute sediments to streams and could inhibit the movement of aquatic organisms within the stream system. Loss of riparian vegetation would compromise large wood and leaf litter contribution to the aquatic system, shading for stream temperature maintenance and the filtering capacity of the riparian area for sediments. The riparian management zone, which addresses perennial and intermittent streams, and the Forest Wide Standards (Chapter 3, S19 and S20) specific to ephemeral channels should mitigate most direct and indirect effects associated with aquatic resources across all action alternatives. Riparian area mapping would occur on a site-specific basis and would address aquatic habitat improvement needs. Implementation of guidelines associated with the riparian area should further minimize effects of land management activities.

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

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

Migration and movement of aquatic species are primarily restricted at road crossings by hanging culverts, high water velocity, inadequate swimming depth or any combination of these 3 factors. Migration and movement barriers would potentially be desirable (in rare cases) to protect a native species and habitats from a non-native competitor or saltwater. During watershed level analysis, 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 electrofishing or replace the culvert to facilitate natural movement back into the area

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

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

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

The areas within Forest Service lands specifically those in area with low private ownership would improve over the length of the plan.

Cumulative Effects

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

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

Composite Sustainability Ranking

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

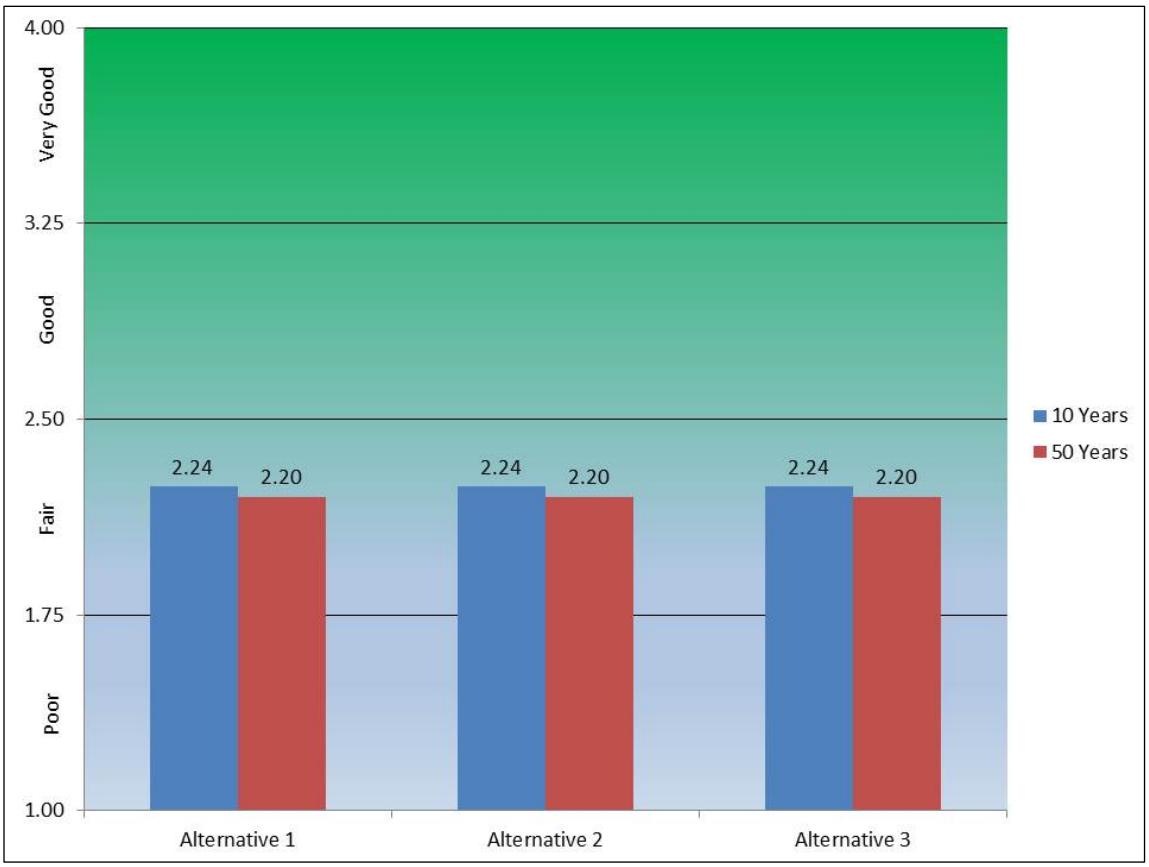

Figure 3-18. Forestwide Rivers and Streams ecological sustainability scores

Table 3-27. Key characteristic and indicators for evaluating sustainability of the ecosystems associated with the rivers and streams ecosystem group

Key Characteristic	Indicator
Potential for Coarse Woody Debris Abundance	Percent Riparian Forested
Hydrologic Function	Major Hydroelectric Dam Proximity/Influence
Water Quality--Toxics	Point Source Rating
Hydrologic Function	Road Crossing Rating
Climate Change	Sea Level Rise, with saltwater intrusion in aquatic systems
Hydrologic Function	Severity of Hydrologic Control Structures

3.3.2 Threatened and Endangered Species

This section covers federally threatened and endangered (T&E) species and any applicable candidate and proposed species which require protection or consultation under the Endangered Species Act (36 CFR 219.16). The Forest Service cooperates with both the United States Fish and Wildlife Service (USFWS) and National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA) in the identification and evaluation of species likely to be affected and in the development of Forest plan components that contribute to their recovery. Further information on the process used to identify effects to T&E species is included in Appendix E to this document and the biological assessment.

3.3.2.1 Affected Environment

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

Table 3-28. List of federally threatened, endangered, proposed and candidate species on the Francis Marion

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

3.3.2.2 Environmental Consequences

Forest planning is a 2-tier system consisting of:

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

Forest plan components, such as desired conditions, standards and guidelines and objectives, provide broad management direction. These forest plan components comply with the requirements of the Endangered Species Act of 1973 (ESA) and the associated recovery plan for each federally listed species.

Project-level analysis evaluates site-specific impacts, based on-the-ground conditions. Additional mitigation measures may be developed, if it is determined that they are needed.

Direct and Indirect Effects Common to All Alternatives

In general, all federally T&E species would continue to be managed and protected across the forest in accordance with Forest Service policy, recommended protection measures in the recovery plans and all applicable state and federal laws. Individual projects during the next planning period may result in direct negative effects to an individual, but effects analysis and consultation will take place at the project level should this situation ever occur.

The following sections provide information for each of the federally listed species with regards to the effects of implementing each alternative. Each section also addresses how the 3 alternatives relate to each species and their effect determination. The effects of probable activities and the measures to mitigate the effects to the individual species are analyzed across all alternatives.

Cumulative Effects Common to All Alternatives

Public lands play a critical role in the conservation of rare species and native habitats, which sometimes receive little formal protection or conservation on private lands. This is especially true for federally listed plants, which receive no legal protection on private lands. During the next 10 to 50 years of forest plan implementation, human populations are likely to expand, affecting urbanization, roads and associated traffic, and prescribed burning and smoke management (see Figure 3-15). These trends suggest not only that public land will play an increasingly important role in the conservation of T&E species in the future, but also that management to ensure recovery and/or prevention of federal listing of species will be an increasingly difficult challenge.

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

For some species such as the red-cockaded woodpecker (RCW), the Forest Service consistently works beyond the plan area boundary to collaborate and cooperate with USFWS, NOAA, states, tribes, other partners, landowner, and land managers to support an all-lands approach to species recovery. The agency has worked and continues to work with partners to reintroduce at-risk species into historical habitat on National Forest System lands where appropriate.

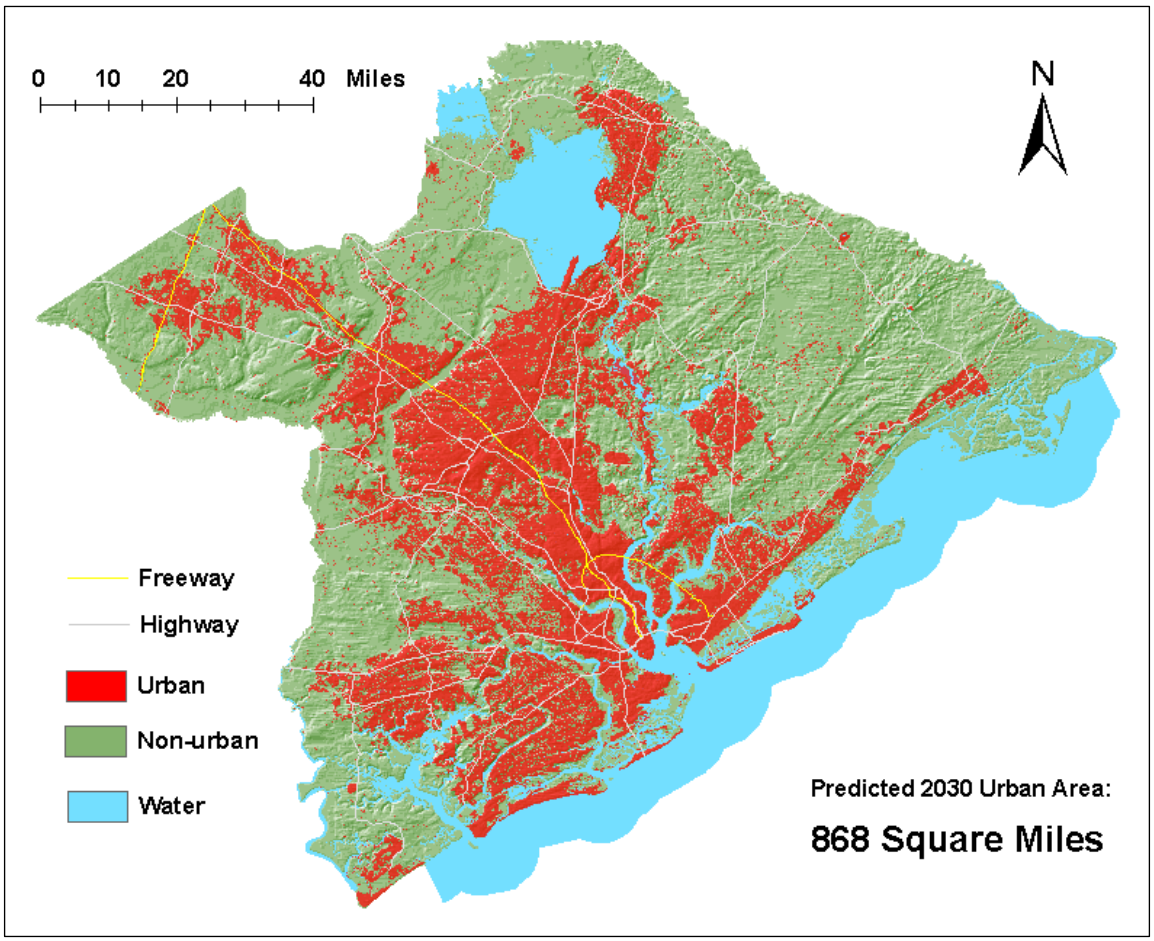

Figure 3-19. Estimated urban development in the vicinity of the Francis Marion National Forest

*American Chaffseed (*Schwalbea americana*)*

The Francis Marion National Forest has four existing American chaffseed populations of nine populations and 20 occurrences once documented. Numbers of American chaffseed plants on the forest declined by 64% between 2001 and 2014; three populations have likely become extirpated (Ballfield, Hwy.41 and Cordesville). 2 populations were enhanced with plants from an adjacent seed source in 2014. Optimal habitat for American chaffseed on the Francis Marion is upland longleaf or loblolly pine woodlands, maintained very open with frequent prescribed fire or mowing and a diverse herbaceous component.

Several studies and monitoring efforts document the dependence of American chaffseed on frequent prescribed fire regimes (Kirkman et al., 1998) and on the Francis Marion declines are evident after 2 years without fire (Streng and Glitzenstein, 2004). Other threats to the species include destruction and adverse modification of habitat through the following: development and incompatible agriculture and silviculture practices; incompatible rights-of-way activities; non-native invasive plants; drought; genetic bottlenecks; and herbivory (USDI, 1995; 2010).

In the 1996 Forest Plan, all American chaffseed occurrences were included in Management Area 26, which was dedicated to longleaf ecosystem restoration and contained a standard to prescribe burn this management area on a 2-3 year rotation. Due to smoke management and public safety concerns in the Wildland -Urban interface (WUI), only 34% of this management area was

prescribed burned on at least a 3-year rotation between 2004 and 2012, and populations which declined went for a period without the frequent prescribed fire needed to maintain them. Given the plant's dependence on frequent fire, the location of several sites in the WUI, and semi-parasitic growth habit resulting in low levels of survival in the field, and difficulties in detection and monitoring, it is likely that this species will always be considered rare.

Alternative 1

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

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

Alternatives 2 and 3

Direct and Indirect Effects. The desired conditions and standards associated with Management Area 1 in both Alternatives 2 and 3 would indirectly facilitate the restoration and maintenance of key characteristics associated with upland longleaf ecosystems and habitat for American chaffseed by creating open conditions maintained with frequent prescribed fire. All existing and historic populations for American chaffseed would be included within Management Area 1 in both Alternatives 2 and 3.

Direct effects to American chaffseed would be unlikely across all alternatives, since T&E species would be addressed and conserved through site-specific analysis.

- As a result of implementing Alternative 1, there are likely to be beneficial effects to American chaffseed and associated longleaf ecosystem habitat.
- As a result of implementing Alternatives 2 and 3, there are likely to be beneficial effects to American chaffseed and associated upland longleaf woodland habitat.

Cumulative Effects

American chaffseed is a perennial herbaceous plant in the figwort family (Scrophulariaceae). Recovery criteria include, "[B]iennial monitoring shows that 50 protected populations are viable as well as stable or increasing over a 10-year period," and "[L]ong-term protection is achieved for 50 geographically distinct, self-sustaining populations." The USFWS conducted a five-year review for American chaffseed in 2010 and identified one site each in Alabama, Florida and Louisiana; 2 in New Jersey; 11 in North Carolina; and 33 in South Carolina.

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

*Canby's Dropwort (*Oxypolis canbyi*)*

On the Francis Marion, one population containing ten plants for Canby's dropwort was confirmed from a depressional wetland pond dominated by pondcypress savanna in 2000. Only one plant was located there by Gaddy in 2006 (USDI, 2006) who described the habitat (Tibwin cypress

savanna) as excellent. No plants have been relocated at this site or at another unconfirmed, pondcypress depression (Gramling, 2003).

Optimal habitat for Canby's dropwort is depressional wetlands or Carolina bays maintained open and herbaceous with frequent prescribed fire. Glitzenstein (2012) found that the species was impacted by succession, lack of prescribed fire, woody competition from red maple and loblolly pine and feral hogs. One of the most significant threats to the species range wide is loss or alteration of rare wetland habitat (USDI, 2010).

Alternative 1

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

Alternative 2 and 3

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

Direct effects to Canby's dropwort would be unlikely across all alternatives since T&E species would be addressed and conserved through the site-specific biological assessment process. There would likely be beneficial effects to Canby's dropwort and associated depressional wetland and Carolina bay ecosystems and habitats in Management Area 1 to the greatest extent in Alternative 2, followed by Alternative 3 and then Alternative 1.

Cumulative Effects

Canby's dropwort is a perennial herbaceous plant in the carrot family (Apiaceae). In the Five-Year Species Review (2010a), the USFWS conclude that eight sites for the species are currently managed and protected, including five in South Carolina (Tibwin Savanna on the Francis Marion National Forest, Monkey Meadow Bay in Clarendon County, Crosby Oxypolis Heritage Preserve in Colleton County, Longleaf Pine Heritage Preserve in Lee County and Lisa Mathews Bay in Bamberg County), 3 sites in Georgia and one in Maryland. The recovery goal is that at least 14 sites are currently extant self-sustaining populations and that necessary management actions are being undertaken by landowners to ensure their continued survival.

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

*Pondberry (*Lindera melissifolia*)*

Pondberry is a woody shrub in the Lauraceae family. The Francis Marion harbored five natural populations for pondberry in 2013, plus one population, which has been introduced (French Quarter Creek Road). Recovery plans emphasize that first priority be given to management and enhancement of populations at known and historic sites for the species, where possible. Since 1996, 11 new occurrences for the plant have been found and, as of 2010, at least nine of those contained 200-1000 stems, though little fruit reproduction has been observed (Gustafson, 2012; Glitzenstein, 2004). As of 2013, 24 occurrences had been documented on the forest (Francis Marion and Sumter National Forests' GIS and monitoring data).

Optimal habitat for pondberry on the Francis Marion are depressional wetlands – including limesinks and associated ecotones maintained open with frequent prescribed fire and with an herbaceous component. A combination of fire, hydrology and open canopies are important in maintaining and restoring the species and could play a role in fruit production. Information on management needs for this species has evolved from protection of colonies to careful management since 1996 (Glitzenstein, 2007; Gustafson, 2012; Lockhart et al., 2013).

Notable declines in pondberry have occurred since 1996 at the Honey Hill population, which at one time harbored the largest concentration of pondberry in South Carolina. Working with the South Carolina Native Plant Society, declines at the Honey Hill population have been reversed by more active management to open the canopy, restore longleaf pine savannas and prescribe burn into the ecotone of the ponds (Glitzenstein , 2007).

The Forest Service working with The Citadel under the guidance of Gustafson (2012) identified genetic limitations to population vigor and enhanced 2 of the forest's pondberry populations, one with female plants (Hoover-Brick Church-Hwy.41) and the other with both males and females at Echaw Road (this population had declined to less than 10 stems).

Other threats to the species include a fungus which causes die back of stems, factors which draw down the hydrology of associated ponds, genetic bottlenecks associated with isolated populations and lack of fire. Although laurel wilt occurs on the forest and is a threat to species in the Lauraceae family, Forest Service research confirmed that pondberry stems are too small to be infected.

Alternative 1

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

Alternative 2 and 3

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

- All known pondberry occurrences and populations occur in the proposed Management Area 1 within Alternative 2.

- In Alternative 3, three occurrences and one introduced population occurring in the Wando Zone would not be included in Management Area 1 and associated depressional wetlands would not be maintained with prescribed fire.

Alternative methods of woody species control could maintain the species in these areas, but indirect benefits to habitats would be greater in Alternative 2 than Alternative 3.

Direct effects to pondberry would be unlikely across all alternatives, since T&E species would be addressed and conserved through the site-specific biological assessment process.

- As a result of implementing Alternative 1, there are likely to be beneficial indirect effects to pondberry and associated habitat, but these improvements in habitat would be less than in Alternatives 2 and 3.
- There are likely to be beneficial effects to pondberry and associated habitat in Alternatives 2 and 3, but benefits would be somewhat greater in Alternative 2 due to the somewhat greater acreage in depressional wetland and Carolina bay ecosystems being restored.

Cumulative Effects

As of 2007, there were 54 potential populations for pondberry including Alabama (2), Arkansas (19), Georgia (7), Mississippi (16), Missouri (1), North Carolina (2), and South Carolina (7). According to the recovery plan (1993), pondberry may be downlisted as threatened when 15 self-sustaining populations are protected and delisted with the permanent protection of 25 self-sustaining populations. Based on long-distance flight distances of ground-dwelling bees that pollinate pondberry, a more recent definition of a pondberry population is, “colony or colonies separated by at least one mile from other colonies” (Devall et al., 2001; USDI, 2007). Climate change could jeopardize the existence of isolated populations in the future which are more likely to have low genetic diversity to adapt to change.

*Red-cockaded woodpecker (*Picoides borealis*)*

The forest is currently managing for RCW under the 2003. Recovery plan for the red-cockaded woodpecker (Picoides borealis): second revision (RCW Recovery Plan). Of all plant and animal species known to occur on the Francis Marion, no other species has a greater influence on Forest Service management than the RCW. The Francis Marion supports the third largest population of the federally endangered RCW in the U.S. and is one of 13 designated core recovery populations.

Prior to Hurricane Hugo in 1989, the RCW population consisted of approximately 477 groups and was one of the only known naturally expanding populations. In one night, Hurricane Hugo killed an estimated 63 percent of the RCW population, destroyed 87 percent of the cavity trees and 59 percent of the foraging habitat across the Francis Marion (Hooper et al. 1990; Hooper et al. 1991). Due to aggressive habitat management and installation of more than 2,800 artificial cavities, the RCW population has rebounded to approximately 469 active clusters as of January 1, 2015 (see Figure 3-16).

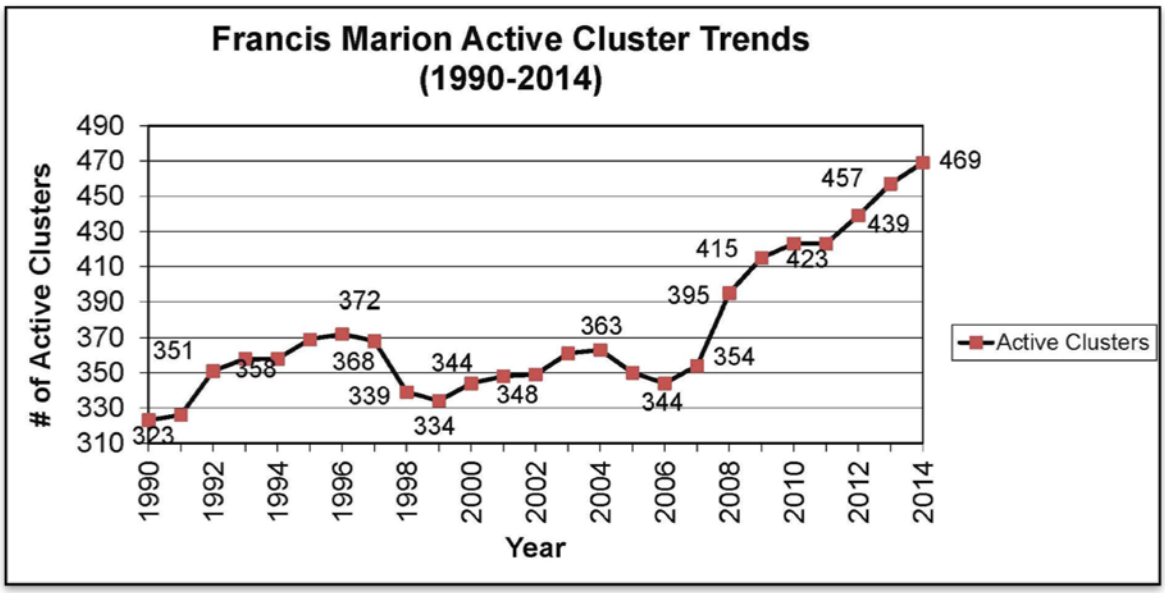

Figure 3-20. Active cluster trends since Hurricane Hugo

Since 2007, the Francis Marion National Forest's RCW population has exceeded the recovery goal of 350 potential breeding groups (PBGs) as described in the RCW Recovery Plan (see Figure 3-17). Despite the fact that the majority of clusters on the forest have foraging habitat that does not meet the recovery standard, the Francis Marion supports one of the most robust populations in the country. Based on intensive monitoring conducted in 2009, the average group size on the Francis Marion is greater than 3 birds/group and reproductive success averages approximately 2.2 to 2.3 fledglings per successful nest.

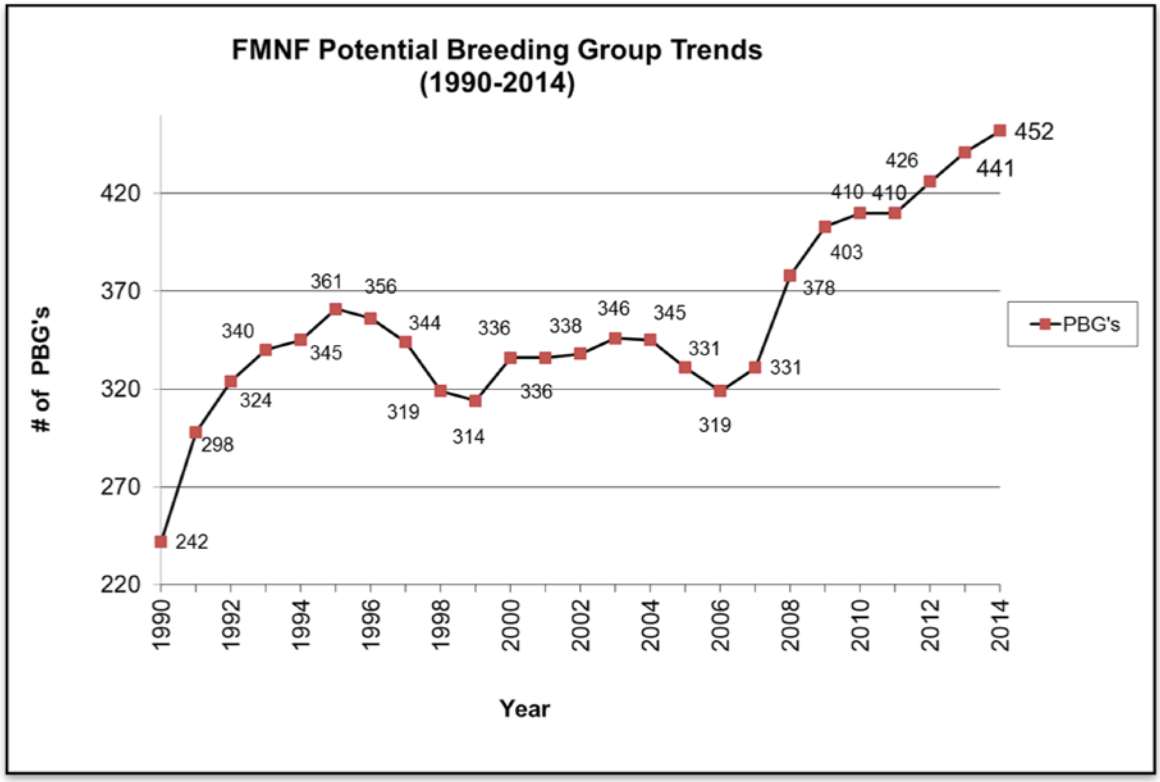

Figure 3-21. Potential breed group trends on the Francis Marion since 1990

The Francis Marion RCW population is expanding in some areas of the forest, especially in those that are consistently burned on a 2-3 year return interval. Areas that have been consistently burned on a 2-3 year return interval are lumped together and called the “core burn” area (See Figure 3-18). There are some areas on the Francis Marion where clusters are becoming inactive or reduced to single bird groups (SBGs). These clusters tend to be concentrated in the wildland/urban interface (WUI) and/or areas where minimal forest management has allowed undesirable midstory succession to occur.

As one might expect, the highest densities of RCW clusters are found within the portions of the forest that have been burned the most frequently (See Figure 3-18 below). However, there are some exceptions to this trend. The southwest portion of the forest, in the vicinity of Mount Pleasant, supports some of the highest densities of RCW’s. Unfortunately, this area, particularly along Highway 41, has numerous wildland urban interface issues, which have severely limited the Forest Service’s ability to burn this area frequently.

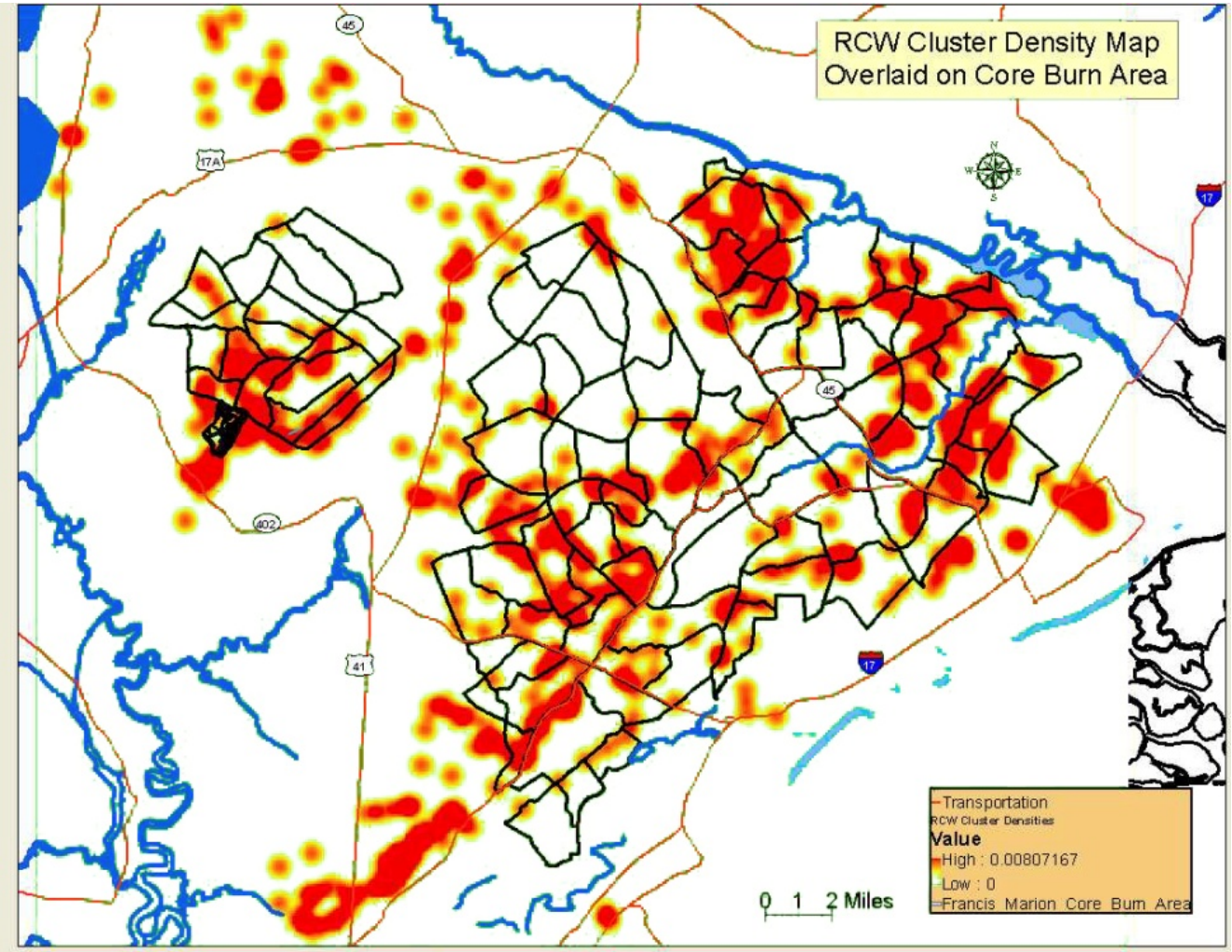

Figure 3-22. RCW clusters

Alternative 1

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

Direct effects to the RCW would be likely to occur due to the fact that prescribed burning would continue to be used. Although the RCW is dependent upon fire maintained ecosystems for its survival, the RCW is sensitive to fire injury. RCW cavity trees are highly flammable due to the amount of sap and resin that covers the main tree stem. As such, the RCW can be injured by effects of direct fire. Fire also can harm RCW cavity trees and nestlings. The latter are especially susceptible if the cavity tree catches on fire.

The desired conditions and standards associated with Management Area 26 in the 1996 Forest Plan would continue to indirectly facilitate the restoration of upland longleaf habitat for species like the RCW by creating and maintaining longleaf ecosystems with frequent prescribed fire. Although the RCW population has done well on the Francis Marion during the 1996 Forest Plan planning period, RCW management will be needed for many years to come (e.g., artificial cavity installation and replacement, mechanical midstory control and annual monitoring). Without more specific desired conditions for low canopy cover, control of NNIS and overall ecosystem restoration, Alternative 1 would not produce the amount of direct and indirect benefits that Alternative 2 is expected to produce for the RCW.

Alternative 2

Direct and Indirect Effects. Direct effects would be the same as Alternative 1. Indirect effects would be expected to improve RCW habitat to a greater extent than Alternatives 1 and 3.

Increased restoration of the longleaf pine ecosystem would ensure that suitable RCW habitat would be available well into the future. Longleaf restoration, age class diversity and structural diversity are necessary to ensure that adequate habitat for the RCW and other species of the longleaf pine ecosystem can be perpetuated. To restore some of the natural ecosystems on the Francis Marion, the forest would likely need to harvest foraging-size pine trees within RCW clusters that currently do not meet the managed stability standard, or are currently above but would go below the standard post harvesting. However, the effects of such reductions in RCW foraging would be anticipated to be beneficial, insignificant or discountable as long as the ultimate goal is to restore the natural ecosystem. Restoration of the native ecosystems, especially the 2 longleaf pine ecosystems, should benefit the RCW in the long term.

Measures to protect RCW cavity trees have been used since the 1996 Forest Plan and would be expected to continue during the next 10-15 years. Such protection measures would be consistent with the RCW Recovery Plan and Final Environmental Impact Statement for the Management of the RCW in the Southern Region. Although protection measures would be implemented (e.g., raking and clearing fuels around the cavity tree), cavity trees would still catch on fire during prescribed burns. Under the right conditions, radiant heat can even catch an RCW cavity tree on fire due to the high combustibility of pine sap, pitch and resin.

Alternative 3

Direct and Indirect Effects. Direct effects to RCW would be the same as Alternative 1. Individual birds may be injured by fire. However, the potential for negative impacts to the RCW and its habitat would be greatest under this alternative.

Increased fire exclusion and suppression in some of the highest RCW density areas on the forest (e.g., Wando Area), coupled with increased wilderness designations, in Alternative 3 would be expected to lead to negative indirect effects for RCW habitat (see Figure 3-19). Although fire may sometimes still be used in the Wando Area under Alternative 3, this area would not be prescribed burned on a 1 to 3 year fire return interval; alternative silvicultural practices would have to be relied upon much more than prescribed burning (e.g., mechanical, herbicide and even possible use of grazing). As a result, species that are dependent upon fire maintenance would be indirectly affected by the anticipated decline in habitat quality and, depending upon the activity being used, may lead to cascading indirect effects throughout the ecosystem . This would be especially true if there were an increased use of herbicides and potential grazing. Based on these indirect effects, many clusters would become inactive during the next 10-50 years under Alternative 3.

Direct effects to RCW are unlikely across all alternatives, since T&E species would be addressed and conserved through the site-specific biological assessment process.

- Indirect effects to habitat would vary by the 3 alternatives. In Alternative 1, RCW habitat would continue to be maintained and enhanced as it has been since the 1996 Forest Plan was implemented.
- In Alternative 2, habitat conditions for the RCW would be expected to improve dramatically.
- In Alternative 3, habitat would be expected to decline, especially in the Wando Area.

Cumulative Effects

Negative cumulative effects would not be expected for the RCW under Alternatives 1 and 2. RCW habitat would continue to be maintained and enhanced as it has been since the 1996 Forest Plan was implemented or would be greatly enhanced under Alternative 2. Benefits to the RCW population under Alternatives 1 and 2 would be expected to offset any potential negative increased urbanization, road density and human disturbances.

Increased urbanization and population growth would be anticipated to lead to negative cumulative RCW effects under Alternative 3. This is primarily due to the fact that the increased urbanization, coupled with decreased prescribed burning, would be expected to lead to increases in the following: road densities and associated traffic; NNIS; fire exclusion and suppression; and use of alternative silvicultural practices (e.g., mastication, grazing and pesticide application).

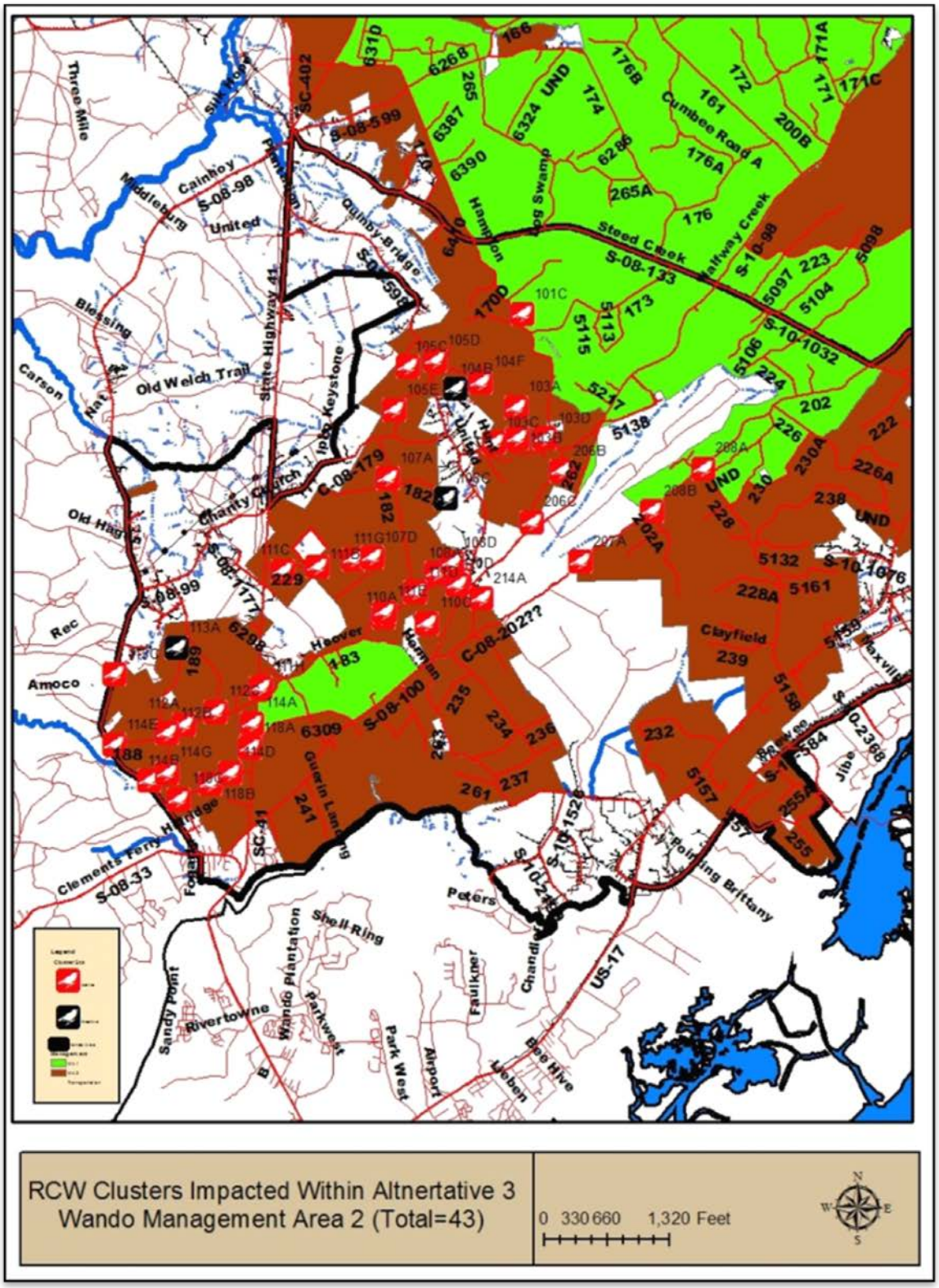

Figure 3-23. RCW clusters that fall within Management Area 2 under Alternative 3. MA 1 is green. MA 2 is in brown

*Bachman's Warbler (*Vermivora bachmanii*)*

Although suitable habitat for the Bachman's warbler can be found on the forest, the last confirmed sighting was in 1963 on private lands.

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

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

During 1975-1977, several sightings of Bachman's warblers were reported in the I'On Swamp area of the Francis Marion National Forest (Shuler 1977b; Shuler et al. 1978; Forsythe 1991). However, repeated attempts by Hamel and others to relocate these individuals failed (Forsythe 1991). Hamel (1978) concluded that his inability to locate any of the birds reported in I'On Swamp, along with the lack of documentation on these sightings, makes these records questionable (Forsythe, 1991). Hamel (1978) considered the last documented Bachman's warbler sighting to be the single male from Moore's Landing Road (AKA Bulls Island Road, which leads to Garris Landing), which was seen by many in April 1962 (Forsythe, 1991).

From 1986 through 1991, the forest implemented experimental cuts and conducted surveys for the species during five nesting seasons in an agreement with the USFWS. Systematic surveys on agreed upon sites were conducted by qualified personnel using tape recordings of the species. During these surveys, Bachman's warblers were neither seen nor heard.

Alternatives 1-3

Direct and Indirect Effects. Historical accounts of Bachman's warbler habitat are neither plentiful nor specific, and there was considerable disagreement among experts as to what actually constituted preferred nesting habitat (Forsythe, 1991). Hooper and Hamel (1977) stated, "The overstory of areas chosen for nesting appeared to have been subjected to disturbance, either natural or man caused, that stimulated development of a relatively dense understory." Widmann (1897) found the birds nesting in areas that had been selectively harvested. Others have argued that the birds preferred habitat was "relatively mature, dense-canopied swamp forest" (Schulre, 1977) or dense thickets of cane under a relatively open canopy of large trees (Remsen, 1986). Hamel (1986) concludes the following, "A possible synthesis of the various opinions on breeding habitat may be that the birds' original habitats were secondary successional (i.e., gap-phase) openings in the swamp forest canopy, such as might be caused by storms or insect damage. However, we will never have a satisfactory explanation until breeding birds can be found and studied" (Forsythe, 1991).

Regardless of which habitat the species truly prefers, all of the aforementioned conditions would be created and maintained under all alternatives. Management activities proposed under the 3 alternatives would create and/or maintain suitable habitat for Bachman's warbler based on the forested ecosystems where the species would be likely to occur.

Cumulative Effects. The Bachman's warbler is likely one of the rarest songbirds in the world. Based on the literature, Bachman's warbler has not been officially observed in Berkeley or Charleston counties in approximately 53 years. As previously mentioned, many species experts believe that the Bachman's warbler is now extinct in South Carolina. Extensive surveys conducted throughout the South Carolina Coastal Plain in 1991 also failed to document the species. Therefore, it is highly unlikely that the species occurs on the Francis Marion. However, the species is one of particular interest to the birding community, and is annually searched for by individual birders, particularly in the I'on Swamp area of the forest.

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

*Wood Stork (*Mycteria Americana*)*

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

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

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

*Frosted Flatwoods Salamander (*Ambystoma cingulatum*)*

The frosted flatwoods salamander (*Ambystoma cingulatum*) was designated as a federally threatened species in 1999 (Federal Register Vol.64, No.62: 15691-15704). The frosted flatwoods salamander is a mole salamander which breeds within seasonally flooded isolated wetlands (SFIW's) embedded within fire-maintained pine woodlands and savannas. This salamander burrows near water or moves about under debris on the forest floor. It is carnivorous and an opportunistic feeder, primarily eating earthworms and arthropods. The species needs shallow winter flooded isolated wetlands to breed and for larvae to develop. It also needs fire maintained pine uplands for the remainder of its life cycle. As with most pond breeding amphibians, the species does not do well in wetlands that contain fish. The timing and frequency of rainfall is critical to the successful reproduction and recruitment of Flatwoods salamander (Final Rule for Listing, 1999). Surviving populations are currently threatened by habitat loss and degradation from agriculture, urbanization, and various silvicultural practices (Final Rule for Listing, 1999). The Flatwoods salamander is extremely rare in South Carolina; the Francis Marion is home to one of only four known populations in the entire state.

Most known, historic and potential frosted flatwoods salamander breeding wetlands on the forest (as identified by Harrison in monitoring report dated 2004 and internal surveys since 2004) occur in designated critical habitat near the community of Wando located on the southwest corner of the Francis Marion (see Figure 3-20). The August 13, 2008 Federal Register (Volume 73, Number 157) designated critical habitat for *A. cingulatum*. Critical habitat on the Francis Marion was given the unique identifier of Unit FFS-6. The Federal Register stated the following for Unit FFS-6:

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

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

Numerous isolated breeding wetlands have been severely altered by previous land management practices prior to establishment of the Francis Marion. Some of the best examples of frosted Flatwoods salamander breeding wetlands on the Francis Marion are bordered by a former tram bed that was used to transport lumber in the early to mid-1900s. The Tuxbury Horse Trail in compartments 114, 115 and 116 is located on this historic tram bed. Figure 3-21 is a Lidar map depicting a portion of the Tuxbury Horse Trail/tram bed in compartments 115 and 116. Some of the impacts created by the tram bed include:

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

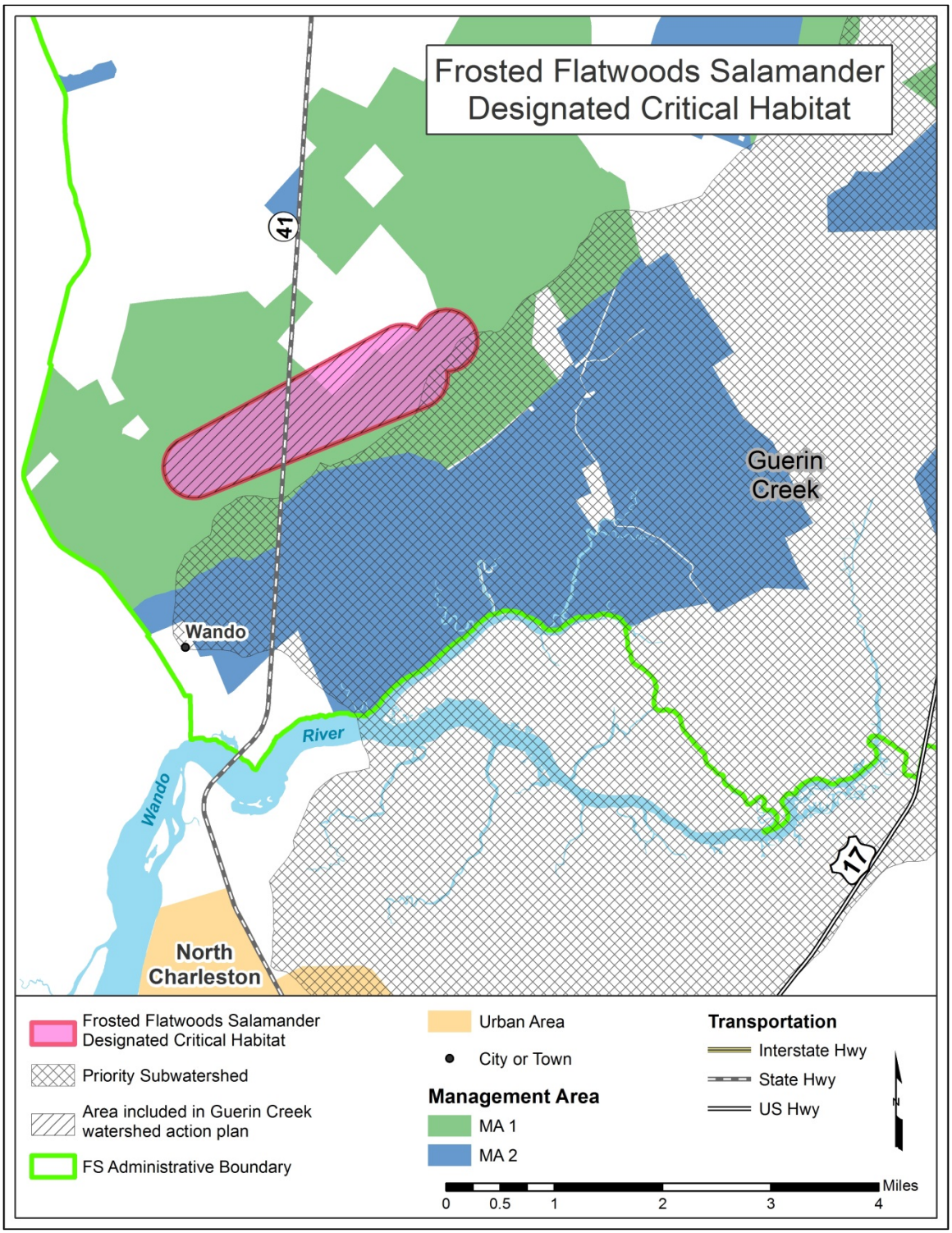

Figure 3-24. Designated critical habitat for the Frosted Flatwoods Salamander on the Francis Marion National Forest

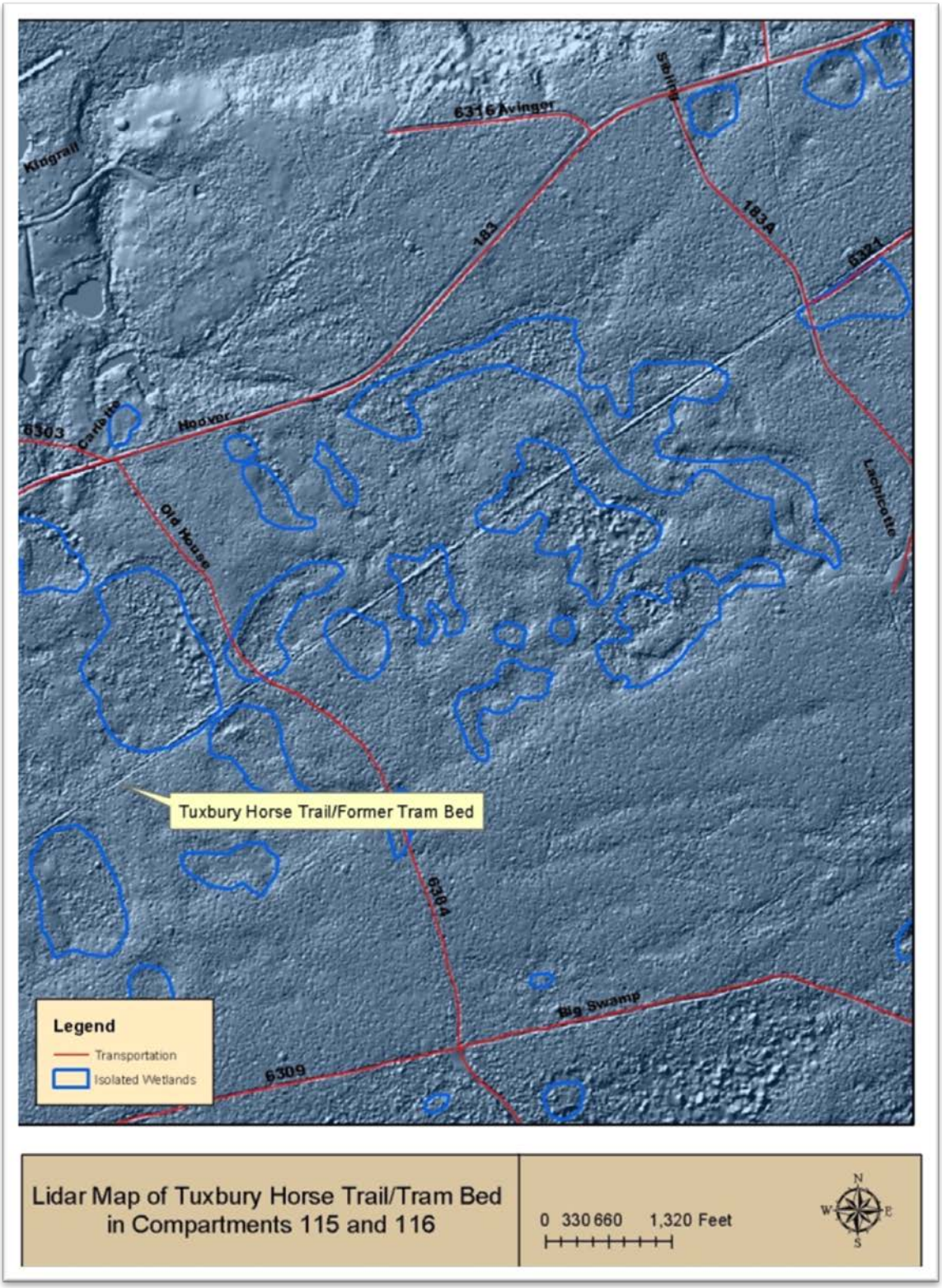

Figure 3-25. Hillshade map derived from LiDAR depicting tram bed impacts to breeding wetlands within the Designated Critical Habitat for the Frosted Flatwoods Salamander

Habitat Required for Migration Routes. Generally, flatwoods salamander breeding ponds and upland habitats are separated by an ecotone (area of transitional habitat) through which salamanders must move during pre- and post-breeding events (Palis, 1997). The grass-like ecotone represents a distinct habitat type and is important for maintaining connectivity between aquatic and terrestrial habitats. When the ecotone provides cover and appropriate microclimatic conditions, survival of migratory salamanders is enhanced. Studies of migratory success in post-metamorphic salamanders have demonstrated the importance of high levels of survival of these individuals to population maintenance and persistence (Rothermel, 2004). Post-larval and adult frosted and reticulated flatwoods salamanders occupy upland flatwoods sites where they live underground in crayfish burrows, root channels, or burrows of their own making (Goin, 1950; Neill, 1951; Mount, 1975; Ashton and Ashton, 2005). The occurrence of these belowground habitats is dependent upon protection of the soil structure within Flatwoods salamander terrestrial sites."

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

Since 2006, the Francis Marion has only been able to conduct surveys for this species during 2009 and 2010 due to drought conditions and/or unsuitable sampling conditions. During 2010, John Palis and Joyce Marie Klaus conducted surveys on the Francis Marion. Nineteen wetlands were surveyed and *Ambystoma cingulatum* was documented on the forest for the first time since 2003. Six larvae were collected from a previously undocumented breeding wetland during March 2010. Three larvae were taken to Riverbanks Zoo in Columbia, S.C. where Scott Pfaff (Curator of Herpetology) successfully raised them to metamorphosis. At the time of collection, the larvae were too small to collect tail tissue, so the zoo reared them until they were big enough to collect tissue. DNA analysis was performed; results indicate that individuals from the Francis Marion do not represent a distinct species and are closely related to other populations of the frosted Flatwoods salamander. This was the first genetic material available from South Carolina.

Direct Effects from All Alternatives

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

Indirect Effects from All Alternatives

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

from silvicultural practices that destroy the below-ground soil structure and underground refugia, increased road mortality and potential hydrologic changes resulting from adjacent highways, roads and trails.

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

- Thinning and restoration treatments can reduce densely stocked pine stands and provide structural characteristics that are important for the species. These treatments can also create underground refugia when stumps and large woody debris are left intact. Coarse woody debris (CWD), root mounds and stump holes provide critical refugia for numerous species of wildlife, and can allow species such as the frosted Flatwoods salamander to have critical escape cover from fires and the elements.
- Silvicultural thinning treatments have been used to reduce stocking levels in densely stocked pine stands across the Francis Marion, but it is critical to follow mechanical treatments with frequent low intensity fires.

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

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

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

- Frequent fire is needed to keep succession occurring in breeding wetlands. Some compartments on the Francis Marion (e.g., compartments 113 and 114 between Hwy. 41 and Cainhoy Road) have not been burned in more than 20 years allowing encroachment of trees into the wetlands. A grass-like cover is preferred in these wetlands. Figure 3-22 depicts an historical Carolina gopher frog breeding wetland that has only seen prescribed fire once in the past 24 years. In contrast, Figure 3-23 depicts a known Carolina gopher frog and potential frosted Flatwoods salamander breeding wetland within the A. cingulatum critical habitat.

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

Figure 3-26. Potential breeding wetland negatively impacted by fire exclusion and the resulting tree encroachment

Figure 3-27. Potential breeding wetland maintained by fire with desired herbaceous cover

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

Alternative 1

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

Alternative 2

With an emphasis on increased prescribed burning and ecosystem restoration and maintenance, particularly in the Wando Area, Alternative 2 would be expected to dramatically improve habitat for the frosted Flatwoods salamander and other species of the longleaf pine ecosystems. As such, Alternative 2 would be expected to provide the greatest amount of benefits and protection for the frosted Flatwoods salamander.

Alternative 3

Habitat conditions would decline under Alternative 3. Only 482 acres of the designated critical habitat would be located in Management Area 1 in this alternative. This means that approximately 63 percent of the 1,300 acres that have been designated as critical habitat fall within Management Area 2 in Alternative 3. As such, this portion of the critical habitat would not be expected to be adequately maintained with prescribed burning. Alternative methods to reduce hazardous fuel loadings (e.g., herbicide application and grazing) may be detrimental to the frosted Flatwoods salamander. Mechanical and herbicide activities would not be a substitute for fire and, in the case of the latter, can be lethal for amphibians like the frosted Flatwoods salamander. Increased use of herbicides and mechanical activities would compound the potential for negatively impacting the species. If grazing were allowed to occur within the critical habitat and other potential *Ambystoma cingulatum* habitat, it could have detrimental impacts to not only the species' breeding wetlands, but also its upland terrestrial habitats.

Cumulative Effects

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

In terms of habitat concern for the frosted Flatwoods salamander, the Wando Area described in Alternative 2 would be likely the number one area on the Francis Marion to be concerned about during the next 10-15 years. Due to the predicted amount of urbanization, habitat conditions are only expected to deteriorate in the future unless adequate fire return intervals occur in this area. As a result of the increased reliance on mechanical treatments and nontraditional techniques such as herbicides and grazing in Alternative 3, habitat conditions for the frosted Flatwoods salamander would decline. Under Alternatives 1 and 2, frosted Flatwoods salamander habitat would be maintained and enhanced, but increased urbanization would increase the likelihood for negative impacts to the species.

Due to the potential threats that exist in the designated critical habitat, the Francis Marion would need to examine opportunities for translocation and reintroduction of species such as the frosted

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

Special management of the PCEs may also be required for the threats posed by agricultural and urban development on the lands within the designated critical habitat in private ownership. All lands proposed for designation would contain all PCEs and support multiple frosted Flatwoods salamander life processes.

*West Indian Manatee (*Trichechus manatus*)*

The West Indian Manatee (*Trichechus manatus*) is federally and state endangered in South Carolina. Manatees are protected under the Marine Mammal Protection Act, which prohibits the take (i.e., harass, hunt, capture or kill) of all marine mammals. Manatees are found in marine, estuarine and freshwater environments. The West Indian manatee, *Trichechus manatus*, includes 2 distinct subspecies, the Florida manatee (*Trichechus manatus latirostris*) and the Antillean manatee (*Trichechus manatus manatus*). Potential threats to the species include habitat loss and degradation, mortality from boat collisons, entanglement in fishing gear, entrapment in water control structures and exposure to cold temperatures.

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

Manatee sightings in Berkeley and Charleston County have been reported to SCDNR, most of which have come from the Cooper River. However, it would not be unexpected if the species occasionally swims in state waters on or adjacent to the forest such as Wambaw Creek, Tibwin Creek, Awendaw Creek, Guerin Creek and Huger Creek. The species was documented in the Santee River next to the forest in 1993 and has been repeatedly reported from the Cooper River and Wando River. Manatee sightings have been reported on the Cooper River as far north as Moncks Corner. During 2012 one manatee made it through locks on the Santee Cooper Lakes and wound up becoming trapped in Lake Marion. Unfortunately, this manatee was eventually found dead near Camp Bob Cooper on Lake Marion during November 2012.

Direct, Indirect and Cumulative Effects

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

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

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

Two endangered fish species inhabit waters adjacent to the forest—the Atlantic and Shortnose Sturgeon. Although known populations of sturgeon occur in the Santee-Cooper Rivers, the species abundance and spawning success is not well known. Threats to these species include isolation of spawning areas, altered stream flow and water temperature and water pollution from damming, and habitat degradation from siltation, and dredging.

Direct, Indirect and Cumulative Effects

Section 3.3.3 Species Diversity, section on large river/main channel associates species group, includes a complete description of direct, indirect and cumulative effects to Atlantic and Shortnose sturgeon. No direct impacts to these 2 sturgeons are anticipated. Management activities proposed in the Forest Plan would not be expected to impact the habitat for Shortnose or Atlantic Sturgeon as soil and water guidelines described for all alternatives are designed to minimize impacts to water quality. Analysis and consultation with applicable state and federal entities would be conducted at the project level when projects have the potential to impact the Shortnose or Atlantic Sturgeon. These populations are primarily influenced by hydroelectric dams and land management upstream.

No direct, indirect or cumulative effects to these 2 sturgeons would be expected.

3.3.3 Species Diversity (Species of Conservation Concern)

Fire-maintained longleaf pine ecosystems[2] of the Atlantic Coastal Plain support some of the largest biodiversity outside the tropics (Glitzenstein et al., 2012; Sorrie and Weakley, 2001). The planning team evaluated ecological conditions on the Francis Marion National Forest (Francis Marion or FMNF) to provide for species diversity using a coarse-filter/fine-filter approach. Most plant and animal species on the forest will be sustained by maintaining and restoring the composition, structure, function and connectivity of a diversity of ecosystems in the plan area.

Where needed, the team developed fine-filter strategies to contribute to the recovery of threatened and endangered species, conserve proposed and candidate species and maintain a viable population of each species of conservation concern – all collectively called “at-risk species.” These at-risk species are identified for forest planning purposes as follows:

1. Federally-listed threatened, endangered, proposed and candidate species; and
2. Species of conservation concern.[3]

To assess species diversity, a comprehensive list of plant and animal species was compiled as part of the Francis Marion National Forest Plan Assessment by combining species lists from a variety of sources, including the following:

1. Federally-listed threatened and endangered species obtained from the U.S. Fish and Wildlife Service;

[2] For the purposes of this section, the terms ecological systems, ecosystem groups and ecosystem(s) are used interchangeably.
[3] Species of conservation concern are those plant and animal species whose long-term persistence within the plan area is of known conservation concern.

2. State species of conservation from the South Carolina Natural Heritage Program, State Comprehensive Wildlife Conservation Strategy;
3. Birds of conservation concern compiled by the U.S. Fish and Wildlife Service; and t
4. The Forest Service's list of sensitive species.

Additional species were added based on input from recognized conservation experts within the state. All species were considered in the design of ecological conditions within the plan area. Species were then screened for inclusion in the framework and designated as species of conservation concern. The planning team used a species and ecological system sustainability evaluation framework for the analysis of species diversity and ecological sustainability and integrity built around principles developed by The Nature Conservancy (TNC) in their Conservation Action Planning Workbook (TNC, 2005). This process is further described in Appendix E – Ecosystem and Species Diversity Report.

Many of the proposed species of conservation concern are also considered to be at-risk species by the U.S. Fish and Wildlife Service; many have been petitioned to list under the Endangered Species Act. In South Carolina, large publicly owned landscapes such as the Francis Marion support some of the best habitat and highest densities of at-risk species in the state (e.g., red-cockaded woodpecker, Carolina gopher frog, Bachman's sparrow, pondberry, pondspice and American chaffseed).

The 2012 Forest Planning Rule requires that species of conservation concern be, "known to occur in the plan area" and that the regional forester identify the species of conservation concern for which "the best available scientific information indicates substantial concern about the species' capability to persist over the long term in the plan area." The 2012 Forest Planning Rule recognizes that there are limits to the agency's authority and the inherent capability of the land in providing for species. In contrast, the 1982 Forest Planning Rule required management prescriptions to, "provide for adequate fish and wildlife habitat to maintain viable populations for all existing species." The management emphasis on species of conservation concern is more focused than the viability provision under the 1982 rule. If the responsible official determines that it is beyond the authority or not within the inherent capability of the plan area to maintain or restore ecological conditions to maintain a viability of a species of conservation concern in the plan area, then the responsible official shall:

1. Document the basis for that determination;
2. Include plan components, including standards and guidelines, to maintain or restore ecological conditions within the plan area to contribute to maintaining a viable population of the species within its range.

Terrestrial and Aquatic Species Covered By Ecosystem Components (Coarse filter)

For the purposes of this analysis, the planning team used species groups, as needed, as an evaluation tool to improve planning efficiency and for development of management strategies. Species were grouped according to ecosystem group or habitat needs, limiting factors, threats or specific habitat elements. All federally listed threatened and endangered species, and potential species of conservation concern were included in species groups because their habitats are connected to ecosystem group maintenance and restoration and ecological sustainability. Each group was analyzed by species and determinations made on whether species needs were fully met by plan components, considering locations for species and management area direction associated

with their known populations. A description of affected environment and direct, indirect and cumulative effects of plan alternatives on species groups, including links to ecological system groups, desired conditions and weights for key characteristics associated with habitats, including stressors or threats which weigh most heavily in determining current condition and trends for species groups, is given below. The following species groups can be linked to key characteristics and associated plan direction associated with the maintenance and restoration, of the following ecological system groups - or other plan components as listed in Table 3-25.

Table 3-29. Species Group and Associated Ecological System Group(s) and other relevant Plan Components

Species Group	Associated Ecological System Group(s) and other Plan Components
Forested Wetland Associates	Broad Forested Swamps and Large River Floodplain Forests; Riparian Management Zones; Eligible Wild and Scenic Rivers; Forestwide
Herbaceous Seepage Slope and Pine/Wetland Ecotone Associates	Management Area 1; Ecotone between narrow Forested Swamps and Blackwater Stream Floodplain Forests, pocosins, depressional wetlands and Carolina bays, upland longleaf pine/loblolly pine woodlands and wet pine savannas; Rare Communities
Mesic and Wet Savannas and Flatwoods Associates	Wet Pine Savannas and Flatwoods within Management Area 1; Rare Communities
Pondcypress Savanna Associates	Depressional Wetlands and Carolina Bays within Management Area 1; Rare Communities
Upland Longleaf and Loblolly Woodland Associates	Upland Longleaf and Loblolly Pine Woodlands within Management Area 1
Wet Marl and Calcareous Mesic Hardwood Slope Associates	Narrow Forested Swamps and Blackwater Stream Floodplain Forests; Oak Forests and Mesic Hardwood Forests; Rare Communities; Riparian Management Zones; Eligible Wild and Scenic Rivers; Forestwide
Aquatic Large river/Main Channel Associates	Rivers and Streams
Aquatic Species Associated with Streams and Smaller Waters	Rivers and Streams

Each species was linked to a species group and assigned a group weight as follows in Table 3-26.

Table 3-30. Group weight and descriptions for species groups

Group Weight*	Group Weight Description
Very High	All or nearly all of the species' requirements are met by the species group.
High	A high proportion of the species' requirements are met by the species group.
Moderate	A moderate proportion of the species' requirements are met by the species group.
Low	A low proportion of the species' requirements are met by the species group.

Note: Group weight for each species was initially developed by Forest Service specialists, but then refined by experts in a series of public meetings held in April 15, 16 and 17, 2014.

Direct and Indirect Effects Common to All Alternatives

In general, fire and mechanical treatments would be the primary management activities used to maintain and improve desired habitat conditions for at-risk species in all 3 alternatives. However, the amount of fire and mechanical treatments and the resulting quality and amount of habitat vary across the alternatives.

Portions of the forest that have been heavily impacted by past land management activities (e.g., stumping, ditching, bedding and plowing) should be restored to improve habitat for at-risk species that have been or continue to be impacted by these activities. Restoration of hydrologic function would remain unaddressed in Alternative 1; however, Alternatives 2 and 3 would place an emphasis on restoring hydrologic function, particularly in wetlands that are critical breeding habitat for at-risk amphibians in the Wando RIZ.

Additional management may be needed for extremely rare species such as the frosted Flatwoods salamander, Carolina gopher frog, pondberry and American chaffseed. Some at-risk species may be translocated (animals) or transplanted (plants) to maintain and improve species viability. For instance, the frosted Flatwoods salamander and Carolina gopher frog may need to be translocated, or head-started in captivity and released into suitable habitats on the forest. These activities would be able to occur with all 3 alternatives.

Cumulative Effects Common to all Alternatives

Public land plays a critical role in the conservation of rare species and native habitats, which receive little formal protection or conservation on many private lands. During the next 10-50 years, human populations are likely to expand, which will lead to increasing roads and the associated fragmentation, as well as the spread of non-native invasive plant species. Urban growth is expected to dramatically increase in the tri-county area of Berkeley, Charleston and Dorchester during the next 10-50 years, resulting in increasing pressures to maintain this habitat on national forest land. By 2030, the total urban area around the forest is anticipated to potentially increase from 468 square miles in 2008 to 868 square miles in 2030 (see Figure 3-24).

The Francis Marion will play an increasingly important role in the conservation and restoration of fire-adapted habitats, particularly depressional wetlands and Carolina bays. Management to ensure the ecological integrity of those habitats is likely to be an increasingly difficult challenge in the future. Management strategies incorporate an “all lands” approach that encourages Forest Service personnel to work with private landowners, conservation groups and local governments that will help maintain the habitat of these species groups.

Restoration, resilience and sustainability are broader, interrelated organizing concepts reflected in the development of the forest plan. Restoration in its broadest sense is about protecting, restoring and transforming not only ecosystems, but also human systems toward resilience. Resilience is about sustainability – ecological, economic and social – under the pressures of changing atmospheric, demographic, social and political climates. As values for and use of the forest change, it brings in new uses that have never been considered (e.g., the growing importance of carbon sequestration and other ecosystem services).

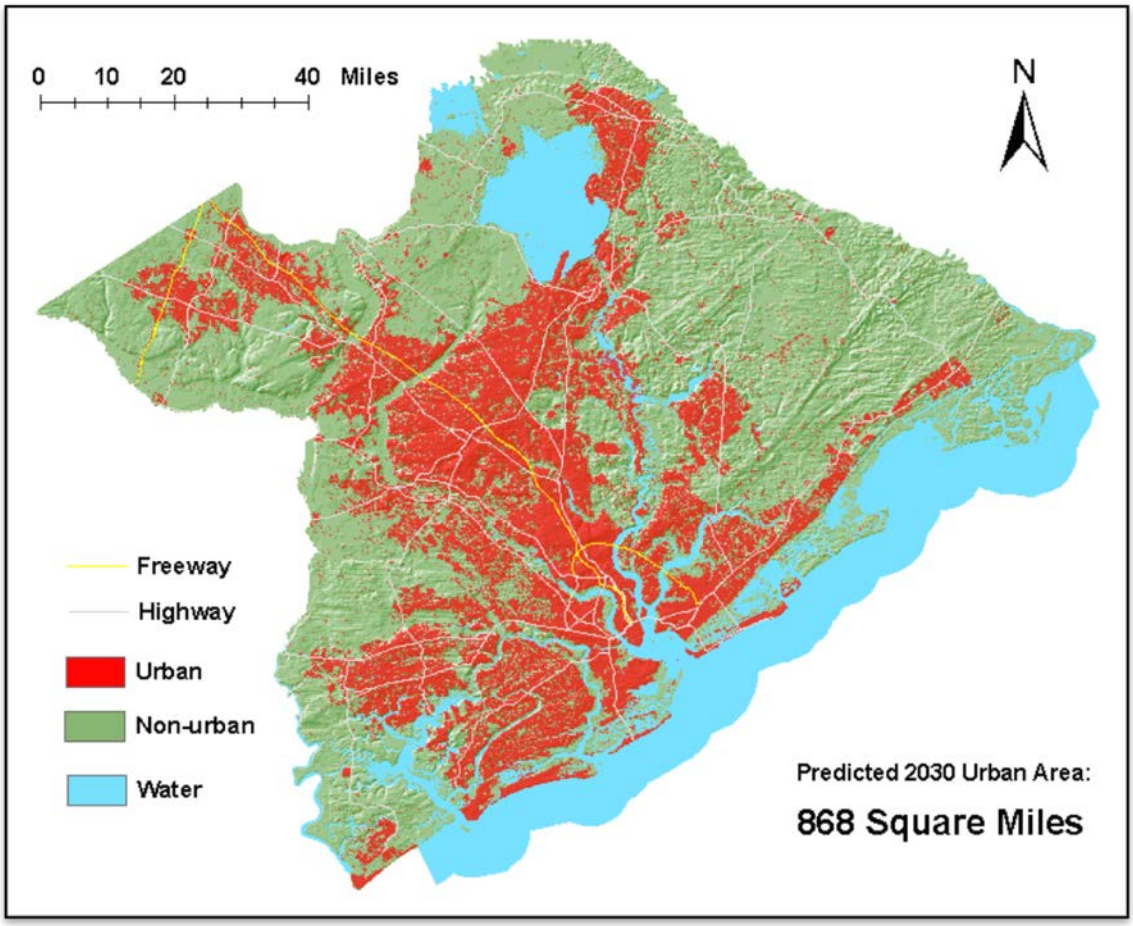

Figure 3-28. Potential urban area of Berkeley, Charleston and Dorchester counties in 2030

Many other factors will continue to intersect with climate change to create context for managing resources -exploding demographic diversity, urbanization, technology, new attitudes about resource use, protection, social license, governance and the role of government. Resilience is about not only the ecosystem's ability to respond, but also society's ability to find a balance among different values affected by climate-driven effects and to plan for the future.

Due to the interaction of climate change and other factors, such as sea-level rise, the Francis Marion National Forest is experiencing increased threats from fire, insect and plant invasions, disease, extreme weather and drought. Scientists project increases in temperature and changes in rainfall patterns that can make these threats occur more often, with more intensity and/or for longer durations. These impacts are discussed in more detail in Chapter 3, Climate Change. Some notable impacts include:

1. Plants and animals at-risk will respond to environmental changes by adapting, moving or declining. Species with high genetic variation will be better able to survive in new conditions.

2. With changing climatic variability, invasive and aggressive plant and insect species may increasingly outcompete or negatively affect native species.

3. Wildfire frequency is expected to increase across the Southeast region.
4. The potential for severe storms is expected to increase, including less frequent but more intense hurricanes making landfall in the South.
5. Shifts in rainfall patterns will lead to periods of flooding and drought that can significantly impact water resources.
6. Coastal areas in the Southeast have already experienced an average of one inch of sea-level rise per decade during the 20th century (Kemp et al., 2009), a rate that will continue to increase in the future.
7. Heat stress may limit the growth of some Southern pines and hardwood species. Additional stresses from drought, combined with wide-scale pest outbreaks, have the potential to cause broad-scale forest dieback.
8. Increases in temperature and changes in precipitation patterns leading to lower baseflows and altered hydrology in streams and lakes will affect both plant and animal species in aquatic environments.
9. Increased frequency of droughts can lead to poor water quality and habitat squeezes. Fish-kills due to high summertime temperatures are likely to become more common in shallow waters of the Southeast.

Forested Wetland Associates

Threats to the Forest Wetlands Associate species group (see Table 3-27) include reforestation practices which favor pine, prescribed burning which is too frequent, non-native invasive species and fragmentation due to roads and OHV trails. Of the species listed in Table 3-27, American swallow-tailed kite, bald eagle, Rafinesque's big-eared bat, wood stork and Bachman's warbler are addressed as proposed, endangered, threatened or sensitive species (PETS) in the 1996 Forest Plan. In fact, the Rafinesque's big-eared bat was actually considered a candidate species for inclusion under the Endangered Species Act in 1996, when the last forest plan was written.

Table 3-31. Forested wetland associates

Species Group	Latin Name	Common Name	Designation	Group Weight
Bird	*Elanoides forficatus*	American Swallow-tailed Kite	PSCC	High
Bird	*Haliaeetus leucocephalus*	Bald Eagle	PSCC	Very High
Bird	*Mycteria americana*	Wood Stork	Federally Endangered	Moderate
Bird	*Vermivora bachmanii*	Bachman's Warbler	Federally Endangered	High
Insect	*Zale perculata*	Okefenokee Zale Moth	PSCC	Very High
Insect	*Amblyscirtes alternata*	Dusky Roadside Skipper	PSCC	Very High
Insect	*Euphyes berryi*	Berry's Skipper	PSCC	Very High
Mammal	*Corynorhinus rafinesquii*	Rafinesque's big-eared bat	PSCC	High
Mammal	*Myotis austroriparius*	Southeastern myotis	PSCC	High
Mammal	*Trichechus manatus*	West Indian Manatee	Federally Endangered	High
Reptile	*Clemmys guttata*	Spotted Turtle	PSCC	Very High
Vascular Plant	*Ruellia strepens*	Limestone Petunia	PSCC	Very High

The species in this group can be linked to desired conditions and management strategies associated with large river floodplain forests, narrow non-riverine swamp and wet hardwood forests and broad non-riverine swamp and wet hardwood forests. Total Forest Service ownership within these systems is listed in Table 3-28. Key characteristics of desired habitat conditions are listed in Table 3-29.

Table 3-32. Ecological systems used by forested wetland associates

Ecological System	National Forest Acreage
Large River Floodplain Forest	3,297
Narrow Non-riverine Swamp and Wet Hardwood Forest	26,763
Broad Non-riverine Swamp and Wet Hardwood Forest	39,564

Typically, the overstory of the Forested Wetland Associates' habitat is dominated by late-successional conditions. Vegetation is often dominated by baldcypress and tupelo (Nyssa spp.) on the wettest sites and bottomland hardwoods consisting of oak, hickory and loblolly pine mixtures on the drier portions of the floodplains. On sites not dominated by baldcypress and tupelo, oaks are favored over other species. Some species like sweetgum and red maple are not desired at high densities. Where floodplain headwaters reach into fire-maintained uplands, native cane may be found in abundance. Except in the wettest examples, native understory, shrub and herbaceous layers are well developed and native woody vines are prominent.

Flooding and associated excess rainfall are the dominant ecological drivers in these ecological systems but fire is important in a subset of these ecosystem groups (narrow non-riverine swamp), Flooding ranges from semi-permanent in the wettest floodplains to intermittent, short term or ephemeral in higher gradient streams. Natural fire regimes vary in these 3 ecological systems, but

tend to be infrequent (1 to 218 years); they are most frequent at the ecotones that border longleaf pine ecosystems. However, some areas of narrow non-riverine swamps were likely once canebrakes when maintained by periodic fire.

Table 3-33. Key Characteristics ranked Very High for predicting effects to Forested Wetland Associates

Key Characteristic	Indicator
Composition	Percent of Ecosystem Extent Impacted by Feral Hogs
Structure	Percent of Old Growth Forest
Structure	Ecological Departure Ranking (Structure)
Connectivity	Paved Open Road Density
Composition	Percent of Ecosystem Extent dominated by characteristic Native Species

Alternative 1

Direct and Indirect Effects. Habitat for the Forested Wetland Associates is included under Management Area 27 Loamy Ridges, Flats and River/Creek Bottoms in the 1996 Forest Plan. Total acreage in Management Area 27 is 27,324 acres, of which 26,180 acres are identified as suitable for timber production and 1,144 acres are unsuitable for timber production.

The desired condition in Management Area 27 would continue to address species composition and age classes as follows:

> mixed pine/hardwood stands…on a variety of sites. Mast–producing hardwoods are common in hardwood stands, mixed stands and scattered throughout pine stands. Pine stands in close proximity to red-cockaded woodpecker clusters have fewer hardwoods. Low–intensity fire is occasionally seen in pine stands, usually in the dormant season. A variety of age classes and conditions are found in the hardwood, pine and mixed forest types. This area provides a visually diverse scene in contrast to other areas of the forest containing the open, park-like stands.

Standards and guidelines that addressed prescribed burning, species composition and habitat structure in the 1996 Forest Plan would continue to protect habitats

Alternatives 2 and 3

Direct and Indirect Effects. The 3 ecosystem groups listed in Table 3-28 provide habitat for this species group. Desired conditions, objectives and management strategies in Alternatives 2 and 3 would emphasize ecological conditions that promote a diversity of native plant and animal species, connect habitats and reduce the risk associated with small populations and the impacts of open roads where feasible.

Under Alternatives 2 and 3, plan components are designed to create, maintain and improve habitat for species in this group. In fact, under Alternatives 2 and 3, forest management would be expected to actually improve habitat for species in this group to a much greater extent than Alternative 1. As such, the direct and indirect effects for species in this group would be more beneficial in Alternatives 2 and 3 than those provided under Alternative 1 and would be expected to result in good ecological sustainability rankings for this group during the next 10-50 years.

Based on current conditions, the ecological ranking for this group would be expected to remain good during the next 10 years for all alternatives (Figure 3-25 and Figure 3-26). However,

Alternative 1 would likely result in a fair ranking for this group during the next 50 years. (Figure 3-25 and Figure 3-26). Because Alternatives 2 and 3 will continue to directly and indirectly provide habitat for species in this group, the sustainability ranking for this group is expected to remain in the good category during the next 10 to 50 years.

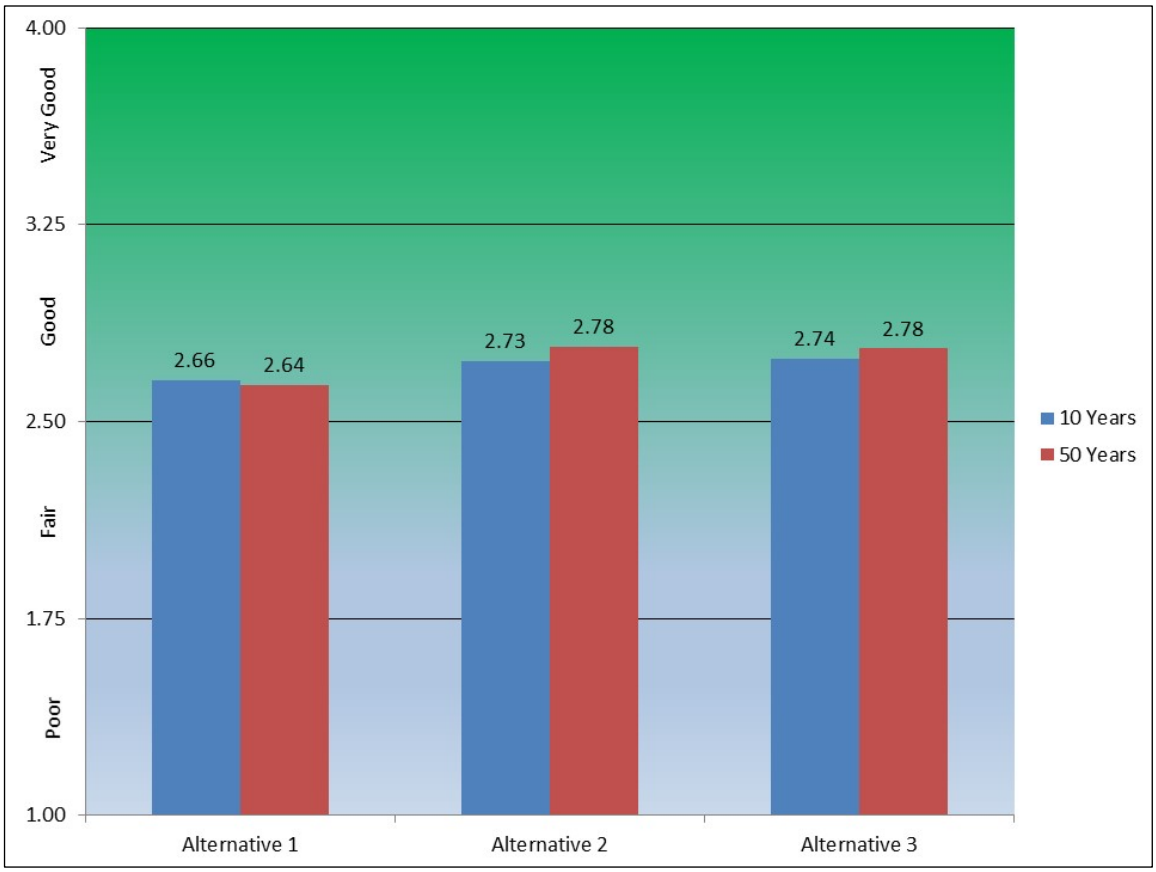

Figure 3-29. Estimated ecological sustainability rankings for Broad Forested Swamps and Large River Floodplain Forests under the three alternatives for 10 and 50 years

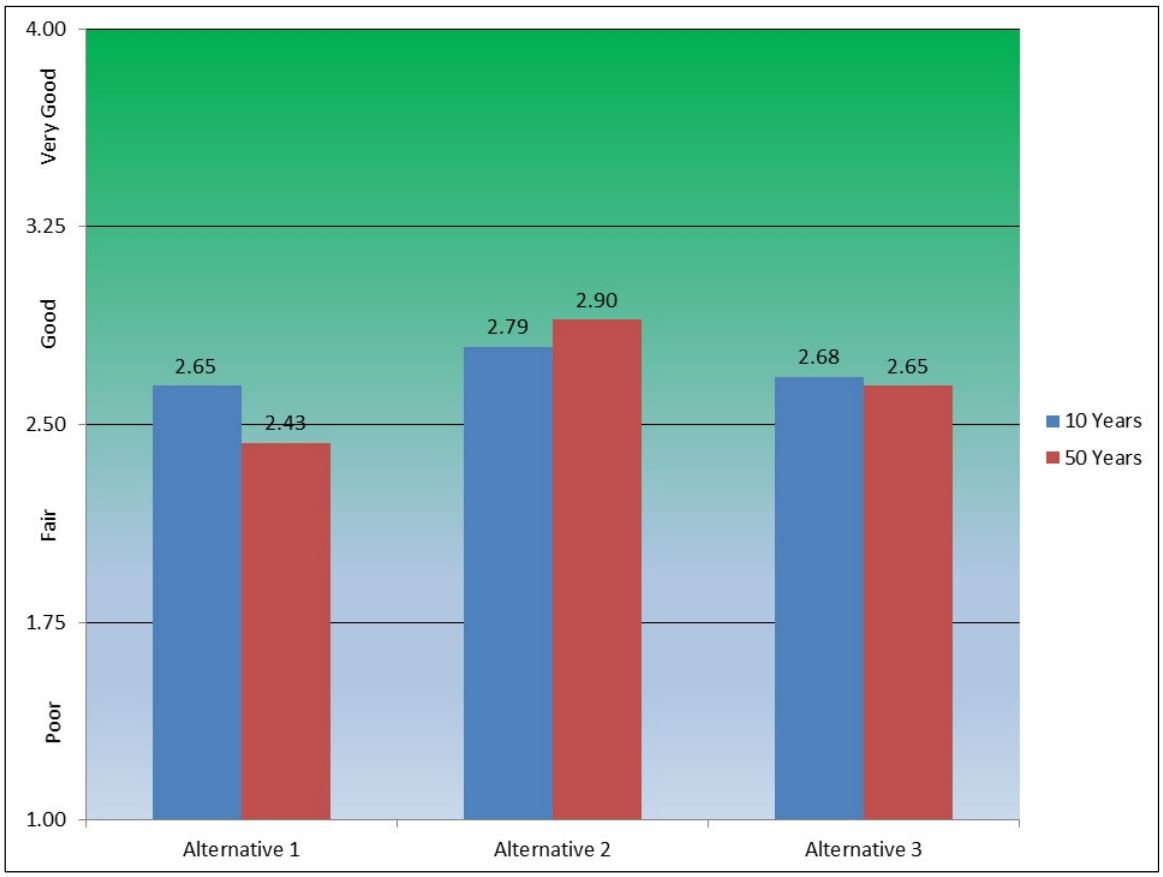

Figure 3-30. Estimated ecological sustainability rankings for Narrow Forested Swamps and Blackwater Stream Floodplain Forests under the three alternatives for 10 and 50 years

Cumulative Effects. As was mentioned for Alternative 1, the increased urbanization and population growth of the tri-county area is anticipated to result in negative cumulative effects for species in this group. This is primarily due to the fact that the increased urbanization, coupled with decreased prescribed burning, would be expected to lead to increases in the following: road densities and associated traffic; non-native invasive species; fire exclusion and suppression; and use of insecticides in and around the forest. These negative cumulative impacts to habitats would likely be offset by the increased ecosystem management and restoration proposed under Alternatives 2 and 3.

All alternatives are expected to directly and indirectly benefit species in this group by providing forest opening habitat components via biotic and abiotic forces. Negative effects to habitats from private land management are predicted to occur under all alternatives.

- Because Alternative 1 would continue to directly and indirectly provide habitat for species in this group on the forest, the sustainability ranking for this group is expected to remain fair to good during the next 10 to 50 years.
- Because Alternatives 2 and 3 would continue to directly and indirectly provide habitat for species in this group on the forest, the sustainability ranking for this group is expected to remain good during the next 10 to 50 years.

Herbaceous Seepage Slope and Pine Upland/Wetland Ecotone Associates

The proposed at-risk species associated with herbaceous seepage slopes and the ecotones between upland longleaf woodlands and wetland pocosins, narrow forested swamps and blackwater stream floodplain forests and Carolina bay and depression ponds are listed in Table 3-30.

Of these species, American swallow-tailed kite and savanna milkweed are addressed as threatened, endangered or sensitive species (PETS) in the 1996 Forest Plan. Morgan Creek Bog, the known location for four vascular plant species in this group, is addressed as a designated botanical/natural area in the 1996 plan and would be included as a rare community in Alternatives 2 and 3. A limited number of known plant populations exist on the forest for species in this group. Known populations for Carolina bird-in-nest on the forest are introduced. More detailed analysis of this species group can be found in Appendix E.

Table 3-34. Herbaceous Seepage Slope and Pine Upland/Wetland Ecotone Associates

Species Group	Latin Name	Common Name	Designation	Group Weight
Bird	*Elanoides forficatus*	American Swallow-tailed Kite	PSCC	Moderate
Vascular Plant	*Andropogon mohrii*	Mohr's Bluestem	PSCC	Very High
Vascular Plant	*Asclepias pedicillata*	Savanna Milkweed	PSCC	High
Vascular Plant	*Calopogon barbatus*	Bearded Grass-pink	PSCC	High
Vascular Plant	*Calopogon multiflorus*	Many-flower Grass-pink	PSCC	High
Vascular Plant	*Carex elliottii*	Elliott's Sedge	PSCC	Very High
Vascular Plant	*Coreopsis integrifolia*	Ciliate-leaf Tickseed	PSCC	Very High
Vascular Plant	*Lysimachia loomisii*	Loomis' loosestrife	PSCC	Very High
Vascular Plant	*Macbridea caroliniana*	Carolina Bird-in-a nest	PSCC	Very High
Vascular Plant	*Rhynchospora cephalantha var. attenuata*	Small bunched Beak Sedge	PSCC	Very High
Vascular Plant	*Rhynchospora oligantha*	Few-flowered Beaked-rush	PSCC	High
Vascular Plant	*Rhynchospora stenophylla*	Chapman Beakrush	PSCC	Very High
Reptile	*Crotalus adamanteus*	Eastern Diamondback Rattlesnake	PSCC	Moderate

Declines at Morgan Creek Bog have been noted in regard to successional woody vegetation, plant poaching and lack of frequent and growing season prescribed fire (Everett, 2012). Additional threats include feral hogs and canopy closure. Known locations for all vascular plants in this group would occur in Management Area 26 and in Management Area 1, the fire-adapted Management Area in both Alternatives 2 and 3. Desired conditions and standards for this species group would be consistent with those for all fire-adapted ecosystem groups within Management

Area 1, particularly at the landscape scale where prescribed fire would be allowed to burn from upland habitats into the adjacent wetland ecotones. The species in this group can be linked to the desired conditions and management strategies associated with fire-adapted ecosystems in Management Area 1. The proposed at-risk species and ecosystem group key characteristics associated with this species group are listed in Table 3-31.

Table 3-35. Key Characteristics for Habitat for Herbaceous Seepage Slope and Pine Upland/Wetland Ecotone Associates

Key Characteristic	Indicator
Function	Percent of System Acres Burned at Desired Return Interval
Function	Percent of System Acres Burned During the Growing Season
Structure	Percent of Ecological System Acres in Open Canopy Structure (Woodland Savanna or Grassland)
Composition	Relative abundance of native herbaceous groundcover
Composition	Non-native Invasive Species Abundance - percent of Ecosystem Extent Impacted by Feral Hogs

Alternative 1

Direct and Indirect Effects. Longleaf-associated ecosystems, particularly upland ecosystems, would continue to be emphasized in Management Area 26 and also the Morgan Creek Bog Botanical Area. These areas would be maintained and restored on a 2-3 year prescribed fire regime, though prescribed burning of wetlands and associated ecotones is not addressed in the 1996 Forest Plan. Directly, forest plan activities, including but not limited to timber harvesting, prescribed burning and trail and road construction could have direct impacts on some species in this group. Indirectly, associated upland/wetland ecotone habitats could be maintained and restored with frequent fire, though this fire would not likely occur at the seasonality and frequency needed to maintain and restore wetland ecotones for species associated with this group. Indirectly, non-native invasive species, including feral hogs, would likely increase under Alternative 1.

As a result of implementing Alternative 1, the sustainability of species in this group would likely be fair in the next 10 years and poor in the next 50 years. Desired conditions and objectives would not address restoration needs for species in this habitat group.

Alternatives 2 and 3

Direct and Indirect Effects. Under both Alternatives 2 and 3, desired conditions for fire-adapted ecosystems in Management Area 1 and rare communities would provide desired conditions and objectives for the maintenance and restoration of the species in this habitat group. Habitats would be maintained and restored by applying a 1-3 year prescribed fire regime including growing season burns every third burn. Direct and indirect effects from ground-disturbing management activities, such as timber harvesting, prescribed burning and associated fireline construction and trail and road construction, would be unlikely due to standards and guidelines contained in Alternatives 2 and 3. During project-level planning, additional since measures may be developed to conserve documented occurrences and associated habitat for species of conservation concern. Adaptive monitoring and management of these habitats would occur to ensure that ecological conditions to provide for sustainable populations continue to occur across the landscape. The direct and indirect effects of this alternative would be an improvement in the vegetation composition, structure, function and connectivity of herbaceous seepage slope and pine/wetland

ecotone species and associated habitat. The ecological sustainability of this species group would likely be good in the next 10 years and good in the next 50 years in Alternative 1.

Cumulative Effects. Given the limited number of known plant populations for many species in this group, an all lands approach would contribute towards maintaining many of the species in this group. Management to ensure the ecological integrity of fire-adapted and upland/wetland ecotone habitats will be an increasingly difficult challenge in the future.

As a result of implementing Alternatives 2 and 3, there would likely be beneficial effects to species associated with herbaceous seepage slope ecotones. Beneficial effects would likely be greater in Alternative 2 than 3, given the larger quantity of fire-adapted ecosystems that would be maintained and restored in Alternative 2. The ecological sustainability of species in this group would likely be good in both the next 10 and the next 50 years in Alternative 2 and fair to good in Alternative 3, due to the lower relative amount of both upland longleaf and narrow forested swamps and blackwater stream floodplain forests which would be maintained and restored with prescribed fire in Alternative 3.

Mesic to Wet Pine Savanna and Flatwoods Associates

Frosted Flatwoods salamander, gopher frog, Bachman's sparrow, red-cockaded woodpecker, Rafinesque's big-eared bat and 2 vascular plants (*Asclepias integra*, *Platanthera integra*), were addressed as PETS and four other vascular plant species in this group were designated as sensitive species in 2001. Wardfield and Awendaw Savannas are included as designated botanical areas in the 1996 Revised Forest Plan. Some of the sensitive species in this group are in decline (*Sporobolus curtisii*, *Sporobolus pinetorum*, *Platanthera integra*), particularly at the wildland-urban interface (Glitzenstein and Streng, 2012).

Most species are threatened by successional woody vegetation, lack of frequent and growing season prescribed fire and overly dense canopies which can play a role in both shading and modifying site hydrology.

The species in this group can be linked to the desired conditions and management strategies associated with mesic to wet pine savannas and mesic woodlands included in Management Area 1. The following proposed at-risk species and ecosystem group key characteristics associated with this species group are listed in Table 3-32 and Table 3-33.

Table 3-36. Proposed Species of Conservation Concern associated with Mesic to Wet Pine Savannas and Flatwoods including Wet Marl Savannas

Species Group	Latin Name	Common Name	Designation	Group Weight
Amphibian	*Ambystoma cingulatum*	Frosted Flatwoods salamander	Federally threatened	Very High
Amphibian	*Lithobates capito*	Gopher frog	PSCC	High
Bird	*Aimophila aestivalis*	Bachman's sparrow	PSCC	High
Bird	*Picoides borealis*	Red-cockaded woodpecker	Federally endangered	Very High
Insect	*Amblyscirtes alternata*	Dusky roadside skipper	PSCC	High
Insect	*Danaus plexippus*	Monarch butterfly	PSCC	High
Insect	*Euphyes berryi*	Berry's skipper	PSCC	Very High
Mammal	*Corynorhinus rafinesquii*	Rafinesque's big-eared bat	PSCC	Moderate
Mammal	*Myotis austroriparius*	Southeastern myotis	PSCC	Moderate
Reptile	*Crotalus adamanteus*	Eastern diamondback rattlesnake	PSCC	Moderate
Vascular Plant	*Agalinis aphylla*	Coastal plain false-foxglove	PSCC	Very High
Vascular Plant	*Anthaenantia rufa*	Purple silkyscale	PSCC	High
Vascular Plant	*Asclepias pedicillata*	Savanna milkweed	PSCC	High
Vascular Plant	*Calopogon barbatus*	Bearded grass-pink	PSCC	High
Vascular Plant	*Calopogon multiflorus*	Many-flower grass-pink	PSCC	High
Vascular Plant	*Carex stricta*	Tussock Sedge	PSCC	Very High
Vascular Plant	*Chasmanthium nitidum*	Shiny spikegrass	PSCC	Very High
Vascular Plant	*Cladium mariscoides*	Twig-rush	PSCC	Very High
Vascular Plant	*Ludwigia lanceolata*	Lance-leaf seedbox	PSCC	Very High
Vascular Plant	*Lysimachia hybrida*	Lance-leaf loosestrife	PSCC	Very High
Vascular Plant	*Platanthera integra2*	Yellow fringeless orchid	PSCC	Very High
Vascular Plant	*Rhynchospora breviseta*	Short-bristle baldrush	PSCC	Very High
Vascular Plant	*Rhynchospora globularis var. pinetorum*	Beakrush	PSCC	Very High
Vascular Plant	*Rhynchospora oligantha*	Few-flowered beaked-rush	PSCC	High
Vascular Plant	*Sporobolus curtisii*	Pineland dropseed	PSCC	Very High
Vascular Plant	*Sporobolus pinetorum*	Carolina dropseed	PSCC	Very High

Species Group	Latin Name	Common Name	Designation	Group Weight
Vascular Plant	*Xyris brevifolia*	Short-leaved yellow-eyed grass	PSCC	Very High
Vascular Plant	*Xyris flabelliformis*	Savannah yellow-eyed grass	PSCC	Very High
Vascular Plant	*Xyris stricta*	Pineland yellow-eyed grass	PSCC	Very High

Table 3-37. Key Characteristics for Habitat for Mesic to Wet Pine Savannas and Flatwoods including Wet Marl Savannas Associates

Key Characteristic	Indicator
Function	Percent of System Acres Burned at Desired Return Interval
Function	Percent of System Acres Burned During the Growing Season
Structure	Percent of Ecological System Acres in Open Canopy Structure (Woodland Savanna or Grassland)
Composition	Relative abundance of native herbaceous groundcover
Composition	Non-native Invasive Species Abundance - percent of Ecosystem Extent Impacted by Feral Hogs
Composition	Percent of Ecosystem in “Maintain” Condition Class

Alternative 1

Direct and Indirect Effects. Upland longleaf-associated ecosystems, which could include mesic Flatwoods ecosystems, would continue to be maintained and restored in Management Area 26 and Awendaw and Wardfield Savannas would continue to be maintained and restored within botanical areas, to include select habitats and locations for species in this group. Directly, management activities, including but not limited to timber harvesting, prescribed burning and trail and road construction could have direct impacts on some species in this group. Measures needed to conserve documented occurrences and associated habitat for threatened and endangered species and species of conservation concern would be developed as needed during project planning and implementation. Indirectly, associated habitats would likely be maintained with frequent fire, though this fire is not likely to occur with the seasonality and frequency needed to maintain and restore wet savannas for species associated with this group. Forested stands would tend to be at a higher density than optimal for mesic to wet pine savanna species. Mesic to wet pine savanna species would continue to be maintained but not likely restored. Indirectly, non-native invasive species, including feral hogs, would likely increase in Alternative 1.

The direct and indirect effects of this alternative would be an improvement in the vegetation composition, structure, function and connectivity of wet pine savanna and Flatwoods species. As a result of implementing Alternative 1, the sustainability of species in the mesic to wet pine savanna group would likely be fair in the next 10 years and poor in the next 50 years. Desired conditions and objectives would not address restoration needs for species in this habitat group.

Alternatives 2 and 3

Direct and Indirect Effects. Within both Alternatives 2 and 3, habitats and species in this group would be maintained and restored on a one-3 year prescribed fire regime, including growing season burns every third burn. All known locations for species in this group would occur in the fire-adapted ecosystems of Management Area 1 or would be given priorities through rare

community consideration. Direct and indirect effects from management activities, such as timber harvesting, prescribed burning and associated fireline construction and trail and road construction, would be unlikely due to standards and guidelines contained in Alternatives 2 and 3. During project-level planning, additional mitgation measures may be developed to conserve documented occurrences and associated habitat for species of conservation concern. Adaptive monitoring and management of these habitats would occur to ensure that desired conditions for wet pine savannas and Flatwoods are maintained and restored, and provide for sustainable populations continue to occur across the landscape.

Proposed management strategies in Alternatives 2 and 3 would emphasize ecological conditions that provide both the continuity of habitat over a large area and historic fire regimes and maintaining preferred habitats.

As a result of implementing Alternatives 2 and 3, there are likely to be beneficial effects to species associated with mesic to wet pine savannas. Beneficial effects are likely to be greater in Alternative 2 than 3, given the larger quantity of fire-adapted ecosystems maintained and restored, in Alternative 2. The ecological sustainability of species in this group are likely to be good in both the next 10 and the next 50 years, in Alternative 2, and fair in Alternative 3 in both the 10- and 50- year timeframes, Alternative 2 provides desired conditions for maintaining and restoring 67% of the total extent of wet pine savanna and Flatwoods ecosystems on the forest with prescribed fire and other tools, 48% of the total extent in Alternative 3.

Cumulative Effects. Given the limited number of populations for species in this group, national forest lands will have a role in providing for the species when considered in conjunction with other lands throughout the range of the species. The ecological sustainability of this species group would likely be good in the next 10 years and good in the next 50 years in Alternative 1.

As a result of implementing Alternatives 2 and 3, there would likely be beneficial effects to species associated with mesic to wet pine savannas. Beneficial effects would likely be greater in Alternative 2 than 3, given the larger quantity of fire-adapted ecosystems that would be maintained and restored in Alternative 2. The ecological sustainability of species in this group would likely be good in both the next 10 and the next 50 years in Alternative 2 and fair to good in Alternative 3 due to the lower relative amount of both upland longleaf and narrow forested swamps and blackwater stream floodplain forests that would be maintained and restored with prescribed fire in Alternative 3.

Pondcypress Savanna Associates

The species in this group can be linked to the desired conditions and management strategies associated with depressional wetlands and Carolina bays in Management Area 1. The following proposed species of conservation concern and threatened and endangered species and ecosystem group key characteristics are associated with each species in Table 3-34 and Table 3-35.

Six plant species are on the PETS list included with the 1996 Forest Plan, including five wildlife species (Rafinesque's big-eared bat, frosted Flatwoods salamander, wood stork, gopher frog and red-cockaded woodpecker) and 3 vascular plants (pondberry, lace-lipped ladies' tresses, Canby's dropwort). Five federally listed species are included in this group (frosted Flatwoods salamander, pondberry, Canby's dropwort, wood stork and red-cockaded woodpecker). Several high-quality pondcypress savannas and herbaceous meadows containing at-risk plant species are designated botanical areas, of which some have documented declines (e.g., beakrushes at Florida Bay), pondberry at Brick Church Road and Honey Hill, Canby's dropwort at Tibwin Bay and Boykin's

lobelia at Echaw Road Bay, Tibwin Bay and McConnell Sink. Most declines are associated with lack of frequent or growing season prescribed fire, succession by woody species, feral hogs, drought or damage off-trail from all-terrain vehicles (ATVs).

Table 3-38. Pondcypress Savanna Associates

Species Group	Latin Name	Common Name	Designation	Group Weight
Amphibian	*Ambystoma cingulatum*	Frosted Flatwoods salamander	Federally threatened	Very High
Amphibian	*Lithobates capito*	Carolina gopher frog	PSCC	Very High
Bird	*Mycteria americana*	Wood stork	Federally threatened	Moderate
Insect	*Amblyscirtes alternata*	Dusky roadside skipper	PSCC	Very High
Insect	*Euphyes berryi*	Berry's skipper	PSCC	Very High
Insect	*Zale perculta*	Okefenokee zale moth	PSCC	Very High
Mammal	*Corynorhinus rafinesquii*	Rafinesque's big-eared bat	PSCC	Very High
Mammal	*Myotis austroriparius*	Southeastern myotis	PSCC	Very High
Vascular Plant	*Andropogon gyrans var. stenophyllus*	Elliott's bluestem	PSCC	Very High
Vascular Plant	*Anthaenantia rufa*	Purple silkyscale	PSCC	High
Vascular Plant	*Burmannia biflora*	Northern burmannia	PSCC	Very High
Vascular Plant	*Eupatorium recurvans*	Coastal-plain thorough-wort	PSCC	Very High
Vascular Plant	*Helenium pinnatifidum*	Southeastern sneezeweed	PSCC	Very High
Vascular Plant	*Lindera melissifolia*	Pondberry	Federally endangered	Very High
Vascular Plant	*Lobelia boykinii*	Boykin's lobelia	PSCC	Very High
Vascular Plant	*Myriophyllum laxum*	Piedmont water-milfoil	PSCC	Very High
Vascular Plant	*Oxypolis canbyi*	Canby's dropwort	Federally endangered	Very High
Vascular Plant	*Rhynchospora harperi*	Harper beakrush	PSCC	Very High
Vascular Plant	*Rhynchospora oligantha*	Few-flowered beaked-rush	PSCC	High
Vascular Plant	*Rhynchospora pleiantha*	Brown beaked-rush	PSCC	Very High
Vascular Plant	*Rhynchospora scirpoides*	Long-beaked beaksedge	PSCC	Very High
Vascular Plant	*Spiranthes laciniata*	Lace-lip ladies'-tresses	PSCC	Very High
Vascular Plant	*Utricularia macrorhiza*	Greater bladderwort	PSCC	Very High
Vascular	*Xyris difformis var.*	Florida yellow-eyed	PSCC	Very High

Species Group	Latin Name	Common Name	Designation	Group Weight
Plant	*floridana*	grass		
Reptile	*Clemmys guttata*	Spotted turtle	PSCC	Very High

Note: PSCC = proposed species of conservation concern.

Table 3-39. Key Characteristics ranked VERY HIGH for Pondcypress Savanna Associates

Key Characteristic	Indicator
Function	Percent of System Acres Burned at Desired Return Interval
Function	Percent of System Acres Burned During the Growing Season
Structure	Percent of Ecological System Acres in Open Canopy Structure (Woodland Savanna or Grassland)
Composition	Relative abundance of native herbaceous groundcover
Composition	Non-native Invasive Species Abundance - percent of Ecosystem Extent Impacted by Feral Hogs

Species within this group are dependent on the hydrological integrity within these habitats and are highly susceptible to hydrologic modifications and chemical soil and water alterations. Numerous wetland communities and the species dependent on them have been degraded to a greater or lesser extent by past management activities. These past management activities have served to drain away water, retain water to an unacceptable level (create ponds where they did not occur) or raise travel routes (e.g., tram beds, trails and roads) above mean high water level or speed up runoff. Each affected example must be examined on a case-by-case basis to determine the best method to restore the desired ecological system.

Some of the best examples of frosted Flatwoods salamander breeding wetlands on the FMNF are bordered by the Tuxbury Horse Trail in compartments 114, 115 and 116. Much of the Tuxbury Horse Trail runs along a former tram bed used to transport lumber in the early to mid-1900s. This tram bed is impacting numerous isolated wetlands in the Wando Area, including potential and known frosted Flatwoods salamander and Carolina gopher frog breeding wetlands. This tram bed is impacting the hydrology of numerous isolated wetlands because it is ditched on both sides and was intentionally built up to traverse through wetlands. Unfortunately, no culverts or bridges exist on this horse trail/tram bed. As such, this artificial land feature serves as a barrier to sheet flow and is impacting the hydrology of adjacent wetlands. Additionally, the ditches on either side of the tram bed drain adjacent wetlands and serve as vectors for undesirable aquatic organisms such as fish. Due to the critically rare status of the frosted Flatwoods salamander in South Carolina and the fact that the FMNF supports one of the last-known populations in South Carolina, restorative activities need to be implemented in areas such as compartments 114, 115 and 116 as soon as possible.

Past management actions in these areas may have resulted in woody plant encroachment and hydrologic alteration of the wetlands. Up until the early 1990s, wetlands such as steams, Carolina bays and pocosins were actually plowed out to try to prevent fire from entering the systems during prescribed burns. In many cases, these plow lines have severely impacted isolated wetland habitats and need to be restored. The few remaining examples are vulnerable to OHV use, ditching and drainage, and invasion by non-native plants and animals. Information on location and size of this community type is not well known or documented.

Many of these wetlands are small in size, seasonally flooded and typically lack predatory fish, making them crucial breeding sites for amphibians. In the designated critical habitat for frosted Flatwoods salamander, the depressional wetlands and the fire-maintained uplands that surround them are important for Carolina gopher frog and frosted Flatwoods salamander breeding and survival. Many of the species in this group thrive in a fishless environment, as fish prey on larval amphibians. Amphibian species in this group generally migrate to depressional wetlands for breeding and are susceptible to hazards caused by crossing roads and burning during migration events.

Alternative 1

Direct and Indirect Effects. Pondcypress savanna ecosystems would continue to be maintained wherever they occur and select pondcypress savannas would continue to be maintained and restored as botanical areas. Habitats for federally-listed species would continue to be maintained and restored wherever they occur. Direct and indirect effects from management activities, such as timber harvesting, prescribed burning, and trail and road construction could have direct impacts on some species in this group. Measures needed to conserve documented occurrences and associated habitat for threatened and endangered species and species of conservation concern would be developed as needed during project planning and implementation. Indirectly, associated botanical areas and habitats for federally listed species would continue to be maintained with frequent fire, though this fire would not likely occur with the seasonality and frequency needed to maintain and restore pondcypress savannas for species associated with this group. Indirectly, non-native invasive species, including feral hogs, would likely increase in Alternative 1. Pondcypress savannas would continue to be maintained but not likely restored.

The direct and indirect effects of this alternative would be an improvement in the vegetation composition, structure, function and connectivity of pondcypress savannas associated with depressional wetlands and Carolina bays. The ecological sustainability of this species group would likely be good in the next 10 years and good in the next 50 years in Alternative 1.

Desired conditions and objectives would not address restoration needs for species in this habitat group.

Alternatives 2 and 3

Direct and Indirect Effects. Under both Alternatives 2 and 3, habitats and species in this group would be maintained and restored on a one-3 year prescribed fire regime, including growing season burns every third burn. All known locations for species in this group would occur in the fire-adapted ecosystems of Management Area 1 or would be given priorities through rare community consideration. Direct and indirect effects from management activities, such as timber harvesting, prescribed burning and associated fireline construction and trail and road construction, would be unlikely due to standards and guidelines. During project-level planning, mitigation measures may be developed to conserve documented occurrences and associated habitat for species of conservation concern .Adaptive monitoring and management of these habitats would occur to ensure that desired conditions for wet pine savannas and Flatwoods would be maintained and restored and provide for sustainable populations to continue to occur across the landscape.

As a result of implementing Alternatives 2 and 3, there would likely be beneficial effects to species associated with pondcypress savannas and depressional wetlands. Beneficial effects would likely be greater in Alternative 2 than 3 given the larger quantity of fire-adapted ecosystems that would be maintained and restored in Alternative 2. The ecological sustainability

of pond cypress savannas and depressional wetlands would likely be good in both the next 10 and the next 50 years in both Alternatives 2 and 3, and greatest in Alternative 2 due to the higher amount of depressional wetland and Carolina by ecosystems which will be maintained and restored with prescribed fire in Alternative 3.

Cumulative Effects. No cumulative effects would be expected beyond what is described at the beginning of this section.

Upland Pine Woodland Associates

Ten of the species in this group are included on the 1996 PETS list, including 3 vascular plants (crested fringed orchid, American chaffseed and savanna milkweed), seven wildlife species (frosted Flatwoods salamander, gopher frog, Bachman's sparrow, red-cockaded woodpecker, Rafinesque's big-eared bat, Southern hognose snake, Northern pine snake) and 3 federally listed species (red-cockaded woodpecker, American chaffseed and frosted Flatwoods salamander). Monitoring specific to at-risk species in this group suggests that dense canopies, plant poaching, lack of frequent prescribed fire (1 to 3 year burning regime) and lack of growing season fire are primary threats to this group. The species in this group would be linked to desired conditions and management strategies associated with upland longleaf and loblolly pine woodlands in Management Area 1. The species and ecosystem group key characteristics associated with this species group are listed in Table 3-36 and Table 3-37.

Table 3-40. Upland Pine Woodland Associates

Species Group	Latin Name	Common Name	Designation	Group Weight
Amphibian	*Ambystoma cingulatum*	Frosted Flatwoods salamander	Federally threatened	Moderate
Amphibian	*Lithobates capito*	Gopher frog	PSCC*	High
Bird	*Aimophila aestivalis*	Bachman's sparrow	PSCC	Very High
Bird	*Picoides borealis*	Red-cockaded woodpecker	Federally endangered	Very High
Insect	*Amblyscirtes alternata*	Dusky roadside skipper	PSCC	Very High
Mammal	*Corynorhinus rafinesquii*	Rafinesque's big-eared bat	PSCC	Moderate
Mammal	*Myotis austroriparius*	Southeastern myotis	PSCC	Moderate
Vascular Plant	*Asclepias pedicillata*	Savanna milkweed	PSCC	Very High
Vascular Plant	*Pteroglossapsis ecristata*	Crestless plume orchid	PSCC	Very High
Vascular Plant	*Schwalbea americana*	American chaffseed	Federally endangered	Very High
Vascular Plant	*Tridens chapmanii*	Chapman's redtop	PSCC	High
Reptile	*Crotalus adamanteus*	Eastern diamondback rattlesnake	PSCC	High
Reptile	*Heterodon simus*	Southern hognose snake	PSCC	Moderate
Reptile	*Micrurus fulvius*	Eastern coral snake		Moderate
Reptile	*Pituophis melanoleucus melanoleucus*	Northern pine snake	PSCC	Moderate

Note: PSCC=Proposed Species of Conservation Concern.

Table 3-41. Key Characteristics ranked VERY HIGH for Upland Pine Woodland Associates

Key Characteristic	Indicator
Function	% System Acres Burned at Desired Return Interval
Function	% System Acres Burned During the Growing Season
Structure	% Ecological Departure from Reference Conditions
Structure	% Ecological System in Open Woodland Savanna, or Grassland
Structure	% Future Old Growth
Composition	% of Ecosystem in "Maintain" Condition Class

Alternative 1

Direct and Indirect Effects. Upland longleaf-associated ecosystems would continue to be maintained and restored in Management Area 26 using frequent, prescribed fire. Habitat for red-cockaded woodpecker would continue to be maintained and restored within the red-cockaded woodpecker habitat management area. Direct and indirect effects from management activities, including but not limited to timber harvesting, prescribed burning, and trail and road construction, could have direct impacts on some species in this group. Measures needed to conserve documented occurrences and associated habitat for threatened and endangered species and

species of conservation concern would be developed as needed during project planning and implementation.

Indirectly, associated habitats would likely be maintained with frequent fire as needed, particularly federally listed species, though this fire may not occur at with the seasonality and frequency that would be needed to maintain and restore wet savannas for species associated with this group. Forested stands would tend to be at a higher density than optimal for many of the species associated with this group. Upland longleaf and loblolly pine woodlands would continue to be maintained and restored. Indirectly, non-native invasive species, including feral hogs, would likely increase in Alternative 1.

As a result of implementing Alternative 1, the sustainability of species in the upland pine woodland group is likely to be poor in the next 10 years and poor in the next 50 years. In Alternative 1, the key characteristics related to fire regime, non-native invasive species, old growth, structural diversity, and vegetation condition for upland pine ecosystems all were rank poor to fair in terms of ecological sustainability across the landscape.

Alternatives 2 and 3

Direct and Indirect Effects. Within both Alternatives 2 and 3, habitats and species in this group would be maintained and restored on a 1 to 3 year prescribed fire regime, including growing season burns every third burn. All known locations for species in this group would occur in the fire-adapted ecosystems of Management Area 1 or would be given priorities through rare community consideration. Direct and indirect effects from management activities, such as timber harvesting, prescribed burning and associated fireline construction, and trail and road construction, would be unlikely due to standards and guidelines. During project-level planning additional mitigation measures may be developed to conserve documented occurrences and associated habitat for species of conservation concern. Adaptive monitoring and management of these habitats would occur to ensure that desired conditions for upland pine woodlands would continue to be maintained and restored, and sustainable populations would continue to occur across the landscape. Given the limited number of populations for species in this group, national forest lands would have a role in providing for the species when considered in conjunction with other lands throughout the range of the species. The direct and indirect effects of this alternative would be an improvement in the vegetation composition, structure, function and connectivity of upland pine woodland species. The ecological sustainability of this species group would likely be good in the next 10 years and good in the next 50- years in Alternative 1.

As a result of implementing Alternatives 2 and 3, there are likely to be beneficial effects to species associated with upland pine woodlands. Beneficial effects are likely to be greater in Alternative 2 than 3, given the larger quantity of fire-adapted ecosystems maintained and restored, in Alternative 2. The ecological sustainability of species in this group are likely to be good in both the next 10 and the next 50 years, in Alternative 2, and fair in Alternative 3, due to the lower relative amount of both upland pine woodlands which will be maintained and restored with prescribed fire in Alternative 3.

Cumulative Effects. No cumulative effects beside what has been described are anticipated.

Wet Marl Hardwood and Calcareous Mesic Slope Associates

The species in this group can be linked to the desired conditions and management strategies associated with mesic slope forests and narrow non-riverine swamps and blackwater stream floodplain forests forestwide (see Table 3-38 and Table 3-39).

Table 3-42. Proposed Species of Conservation Concern associated with Wet Marl Hardwood and Calcareous Mesic Forests

Species Group	Latin Name	Common Name	Designation	Group Weight
Vascular Plant	*Carex basiantha*	Widow sedge	PSCC	Very High
Vascular Plant	*Carex chapmanii*	Chapman's sedge	PSCC	Very High
Vascular Plant	*Carex crus-corvi*	Ravenfoot sedge	PSCC	Very High
Vascular Plant	*Carex granularis*	Meadow sedge	PSCC	Very High
Vascular Plant	*Carya myristiciformis*	Nutmeg hickory	PSCC	Very High
Vascular Plant	*Listera australis*	Southern twayblade	PSCC	Very High
Vascular Plant	*Matelea flavidula*	Yellow spinypod	PSCC	Very High
Vascular Plant	*Ponthieva racemosa*	Shadowwitch orchid	PSCC	Very High
Vascular Plant	*Quercus similis*	Bottomland post oak	PSCC	Very High
Vascular Plant	*Triphora trianthophora*	Three birds orchid	PSCC	Very High

Table 3-43. Key Characteristics ranked VERY HIGH for predicting effects to species associated with Wet Marl Hardwood and Calcareous Mesic Forests

Key Characteristic	Indicator
Composition	Percent of Ecosystem Extent dominated by characteristic Native Species
Composition	Percent of Ecosystem Extent Impacted by Invasive Plant Species
Function	Percent of System Acres Burned at Desired (infrequent) Fire Return Interval
Structure	Percent of Old Growth Forest

Only 3 birds orchid are identified as a PETS species in the 1996 Revised Forest Plan. The 1996 Revised Forest Plan contained an objective to identify and maintain… "calcareous mesic forests, and several examples of mesic slope forests are influenced by marl or calcareous geology" and are addressed as natural areas in the 1996 forest plan and also as rare communities in Alternatives 2 and 3. High-quality examples occur on gentle slopes near the Santee River and Echaw Creek, along the Echaw Creek drainage to the confluence with the Santee River and in the Huger Creek drainage sub-basin – Huger Creek, Nicholson Creek, Turkey Creek and Fox Gully Branch, mostly west of Hwy. 41 (Everett, 2012; McMillan et al., 2001; Porcher, 1995). Threats include reforestation practices which favor pine, prescribed burning which is too frequent, non-native invasive species and fragmentation due to roads.

Alternative 1

Direct and Indirect Effects. Management activities, including but not limited to timber harvesting, prescribed burning, and trail and road construction, could have direct impacts on some species in this group. Measures needed to conserve documented occurrences and associated

habitat for threatened and endangered species and species of conservation concern would be developed as needed during project planning and implementation. Directly and indirectly, these species occurring in designated high calcium mesic communities would continue to be maintained on the landscape, but they would not be restored. Indirectly, non-native invasive species, including feral hogs, would likely increase in Alternative 1.

As a result of implementing this Alternative 1, species and habitats associated with wet marl hardwood and calcareous mesic slopes are likely to be fair to poor in terms of ecological sustainability. In Alternative 1, key characteristics related to non-native invasive species, old growth forests, and vegetation composition integrity are ranked poor to fair.

Alternatives 2 and 3

Direct and Indirect Effects. Under Alternatives 2 and 3, measures needed to conserve species of conservation concern would be addressed during project planning and implementation. Probable activities would include removal of loblolly pine through thinning favoring hard mast oak species, more moderate fire regimes and non-native invasive species control. At the coarse filter, hardwood forests would be maintained, improved and restored on appropriate sites wherever they occur. Rare communities would be a priority for maintenance and restoration including habitats for this species group. The direct and indirect effects of this alternative would be an improvement in the vegetation composition, structure, function and connectivity of hardwood forests on appropriate sites across the landscape. The ecological sustainability of this species group would likely be fair in the next 10 years and good in the next 50 years in Alternative 1.

As a result of implementing both Alternatives 2 and 3, there likely would be beneficial effects to Wet Marl Hardwood and Calcareous Mesic Slope Associates. The acreage being maintained and restored in this hardwood species groups would result in good sustainability in Alternatives 2 and 3 in both the 10- and 50-year intervals. Alternatives 2 and 3 would provide desired conditions for maintaining and restoring 100% of the total extent of hardwood ecosystems on appropriate ecological sites on the forest.

Cumulative Effects. There would be no additional cumulative effects beyond what is identified.

Aquatic Large river/Main Channel Associates

The species in this group (see Table 3-40) inhabit large river habitat including species that migrate from salt and brackish waters into freshwater habitats. The group is sensitive to in-stream flow modifications which include channelization, dredging, dams, road crossings and culverts. In many cases, hydrologic modification impedes or completely prevents natural migration and dispersal strategies. In other cases, hydrologic alteration may change water temperature regimes and water quality variables such as point and non-point source pollution. Other more subtle impacts of hydrologic alteration include unnatural fluctuations in hydro period that may impede reproduction or other phases in the life history of associated species.

Performance measures for hydrologic function, water quality and climate change serve as indicators for this species group (see Table 3-41). Both are at sustainable levels and are expected to remain sustainable in the future as long as guidelines established are followed. Plan components include desired conditions for floodplain forests and watershed health, objectives to maintain mature closed canopy forests in riparian areas and guidelines for soil and water.

Table 3-44. Large River/Main Channel Associates

Species Group	Latin Name	Common Name	Designation	Group Weight
Fish	*Acipenser brevirostrum*	Shortnose sturgeon	Federally endangered	Equal
Fish	*Acipenser oxyrinchus*	Atlantic sturgeon	Federally endangered	Equal

Table 3-45. Key Characteristics ranked VERY HIGH for predicting effects to Large River/Main Channel Associates

Key Characteristic	Indicator
Hydrologic Function	Major Hydroelectric Dam Proximity/Influence
Water Quality--Toxics	Point Source Rating
Climate Change	Sea Level Rise, with saltwater intrusion in aquatic systems
Hydrologic Function	Severity of Hydrologic Control Structures

All Alternatives

Direct, Indirect and Cumulative Effects. Algorithms in the ecological sustainability evaluation (ESE) tool were developed taking into account all weights, rankings and scores associated with the Large River/Main Channel Associates group to derive composite current scores and estimated scores by alternative for the first and fifth decade intervals. These composite scores were calculated at both the unit level and aggregately across the forests. A forestwide species group by alternative summary of these scores is presented in Figure 3-27.

Hydrologic alterations within subject watersheds occur both on privately owned adjacent lands and Forest Service land. Other than man-made impoundments and stream crossings, National Forest System lands should not contribute negative impacts to hydrologic regimes. In some cases, the Forests may actually restore hydrologic regimes, particularly through stream enhancement and restoration projects. Stream crossings may increase sediment loads and modify hydraulic processes as well as serve as an impediment to species migration and dispersal. The creation and retention of manmade impoundments can also disrupt flow regimes as well as migration patterns and dispersal of some riverine aquatic species.

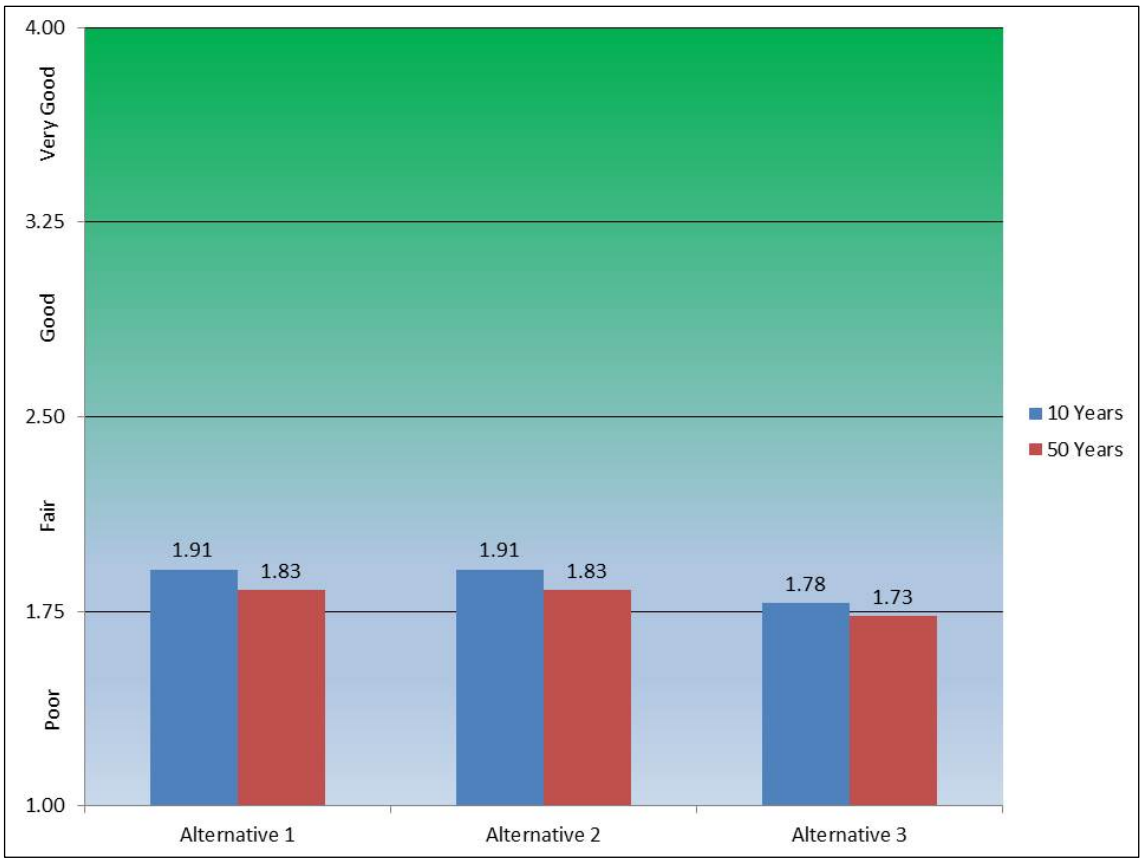

Figure 3-31. Aquatic Large river/Main Channel Associates. Species association current (watershed-wide) and predictive status based on National Forest System land management and activities

The resulting scores of the analysis described above, which are measured watershed-wide regardless of ownership profiles, result in a fair rating for current status and all alternatives. While neighboring landowners may contribute varying and unpredictable levels of risk to watershed health, the national forests would continue to maintain a positive contribution to aquatic sustainability. As a result, watershed health should remain relatively stable, at least to the extent that the forest can control based on ownership profiles. Dam densities, channelization, ditching, dredging, and stream crossings, a large majority of which are on neighboring privately owned lands, play a major role in elevating risk levels to hydrological integrity.

Aquatic Species Associated with Streams and Smaller Waters

This species (Table 3-42) is dependent on quantities of coarse woody debris, pollution, hydrologic modification and road crossing located in the stream or riparian area. Coarse woody debris plays a vital role in the life history this species or its prey. Coarse woody debris is measured as a byproduct of a mature riparian area enclosing the stream. A sustainable amount of debris will enter the stream if the surrounding riparian area contains a mature, closed canopy forest with little or no unnatural disturbance. Trees and other woody debris should not be removed from streams unless it is for safety or transportation needs. If removed for transportation requirements, only those trees in the area adjacent to the road or causing direct impacts to roads, trails or bridges should be removed.

Table 3-46. Streams and Smaller Waters Associates

Species Group	Latin Name	Common Name	Designation	Group Weight
Fish	*Anguilla rostrata*	American eel	Petitioned for listing	Equal

Performance measures for potential for coarse woody debris abundance, hydrologic function, water quality and climate change serve as indicators for this species (Table 3-43). Both are at sustainable levels and are expected to remain sustainable in the future as long as guidelines established are followed. Plan components include desired conditions for floodplain forests and watershed health, objectives to maintain mature closed canopy forests in riparian areas and guidelines for soil and water.

Table 3-47. Key Characteristics ranked VERY HIGH for predicting effects to Streams and Smaller Waters Associates

Key Characteristic	Indicator
Potential for Coarse Woody Debris Abundance	Percent Riparian Forested
Hydrologic Function	Major Hydroelectric Dam Proximity/Influence
Water Quality--Toxics	Point Source Rating
Hydrologic Function	Road Crossing Rating
Climate Change	Sea Level Rise, with saltwater intrusion in aquatic systems
Hydrologic Function	Severity of Hydrologic Control Structures

All Alternatives

Direct, Indirect and Cumulative Effects. Algorithms in the ecological sustainability evaluation (ESE) tool were developed taking into account all weights, rankings and scores associated with the Streams and Smaller Waters group to derive composite current scores and estimated scores by alternative for the first and fifth decade intervals. These composite scores were calculated at both the unit level and aggregately across the forests. A forestwide species group by alternative summary of these scores is presented in Figure 3-28.

Road and trail density is an important aspect of these data that is unlikely to change or improve over time. Many roads that cross National Forest System lands are administered under the jurisdiction of local, state and other federal entities and are therefore, outside of the control of the national forests. Roads and trails administered by the forest are in most cases considered essential to public access. While some National Forest System roads and trails may be gated and rehabilitated if considered unessential to the public good, the overall road and trail density scores among all alternatives would change little due to the statistical weight of roads outside the forests' jurisdictions. While road densities would be a concern in some instances, in many cases road and trail scores are already in the good or very good range which is expected to continue to contribute to ecological sustainability on National Forest System lands.

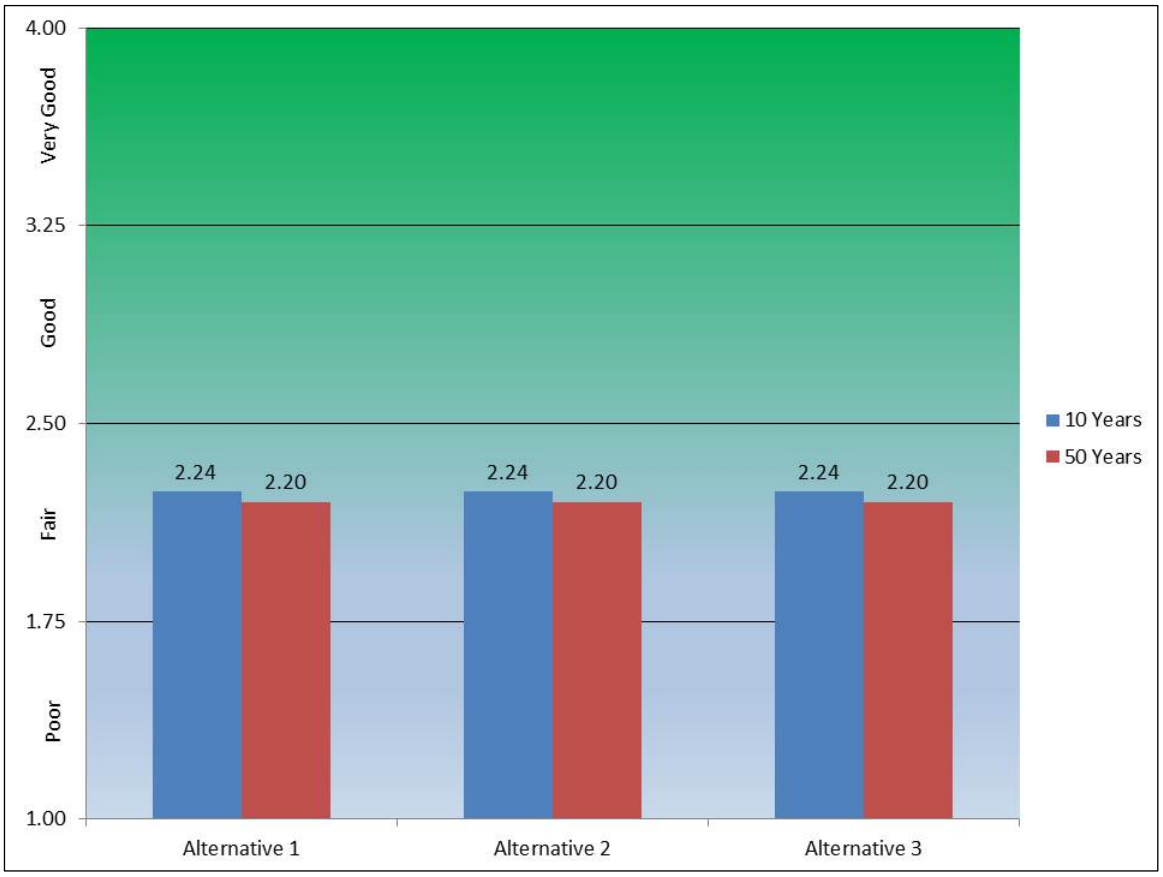

Figure 3-32. Aquatic Species Associated with Streams and Smaller Waters. Species association current (watershed-wide) and predictive status based on National Forest System land management and activities

The resulting scores of the analysis described above, which are measured watershed-wide regardless of ownership profiles, result in a fair rating for current status and all alternatives. While neighboring landowners may contribute varying and unpredictable levels of risk to watershed health, the national forests would continue to maintain a positive contribution to aquatic sustainability. As a result, watershed health should remain relatively stable, at least to the extent that the forest can control based on ownership profiles. In many watersheds, depending on ownership and land-use profiles, the Francis Marion NF may be a primary contributor to coarse woody debris associates due to riparian forest management practices and guidelines.

All Alternatives

Direct, Indirect and Cumulative Effects. Retention and protection of riparian forests should have no negative effects. Positive effects would include maintenance of hydrologic and hydrothermal regimes along with increases in the abundance of coarse woody debris.

Terrestrial Species Groups Not Covered By Ecological System Group Sustainability Plan Components (Fine filter)

Wildlife Species Sensitive to Road Mortality

Species in this group listed in Table 3-44 are sensitive to excessive human disturbance such as trampling, harassment, vehicular mortality and direct mortality. Reptile species are especially

sensitive to being harmed, harassed and killed by humans. This interaction with humans can have long-term negative effects on population sizes and sustainability.

Table 3-48. Wildlife species sensitive to road mortality

Species Group	Latin Name	Common Name	Designation	Group Weight
Amphibian	Ambystoma cingulatum	Frosted Flatwoods Salamander	Federally Threatened	Moderate
Reptile	Clemmys guttata	Spotted Turtle	PSCC	High
Reptile	Crotalus adamanteus	Eastern Diamondback Rattlesnake	PSCC	Very High
Reptile	Heterodon simus	Southern Hognose Snake	PSCC	High
Amphibian	Lithobates capito	Gopher Frog	PSCC	High
Reptile	Pituophis melanoleucus melanoleucus	Northern Pine Snake	PSCC	Moderate

The Carolina gopher frog, frosted Flatwoods salamander, all snakes and many other plant and animal species are especially sensitive to harm due to off-road vehicles, heavy equipment, horses and human traffic. See Table 3-45. Some species are collected commercially and used for a variety of purposes including but not limited to food, medicinal, decorative, gardening/ landscaping and the pet trade.

Table 3-49. Key characteristics ranked moderate to very high for predicting effects to species sensitive to road mortality

Key Characteristic	Indicator
Connectivity	OHV Trail Density. Legal and illegal recreational vehicle trail density and associated fragmentation/connectivity expressed in road miles per square mile of this ecosystem or habitat type.
Connectivity	Unpaved Open Road Density. Unpaved, open public road density and associated fragmentation/connectivity expressed in road miles per square mile of this ecosystem or habitat type.

The following actions could be implemented under Alternatives 2 and 3 to reduce impacts to these species:

1. Design roads to avoid highly populated areas of at-risk species;
2. Design roads to include safe passage for these species;
3. Provide educational materials to the public to increase knowledge and awareness of species needs;
4. Work collaboratively with state agencies to limit take of wildlife species on Forest Service lands; and ,
5. Limit recreational access to sensitive habitats associated with species on this list. Standards and guidelines have been identified to reduce impacts to these species.

Alternative 1

Direct and Indirect Effects. The impacts of roads and the need to minimize road impacts on flora and fauna would continue to not be specifically addressed in the 1996 Forest Plan. However, Alternative 1 would continue the following standards and guidelines related to roads and trails:

1. FW-127 Close all new roads constructed solely to remove timber.
2. FW-101 Avoid construction (roads, trails, recreational sites, etc.) in floodplains and wetlands whenever there is a practical alternative.
3. FW-88 OHV use is restricted to designated OHV trails and if street legal, opened roads.
4. FW-8 Avoid constructing additional plowed firelines. Use existing plowed lines and other barriers such as roads, streams and trails when possible. Where plowed firelines are needed, every effort will be made to reuse the same location for each successive burn.
5. FW-131 (R8–VM) Where practical, native flowering species are established, maintained and enhanced on intermittent service roads when they are closed and on cut-and-fill slopes of all roads.
6. FW-153 Site prepare, fertilize and seed, as needed, intermittent roads, primary skid trails and log decks following timber sale and related activities (to provide wildlife plant cover).
7. FW-155 Emphasize closing roads in areas that will provide a contiguous block of land 250 acres or greater, 1/2 mile from an open road.

The following are identified as research needs in the 1996 Forest Plan related to roads and trails:

1. Determine the effects of past and current maintenance of drainage modification systems (including roads constructed with inadequate cross drainage) and identify the potential costs and benefits associated with restoration of hydrologic function.
2. Determine the effects of off-road vehicle trails or roads on wetland ecosystems. Identify Best Management Practices to use when crossing wetland ecosystems with these trails.

Very few items in the 1996 Forest Plan would address the impacts of roads on flora and fauna. However, the forest did begin analyzing the impacts of roads to forest resources beginning around 2010 and has identified some opportunities for minimizing road impacts. More analysis would be needed to gain a better understanding of road impacts to species and their habitats. Considering what is included in the 1996 Forest Plan to address impacts to species in this group, the negative biological and ecological impacts of roads on the forest would not be addressed under this alternative.

Although there are still data needs, road impacts to this group would be anticipated to increase under Alternative 1. As such, Alternative 1 would be expected to directly and indirectly negatively affect species in this group. The ecological sustainability ranking for this group would be expected to remain poor under Alternative 1.

As a result of implementing Alternative 1, the sustainability of species in this group would likely be poor during the next 10 to 50 years. Desired conditions and objectives would not address restoration/mitigation needs for species in this group.

Alternatives 2 and 3

Direct and Indirect Effects. Under Alternatives 2 and 3, habitats and species in this group would be maintained and restored under a 1 to 3 year fire return interval including growing season burns

every third burn. With the exception of the spotted turtle, all known species in this group occur within and are dependent upon fire maintained ecosystems.

Opportunities to minimize road effects to species in this group would be included under Alternatives 2 and 3 as plan components. As such, the direct and indirect effects of Alternatives 1 and 2 are expected to result in decreased road impacts when compared to Alternative 1. Unfortunately, due to the anticipated rate of human population growth in the tri-county area of Berkeley, Charleston and Dorchester during the next 10-50 years, road impacts to species in this group would only be expected to continue to get worse. As such, the ecological sustainability of this species group is likely to remain poor during the next 10 to 50 years due the anticipated increase in roads and vehicular traffic.

Cumulative Effects. Management that contributes to the viability of species in this group would likely be increasingly difficult in the future (e.g., prescribed burning), especially with the anticipated urban growth that is expected in the tri-county area of Berkeley, Charleston and Dorchester during the next 10-50 years. This is primarily due to the fact that the increased urbanization, coupled with decreased prescribed burning, is expected to lead to increases in the following: road densities and associated traffic; non-native invasive species; fire exclusion and suppression; and use of alternative silvicultural practices (e.g., mastication, grazing and pesticide application).

Due to the fact that Alternatives 2 and 3 actually would address road impacts to species in this group and mitigation measures are identified, these alternatives would be expected to result in beneficial effects for species in this group, especially with regards to Forest Service roads. Unfortunately, due to the projected increase in urbanization in the tri-county area of Berkeley, Charleston and Dorchester during the next 10-50 years, the sustainability of species in this group would likely be poor during the next 10 to 50 years under all alternatives. Cumulatively, negative effects are expected under all alternatives, just less severe under Alternatives 2 and 3.

Wildlife Snag and Large Diameter Hollow Tree Associates

Many species depend on dead and dying trees and/or large diameter hollow trees. In terms of bats, bat species typically live in mature riparian areas on the forests and forage in open areas. See Table 3-46. They use bridges, cisterns, culverts, old abandoned houses, leaf litter, snags and branches, bark and cavities of live trees as roosts. See Table 3-47. They are insectivores and require some proximity to water.

Table 3-50. Wildlife Snag and Large Diameter Hollow Tree Associates

Species Group	Latin Name	Common Name	Designation	Group Weight
Mammal	*Corynorhinus rafinesquii*	Rafinesque's big-eared bat	PSCC	Very High
Mammal	*Myotis austroriparius*	Southeastern myotis	PSCC	Very High

Table 3-51. Key Characteristics ranked very high for predicting effects to wildlife snag and large diameter hollow tree associates

Key Characteristic	Indicator
Terrestrial Habitat Snag, Bat Roost, Woody Debris, Stump Retention	Snag Retention. Number of snags (dead pine and hardwood trees) per acre forestwide.

Unfortunately, habitat data is extremely limited for forest-roosting bats in the Southeast (Miller et al., 2003). This is especially true on the Francis Marion, where only a few bat studies have been conducted in the past 75+ years. Most U.S. studies have primarily occurred in older-aged forests with little to no active forest management. However, in South Carolina, Menzell et al. (2001) examined the foraging habitat of male Rafinesque's big-eared bats in Aiken County. This study was conducted on a 1,057-hectare (ha) property owned and managed by the National Audubon Society known as the Silver Bluff Plantation. Based on the individuals studied, Menzell et al., (2001) observed that *Corynorhinus rafinesquii* had biphasic activity patterns, with most foraging activity occurring during the first four hours after sunset and 2 hours before sunrise. Mean home range size of the animals that Menzell et al., (2001) studied was 93.1 ha. Although there were numerous large contiguous tracts of mature bottomland hardwoods in Menzell et al., 2001's study area, most foraging activity occurred in young pine stands. Only nine percent of foraging areas were in bottomland hardwoods (Menzell et al., 2001). Menzell et al., (2001) found male *Corynorhinus rafinesquii* in approximately 90 percent of the abandoned structures that they surveyed, indicating that manmade structures such as abandoned buildings can be extremely important for species in this group. On the Francis Marion, this species has been observed under Forest Service bridges.

Forestwide desired conditions, as well as desired conditions for each ecological system, serve as ecological system diversity plan components for this group of species. Objectives to restore or maintain mature and old-growth forest help to sustain these species as well. Although ecosystem plan components should supply ample amounts of suitable habitat, this group has additional needs. In riparian areas, it is assumed that if the surrounding riparian area contains mature to old-growth closed-canopy forest with little or no unnatural disturbance, a sustainable amount of bat roost and hibernacula should be present. If retention/recruitment guidelines and other guidelines pertinent to creation of snags are implemented on the forest and there is sufficient mature and old-growth forest (within good or very good rating criteria), then it can assumed that adequate snags are being provided to sustain dependent species.

Although ecosystem plan components should supply ample amounts of suitable habitat for snag and large diameter hollow tree associates, there are additional needs for this group. It is necessary to retain snags and cavity/hollow trees for potential roosting by bats and other snag-dependent species. Pine snags play a critical role in providing prey for species such as the red-cockaded woodpecker and can also minimize kleptoparasitism of RCW cavities by other woodpecker species such as the red-headed woodpecker and red-bellied woodpecker. Snags are also important for providing refugia for many other animal species including insects, small mammals, amphibians and reptiles. Plan provisions to retain this habitat element help to insure sustainability of these species. In addition, human disturbance can interfere with bat roosting behavior and removal of existing artificial habitat can limit reproductive and foraging activity for bats. Bridges, cisterns and culverts should be checked for presence of bats before removal or modification of structure and alternative habitat should be provided when necessary. The key factors for sustainability of this group are recruitment of new snags and hollow trees and the retention of existing trees. Both of these can be measured through implementation monitoring using

guidelines. Artificial cavity installation and roost/den structures may be necessary for some species in this group. Where suitable roosting and nesting habitat doesn't exist, artificial bat and bird houses can be used to improve habitat conditions.

Alternative 1

Direct and Indirect Effects. The 1996 Forest Plan contains the following guideline with regards to snags: "FW-151 During TSI, WSI and site preparation, at least 2 standing dead snags (greater than 12 inches) are retained per acre. Give priority to the largest snags available and to hardwood species; however, pine snags may be substituted if appropriate hardwoods are not available. Appropriate treatments are used to create snags where natural snags are lacking." Data is lacking for the number and density of snags on the Francis Marion, as this has never been measured. However, snags would continue to be created by a combination of biotic and abiotic events on the forest under this alternative. As such, Alternative 1 would be expected to continue to directly and indirectly benefit species in this group by providing snags and habitat components.

Although Alternative 1 would continue to directly and indirectly provide habitat for species in this group, the ecological sustainability ranking for this group would be expected to decline under Alternative 1 during the next 10 to 50 years due to forces that the forest is unable to control (e.g., increased urban growth within and adjacent to the proclamation boundary and white-nose syndrome). Although Alternative 1 would continue to directly and indirectly provide habitat for species in this group, the ecological sustainability ranking for this group would be expected to decline during the next 10 to 50 years due to negative cumulative effects outside of the Forest Service's control. As such, the ecological sustainability ranking for this group would be expected to decline during the next 10-50 years under Alternative 1.

Alternatives 2 and 3

Direct and Indirect Effects. Under Alternatives 2 and 3, plan components are designed to create and maintain snags and hollow trees at a higher level than Alternative 1. As such, the direct and indirect effects for species in this group would be more beneficial than those under Alternative 1.

Although Alternatives 2 and 3 would continue to directly and indirectly provide habitat for species in this group, the ecological sustainability ranking for this group would be expected to decline during the next 10 to 50 years due to forces that are beyond the Forest Service's control (e.g., increased urban grown within and adjacent to the proclamation boundary and white-nose syndrome). However, this decline would likely be less pronounced than under Alternative 1; this is especially true for Alternative 2. Alternative 2 would likely produce the greatest amount of beneficial effects for this species group and the highest ecological sustainability ranking during the next 10-50 years.

Cumulative Effects. As mentioned for Alternative 1, the increased urbanization and population growth of the tri-county area would be anticipated to result in negative cumulative effects for species in this group. This is primarily due to the fact that the increased urbanization, coupled with decreased prescribed burning, would be expected to lead to increases in the following: road densities and associated traffic; non-native invasive species; fire exclusion and suppression; and use of insecticides in and around the forest. Additionally, bats in the U.S. are being plagued by the white-nose syndrome (WNS). Although there is some uncertainty associated with the effects resulting from the disease, WNS is only anticipated to lead to increased cumulative effects.

Although Alternatives 2 and 3 would provide substantially greater habitat for species in this group, the ecological sustainability ranking for this group is expected to decline during the next

10 to 50 years due to cumulative effects outside of the Forest Service's control. Cumulatively, negative effects would be expected under all alternatives, just less severe under Alternatives 2 and 3. This is especially true for Alternative 2.

Wildlife Stump and Root Mound Associates

Coarse woody debris (CWD), root mounds and stump holes provide critical refugia for numerous species of wildlife listed in Table 3-48.

Table 3-52. Wildlife Stump and Root Mound Associates

Species Group	Latin Name	Common Name	Designation	Group Weight
Amphibian	*Ambystoma cingulatum*	Frosted Flatwoods Salamander	Federally threatened	Very High
Reptile	*Crotalus adamanteus*	Eastern Diamondback Rattlesnake	PSCC	Very High
Reptile	*Heterodon simus*	Southern Hognose Snake	PSCC	Very High
Reptile	*Pituophis melanoleucus melanoleucus*	Northern Pine Snake	PSCC	Very High

Where frequent fire would occur, CWD, root mounds and stump holes would provide essential escape cover for slow-moving wildlife species. See Table 3-49. Numerous other wildlife species use these microhabitats as well, including virtually all native snake species, various small mammal species and even turtles such as the Eastern box turtle and spotted turtle. Retention of downed wood, stumps, stump holes and root mounds is essential for this group of species. Objectives to restore or maintain mature and old-growth forest would help to sustain these species as well.

Table 3-53. Key Characteristics ranked very high for predicting effects to wildlife stump and root mound associates

Key Characteristic	Indicator
Underground Access	Root Mounds and Stump Holes. Density of root mounds and mature stumps/stump holes with sufficient surface access and underground cavities to provide seasonally critical refugia to herpetofauna, their predators and prey. Number of stumps/stump holes per acre.

Alternative 1

Direct and Indirect Effects. Coarse woody debris, root mounds and stump holes are not addressed in the 1996 Forest Plan. The 1996 Forest Plan also doesn't have any plan components that would limit activities that directly decrease this habitat component (e.g., stumping operations and site preparation). Species in this group would not benefit under this alternative; potentially destructive activities such as stumping would continue to be allowed. As such, Alternative 1 would be expected to continue to directly and indirectly negatively impact species in this group.

In implementing Alternative 1, the ecological sustainability rankings for this group would likely be poor during the next 10 to 50 years. Plan components in Alternative 1 would not address restoration/mitigation needs for species in this group.

Alternatives 2 and 3

Direct and Indirect Effects. Under Alternatives 2 and 3, habitats and species in this group would be maintained and restored under a 1 to 3 year fire return interval; including growing season burns every third burn. With the exception of the spotted turtle, all known species in this group occur within and are dependent upon fire-maintained ecosystems. Although ecosystem plan components should supply ample amounts of suitable habitat, this group has additional needs that would be provided within plan components in Alternatives 2 and 3, such as creation of underground refugia.

In addition to explicitly protecting and providing habitat for species in this group, Alternatives 2 and 3 also would provide opportunities to minimize road effects. As such, the direct and indirect effects of Alternatives 1 and 2 are expected to significantly improve and maintain habitat for species in this group. Although human population growth is expected to dramatically increase during the next 10-50 years, Alternatives 2 and 3 would provide for greater maintenance, protection and creation of habitat components for species in this group. As such, the ecological sustainability for this species group would be expected to improve during the next 10 to 50 years under Alternatives 2 and 3.

Although there are data gaps for this species group, Alternatives 2 and 3 would be anticipated to greatly improve habitat for species in this group, which should lead to improved ecological sustainability rankings during the next 10-50 years. Only beneficial effects would be anticipated for Alternatives 2 and 3, with Alternative 2 resulting in the greatest benefits for these species.

Due to the fact that Alternatives 2 and 3 would actually address habitat components for this group and identify mitigation measures, these alternatives would be expected to result in beneficial effects for species in this group.

Cumulative Effects. Increased urbanization and population growth are anticipated to negatively impact species in this group. This is primarily due to the fact that the increased urbanization is expected to lead to increase road densities and associated traffic, non-native invasive species and fire exclusion and suppression.

Cumulatively, negative effects would be expected under all alternatives, just less severe under Alternatives 2 and 3. Although urbanization is expected to increase in the tri-county area of Berkeley, Charleston and Dorchester during the next 10-50 years, the overall sustainability of species in this group would be likely to improve during the next 10 to 50 years under Alternatives 2 and 3, but decline under Alternative 1.

Forest Opening Associates

These species depend on openings in the forest created by biotic and abiotic forces (e.g., wind throw and fire mortality) (see Table 3-50). Ecosystem plan components should supply ample amounts of suitable habitat for forest opening associates. Objectives to restore or maintain mature and old-growth forest, along with maintenance of existing permanent wildlife openings would help sustain these species as well. Key attributes and indicators associated with this group include the number, size, structure and distribution of openings (see Table 3-51 and Table 3-52).

Table 3-54. Forest Opening Associates

Species Group	Latin Name	Common Name	Designation	Group Weight
Mammal	*Corynorhinus rafinesquii*	Rafinesque's big-eared bat	PSCC	High
Mammal	*Myotis austroriparius*	Southeastern myotis	PSCC	High

Table 3-55. Key characteristics ranked high for predicting effects to forest opening associates

Key Characteristic	Indicator
Early Successional Openings	Number of permanent openings per analysis unit between .25 and 2 acres in size, no canopy (for bat foraging) and early successional vegetation including a mixture of herbaceous (for Northern bobwhite quail) and shrubs (for Swainson's warbler).

The numbers of known permanent wildlife openings within the Cane Gully, Hellhole, Macedonia, French Santee and Wando Analysis Areas were used to assess the current conditions across the forest (see Figure 3-29 below). Desired conditions would include 30-100 openings (+/-10 percent) within each of the aforementioned analysis areas on the forest. The indicators used to determine ecological sustainability rankings consisted of the number of permanent openings per analysis area that were between 0.25 and 2 acres in size, had no canopy (for bat foraging) and had early successional vegetation including a mixture of herbaceous (for quail) and shrubs (for Swainson's warbler).

Alternative 1

Direct and Indirect Effects. The 1996 Forest Plan contains the following objective that provides habitat for species in this group: "Maintain 5,000 to 10,000 acres in early successional habitat (0-3 year age class, permanent openings, wildlife openings, road rights-of-way, utility rights-of-way) in the short and long term." The 1996 Forest Plan also recognizes 441 acres of wildlife openings in Management Area 26, 133 acres in Management Area 27 and 54 acres in Management Area 29. The 1996 Forest Plan has a standard stating that new wildlife openings would not be constructed within Management Area 29. As was previously mentioned, the numbers of known permanent wildlife openings within the Cane Gully, Hellhole, Macedonia, French Santee and Wando Analysis Areas were used to assess the current conditions across the forest. Desired conditions would include 30-100 openings (+/-10 percent) within each of the aforementioned analysis areas on the forest.

Table 3-56. Key attributes indicators, indicator weights and current indicator ratings for forest opening associates

Element	Key Attribute	Indicator Name	Indicator Description	Poor Criteria	Fair Critiera	Good Criteria	Very Good Criteria	Current Indicator Value	Current Indicator Rating	Indicator Weight
Forest Opening Associates	Early Successional Openings	Cane Gully: Number, Size, Structure and Distribution of Openings	Number of permanent openings per analysis unit between .25 and 2 acres in size, no canopy (for bat foraging) and early succesional vegetation including a mixture of herbaceous (for quail) and shrubs (for Swainson's Warbler). This indicator is measure by a	30-100 openings +/- >25%	30-100 openings +/- 11-25%	30-100 openings +/- 10%	30-100 openings	13	**Poor**	Very High
Forest Opening Associates	Early Successional Openings	French Santee: Number, Size, Structure and Distribution of Openings	Number of permanent openings per analysis unit between .25 and 2 acres in size, no canopy (for bat foraging) and early succesional vegetation including a mixture of herbaceous (for quail) and shrubs (for Swainson's Warbler).	30-100 openings +/- >25%	30-100 openings +/- 11-25%	30-100 openings +/- 10%	30-100 openings	161	**Poor**	Very High
Forest Opening Associates	Early Successional Openings	Hellhole: Number, Size, Structure and Distribution of Openings	Number of permanent openings per analysis unit between .25 and 2 acres in size, no canopy (for bat foraging) and early succesional vegetation including a mixture of herbaceous (for quail) and shrubs (for Swainson's Warbler).	30-100 openings +/- >25%	30-100 openings +/- 11-25%	30-100 openings +/- 10%	30-100 openings	47	**Very Good**	Very High
Forest Opening Associates	Early Successional Openings	Macedonia: Number, Size, Structure and Distribution of Openings	Number of permanent openings per analysis unit between .25 and 2 acres in size, no canopy (for bat foraging) and early succesional vegetation including a mixture of herbaceous (for quail) and shrubs (for Swainson's Warbler).	30-100 openings +/- >25%	30-100 openings +/- 11-25%	30-100 openings +/- 10%	30-100 openings	33	**Very Good**	Very High
Forest Opening Associates	Early Successional Openings	Wando: Number, Size, Structure and Distribution of Openings	Number of permanent openings per analysis unit between .25 and 2 acres in size, no canopy (for bat foraging) and early succesional vegetation including a mixture of herbaceous (for quail) and shrubs (for Swainson's Warbler).	30-100 openings +/- >25%	30-100 openings +/- 11-25%	30-100 openings +/- 10%	30-100 openings	31	**Very Good**	Very High

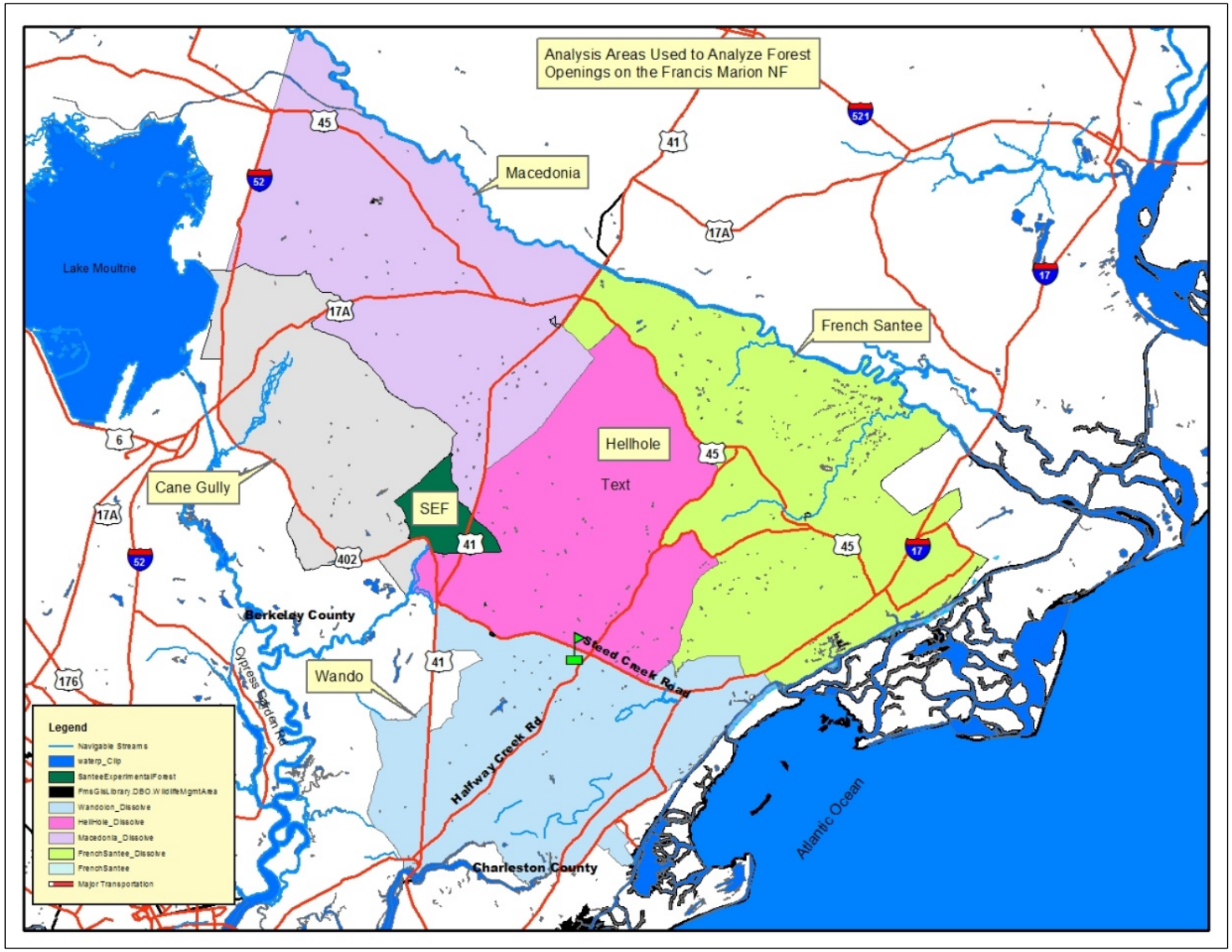

Figure 3-33. Analysis areas used to analyze current conditions for forest opening associates

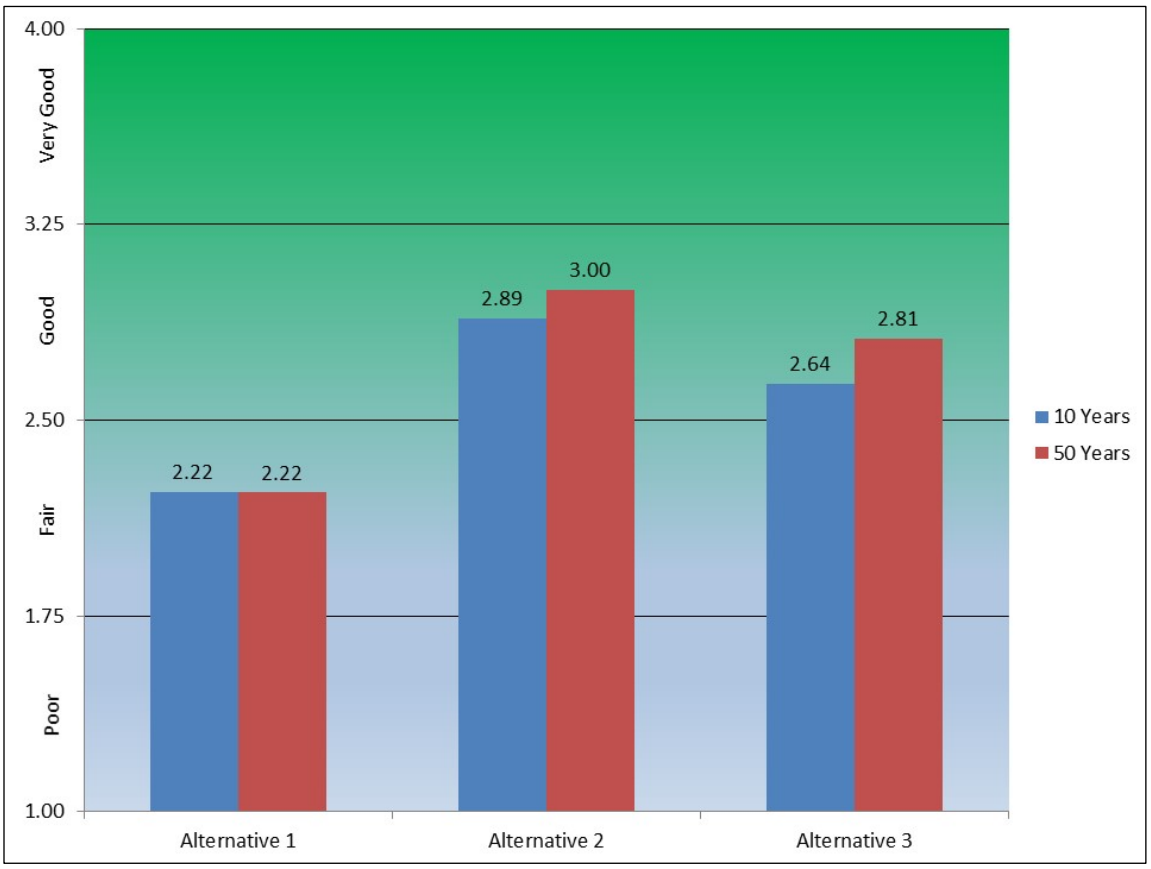

Figure 3-34. Estimated ecological sustainability rankings for forest opening associates under the 3 alternatives for 10 and 50 years

Based on the current conditions, the ecological ranking for this group would be expected to remain fair during the next 10-50 years under Alternative 1 (see Figure 3-30). Alternative 1 would be expected to continue to directly and indirectly benefit species in this group by providing forest opening components via biotic and abiotic forces, but to a lesser extent than Alternatives 2 and 3.

Alternatives 2 and 3

Direct and Indirect Effects. Under Alternatives 2 and 3, plan components would be designed to create and maintain habitat for this group to a much greater extent than Alternative 1. As such, the direct and indirect effects for species in this group would be more beneficial than those provided under Alternative 1.

Alternatives 2 and 3 would continue to directly and indirectly provide habitat for species in this group. The ecological sustainability ranking for this group would be expected to remain at the good level during the next 10 to 50 years, which is primarily related to the increased amount of ecological restoration expected to occur under Alternatives 2 and 3. However, due to the decreased acreage of Management Area 1, along with the increased wilderness areas, Alternative 3 would be expected to produce somewhat less beneficial effects than Alternative 2 (see Figure 3-30).

Because Alternatives 2 and 3 would provide substantially greater habitat than Alternative 1, the ecological sustainability ranking for this group would be expected to remain good during the next 10 to 50 years.

Cumulative Effects. Additionally, bats in the U.S. are being plagued by the white-nose syndrome. Although there is some uncertainty associated with the effects resulting from the disease, WNS is only anticipated to lead to increased cumulative effects. However, all things being considered, anticipated negative cumulative effects should be offset by habitat management practices on the forest.

The potential negative cumulative effects would be expected to prevent this group from achieving good ecological sustainability rankings. Cumulatively, negative effects would be expected under all alternatives, just less severe under Alternatives 2 and 3.

3.3.4 Forest Health and Protection

This section of the EIS focuses on old growth, native insects and diseases, and non-native invasive species (NNIS). Healthy forests have the physical and biotic resources to support functioning ecological systems that support a diversity of native plants and animals. Native ecosystems are resistant or resilient to dramatic change caused by abiotic and biotic stressors (urban development, climate change) and mortality agents (e.g., the southern pine beetle). Through an adaptive management approach, priorities for management activities may shift to respond to changing conditions such as expansion of non-native invasive species, southern pine beetle outbreaks, disease infestations, or storm events.

3.3.4.1 Affected Environment: Old Growth

In June, 1997 the Southern Region of the Forest Service completed a report entitled Guidance for Conserving and Restoring Old Growth Forest Communities on National Forests in the Southern Region (USDA-FS, 1997). The old growth report contains direction for promoting development of a ne2rk of small, medium and large-sized patches of native old growth communities in conjunction with forest plan revision. The report includes desired conditions for a diversity of old growth community or ecosystem types throughout the Southern Region, given the best information available at that time. On the Francis Marion National Forest (FMNF or Francis Marion), the planning team used these ecosystem groups to provide the framework for eight old growth ecosystems on the forest (including associated composition, structure and disturbance regimes) as a better and more consistent reflection of the local diversity. Direction to maintain and restore ecosystem groups in Alternatives 2 and 3 will promote conditions compatible with old growth characteristics in the future.

Old growth remnants appear to be both biologically and socially significant on the Francis Marion. Forests with large trees create a special place for people who come to the national forest to view nature and escape urbanization. Old growth forests contribute ecologically to landscape structural diversity. Old growth longleaf forests provide habitat for a variety of animal species, namely red-cockaded woodpecker, which require old living pine trees for cavity excavation and foraging. Walker (1999) sites 22 birds and frosted Flatwoods salamander as other animal species more typical of intact longleaf old growth forests. Twenty wildlife species were identified as old growth associates through the forest ecological sustainability evaluation process.

Old growth desired conditions vary with ecosystem type. Old growth suggests large trees, accumulations of large-sized dead standing and fallen trees, canopy gaps and multiple canopy layers, and wide variation in tree size and spacing (USDA, 1997). Pond cypress trees in the

Florida Bay Pond Cypress Savanna were recently aged at more than 400 years (Gaddy, 2014); pond cypress along the Santee River in the Guilliard Lake Research Natural Area could approach 1,200 years old. Characteristics specific to old growth longleaf forests and woodlands include open, low density park-like stands of flat-topped and contorted longleaf pine tree crowns, multiple tree size classes, a species-rich herbaceous layer dominated by grasses and forbs, multiple size classes of trees and naturally frequent fire regimes (Walker, 1999). The minimum age for longleaf pine old growth ranges from 150–200 years (USDA, 1997), although Walker (1999) notes that old growth characteristics can be observed in stands as young as 100 years of age.

Given the land use history of southern forests, very little true old growth exists today, though few inventories have been conducted. Most of the available data is based on dominant tree ages.

Possible Old Growth. To develop the strategy for providing for old growth conditions in the Francis Marion, the planning team developed an inventory of possible old growth,using stand data from the agency's forest vegetation database, FSVeg. The team first queried all stands on the forest meeting a minimum age criteria of >=110 years (age year <=1903), which is the minimum half-life for the predominant longleaf communities based on the 1997 guidance report. The team also looked at stands meeting the lower age criteria of 100 years (age year <=1913) and compared it to what was identified in the FEIS (USDA, 1996a). These stands were also evaluated as a percentage of ecosystem group extent, and in relation to prescribed fire history.

The areas of possible old growth were used to help identify areas to consider for old-growth allocation during the forest plan alternative development. The identification of a stand as possible old growth infers no land management decision regarding the stand's status of existing or future old growth.

Table 3-57. Possible Old Growth (2013) by Forest Type Group (Age Year <=1903 and by Age Year <=1913) compared to FEIS (1996), Francis Marion National Forest

	1996 FEIS	1996 FEIS	2013	2013
	Suitable Lands >100 years	Unsuitable Lands	>=110 years	>= 100 years
Loblolly Pine and mixtures w/hrdwd	0	3,201	343	2,898
Longleaf Pine and mixtures	527	3,141	795	3,583
Sweetbay-swamp tupelo-red maple	0	276	1,286	5,030
Upland Hardwood	53	56	248	939
Bottomland Hardwood	897	1,816	3,144	6,557
Swamp Hardwood	2,933	12,334	4,230	13,276
Brush	7,353	7,286		
Mixed Hardwood and Pine	101	1,761		
TOTAL	**11,864**	**29,871**	**10,046**	**32,283**

Table 3-58. Extent of Stands containing Possible Old Growth Characteristics (Acres by age year <=1915) by Ecosystem Group

Ecosystem Group	Percent of Ecosystem Group Extent
Broad Forested Swamps and Large River Floodplains	26
Depressional Wetlands and Carolina Bays	13
Maritime Forests and Salt Marsh	4
Narrow Forested Swamps and Blackwater Stream Floodplain	15
Oak Forests and Mesic Hardwood Forests	19
Pocosins	.9
Upland Longleaf Pine Woodlands	6
Wet Pine Savannas and Flatwoods	6

Future Old Growth - In developing a forest plan strategy to ensure ecologically sustainable allocations, the planning team identified a minimum desired condition of 10 percent in future old growth for each ecosystem group, and weighted old growth as a high indicator in predicting ecological sustainability. The 10 percent value was determined based on public and partner opinion, existing conditions and input from other national forests. The team included as much of the fire-adapted possible old growth ecosystems in Management Area 1 allocations as possible. Because maritime forests and oak and mesic slope forests were underrepresented, the proposed plan contains a standard to include all maritime forest ecosystems at age year 1915 or younger (10 percent), and at least 10 percent of oak forests and mesic hardwood forests at age year 1915 or younger as future old growth. Future old growth allocations will be assigned the FSVeg land class code of 699.

Pine ecosystems selected for old growth management would be suitable for timber harvest but not suitable for timber production. Timber harvests planned within these old growth areas would be designed to protect and promote old-growth characteristics. If a determination is made that an area no longer has old growth character, or should be harvested and restored to a more ecologically suitable forest type, these areas may be regenerated.

In evaluating effects to old growth across alternatives, the team considered future old growth compatible allocations to include lands classified as the following:

1. Unsuitable for timber production (including wilderness, riparian management zones, select special and designated areas);
2. Rare communities (Alternatives 2 and 3), or Botanical Areas (Alternative 1);
3. All ecosystems occurring in pocosin and depressional wetland and Carolina bay groups, likely to be managed with prescribed fire (Management Area 1 in Alternative 2 and 3, or Management Area 26 in Alternative 1);
4. Pine stands occurring within red-cockaded woodpecker 0.5-mile foraging partitions (estimated to be managed on a 120-year rotation).

Table 3-55 displays the percentage of each ecosystem group in future old growth-compatible allocations by alternative and ecosystem group

Table 3-59. The percentage of each ecosystem group in future old growth-compatible allocations by alternative

Ecosystem Group	ALT. 1	ALT. 2	ALT. 3
Upland Longleaf and Loblolly Pine Woodlands and Forests	51	53	17
Wet Pine Savannas and Flatwoods	25	51	32
Depressional Wetlands and Carolina Bays	50	73	52
Pocosins	79	79	63
Narrow Forested Swamps and Blackwater Stream Floodplain Forests	48	48	40
Oak Forests and Mesic Hardwood Forests	26	18	20
Maritime Forests Only	76	78	78
Broad Forested Swamps and Large River Floodplain Forests	54	37	47

3.3.4.2 Environmental Consequences: Old Growth

Alternative 1 – Current Management (1996 Forest Plan)

Direct and Indirect Effects. Old growth conditions would be promoted on lands unsuitable for timber production, which account for 11.5 percent of forested acres the majority of which occur as broad forested swamps and large river floodplains. Provisions in the 1996 Forest Plan do not consider old growth community composition, structure, connectivity and prescribed fire management needs for longleaf ecosystems above and beyond needs for the red-cockaded woodpecker. There are no provisions for promoting old growth conditions for a diversity of ecosystems to include maritime forests and oak and mesic slope forests, which are not well represented in the unsuitable land base.

Old growth characteristics could be directly affected, particularly in ecosystems commonly managed and not addressed, including oak and mesic slope forests and maritime forests. Indirectly, non-native invasive species infestations would be likely to impact old growth characteristics in all ecosystem groups. Longleaf ecosystems would be less likely to have the composition and structure typical of typical old growth communities, which would affect their value in providing diversity across the landscape.

Alternatives 2 and 3

Direct and Indirect Effects. Desired conditions and standards associated with ecosystem groups in Alternatives 2 and 3 would ensure that, at a minimum 10 percent of the extent of all ecosystem groups would be managed to maintain or restore old growth characteristics, including consideration of composition, structure, function and connectivity. These conditions would be most likely to occur within fire-adapted ecosystems in Management Area 1 and within all ecosystems in both management areas.

The majority of longleaf pine dominated ecosystems identified in the possible old growth inventory would be maintained in future old growth through Management Area 1 direction. In Alternative 2, all but 83 acres of the longleaf-dominated stands over 100 years would be maintained and restored as future old growth, whereas in Alternative 3, approximately 808 acres of longleaf-dominated stands would not occur in the fire-adapted restoration prescription. Direct and indirect effects could impact them as a result of harvesting and lack of prescribed fire management. Indirect effects due to management activities would be addressed at the project level as needed to ensure that old growth values are protected.

Both Alternatives 2 and 3 would directly and indirectly benefit development of future old growth conditions and characteristics across all ecosystem types. Benefits would be less in Alternative 3, where 808 acres of longleaf dominated stands on the possible old growth inventory would not be maintained with prescribed fire.

Cumulative Effects. The availability of old growth conditions on private lands is likely to decline in the future, as population centers and the demand on older forests for timber products continue to grow. This trend suggests that national forests will fill a large role in creating and maintaining these areas in the future. The urban-interface between the forest and Charleston will continue to expand and challenge our prescribed burning activities in the future, particularly in and around state highways.

Alternative 1 would likely provide very good to good direct, indirect and cumulative effects to broad forested swamp and large river floodplain old growth conditions in the future. However, it would also likely be fair to poor in providing for a diversity of other old growth ecosystem types, both at the 10- and 50-year interval.

Alternatives 2 and 3 would likely provide very good to good direct, indirect and cumulative effects to the development of all old growth ecosystems on the forest, both at the 10- and 50- year intervals. Alternative 2 would provide for the restoration and maintenance of a higher proportion of longleaf ecosystems, including those on the possible old growth inventory.

3.3.4.3 Native Insects and Diseases

Insect damage and plant disease are natural disturbances that are part of a healthy, functioning ecosystem, as are certain amounts of fire and wind damage. At times, the Forest Service uses vegetation management activities, such as timber harvest, fire, manual and chemical treatments to promote forest health (see sections 3.4.1 Forest Products/Timber Harvesting and 3.4.2 Community Wildfire Protection Planning). This section examines the most serious threats to forest health and those that require the most active prevention, suppression or monitoring efforts, as well as strategies in each of the 3 alternatives for achieving healthy forests.

Each alternative uses a combination of vegetation management practices to restore and maintain resilient native ecosystems, including prescribed burning. Though the extent and location of these activities differs with each alternative, the emphases in each one is to:

1. Apply frequent prescribed fire in designated portions of the forest;
2. Convert loblolly pine stands to longleaf pine forests on appropriate sites;
3. Maintain moderate stand densities; and
4. Control several NNIS.

These actions are expected to improve not only native species diversity but also the resilience of ecological communities to stressors such as disease and insect outbreaks, extreme weather disturbances associated with climate change and others. In addition to resilience, a variety of age classes, including old growth, are needed for ecological sustainability.

Numerous native insects and diseases may be found on the Francis Marion National Forest. The one likely to have the most harmful effect is a native pest—the Southern pine beetle (SPB).

Southern Pine Beetle

SPB (*Dendroctonus frontalis*) infestations have occurred cyclically throughout recorded history in the South. Outbreaks move from low levels of infestation to high levels over several years. Cycles may be localized or regional and depend upon weather, other stress factors and the interrelationship between SPB populations and its predators.

Factors that determine SPB hazard include:

1. The proportion of susceptible host trees such as southern yellow pine species (the more host trees, the higher the risk);
2. Radial growth of those trees over the past five years (slower growth brings higher risk); and
3. Density of host trees (higher densities equal higher risk).

Because individual tree radial growth data to estimate susceptibility is unavailable, the planning team used age as a proxy for radial growth. For the purpose of this analysis, stands equal to or older than 60 years old are considered to be of a higher susceptibility to SPB.

Currently, approximately 63 percent of the Francis Marion is in pine dominated forest types. Of this acreage, approximately 26 percent are 61 years of age or older. Natural enemies, such as diseases, parasites, predators and weather help maintain SPB populations and bring cyclic outbreaks under control.

Alternatives 1, 2 and 3

Direct and Indirect Effects. When SPB outbreaks occur, direct suppression would need to be implemented using integrated pest management strategies. Integrated pest management may be achieved through rapid salvage and use of infested trees, piling and burning infested materials, chemical control in high value resources and cut-and-leave.

Thinning is the preferred practice for reducing a forest stand's SPB susceptibility. Maintaining pine stands below a threshold of about 100 square feet per acre of basal area (USDA Forest Service, 1985) decreases the frequency and severity of SPB infestations, reduces intraspecific competition and provides trees with enhanced ability to ward off SPB attacks via increased resin flow. Reducing stand density through thinning also disrupts SPB pheromone communication by increasing the amount of air flow within the stand (Ayres et al., 2009).

Restoring longleaf pine and other native ecosystems can reduce the impacts of SPB infestations on the Francis Marion. In the event that climate change brings more periods of drought, longleaf pine is more drought tolerant and less susceptible to attack by SPB than loblolly pine.

Table 3-60. Acres in pine-dominated ecological systems regenerated and thinned and at risk from southern pine beetle effects at the end of the first decade by alternative

	Alternative (acres)		
Activity in Susceptible Types	**Alternative 1**	**Alternative 2**	**Alternative 3**
Pine Acres Regenerated by Harvest	6,911	28,257	23,631
Pine Acres Thinned by Harvest	48,647	17,864	27,506
Total Acres Mature (60+) Pine	48,226	46,292	43,450

Each alternative emphasizes maintaining moderate densities in pine stands. Alternative 1 would thin more acres in the first decade. However, a significant portion of these thins would be reducing moderate stand densities to relatively low densities to provide better habitat for red-cockaded woodpecker. Alternatives 2 and 3 would convert more acreage from loblolly pine types to longleaf pine types, which are generally at much lower risk of SPB attack. Acres of mature pine are very similar across the 3 alternatives.

Cumulative Effects. When considering actions on private and other agency lands within or directly adjacent to the Francis Marion, cumulative effects regarding SPB hazard are somewhat mixed. Management actions on privately held lands vary quite a bit depending upon the objectives and beliefs of individual landowners. Forested lands held for timber investment are likely to be intensively managed and SPB outbreaks aggressively fought using timber harvest. However, many acres of privately held lands would remain unmanaged and likely increase the probability of SPB outbreaks regardless of the responsible official's decision. Each alternative would help decrease SPB outbreaks on the FMNF, thus decreasing SPB spread from the forest to adjacent lands.

3.3.4.4 Affected Environment: Non-Native Invasive Species

Non-native invasive species (NNIS) pose a long-term risk to the health of the America's forests. In the absence of natural predators, NNIS can increase across the landscape with little opposition beyond limited control and reclamation measures. These species interfere with natural and managed ecosystems, degrade wildlife habitat, reduce the sustainable production of natural resource-based goods and services and increase the susceptibility of ecosystems to other disturbances such as fire (by increasing fuel loads to hazardous levels). NNIS are believed to be the second greatest cause of species endangerment and decline worldwide with habitat destruction being the first.

Trends. Insect damage and plant disease are natural disturbances that are part of a healthy, functioning ecosystem, as are fire and wind damage. However, both native and non-native insects and diseases have caused above-normal mortality rates on forested lands in the United States. High mortality rates can accelerate the development of high fuel-loading in fire-dependent forests, effectively removing important ecosystem elements and reducing private property values. The non-native insects and diseases of most concern include the emerald ash borer, sudden oak death, redbay ambrosia beetle (associated with laurel wilt disease), Asian longhorned beetle and sirex woodwasp. The highest profile non-native animals found on the Francis Marion National Forest are feral hogs. Feral hogs disrupt plant life, devastate ecosystems and have been known to decimate hardwood seedling plantings.

Aside from the potential economic loss from timber volume, many wildlife and fish species are dependent on the ecosystems affected by these invasive animals, insects and diseases.

Non-native Diseases

Diseases of most concern for the purposes of this analysis include laurel wilt and sudden oak death. The effects of the 3 alternatives on non-native diseases would be similar.

Laurel Wilt

Laurel wilt is a deadly disease of redbay (*Persea borbonia*) and other tree species in the laurel family (Lauraceae). The disease is caused by a fungus (*Raffaelea lauricola*) that is introduced into host trees by a non-native insect, the redbay ambrosia beetle (*Xyleborus glabratus*). The fungus plugs the water-conducting cells of an affected tree and causes it to wilt. Laurel wilt has

caused widespread and severe levels of redbay mortality on the Francis Marion and in the southeastern coastal plain.

Direct, Indirect and Cumulative Effects. Laurel wilt is now well established in the Francis Marion as well as the southeastern Atlantic Coastal Plain; eradication of the vector and pathogen on the Francis Marion or in this region is not feasible. Continued dramatic reductions in redbay populations are anticipated not only on the Francis Marion, but also across the southeastern Altantic Coastal Plain, although survival of redbay regeneration in the aftermath of laurel wilt epidemics suggests that redbay will not go extinct. (Agricultural Research Service, 2009).

The ecological impacts of drastic reductions in redbay populations are not well researched or have not yet been reported in the scientific literature. Potential ecological impacts on host species other than redbay are even less certain at this time. Other native forest species such as sassafras (*Sassafras albidum*) and the endangered pondberry (*Lindera melissifolia*) are also susceptible hosts of the disease, but the impact (both realized and potential) on these species is less certain. Due to this uncertainity, the impacts of management activities in the 3 alternatives are expected to be similar.

There are not any identifiable cumulative activities on private or other public lands that would combine with Francis Marion management activities to alter the impacts of redbay ambrosia beetle and associated laurel wilt.

Sudden Oak Death (SOD)

Sudden oak death (*Phytophthora ramorum*) was first reported in 1995 in central coastal California. Since then, tens of thousands of tanoaks (*Lithocarpus densiflorus*), coast live oaks (*Quercus agrifolia*) and California black oaks (*Quercus kelloggii*) have been killed by this newly identified fungus, *Phytophthora ramorum* which causes a bleeding canker on the stem. The pathogen could also infect southeastern species including some from both the red and white oak groups and others such as the Southern magnolia (*Magnolia grandiflora*), Southern red oak (*Q. falcata*), pin oak (*Q. palustris*), Northern red oak (*Q. rubra*), white oak (*Q. alba*), cherrybark oak (*Q. pagoda*), chestnut oak (*Q. prinus*), laurel oak (*Q. laurifolia*), live oak (*Q. virginiana*), water oak (*Q. nigra*) and willow oak (*Q. phellos*).

Widespread susceptibility of many eastern forest and landscape trees and shrubs makes establishment of sudden oak death in South Carolina or other southeastern states a very real possibility. The susceptibility of many popular horticultural plants such as camellias, rhododendrons (including azaleas) and viburnums has already led to the pathogen being spread to some eastern states such as Georgia, Florida, the Carolinas and Mississippi. In these locations, P. ramorum was usually detected in potted plants, soil and water in or adjacent to a nursery that had unknowingly obtained infected stock. So far, the pathogen is not yet established in natural forests in South Carolina or elsewhere in the eastern United States.

Direct, Indirect and Cumulative Effects. Since there is no known cure for oaks infected with *P. ramorum*, control measures focus on regulation (quarantines), detection and education. Federal and state entities monitor nurseries throughout the country for new cases of sudden oak death. When new infestations are discovered, extensive eradication and quarantines should be enacted.

As there are few management actions or treatments identified to reduce susceptibility to or risk of sudden oak death, it is difficult to display differences in effects between the alternatives. At this time the most effective activities in combating sudden oak death on the Francis Marion involve continued detection, cooperating with enforcement of quarantines (administered by the Animal

and Plant Health Inspection Service) and perhaps restrictions on the importation of firewood and certain ornamentals. These activities would continue under all alternatives.

In the event that an infestation is discovered on the forest, removing the infested trees is the only tactic that would prevent further spread. It is expected that all alternatives would use this approach. Therefore, the direct/indirect effects of all 3 alternatives are the same.

Similar to the discussion above, there is a concern about the potential impact of this fungus in our ecosystems. Fortunately, this species has not yet been found on the forest. There are no identifiable cumulative actions or activities that would combine with activities on the Francis Marion National Forest to alter the impacts of *P. ramorum*.

3.3.4.5 Non-native Insects

Insects of most concern for the purposes of this analysis include Asian longhorned beetle, emerald ash borer, gypsy moth and sirex woodwasp. The effects of the alternatives on non-native insects would be similar for each alternative.

Asian Longhorned Beetle

The Asian longhorned beetle (*Anoplophora glabripennis*) has been discovered attacking trees in the United States—tunneling by beetle larvae girdles tree stems and branches. Repeated attacks lead to dieback of the tree crown and, eventually, death of the tree. Asian longhorned beetle probably traveled to the United States inside solid wood packing material from China.

Since its first discovery in Brooklyn, NY in 1996, the beetle has been detected in four other states (Illinois in 1998; New Jersey in 2002; Massachusetts in 2008; and Ohio in 2011), as well as in Toronto and Vaughan, Ontario, Canada. Alert workers have reported the beetle in warehouses in other parts of the United States where the insects were destroyed before they could escape to start new infestations.

This beetle is a serious pest in China. In the U.S., the beetle prefers maple species (Acer spp.). Other preferred hosts are birches, buckeye, elms and willows. Occasional to rare hosts include ashes, European mountain ash, London planetree, mimosa and poplars. A complete list of host trees in the United States has not been determined.

Direct, Indirect and Cumulative Effects. Since Asian longhorned beetle has not yet been found in South Carolina, control measures focus on regulation (quarantines), detection, eradication and education. Federal and state entities are monitoring areas throughout the country for new cases of Asian longhorned beetle. When new infestations are discovered, extensive eradication and quarantines should be enacted. Currently, the only effective means to eliminate this pest is to remove infested trees and destroy them by chipping or burning. Early detection of infestations and rapid treatment response are crucial to successful eradication of the beetle.

Fortunately, this species has not yet been found on the Forest. If it were, the forest would be expected to take all of the measures outlined above regardless of the selected alternative. Therefore, the direct/indirect effects of all 3 alternatives would be the same.

There are no identifiable cumulative activities that would combine with the Francis Marion National Forest to alter the impacts of the Asian longhorned beetle.

Emerald Ash Borer

This non-native boring insect was first identified in the United States in 2002. Initial infestations were located in Michigan and Ontario, Canada. The insect has rapidly spread south and east and now occurs as far south as North Carolina, Tennessee and Georgia. It has not yet been detected in South Carolina. The emerald ash borer feeds on the cambium of ash trees as larvae. It is the destruction of the cambial layer that disrupts the transport of water and nutrients up the tree and causes mortality. A single generation of larvae occurs in any given season, with the larvae overwintering in the sapwood of the tree. Beetles emerge in May or early June to mate and start a new cycle. At this time, only ash trees are believe to be susceptible to this species of borer. Infested trees decline over a few years and may die after 3 to 4 years of heavy infestation.

Ash is rarely a dominant tree in the Francis Marion National Forest; ash species are found there. While this insect pest is not likely to cause widespread severe mortality at the stand or landscape level because the host tree is not a dominant species in the forest, it could lead to severe decline and impact ash species across the forest.

Direct, Indirect and Cumulative Effects. Since there are no known occurrences of emerald ash borer, control measures focus on regulation (quarantines), detection and education. Federal and state entities are continuing to monitor detection throughout the country for new cases of emerald ash borer. When new infestations are discovered, extensive eradication and quarantines should be enacted.

As there are few management actions or treatments identified that can prevent emerald ash borer susceptibility or risk, the effects do not differ between the 3 alternatives. Quarantines are administered by the Animal and Plant Health Inspection Service and may include restrictions on the importation of firewood. These activities would continue under all alternatives. In the event that an infestation is discovered on the forests, removing the infested trees is about the only tactic that would prevent further spread. It is expected that all alternatives would use this approach.

There are no identifiable cumulative activities on nearby property that would combine with the Francis Marion National Forest to alter the impacts of the emerald ash borer.

Gypsy Moth

The European gypsy moth (*Lymantria dispar*) is a major defoliator of deciduous hardwood forests. It was first introduced from Europe into Massachusetts in 1869; because the favored host, oak, is widespread in the eastern deciduous forests, it thrived and continues to expand its range west and south each year. It is established throughout the Northeast; the infested area extends from New England south into Virginia and one county in North Carolina and west into Ohio and all of Michigan. As the infested area expands, the frequency of accidental introductions of gypsy moth on the Southern Appalachian national forests will increase which may lead to the use of insecticides for their elimination or eradication. The continued implementation of the Gypsy Moth Slow the Spread Project (STS) will probably delay the permanent establishment of gypsy moth on the Sumter National Forest. However, STS will not stop its spread.

Gypsy moth larvae feed on more than 500 species of trees, shrubs and vines, including the following;

1. Favored hosts: oak, apple, birch, basswood, witch hazel and willow;
2. Moderately favored hosts: maple, hickory, beech, black cherry, elm and sassafras; and

3. Least favored hosts: ash, yellow poplar, American sycamore, hemlock, pine, black gum, and black locust.

Late instar larvae can feed upon tree species that younger larvae avoid, such as hemlock, maple and pine. Feeding on less favored host plants usually occurs when high density larval populations defoliate the favored tree species and move to adjacent, less favored species of trees to finish their feeding and development.

Defoliation by the gypsy moth may reduce tree vigor and growth of shoots and stem; cause dieback of the crown; trigger a failure of hard mast production; and sufficiently weaken a tree such that it is attacked and killed by wood boring insects and root decay fungi. Hardwoods in a vigorous condition often can tolerate a year or 2 of defoliation before canopy dieback becomes pronounced. However, hardwoods that are stressed by drought, oak decline or some other factor tolerate defoliation less well. The damage caused by gypsy moth feeding in spring is harmful because trees must draw upon reserve carbohydrates and nutrients to produce a second canopy of leaves following defoliation (a process referred to as refoliation). Generally, a tree refoliates when approximately 60 percent of its canopy is consumed. Production of a new set of leaves following defoliation restores the photosynthetic capability of a tree's canopy; however, the refoliation process draws upon nutrient reserves that would normally be used for shoot growth and foliage production the following spring. The refoliated canopy is not able to fully replace the nutrients and stored reserves mobilized by the tree during refoliation, leaving the tree in a weaker condition the following spring. As a result, trees exposed to repeated defoliation and refoliation are weaker and more susceptible to attack by wood-boring insects and root-decay fungi.

Once established, gypsy moth population densities fluctuate widely from year to year resulting in episodes of dramatic and severe defoliation followed by periods of relative innocuousness. At low densities, the gypsy moth is regulated, but not eliminated, by natural enemies such as parasitic insects and predaceous vertebrates, particularly small mammals. As populations increase beyond the control of these natural enemies, the gypsy moth is regulated by different mortality factors, primarily diseases and starvation. Of these 2 factors, diseases caused by the nucleopolyhedrosis virus (gmNPV) and the gypsy moth fungus (E. maimaiga) lead to the collapse of outbreak populations of gypsy moth. At the forest stand level, the period between outbreaks may range from 2-five years; 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 Great Lake states for a period of years and then drop to very low levels for several years. Factors regulating these regional outbreaks and collapses of gypsy moth populations are not well understood.

Direct, Indirect and Cumulative Effects. Gypsy moth is not expected to spread to the Francis Marion National Forest within the planning period. Therefore, management actions in any of the alternatives are not expect to affect the risk of a gypsy moth outbreak spread.

There are no identifiable cumulative activities that would combine with Francis Marion National Forest activities to alter the impacts of gypsy moth.

Sirex Woodwasp

Sirex woodwasp (*Sirex noctilio*) has been the most common species of exotic woodwasp detected at United States ports-of-entry associated with solid wood packing materials. It has been found in Michigan, New York, Vermont, Connecticut, Pennsylvania and Ohio. The sirex woodwasp is considered a secondary pest of trees in its native range of Europe and Asia. Where it has been

introduced it is considered a major pest. Females carry a fungus, *Amylostereum areolatum*, that they deposit in trees when laying their eggs. This fungus and the mucus injected by the wasp rapidly weaken and kill host trees; the developing larvae feed on the fungus. This pest is attracted to stressed trees that are often used to make solid wood packing material. Since the life cycle can take a year or more, the insect is transported easily in pallets or other solid wood-packing material and not readily detected at a port.

Since sirex woodwasp has not yet been found in South Carolina, control measures focus on regulation (quarantines), detection, eradication and education. Federal and state entities are monitoring areas throughout the country for new cases. When new infestations are discovered, extensive eradication and quarantines should be enacted. Sirex woodwasp has been successfully managed using biological control agents. The key agent is a parasitic nematode, *Deladenus siricidicola*, which infects sirex woodwasp larvae and ultimately sterilizes the adult females. These infected females emerge and lay infertile eggs that are filled with nematodes, which sustain and spread the nematode population. In addition to the nematode, hymenopteran parasitoids have also been introduced into sirex woodwasp populations in the Southern Hemisphere, most of which are native to North America. Early detection and rapid treatment are crucial to successful eradication of this insect.

Direct, Indirect and Cumulative Effects. Fortunately, this species has not yet been found on the Forest. In the event that an infestation is discovered on the forest, control by use of biological agents and silvicultural practices would be implemented. The forest would be expected to take the same approach regardless of the selected alternative. Therefore, the direct/indirect effects of all 3 alternatives would be the same.

There are no identifiable cumulative actions or activities that would combine with the Francis Marion National Forest to alter the impacts of the sirex woodwasp.

3.3.4.6 Affected Environment: Non-Native Invasive Plant Species

A multitude of non-native invasive plants threaten the integrity of native ecosystems and forest health on the Francis Marion. Although not addressed in the 1996 Forest Plan, the national forests in the Southern Region began implementing a noxious and invasive weed strategy following the signing of National Executive Order 13112 in June, 1999. This order charges federal agencies with the following:

1. To prevent the introduction of invasive species;
2. To detect and respond rapidly to control new invaders;
3. To monitor;
4. To provide for restoration of native species and habitat conditions in invaded ecosystems;
5. To promote public education on invasive species; and
6. To avoid actions likely to cause their introduction and spread.

Non-native invasive plant species surveys were incorporated into project plant surveys on the Francis Marion beginning in 2002. To date, more than 35,000 acres have been surveyed for rare species and non-native invasive plants. (forest data, 2013); Acres treated are estimated at 2,500 in 2014. Infestations are at relatively low and controllable levels (ranging from one-five percent infestation), compared to districts on the Sumter National Forest (internal forest and national Forest Inventory and Analysis data). Table 3-57 displays non-native invasive plant species that have been confirmed on the forest from 2002-2014 and the number of documented occurrences. Of the terrestrial and riparian non-native invasive plant species known or likely to occur on the

Francis Marion, only cogongrass, common reed and alligator weed are regulated as state or federal noxious weed species (http://drpsp.clemson.edu/dpi/npp.htm) or aquatic nuisance species (http://www.dnr.sc.gov/water/envaff/aquatic/index.html).

Table 3-61. Non-native invasive plants documented on the Francis Marion National Forest as of September 2014

Latin name	Common name	Total Area (acres)	Infested Area (acres)	Infestation Count
Ailanthus altissima	tree of heaven	0.0067	0.0067	1
Albizia julibrissin	silktree	23.6928	1.6495	41
Alternanthera philoxeroides	alligatorweed	0.0008	0.0006	1
Arundo donax	giant reed	0.0096	0.0096	2
Arthraxon hispidus	small carpgrass	15.6701	7.6153	37
Elaeagnus pungens	thorny olive	0.0144	0.0144	3
Elaeagnus umbellata	autumn olive	0.0384	0.0008	8
Imperata cylindrica	cogongrass	0.0139	0.0139	3
Lagerstroemia indica	crapemyrtle	0.0048	0.0048	1
Lepidium bidentatum	Kunana pepperwort	0.7757	0.0385	4
Lespedeza bicolor	shrub lespedeza	0.0048	0.0048	1
Lespedeza cuneata	sericea lespedeza	407.4199	109.6619	91
Lemna	duckweed	0.0048	0.0048	1
Ligustrum lucidum	glossy privet	1.1521	0.8653	2
Ligustrum sinense	Chinese privet	676.5557	39.2621	231
Lolium arundinaceum	Tall fescue	275.3382	61.2985	41
Lonicera japonica	Japanese honeysuckle	1018.9304	60.0268	138
Ludwigia peploides	floating primrose-willow	0.0056	0.005	2
Lygodium japonicum	Japanese climbing fern	2171.9061	472.7667	3146
Mahonia bealei	Beale's barberry	0.0048	0.0048	1
Melia azedarach	Chinaberrytree	544.0924	31.8665	64
Miscanthus sinensis	Chinese silvergrass	1.6342	0.8171	1
Microstegium vimineum	Nepalese browntop	533.1629	28.5852	90
Paspalum notatum	bahiagrass	0.1042	0.1042	2
Phragmites australis	Common reed	undocumented	undocumented	2
Phyllostachys aurea	golden bamboo	0.1056	0.0022	22
Pueraria montana	kudzu	0.0096	0.0096	2
Pyrus calleryana	Callery pear	0.0048	0.0048	1
Pyracantha koidzumii	Formosa firethorn	6.8623	0.3431	1
Rosa multiflora	multiflora rose	0.0079	0.0001	1

Latin name	Common name	Total Area (acres)	Infested Area (acres)	Infestation Count
Sesbania punicea	rattlebox	0.0048	0.0001	1
Triadica sebifera	Chinese tallow	18.5641	18.5641	5
Wisteria sinensis	Chinese wisteria	14.2865	7.0094	43
TOTAL		5710	841	3990

Public and agency awareness of the threat of non-native invasive species on forest health, biodiversity and ecological sustainability has increased since 1996. Established in 1999, the Southeast Exotic Pest Plant Council serves as an educational, advisory and technical support council on all aspects of invasive exotic pest plant issues across the Southeast. The Chief of the Forest Service named non-native species as one of the four major threats to the National Forest System in 2006. The Forest Service updated their national strategic framework for invasive species management in 2013 (USDA, 2013). Across the Southeast, of the 380-plus recognized non-native plants in Southern forests and grasslands, 53 are rated high-to-medium risk for natural communities (Wear and Greis, 2012). The South Carolina Comprehensive Wildlife Strategy (2011) includes as a high priority conservation action preventing the spread of existing invasive and non-native species, and eliminating them, where possible.

Cogongrass, a federal and state noxious weed, occurs at 3 locations on the forest and continues to be a priority for the South Carolina Cogongrass Task Force and the Forest Service. Cogongrass surveys have been conducted in conjunction with the task force throughout South Carolina since it was discovered on the Forest in 2007. Japanese climbing fern, which has the potential to disrupt fire regimes, is the most common non-native invasive plant species on the forest (68 percent or 1,888 of 2,769 records in longleaf ecosystems). Chinese tallow is a primary threat at the forest's borders with Cape Romaine National Wildlife Refuge.

The South Carolina Exotic Pest Plant Council maintains state lists of early detection and rapid response (EDDR) species and more common non-native invasive plant species posing the most threat to natural areas in the state (www.sc-eppc.org). Invasive plant species are expected to increase with changes in climate (SCDNR, 2013; Wear and Greis, 2012) and will increasingly threaten ecological integrity and forest health on the Francis Marion National Forest in the future.

3.3.4.7 Environmental Consequences

Alternative 1

Direct and Indirect Effects. Under Alternative 1, there is no forest plan direction, desired conditions nor standards to help ensure the prevention, early detection and rapid response, control and management, nor rehabilitation and restoration of ecosystem degraded by non-native invasive plant species. Activities which disturb soil and increase light availability in proximity to known non-native invasive plant populations have the potential to increase the possibility for spread of these populations (Evans et.al., 2006). Non-native invasive plants would continue to increase across the landscape, impacting forest and ecosystem health and composition, structure and function.

Non-native invasive plant species would have the greatest impacts on forest health and ecosystem sustainability in Alternative 1. Ecological integrity is predicted to be poor (>5 percent infestation) or fair (1-5 percent infestation) for all of our ecosystems groups in the 50- year interval.

Alternatives 2 and 3

Direct and Indirect Effects. Under Alternatives 2 and 3, ecosystems would be maintained with no or low levels (<1 percent infestation) of non-native invasive species, including plants, particularly within fire-adapted ecosystems in Management Area 1, which includes high priority ecosystem and species groups for at-risk species. Within these areas, frequencies of prevention, early detection and rapid response and integrated control efforts would be highest; non-native plant populations would be treated to ensure they do not proliferate and dominate stands. As part of prevention, roads not needed for administrative access would be closed and re-vegetated with native plant species. Non-native invasive species such as tall fescue, bahiagrass and sericea lespedeza would not be used to vegetate or re-vegetate roads or right-of-ways (road and utility) on the forest. Equipment cleaning, which prevents the introduction and spread of non-native invasive species would be incorporated when implementing projects involving mowing or ground-disturbance, including contracts and special uses. Native perennial or annual plant species would be used, preferably from local ecotypes when seeding temporary openings (ex. temporary roads, skid trails and log landings) or when other agreements with road and utility partners are secured. Landscape-level cooperation in the form of cooperative weed management areas, though not common due to the fragmented nature of land ownership patterns, would be encouraged and considered.

Cumulative Effects. The Southern Forest Futures Project conservatively estimates that the annual spread of nonnative invasive plants in southern forests is 145,000 acres, accelerated by a warming climate and by increasing numbers of forest disturbances that accommodate and support growing human populations (Wear and Greis, 2012). The majority of non-native invasive plants are unregulated on all but federal lands; some continue to be sold commercially.

Given the lack of adequate regulatory mechanisms, the exponential growth curve of non-native invasive plant infestations, climate change predictions and the high costs of control, invasive plant species will increasingly threaten the composition and function of our terrestrial and aquatic ecological systems across the United States in the future.

In Alternatives 2 and 3, ecological integrity and forest health are predicted to be good (<1 percent infested) for most of forest ecosystems at both 10- and 50- year intervals. An exception is the Santee River large river floodplain ecosystem, which is predicted to be maintained at fair (one-five percent) in the next 10 years, and then go to poor (>5 percent) in the next 50 years. Rates of Japanese climbing fern infestation in the Santee River floodplain are currently more than one percent; they are anticipated to be relatively high in both alternatives in the future due to their relatively low accessibility, low management priority and as habitat for at-risk species.

Non-native invasive plant species would have much less impacts on forest health and ecosystem sustainability in Alternatives 2 and 3. Ecological integrity is predicted to be maintained at good or very good for all of ecosystems groups in the 10- to 50-year interval, with the exception of the Santee River floodplain ecosystem, which is predicted to be at fair or even poor levels of infestation in the future.

3.3.4.8 Affected Environment: Non-native Fauna

Feral Hogs

In terms of faunal NNIS, the wild pig (*Sus scrofa*) is currently the most widespread and destructive species on the Francis Marion. The pig family (Suidae) is not indigenous to North America so the wild pig has the potential to significantly impact ecosystems on the forest. Local

feral hog populations have proliferated and expanded their range across the forest. Feral hogs have the potential to damage ecosystems as they create wallows and root for food, compete with native species and transmit diseases.

Foraging by wild pigs may reduce oak regeneration because the animals will feed on acorn crops. These pigs also damage longleaf pine regeneration when they root up seedlings to feed on their roots and grubs. They can also compete with and prey upon native wildlife species. Habitat damage in sensitive areas may have a negative impact on endangered and sensitive species and their habitat, as well as game species, such as turkeys and deer. Feral hogs may also destroy the nests, eggs and offspring of ground nesting birds and can impact other animals directly or indirectly.

Wild pigs are highly mobile and freely move across land ownership boundaries. Attempts to reduce wild pig impacts to National Forest System land and water must be considered within the context of what occurs on adjacent land. Coordination of control efforts across boundaries is imperative. Reducing or eliminating impacts of wild non-native pigs can be both challenging and expensive. It is difficult to remove all members of a population. Even if all pigs were to be removed, the potential for wild pigs repopulating the area remains. Hunting and trapping these animals remains the most viable method of control. The Francis Marion National Forest will cooperate with federal, state and private entities in order to proactively control the species across the Forest.

During 2011, a total of 118 wild pigs were controlled on the Francis Marion by SCDNR employees. They were primarily trapped in the Waterhorn Hunt Unit; some were also trapped in the Santee and Wambaw Hunt Units. Since 2009, SCDNR employees have trapped approximately 100-125 pigs annually. Trapping efforts that started in 2009 were the first targeted control efforts (other than special pig hunts) that the Francis Marion has implemented in the past 30+ years. Since 2009, the National Wild Turkey Federation has purchased six corral-style pig traps for the Forest Service . Plans are currently underway to increase control efforts on the forest; increased funding should be available through Stewardship and Knutson Vandenberg sources. The use of dogs and aerial gunning appear to be 2 of the most efficient methods for controlling the wild pig. During a 3-week time period in 2015, dog contractors controlled over 34 pigs on the Forest.

Direct, Indirect and Cumulative Effects. Even though the wild pig was not even mentioned in the 1996 Forest Plan, control activities are expected to continue and even increase under all alternatives. In the event that a landscape-wide control method is feasible, control would be implemented. The forest would be expected to take this approach, regardless of the selected alternative. Therefore, the direct/indirect effects of all 3 alternatives would be the same. There are no identifiable cumulative actions or activities that would combine with forest activities to alter the impacts of wild pigs.

Nine-banded Armadillo

Another non-native species of animal that is rapidly expanding across the Southeast and Midwest is the nine-banded armadillo (*Dasypus novemcinctus*). Nine-banded armadillos are only native to the southwestern United States. This species has been confirmed in the nearby town of Moncks Corner (Mark Danaher personal road kill observation, 2012) and is a common occurrence in Dorchester County, especially between the towns of Summerville and Walterboro. Armadillos can be destructive in natural habitats as they forage for food. They also carry diseases such as St. Louis encephalitis, leptospires, arboviruses and leprosy.

Armadillos typically rest in a deep burrow during the day, and are primarily active during the night and early morning. Armadillo burrows are usually located under brushpiles, stumps, rootmounds, rock piles, and dense brush. Burrows are typically about 7-8 inches (18-20 cm) in diameter and can be up to 15 feet (4.5 m) long. Armadillos often have several burrows throughout their territory, but use only one to raise their young. Armadillo burrows can provide underground refugia for native animal species, especially reptile and amphibians that require underground microhabitat for refugia (e.g., Eastern Diamondback Rattlesnake, Carolina Gopher Frog and Frosted Flatwoods Salamander). Personal observations have shown that armadillo burrows can be used by slow moving species such as the Eastern Box Turtle and Eastern Diamondback Rattlesnake, and may offer protective cover from fire and predators.

Armadillos primarily feed on beetles, caterpillars, snails, centipedes and other insects and invertebrates. Plants, eggs and small vertebrates likely constitute < 10 percent of their diet (NatureServe, 2013; Figg, 1993). Although the Nine-banded Armadillo is a non-native invasive species, the presence of the species on the Francis Marion during the next 15-20 years is not expected to be severe enough to warrant specific control activities.

Direct, Indirect and Cumulative Effects. Armadillos move freely across land ownership boundaries, so it is not a question of if the nine-banded armadillo will show up on the Francis Marion, but a question of when. Effects from armadillos are uncertain, but are expected to be similar for each of the 3 alternatives and minor during the next 15-20 years. For all alternatives, activities to address the armadillo and other NNIS species will be addressed at the project level if necessary.

There are no identifiable cumulative activities on lands bordering the Francis Marion that would combine with the Francis Marion management actions to alter the impacts of the armadillo.

3.3.4.9 Affected Environment: Non-Native Invasive Aquatic Species

Introductions of non-native aquatic species have had a significant impact on native aquatic fauna in the Coastal Plain Ecoregion. The species currently on the forest range from fish to snails and are listed in Table 3-58.

Table 3-62. Occurrence of non-native aquatic species on the Francis Marion National Forest

Scientific Name	Common Name	Occurrence
Cyprinus carpio	Common carp	Large rivers
Pylodictis olivaris	flathead catfish	Large rivers
Ictalurus furcatus	blue catfish	Large rivers
Corbicula fluminea	Asian clam	Three sites
Viviparus georgianus	banded mysterysnail	One site
Viviparus purpureus	olive mysterysnail	Potential – upstream of forest
Bellamya/Cipangopaludina japonica	Japanese mysterysnail	Potential – upstream of forest
Procambarus clarkii	red swamp crayfish	Potential
Aedes albopictus	Asian tiger mosquito	widespread
Pomacea insularum	Island applesnail	Potential
Pterois volitans	red lionfish	Potential

Common carp, flathead catfish and blue catfish are established in several drainages. Flathead catfish are known to prey on bullheads, darters, shad, suckers and sunfish. Declines in native species have been observed after the introductions of flathead catfish. Common carp occur in every South Carolina drainage and are considered a pest, but their impact on native fauna is not well known. Common carp disrupt aquatic habitats by rooting around in the substrate, which uproots aquatic plants and increases turbidity and siltation. They also have been shown to prey on the eggs of other fish species (www.dnr.sc.gov/cwcs/pdf/habitat/CoastalPlainAquatics.pdf). Grass carp are used as biological control agents for nuisance aquatic vegetation in South Carolina. SCDNR regulates and tests this species as they are brought in by growers from other states; only triploid grass carp are permitted. This insures that they are sterile and cannot reproduce if escapement occurs (South Carolina Aquatic Invasive Species Management Plan, 2008). No reproducing populations of grass carp occur on the forest, but sterile grass carp have been stocked in the past to control aquatic vegetation in recreational fishing ponds.

The Asian clam has been introduced and has widely spread throughout the United States, including South Carolina. The effects of the Asian clam on native species are not particularly well understood. Three invasive snail species (*Viviparus georgianus*, V. *purpureus* and *Bellamya/Cipangopaludina japonica*) are present in Lake Marion and Lake Moultrie just west of the forest; however, their impact on native fauna is not known (SCDNR Coastal, 2015). The island applesnail has been found in the South Carolina coastal plain, but not yet reported from the Forest. Potential impacts of introduced populations of the island applesnail are broad reaching and can even have human health implications. Because they eat such a wide range of aquatic plants, they are a potential threat to South Carolina aquatic ecosystems. Infestations can be very dense and cover large areas, causing harm to the aquatic environment by destroying native plant species and drastically affecting the food web through their ability to kill or out-compete native snail species (SCDNR Snail, 2015).

The red swamp crayfish has been introduced to South Carolina and has been observed at several locations in the southeastern plains and coastal plain, but it is unclear how widespread it is in the state. The lack of survey work since its introduction and the difficulty distinguishing the red swamp crayfish from a native crayfish (Eastern red swamp crayfish) have made it particularly difficult to determine the extent of its introduced range (SCDNR Coastal, 2015). It is possible that the red swamp crayfish occurs on the forest; it would be expected to occur in the types of habitat where the Eastern red swamp crayfish has been collected. The 2 are very closely related species and have similar habitat requirements. The red swamp crayfish has been introduced as an aquaculture species within the range of Eastern red swamp crayfish in South Carolina, but little is known about the distribution of escaped the red swamp crayfish populations in South Carolina (Jones and Eversole, 2011).

The Asian tiger mosquito now occurs statewide. This species is a competent vector of many viruses including dengue fever, Eastern equine encephalitis, potentially St. Louis and La Crosse encephalitis, as well as dog hear2rm. The life cycle of this species is closely associated with human habitat and it breeds in containers of standing water. It is a very aggressive daytime biter with peaks generally occurring during early morning and late afternoon. It feeds on a number of hosts, including man, as well as domestic and wild animals. Its generalized feeding behavior contributes to its vector potential (SCDNR, 2008.).

The USDA Forest Service Southern Region Aquatic Nuisance Species Strategy, Aquatic Animals (Leftwich, 2013) provides guidance for managing nuisance species and supports the South Carolina Aquatic Invasive Species Management Plan 2008. State agencies are recognized as the

lead agency in controlling the establishment of aquatic nuisance species and managing established aquatic nuisance species both on and off the forest.

Aquatic Nuisance Species and Climate Change. Increased temperatures, changes in rainfall and other environmental factors affected by climate shifts or change can create ideal conditions for proliferation of invasive plant and animal species, including parasites and pathogens. An increase in the number and diversity of native and non-indigenous invasive plant and animal species has been documented in South Carolina's terrestrial, freshwater and marine habitats. Some of these species may have been released accidently, but others are likely migrating northward from more tropical climates as a result of warming temperatures. Regardless of the manner in which they have become established, these species already are impacting native animals and their habitats. As climate changes, an increasing number of exotic species likely will migrate to South Carolina. Habitats can be destroyed as resources are over-used. Invasive and non-indigenous species have the potential to outcompete native species for food and other resources.

Tilapia is a warmwater, non-indigenous group of fish that are stocked extensively under permit in the state to control algae in private ponds. With few notable thermal refuges excluded, tilapia will die from cold stress in a typical South Carolina winter when water temperatures drop below 50°F (10°C). Historically, south coastal South Carolina water temperatures routinely drop to 45 to 50°F (7 to 10°C) during the winter. Tilapia could overwinter in the state if waters were to become warmer. Tilapia currently overwinters in Florida and has become an invasive species and a major management problem. If tilapia were to routinely overwinter in South Carolina it would result in direct competition with native and existing species for space, food, habitat and spawning areas, which could drastically alter natural fish communities. The destruction that non-indigenous peacock bass (*Cichla* spp.) can cause to native fish communities is well documented. In Florida, these fish currently are widespread, but are very temperature dependent and do not typically survive in waters cooler than 60°F (16°C). Given current South Carolina winter low temperatures, tilapia is much more of an eminent threat than peacock bass. However, if winter temperatures increase, peacock bass could become a threat in South Carolina. Other invasive fish that are common in Florida and could become established in South Carolina include various cichlids, pleco (*Hypostomus plecostomus*), Asian swamp eel (*Monopterus albus*), walking catfish (*Clarias batrachus*), various piranha and oscar (*Astronotus ocellatus*). All of these fish could, like tilapia, compete with native species for habitat, food and spawning resources (SCDNR Climate Change, 2015).

The primary threats to lentic systems include sedimentation and water chemistry modification. Stresses include roads, drought, forestry management practices and aquatic nuisance species. Road maintenance decreases vegetative growth in ditches where aquatic species forage and find refuge. Sediments also are added to ditches with road-grading activities. Impacts from forestry management practices are similar to those discussed for streams and rivers. Both plant and animal aquatic nuisance species can have huge impacts on contained pond systems where native species have no escape route. Drought conditions have been prevalent over the past decade on the forest impacting pond water levels, water quality and populations.

3.3.4.10 Environmental Consequences: Non-Native Invasive Aquatic Species

Alternative 1

Direct and Indirect Effects. Under this alternative, there is no forest plan direction, desired conditions nor standards to help ensure the prevention, early detection and rapid response, control and management, nor rehabilitation and restoration of ecosystems degraded by non-native

invasive aquatic species. Therefore, non-native invasive aquatic species likely would continue to negatively impact the forest's aquatic ecological systems.

Alternative 2 and 3

Direct and Indirect Effects. Under these alternatives, there is management direction, desired conditions and guidelines to help ensure the prevention, early detection and rapid response, control and management, rehabilitation and restoration of ecosystems degraded by non-native invasive aquatic species. Therefore, non-native invasive aquatic species would have much less impacts on the forest's aquatic ecological systems in Alternatives 2 and 3.

Cumulative Effects. As noted previously, the majority of non-native invasive aquatic species are unregulated on all but federal lands. Given this fact, as well as the demand for some species for sport, climate change predictions and the high costs of control, invasive species will increasingly threaten the composition and function of aquatic ecological systems on the landscape in the future, both in the 10-year, and to much greater extent in the 50-year interval.

3.4 Economic and Social Environment

3.4.1 Forest Products/Timber Harvesting

3.4.1.1 Affected Environment

Forestry is first in South Carolina among manufacturing industries in jobs (90,624) and payroll ($4.1 billion) according to the South Carolina Forestry Commission, Forest Management Facts. By 2015, the state desires to increase forestry's economic impact from $17.4 billion to $20 billion and increase job numbers by about 12,000.

A sustainable supply of wood products is one of the uses provided by the forest. The Francis Marion's role in the timber supply and demand picture, while small in the context of regional and state markets is nevertheless important to the local timber industry. Though the forest products industry has been through a continuing trend of consolidation, a strong, competitive market still exists. Strong local demand has been reflected by the fact that the Francis Marion has been able to sell all the live timber sales it has offered for many years. This held true even through the severe recent recession and depressed construction market.

Timber harvest is a valuable ecological and fuels management tool. In addition to the continuing economic value it produces, timber harvest serves valuable functions in helping to achieve desired conditions, maintaining or restoring key ecosystem characteristics, improving forest resistance and resilience to pests and reducing the risk of wildfire. Some examples of this are:

1. Moderating tree densities to help create desired habitat for the endangered red-cockaded woodpecker;
2. Removing species and individual trees that are less desired to move forests toward desired species composition and structure;
3. Reducing tree densities in pine stands to make them less susceptible to Southern pine beetle;
4. Reducing tree densities in pine stands to make them less susceptible to damage from wildfire and to present less risk of wildfire spread than dense un-thinned conditions;
5. Serving as a tool to help restore longleaf pine;
6. Serving as a tool to help restore pine savannas;

7. Creating new young forest stands to provide diverse habitats, a flow of habitats over time and resilience to wind events and pest outbreaks;
8. Capturing carbon sequestered by the forest and increasing the carbon sequestered by the forest as an effect of creating young rapidly growing stands; and
9. Removing fuel that has accrued as tree biomass.

Trends. Following are 3 key trends noted in the Francis Marion National Forest Plan Assessment

1. According to Forest Inventory and Analysis (FIA-USFS) data there has been a large increase in timber inventory since the 1996 forest plan was signed. Comparing recent harvest levels for the forest to both FIA growth estimates and to the sustained yield limit estimate indicates that harvest levels are easily sustainable.
2. Data in the 2010 Resources Planning Act Assessment indicate that long-term timber demand is expected to remain steady or increase.
3. Forest data shows that the age class distribution has shifted with time. Defined as forest stands 0-10 years of age, the amount of early successional, young aged forest is quite low, comprising only about 0.1% of the Forest.

Land suitable for timber production and product yields. For each alternative, Table 3-59 below displays the acreage suitable for timber production, sustained yield limit and estimated projected wood sale quantity. As conversion of loblolly pine to longleaf pine is completed, PWSQ would be decline in the 5th decade.

Table 3-63. Acres suitable for timber production and estimated 10-year timber volumes sold for the different plan alternatives

Alternative	1	2	3
Land Classified as Suitable for Timber Production (acres)	184,343	194,023	177,307
Percent of Land Ownership Classified as Suitable for Timber Production	71%	75%	68%
	MMCF		
Sustained Yield Limit			113.8
Projected Wood Sale Quantity, 1st decade	98.6	98.6	100.4
Projected Wood Sale Quantity, 5th decade	87.7	96.2	97.3

MMCF = Million cubic feet

3.4.1.2 Environmental Consequences- All Alternatives

Direct and Indirect Effects. As shown in Table 3-59, most of the land base on the Francis Marion National Forest is considered suitable for timber production under each alternative.

Offsetting features makes the yields of the different alternatives similar to each other. Compared to Alternative 2, Alternative 1 would have almost 10,000 acres fewer lands suitable for timber production. However, it keeps Flatwoods in loblolly pine forest types, which are more productive than the longleaf pine in Alternative 2.

Alternative 3 would have almost 17,000 fewer acres of land suitable for timber production than Alternative 2. Almost all of this change in Alternative 3 would be due to larger allocations to wilderness. Alternative 3 also would have around 20,000 acres less allocated to Management

Area 1, meaning a larger allocation to Management Area 2. This would increase the portion of pine lands that are:

1. Managed for loblolly pine instead of longleaf pine; and
2. Have less extended rotations than Management Area 1.

These 2 factors would increase productivity with the result that the estimated yields for Alternative 1 would be very similar to Alternative 2 and even slightly higher.

Projected timber volumes are somewhat lower for each alternative in the 5th decade compared to the 1st decade. In Alternatives 2 and 3, the intent is to convert very large acreages of loblolly pine to longleaf pine in the first decade. This tends to create a large spike in harvest the first decade, and a drop in the following several decades.

The age class distribution resulting from Hurricane Hugo also contributes to this same tendency. The acreage in age 20-30 year old forest is quite large, resulting in a large pulse of acres needing thinning immediately, but in which less thinning will be needed by the 5th decade. This effect is most pronounced for Alternative 1. In that alternative, age 20-30 loblolly pine stands in flatwoods and wet pine savannas would not be converted to longleaf pine, but would remain as loblolly pine and grow to age 70-80 by the 5th decade, not yet of age for regeneration, nor as much in need of thinning.

Sustainability and Long-Term Productivity: The alternatives considered in detail, including the preferred alternative, would incorporate the concept of sustained yield of resource outputs while maintaining the productivity of all resources. The specific direction and mitigation measures included in the forest-wide management standards and guidelines ensure that long-term productivity would not be impaired by the application of short-term management practices. Planned timber sale program quantities would not exceed the sustained yield limit of the forest. As stated above, FIA data indicate that proposed harvest levels are very sustainable. While this data has sizeable error terms, it shows that over the last 2 years the Francis Marion National Forest has grown approximately 28 MMCF per year. Figure 3-31 shows the current age class distribution of the Francis Marion National Forest.

When the 1996 forest plan was written, the forest had an overabundance of very young forest due to Hurricane Hugo. That event is 25 years in the past and young forest habitats are now scarce. Diverse age classes make forests more resilient to disturbance events, insects and pathogens; and provide a sustained flow of habitats over time. While there are younger age trees in the understory of many fire maintained stands, the age of main stand canopies remains as shown in Figure 3-31. The acreage of stands aged 0-10 is 0.1 percent of the forest. The acreage of stands aged 0-20 is approximately 2 percent of the forest. Longer term, it is expected that longleaf pine stands in Management Area 1 in both upland longleaf pine ecosystems and wet pine savanna and Flatwoods ecosystems would likely be managed as uneven-aged. For the next several decades, however, these forests would probably remain relatively even-aged.

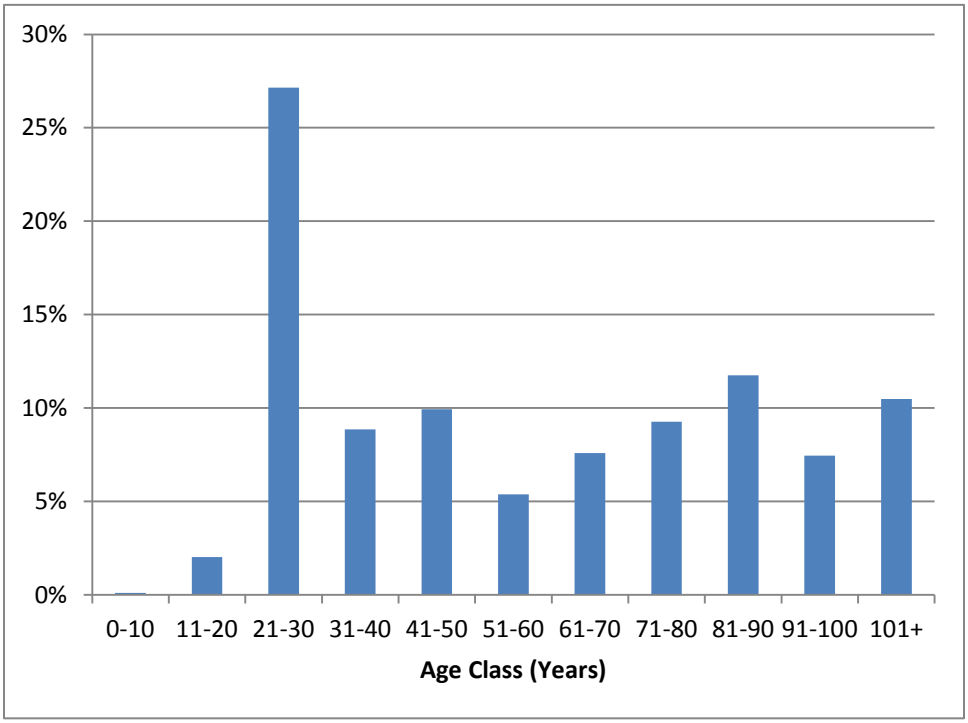

Figure 3-35. Age class distribution of the Francis Marion as of September 2014

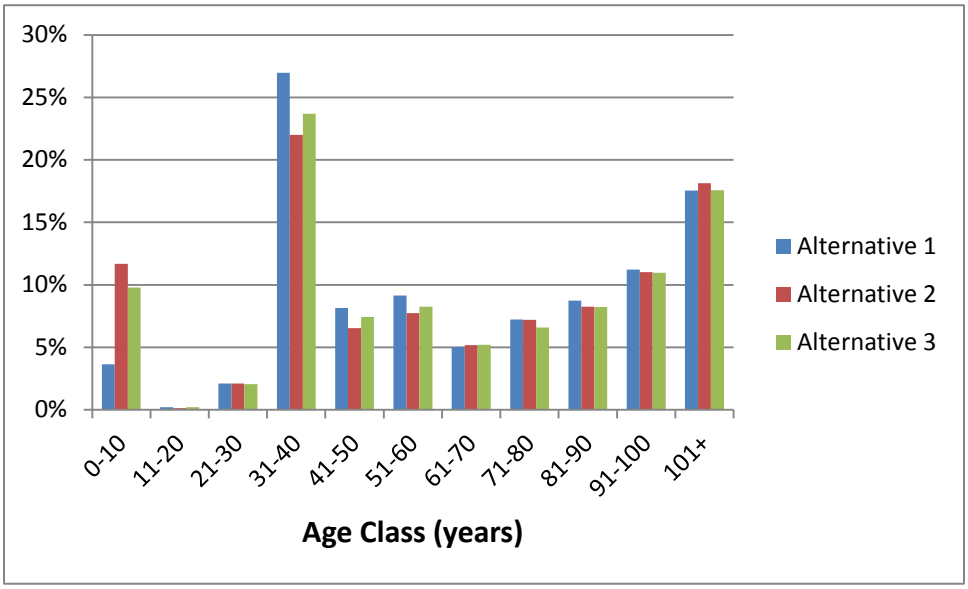

Figure 3-36. Projected age classes for each alternative, end of decade one

Figure 3-32 displays the projected age class distribution at the end of the first decade for each of the 3 alternatives. Comparing Figure 3-31 and Figure 3-32 shows several things.

1. Alternatives 2 and 3, especially Alternative 2, would put far more acres than Alternative 1 into the 0-10 year age class due to large acreages planned for restoration of longleaf pine in these 2 alternatives.
2. Alternatives 2 and 3, especially Alternative 2, would reduce the large post-Hugo age class from 27 percent to 22 percent and 24 percent respectively. This is because Alternatives 2 and 3 would convert large acreages of age 20-50-year-old stands from loblolly pine to longleaf pine forest types.
3. The 101 years plus age class should have a large increase under each of the 3 alternatives as age 91-100-year forest moves into this next age class. This increase is just under double, increasing from approximately 10 percent to 18 percent.

The age class distribution changes significantly after 5 decades, as shown in Figure 3-33 below.

Figure 3-37. Projected age classes for each alternative, end of decade five

After 5 decades, forest over 100 years of age increases dramatically to 33-35% of the Francis Marion National Forest. The majority of these oldest ages, over 55% of the total, are in lands not suitable for timber production, and about 1/2 of this amount is in cypress-tupelo types. On lands suitable for timber production, longleaf pine maintained by frequent fire is carried to ages of at least 120 years and cypress-tupelo types are generally carried to ages beyond that.

The Hurricane Hugo pulse of the 71-80 age class remains prominent, as does the trough in ages 51-70.

There are differences, however, in the alternatives. Alternatives 2 and 3 have far fewer acres in the 71-80, 81-90 and 91-100 age classes. That is due to the emphasis that those alternatives place on converting young loblolly pine stands to longleaf pine back in the first decade. Alternatives 2 and 3 also have far more acres in the 41-50 years age class for the same reason.

Alternative 3 has fewer acres in the 41-50 age class after 5 decades than Alternative 2 because large additions to wilderness in Alternative 3 reduce the acres suitable for timber production and therefore the acres available to regenerate to new age classes. Alternative 3's additional acreage in wilderness also accounts for the slightly higher percentage of forest age 101 or older.

Methods of Harvest and Site Preparation: The Francis Marion Forest Plan would not select or prescribe silvicultural systems to be used. Those are project-level decisions. However, probable methods of timber harvest are provided in Table 3-60.

Table 3-64. Estimated harvest and site preparation methods

Estimated Acres of Harvest Methods and Site Preparation for First Decade			
Practice	**Alternative 1**	**Alternative 2**	**Alternative 3**
Regeneration Harvest (even- or 2-aged)	8,826	28,257	23,631
Uneven-aged Management	0	94	86
Commercial Thinning	49,998	17,864	27,506
Site Preparation, Herbicide	4,457	22,757	19,797
Site Preparation, Mechanical	937	4,562	3,964

Compared to Alternative 1, regeneration harvest would be much higher in Alternatives 2 and 3 because of large longleaf pine restoration efforts. Likewise, estimated regeneration harvest would be about 4,600 acres more in Alternative 2 than Alternative 3 because Alterative 2 would have more acres allocated to Management Area 1. Estimated site preparation follows the acres of regeneration harvest. Adverse effects of herbicide application would likely be minimal because threatened or endangered species would be avoided, buffer zones would be in place near streams, desired herbaceous species tend to recover quickly, applications may be banded if necessary and applications typically only take place during stand establishment. Thinning quantities would be much lower in Alternatives 2 and 3 because large acreages that would otherwise be thinned (ages 20-50 loblolly pine) would instead be regenerated to longleaf pine. Thinned acres also would be limited in Alternatives 2 and 3 to stay within the sustainable yield and still accomplish the desired conversions from loblolly pine to longleaf pine.

Anticipated Changes in Longleaf Pine Acreage Due to Restoration - Restoration of the longleaf pine forest and its associated ecological systems would be one of the highest priorities of the revised plan. The acres of forest in regeneration (0-10 years) and mature condition (age 61 years and over) would be important for evaluating ecological conditions of each system. For longleaf pine, the acres in regeneration all would be the result of conversion from loblolly pine.

Table 3-65. Anticipated Longleaf Pine Restoration

	Longleaf Pine Forest Age Structure After First Decade		
	Acres of Longleaf Pine	**Acres age 0-10**	**Acres of Mature Forest**
Existing:	49,581	4	19,270
Alternative 1	53,974	4,526	23,113
Alternative 2	75,816	26,237	23,191
Alternative 3	65,805	18,002	21,444

Alternatives 2 and 3 would restore far more acres to longleaf pine in the first decade than Alternative 1. Restoration would also be more operationally realistic in Alternatives 2 and 3 because the longleaf pine restoration emphasis in Management Area 1 would align far better with areas that can operationally be burned under prescription than Management Area 26 in Alternative 1. This would probably be the single most important difference in Alternative 1 compared to Alternatives 2 and 3.

Alternative 2 would restore significantly more acres to longleaf pine than Alternative 3 because that alternative would have approximately 20,000 more acres in Management Area 1.

Alternative 3 would have fewer acres of mature longleaf pine forest than the other 2 alternatives. The reason is that it would allocate less land to Management Area 1 and therefore more land to Management Area 2, which would not manage for longleaf pine forest because prescribed fire would unlikely be applied with the frequency needed to maintain longleaf pine systems.

Cumulative effects. National forest lands comprise about 4.6 percent of the land in South Carolina and 6 percent of the timber inventory. Although the Francis Marion's role in the overall supply and demand picture is relatively small, it is important to loggers and mills in the area. Even through the recent recession and depressed construction market, the forest has been able to sell all the live timber sales it has offered. These sales are especially important during depressed markets since little privately owned timber is offered during such times. In regard to forest products any difference in cumulative effects between the 3 alternatives would be small.

3.4.2 Community Wildfire Protection Planning

Note: For more information on fire management, see Section 3.2.3 Air Quality and Section 3.3.1 Ecological Systems sections.

3.4.2.1 Affected Environment

No other ecosystem driver across the U.S., and specifically the Southeast, has had a more profound and influencing role on the ecological processes of plant and animal diversity than wildland fire. Furthermore, some 95 percent of the forest, shrubland and grassland ecosystems of the Southeast Coastal Plain have been shaped by the occurrence of fire (Frost, 1993). The current health of Southern ecosystems can be attributed to the role of fire, the presence or lack thereof, and the implementation of policies and/or practices throughout the past several hundred years.

Throughout the past several hundred years, agriculture, urban growth, wildland fire suppression and smoke management constraints have completely altered these natural fire cycles and fire exclusion has created a dangerous trend of larger, faster and more destructive wildfires (Duncan and Mitchell, 2009). The effects of these aforementioned fire-spread inhibitors have been dramatic in terms of large-scale fuel accumulations and changing structure and composition of many ecological systems in South Carolina (Fairchilds and Trettin, 2006).

A large and rapidly expanding wildland urban interface (WUI), driven by swiftly expanding population growth and urbanization, has added new complexities to both wildland fire suppression and prescribed fire operations. Within the Francis Mario proclamation boundary, approximately 38 percent of the land is privately owned; which contributes to the WUI. The South is projected to experience the largest decline in forest area by 2060, losing about 17 million acres in one population growth scenario (Bowker et al., 2012). Total population growth within eight counties that encompass and surround the Francis Marion increased by 60 percent from 1980 to 2010. Berkeley County alone observed a significant doubling of housing units between 1980 (31,771 units) and 2010 (65,367 units) (http://www.berkeleycountysc.gov/dept/planning/comp/).

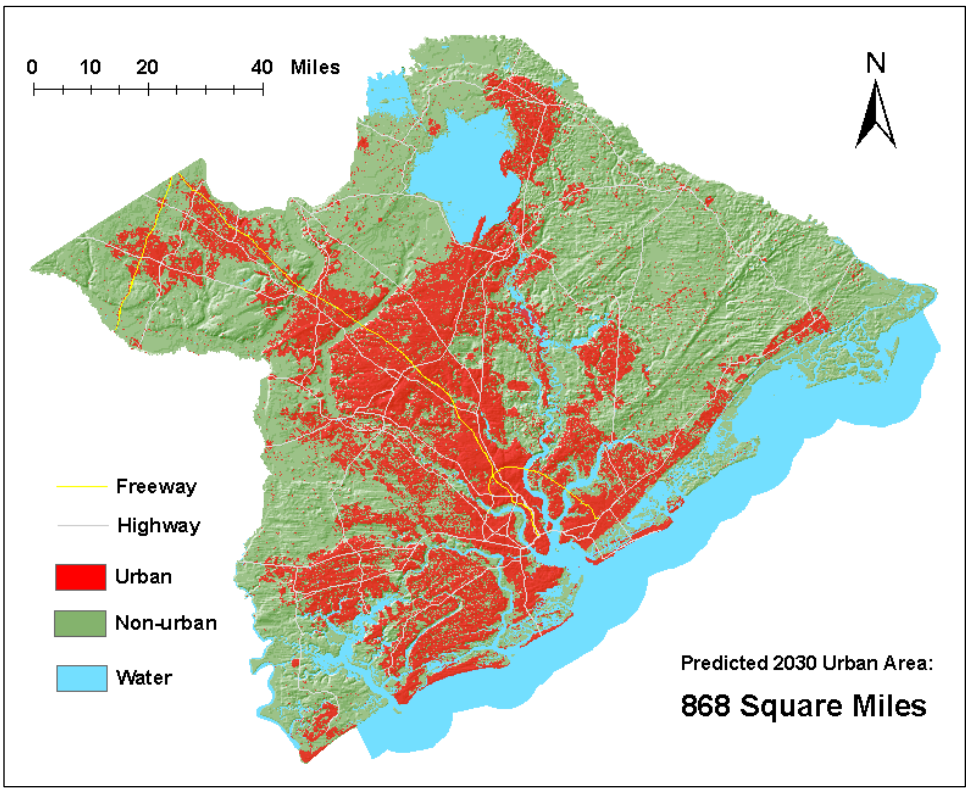

Figure 3-38. Population growth from 1970 through 2005 with 2030 projected

Uncharacteristic fire behavior in ecological systems excluded from fire can threaten the life and safety of both the public and wildland firefighters while also leading to direct loss of community infrastructure including communication, transportation, energy and water supplies. Due to limited resources for treatments and elevated values adjacent to these ecological systems, treatments have historically been accomplished almost exclusively in systems where implementation risk and consequence is mitigated by distance of human presence. Fire is a natural ecological process, but unlike the others (hurricanes, floods, tornadoes, etc.) humans have the capability to use fire as a tool and, as recent history has shown, to suppress the natural processes of fire. By doing so, humans have most certainly changed the landscape and effects of fire once present. The consequences of all our management decisions must be considered, and suppression versus the use of planned and unplanned wildland fire must be weighed to adequately manage the ecosystems entrusted to land managers.

To help protect people and their property from potential catastrophic wildfire, the National Fire Plan (Forestsandrangelands.gov) directs funding to projects designed to reduce the fire risks to communities. A fundamental step in achieving this goal was the identification of communities that are at high risk of damage from wildfire. These high-risk communities identified within the wildland-urban interface were published in the *Federal Register* in 2001 (*Federal Register* 66:3). At the request of Congress, the *Federal Register* notice only listed those communities neighboring federal lands. The August 2001 *Federal Register* 66:160, lists 12 communities at risk (i.e. . Germantown, Tibwin, McClellanville, Awendaw, Wando, Honey Hill, Germantown, Shulerville, Huger, Cordesville, Bethera, Jamestown and St Stephen) that are within the Francis Marion proclamation boundary. The Forest Restoration Act (2003) further supports the creation of fire-adapted human communities by calling for preparation of community wildfire protection plans (CWPPs) to define the wildland-urban interface and establish priorities for wildfire preparedness and hazardous fuels reduction work in these areas. Currently, there is one CWPP that covers more than 144,431 acres on federal, state, county and private lands in and around the Francis Marion. Of this, approximately 66,504 acres is on National Forest System lands. This CWPP is for Awendaw District Fire Department and the surrounding communities within the Resource Integration Zones.

Additional areas on the forest meet the Forest Service Manual definition of wildland-urban interface and would greatly benefit from the establishment of CWPPs. For the plan revision, wildland-urban interface is defined in the Forest Plan Assessment.

The concept of fire regimes can help us categorize the many-faceted role of fire while also characterizing and describing expected severity. Knowledge of fire regimes is increasingly recognized as a critical basis for ecosystem management. “Fire regime” refers to the nature of fire occurring over long periods and the prominent immediate effects of fire that generally characterize an ecosystem (Brown, 2002). “Fire regime group” is a classification system used to describe fire severity within separate ecosystem types.

Table 3-66. Fire regime group in terms of fire regime and severity type

Fire Regime Group	Fire Regime	Fire Severity Type	Severity Description
I	0-35 years	Low/Mixed	Generally low-severity fires replacing less than 25 percent of the dominant overstory vegetation; can include mixed-severity fires that replace up to 75 percent of the overstory
II	0-35 years	Replacement	High-severity fires replacing greater than 75% of the dominant overstory vegetation
III	35-200 years	Low/Mixed	Generally mixed-severity; can also include low severity fires
IV	35-200 years	Replacement	High-severity fires
V	200+ years	Replacement/ Any	Generally replacement severity; can include any severity type in this frequency range

An FRCC uses 3 condition classes to describe low departure (FRCC 1), moderate departure (FRCC 2) and high departure (FRCC 3). This departure results from changes to one or more of the following ecological components:

1. Vegetation characteristics, including species composition, structural stage, and canopy cover; and
2. Spatial fire regime characteristics, including fire frequency and severity (Hann and Bunnell 2001; Schmidt and others 2002; Hardy and others 2001; Hann and others 2004).T

There are no wildland vegetation and fuel conditions or wildland fire situations that do not fit within one of the 3 FRCCs.

The 3 FRCCs are defined in the Interagency FRCC Guidebook as follows:

1. Fire Regime Condition Class 1: Fire regimes are within the natural or historical range and risk of losing key ecosystem components is low. Vegetation attributes (composition and structure) are intact and functioning.
2. Fire Regime Condition Class 2: Fire regimes have been moderately altered. Risk of losing key ecosystem components is moderate. Fire frequencies may have departed by one or more fire intervals (either increased or decreased). This may result in moderate changes in fire and vegetation attributes.
3. Fire Regime Condition Class 3: Fire regimes have been substantially altered. Risk of losing key ecosystem components is high. Fire frequencies may have departed by multiple fire intervals. This may result in dramatic changes in fire size, fire intensity and severity, and landscape patterns. Vegetation attributes have been substantially altered.

FRCC lends itself well to monitoring and assessing current conditions of wildland ecosystems, as well as providing a good understanding of potential hazards and risks across the landscape.

Table 3-63 describes the FRCC of all wildland vegetation on the Francis Marion.

Table 3-67. FRCC of all wildland vegetation on the Francis Marion

Francis Marion National Forest Wildland Vegetation Acres		
FRCC 1	FRCC 2	FRCC 3
140,338	59,143	55,879

Table 3-68. Total annual prescribed burn acreage by year

Year	Dormant Acres		Growing Season Acres		Dormant Acres	Growing Season Acres
	Longleaf	Total All Veg Types	Longleaf	Total All Veg Types	Longleaf Total	All Veg Types
1997[1]		14,141		4,960		19,101
1998[1]		20,396		13,038		33,434
1999[1]		19,210		9,286		28,496
2000[1]		18,987		11,077		30,064
2001[1]		22,269		13,017		35,286
2002[1]		18,668		4,568		23,236
2003[1]		18,114		22,580		40,694
2004[1]		23,588		8,010		31,598
2005[1]		24351		12,100		36,451
2006	7,140	19,521	5,029	11,409	12,169	30,930
2007	8,546	24,008	2,688	10,501	11,234	34,509
2008	9,859	25,539	4,426	13,710	14,286	39,249
2009	9,908	28,985	2,560	5,894	12,468	34,879
2010	10,865	25,933	2,130	7,572	12,996	33,505
2011	5,360	17,304	4,980	14,136	10,341	31,440
2012	7,586	21,380	1,813	8,964	9,399	30,344

[1] Dormant/growing season acreage breakdown not available.

Due to a successful history of prescribed fire in the core of the Francis Marion, significant portions of the forest are in FRCCs 1 and 2. The prescribed fire strategy on the forest currently is to maintain ecosystems with frequent prescribed burning rotations. Continuing to follow this strategy would allow the forest to maintain condition class 1 areas and move condition class 2 areas into condition class 1. Increasing the current core area of burning would also result in moving additional condition class 2 areas into condition class 1 while beginning to further move condition class 3 areas into condition class 2.

3.4.2.2 Environmental Consequences

Alternative 1 - Continue with 1996 Forest Plan Direction

Direct and Indirect Effects. Alternative 1 would not address the hazards and risks associated with wildland-urban interface, nor would it follow the National Cohesive Wildland Fire Management Policy and associated guidance in creating fire-adapted human communities. More than a decade of prescribed burning following Hurricane Hugo has significantly reduced fuel loadings and moved FRCC closer to historic levels within core areas of the forest; however, in spite of this and coinciding are complexities and challenges land managers face when attempting

to reintroduce fire to fire-dependent and once fire-adapted systems: growing and expanding human communities; fragmented lands intermixed with highways, infrastructure and utility corridors; potentially volatile fuels; and smoke management issues all elevate risk. The forest acknowledges that those most intensive wildland-urban interface areas are simultaneously the areas of greatest threat to our communities and those of greatest value from (and highest priority for) treatment. Desired treatment is any mechanical, biological or fire treatment (or combinations of each) that reduces future (0 to 10 years) fire intensity and severity.

Alternative 1 carries and creates the greatest risk. By not treating the build-up of hazardous fuels within fire dependent ecosystems in the WUI these systems will continue display uncharacteristic fire intensity and fire severity characteristics. These uncharacteristic fire intensities are more difficult to react to and suppress and are more unpredictable.

Alternative 1 would significantly decrease opportunities to work with neighboring partners and land managers in the treatment of hazardous fuels through CWPP implementation across federal, state and private boundaries.

Alternative 1 would present the least opportunity for implementing treatments because it constrains using unplanned wildfires to meet resource objectives and includes a general lack of emphasis on alternative treatments within the WUI. Alternative 1 would explicitly prohibit wildfires to meet resource objectives.

Alternative 2 - Proposed Action

Direct and Indirect Effects. Alternative 2 would provide the greatest opportunity to reduce the threat and risks associated with wildland fire. Alternative 2 would provide the greatest opportunity for treatment by explicitly stating desired conditions and the need to mimic fire using alternative treatments within the WUI. Where Alternative 1 is silent on hazardous fuels reduction and possible treatment activities, Alternative 2 details the broad array of tools managers could use to assist in creating fire-adapted human communities:

Alternatives to landscape level prescribed burning include:

1. Prescribed burning in smaller burn blocks. In Management Area 1, fire compartments could be thousands of acres; in Management Area 2, these fire compartments could be hundreds of acres.
2. Mechanical methods to reduce fuel loading. Some methods could include mastication or chipping the midstory or roller drum chopping after a regeneration harvest.
3. Herbicide Use. Herbicides could be used to reduce fuel buildup in the understory.
4. Grazing. Cattle, goats, llamas or donkeys could be used to control vegetation and reduce fuel loading, except within riparian management zones.

Alternative 2 would provide increased opportunities for federal, state and private partners to work together while creating fire-adapted human communities. By working with partners and homeowners to reduce hazardous fuels, the likelihood that a wildfire burning in adjoining vegetation would ignite homes or other structures can be mitigated. Using existing programs, such as CWPPs and firewise education would be effective tools to encourage homeowners and local governments to create fire resistant neighborhoods and communities.

Alternative 2 also incorporates Federal Wildland Fire Management Policy (www.fs.fed.us/fire/management/policy.html) which states, “The role of wildland fire as an

essential ecological process and natural change agent will be incorporated into the planning process." Alternative 2, at a minimum, would offer managers the ability to concurrently manage naturally occurring wildland fire for one or more objectives. Alternative 2 would carry increased risk however, when using a decision support process to guide and document wildfire management decisions, the process would provide situational assessment, analyze hazards and risk, define implementation actions and document decisions and rationale for those decisions

The 1996 Forest Plan defines the need to implement prescribed fire across the landscape of the Francis Marion for several desired effects. Alternative 2 would further define this need while also increasing the area burned and the return interval frequency in the growing season.

Alternative 2 would see increased impacts of smoke production and associated impacts from planned ignitions upon human populations. However, smoke output from maintenance prescribed burning discharges less particulate matter due to less available fuel (frequent fire rotations continually remove understory fuel accumulations). Also, without maintaining hazardous fuel buildup, once ignited and burned under wildfire, these fuels would produce levels of emissions far exceeding those output under planned ignition events. By not treating the build-up of hazardous fuels within fire dependent ecosystems in the WUI these systems would continue to display uncharacteristic fire intensity and fire severity characteristics. These uncharacteristic fire intensities would be more difficult to react to, suppress and predict.

Alternative 3

Direct and Indirect Effects. Alternative 3 would reduce landscape-level prescribed burning in smoke-sensitive areas thus minimizing and even negating smoke to some receptors. This short-term tradeoff however would have profound consequences to long-term human health and safety. Without maintaining hazardous fuel buildup, once ignited and burned by wildfire, these fuels would produce levels of particulate matter and emissions far exceeding those output under most planned ignition events. As more acres are restored to FRCC 1 in ecological communities adapted to low-intensity periodic fire, a grass- and forb-dominated understory would prevail over a larger part of the landscape. In this condition, surface fuels are the primary component contributing to fire behavior. There would not be as much of a woody live and dead fuels component to contribute to either flaming or smoldering fire behavior.

In prescribed fires and wildfires, the grassy component would burn more easily, faster and produce fewer smoke emissions (both in concentration and duration) as compared to current fuel conditions. Fire intensity would be less and there would be less likelihood (risk) of stand replacement burns. Suppression efforts would be less costly while providing a higher degree of safety to both the public and firefighters. By not treating the build-up of hazardous fuels within fire dependent ecosystems, these systems would be more conducive to wildfires with uncharacteristic intensity and severity characteristics. These uncharacteristic fire intensities would be more difficult to react to, suppress and predict. Prescribed fire would also decrease the risk of wildfires burning onto adjacent lands.

The additional recommended wilderness areas in Alternative 3 present further constraints to prescribed fire and alternative treatment activities due to increased coordination needs, logistical complexity (access), potential reduction in fire management tools (e.g., chainsaws, engines, bulldozers, aviation resources) and the need to mitigate activities and motor vehicle use to maintain wilderness character. Several existing roads and firelines are located within the proposed wilderness; new firelines would have to be constructed to implement prescribed fire.

Alternatives 1, 2 and 3

Cumulative Effects. As more acres are restored to FRCC 1 in ecological communities adapted to low-intensity periodic fire, a grass- and forb-dominated understory would prevail over a larger part of the landscape. In this condition, surface fuels are the primary component contributing to fire behavior. There would not be as much of a woody live and dead fuels component to contribute to either flaming or smoldering fire behavior. In prescribed fires and wildfires, the grassy component would burn more readily, faster and produce fewer smoke emissions (both in concentration and duration) as compared to FRCC 2 and 3 systems. Fire intensity would be less and there would be less likelihood (risk) of stand replacement burns. Suppression efforts would be less costly while providing a higher degree of safety to both the public and firefighters.

Table 3-69. Current and projected FRCC conditions across the Francis Marion

FRCC	Alt 1 Acres	Alt 2 Acres	Alt 3 Acres
1	280,674	300,874	244,358
2	118,285	108,185	88,031
3	111,759	101,659	178,121

FRCC is calculated using Region 8 guidance as applied to existing vegetation types.

Alternative 1 is current FRCC breakdown across the forest.

Alternative 2 is current with slight reduction from 2 and 3 to 2 and 1 using proposed plan objective of converting FRCC (approximately 20,000 acres).

Alternative 3 is current with a projected rise from 1 to 3 due to lack of fire treatment in Management Area 2 over the next 10 years.

Table 3-65 and Figure 3-35 display current and projected FRCC conditions across the Francis Marion. These illustrations are used to show shifts of FRCC between alternatives. The substantial increase in FRCC 3 acres on the forest over the next 10 years in Alternative 3 would be due to a decreased prescribed fire program, specifically in Management Area 2.

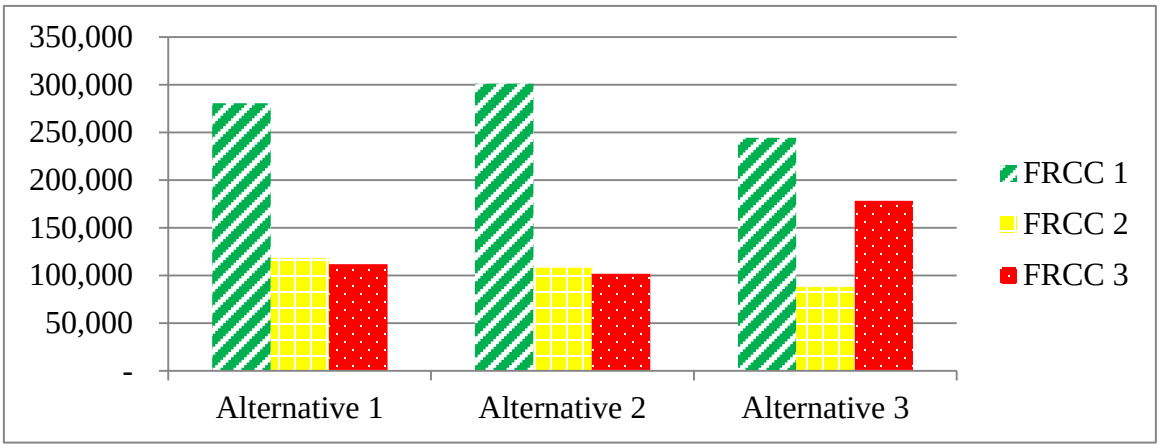

Figure 3-39. Current and projected FRCC conditions across the Francis Marion

The effects of prescribed fires are usually short-lived and cumulative impacts are generally ascribed to impacts to soil and potential for smoke accumulation. Prescribed fire can have short-term negative effects on air quality. These effects may be mitigated by burning at certain times of the year, at certain fuel moisture thresholds and under meteorological conditions that promote smoke dispersion. This information is provided in the burn plan prepared for each prescribed fire. A smoke management plan is required for each burn plan. The impacts of prescribed fire on soils and air would be expected to stay within established limits for all alternatives.

3.4.3 Infrastructure

3.4.3.1 Roads: Affected Environment

A total of 576 miles of forest system roads, in addition to federal highways, state and county roads lie within the proclaimed national forest boundary. The forest road system within the planning area provides access to public lands and private inholdings. The majority of the access is provided for forest administration, public recreation, wildlife management and forest product extraction.

Public National Forest System (NFS) roads are those open for the general public to use. Administrative roads are for Forest Service personnel, contractors and permittees and, therefore, likely have much less use and are not maintained as well as public system roads. Roads used exclusively for regular administrative access to recreation are an exception. Annual Motor Vehicle Use Maps (MVUMs) produced by the forest show which roads are open public travel; all other roads are used for administrative purposes only or unauthorized and under consideration for obliteration. Private roads are roads that provide access to private property. Private roads are administered as easements or special use permits and are considered in the lands special use analysis. The MVUM would not be changed immediately following a decision on the forest plan, regardless of which alternative is selected. Differences among alternatives are based on limitations and desired conditions in the alternatives that would guide future site-specific decisions about roads and access.

Forest roads are designated according to maintenance levels and provide constant use by the motorized public or intermittent use for administrative purposes (gated). Gated roads (Level 1) are closed to motorized access except for more than one trip annually. Level 2 roads may be gated but available for administrative trips. Maintenance Levels 3-5 are open for constant use unless temporarily gated to secure the area for administrative purposes, public safety/health or to protect resources.

Table 3-70. Miles of national forest system roads by maintenance level

Maintenance Level	Miles	Percentage
1	141.5	24.6
2	82.0	14.2
3	295.0	51.3
4	55.8	9.7
5	1.3	0.2
Total	**575.6**	**100**

3.4.3.2 Roads: Environmental Consequences

Guidance for the transportation system in the 1996 Forest Plan is limited to the management of roads within Forest Service jurisdiction. Forest management activities significantly affecting the transportation system are road construction, reconstruction, maintenance and decommissioning. In all alternatives, major roads necessary for through traffic would remain open. Most road closures would be on dead-end roads unless necessary to ensure public safety and mitigate resource damage. Specific roads designated for closure would not be identified at the plan level.

Road construction and reconstruction is related in almost all cases to timber harvest needs and providing adequate access in newly acquired parcels. Road maintenance is determined based on the maintenance level assigned to all national forest roads. Road decommissioning will be determined on a case-by-case basis considering long-term need for current system roads and the need to obliterate illegal travelways within the forest.

Changes to the forest road system were evaluated based on management guidance (e.g., desired conditions, guidelines, standards, objectives and management approaches) and geographic delineations (e.g., recommended wilderness, semi-primitive non-motorized designation and management areas) in each alternative that would influence future motorized access on the forest. Impacts from roads vary according to use, location, road maintenance level and other factors. This analysis looks at management designations and direction that would affect the forest road system and makes the assumption that across the forest reduced miles of NFS roads would generally equate to decreased motorized access and ecological impacts from roads and increased opportunity for more primitive recreation.

The ecological consequences of closing, decommissioning and naturalizing roads generally result in increased wildlife habitat connectivity, reduced dumping, reduced sedimentation and impacts to plants and archaeological sites, decreased vandalism and theft of archaeological sites, and less noise disturbance to wildlife. The exact magnitude and location of these effects, however, is difficult to assess at the plan scale because the effectiveness of achieving these effects is largely dependent on site-specific situations and design features. In general though, fewer roads equates to an overall trend of a decrease in these effects. It is also assumed that roads for administrative use only would have lower use and correspondingly fewer impacts to ecological resources than roads that are open to the public. Among the alternatives, Alternative 3 would provide the greatest amount of recommended wilderness and management areas that decrease future opportunities for public motorized access.

Alternative 1 would provide the greatest number of miles of NFS roads open to motorized travel, but it would not consider any new wilderness or management areas. Alternative 2 would provide a mix between public access and recommended semi-primitive motorized closures, which decreases the motorized travel on the forest but not to the extent of Alternative 3, which would include additional wilderness designation.

Alternative 1

No additional areas are recommended for wilderness in the 1996 Forest Plan. In Alternative 1, four existing wilderness would be maintained, totaling more than 13,000 acres. 2 inventoried roadless areas (Hellhole Ext and Wambaw Ext) would be maintained. No road closures would be needed to implement this alternative.

This would keep the current road system in place only evaluating needs for additional access for timber and new land acquisitions. It is expected that the maintenance level of all forest system roads would be evaluated to reduce the maintenance of the overall current road system.

Alternative 2

This alternative would increase opportunities for remoteness by emphasizing a semi-primitive, motorized desired condition on national forest land adjacent to 3 existing wilderness areas. Four existing wilderness and 2 inventoried roadless areas would be maintained. The semi-primitive motorized areas would emphasize a remote experience totaling more than 11,000 acres, but would not restrict mechanical activities. Over time, road closures would improve wilderness character in the 3 nearby wildernesses through a lower open road density in the semi-primitive, motorized areas. Roads that would need to be gated would be used for administrative access. Road closures would require site-specific NEPA decisions.

This additional emphasis on semi-primitive motorized condition would reduce the current road mileage by 18 miles (eight miles of Management Level 1; four miles of Management Level 2; and 3 miles of Management Level 3). It is likely that additional road miles would be closed based on biological needs and to protect human health/safety and resources.

Alternative 3

Four existing wildernesses would be expanded with four additions of recommended wilderness totaling more than 16,000 acres (including 2 inventoried roadless areas). Over time, road closures would improve wilderness character and lower road density. 2 inventoried roadless areas would be included within the new wilderness recommendations. Roads that would be closed and obliterated would require a site-specific NEPA decision.

This designation would decrease the current mileage of forest roads by 44 (17 miles Management Level 1; nine miles Management Level 2; 16 miles Management Level 4. It is likely that additional road miles would be closed based on biological needs and to protect human health/safety and resources.

With any of the above road mileage activities, motorized vehicle use would eliminate motorized access while encouraging foot travel to areas within the wilderness boundaries.

3.4.3.3 Buildings and Structure: Affected Environment

Sixty-eight Forest Service buildings and structures (both administrative and recreation) support administrative and recreation programs across the Francis Marion.

A Facility Master Plan would be developed to guide the acquisition, continued use, maintenance, improvements and disposal of Forest Service facilities on the Francis Marion. The plan would propose an overall reduction in facilities through consolidation and decommissioning.

3.4.3.4 Buildings and Structure: Environmental Consequences

The probable activities under all alternatives would have little effect on the current status of facilities since most activities are allowed under the current plan. Evaluations for decommissioning existing facilities and new facility construction are not addressed at the forest-plan level.

3.4.4 Special Uses, Energy, Minerals

3.4.4.1 Affected Environment

Approximately 108 special uses have been issued on the forest including rights of way (permits and easements), recreation events, outfitting and guiding, utilities (telephone, cable, fiber optic), community playgrounds, drainage ditches, churches and cemeteries. Grazing permits ceased in 1970 and former agriculture permits were allowed to expire without renewal.

Special use authorizations on the Francis Marion continue to be an important and demanding program as a result of population growth. High population growth in the Lowcountry has resulted in infrastructure demands, new easements, including widened and improved roadways and widened and new utility corridors, and communications facilities.

While research is not often considered to be a major use of federal lands, the Francis Marion issues a number of special use permits for research purposes. Research on flora, fauna, water quality, seismic activity, weather, and soil conditions are common requests. Requests are being considered to restore ecosystems to their former conditions by working with local governments and private entities through mitigation banking. The forest also commonly allows communities, industry and other entities to use public lands for infrastructure, including power lines, rights-of-way, telecommunications and the like. Special-use requests for developments such as electricity, fiber optic communications and telephone services have increased over the past 20 years. With the changes in technology, this trend would increase need and demand for more of these types of developments and the services they provide. The growing demand for energy has generated increased emphasis on the management of utility corridors to provide additional services and to expand or create new corridors. Renewable energy resources such as wind and solar are resulting in new corridors being needed beyond the connections between existing traditional energy generator locations.

Procedures for the review and response times for special use applications and requests are now set by policy and regulations outside the forest plan and would apply regardless of the alternative selected.

3.4.4.2 Environmental Consequences

Encouraging maximum use of existing utility corridors and communication sites is common direction to all alternatives. As a result, new developments would be minimized across the landscape. All alternatives include this use as part of the desired landscape character in the appropriate management areas.

The probable activities under all alternatives would have little effect on the current special uses program, since most of the activities are allowed under the current plan. The most significant effect would be the minimum uses that would be allowed on lands in Alternative 3 with the designation of additional wilderness acreage on the forest. This would specifically be addressed – no utilities, rights of ways or specific recreation activities would be allowed in wilderness.

Alternative 1

Specific special use direction on processing and administration has seen changes in policy and regulation since the1996 plan. Some direction and terminology in Alternative 1 may no longer be consistent with current regulations and screening criteria. Current regulations and direction would need to be followed to provide a legally defensible special use permitting process.

Utility corridor maximizes the use of existing corridors. Corridors are considered in areas of the forest where the resources concerns are minimized. As a result, the location of new corridors on the forest would be limited.

Overall, the continuing the 1996 plan would provide direction on suitable places for special use permits and a goal for special uses meeting the needs of communities and the public. It would encourage working to approve uses that meet the needs of expanding communities, while minimizing impacts to other resource values

Alternative 2

Alternative 2, like Alternative 1, would retain much of the special uses direction from the 1996 plan and would include direction allowing uses when they are compatible with other resource objectives. However, stronger objectives would result in more restrictions on future utility corridors and other larger scale uses, limiting them mostly to existing corridors. Expectations of structures within roadway corridors, including potential wildlife crossings and other roadway facilities, would address the conflict between the valuable resources along major roadway corridors and the need for facilities associated with roads and reducing barriers to wildlife. New and expanded corridors and other special uses that include larger acreages would be limited under the stronger direction in Alternative 2.

Alternative 2 would include more specific direction and desired conditions that describe where special uses can be compatible with other resources than the 1996 plan. Special uses screening criteria and application processes in the regulations would address some specific direction that is included in the previous plan and, therefore, does not need to be included in Alternative 2. Use requests would still be considered, but may be more restricted under this alternative; however, it would allow other resource conditions and objectives to be better achieved. Guidance on infrastructure, utilities and roads, and scenery values in Alternative 2 would be more specific than the 1996 plan. Additional direction for corridors would be similar to the 1996 plan by placing needed facilities in places that reduce ground disturbance and visual effects to multiple resources while recognizing public needs and demands for reliable energy and communication services, as well as transportation and other infrastructure associated with growing populations and communities. Use requests that affect smaller areas could be allowed in less visible places that could meet scenery objectives.

Alternative 2 would rely on a broad public need being demonstrated to avoid communication and utility facilities becoming too frequent, dominating forest landscapes and degrading scenery and impacting other resources from the additional ground disturbance.

Research permit direction would indicate when those activities are appropriate on NFS lands and have national forest values. This would not only address the forest being more supportive of research activities, but also clearly indicate that the forest would be more supportive of research that relates to the Forest Service mission and would not affect recreation opportunities or impact vegetation structure, composition and management objectives long term. Such guidance would clearly articulate and narrow the types of research the forest would consider permitting and support research projects that benefit the agency as well as the sponsoring research organization while reducing environmental impacts from permitted research activities. Climate change and the potential increases in in fire and tree mortality may increase the needs of utility companies (in particular those with aerial lines) to invest more in removing hazards or in repairs to facilities. This may also result in more open areas adjacent to these corridors and the need to treat the adjacent edges to reduce the linear look and soften the corridor.

Alternative 3

The effects of Alternative 3 would be similar to Alternative 2. Additional recommended semi-primitive, non-motorized use could restrict management of existing authorized uses and could limit new uses. Alternative 2 would cover areas adjacent to roads and utility corridors and would limit any potential expansion of these corridors and some maintenance activities that may prove difficult for permit holders in these specific areas.

Ongoing population increases also would likely result in demand for new transportation systems both on and off forest, mostly in road corridors. Potential changes to the transportation system can be anticipated through both current and anticipated studies and plans. These improvements would impact scenery resources, and would have the potential for addressing wildlife connectivity through the construction of wildlife crossings as improvements are constructed. Other travel corridor improvements would also be expected during the life of the plan. These construction activities would have the potential to promote further introduction of invasive weeds along corridors and changes in scenery and recreation opportunities.

Inholdings and residential developments within and adjacent to the forest may also affect NFS lands. When inholdings of private property have gone through a lot-split process instead of a subdivision, access to individual parcels has not been provided for. This has resulted and would continue to result in additional road access requests and the potential for multiple access points and permits on the forest. Subdivision developments may result in higher standard road access corridors to meet local government requirements. These higher standard access roads would have the potential to move the area away from the desired landscape character for scenery, and impact wildlife habitat and recreation experiences.

Population growth in South Carolina continues to place pressure on utility providers to ensure reliable services. This growth results in continued requests for uses that allow for redundancy or alternative feeds (wireless and other communications services, water pipelines, electricity grids, power substations and gas pipeline circuits), as well as additional storage facilities like water tanks. Locations for new uses would be limited because of the desire to maintain high or moderate scenic integrity objectives in most of the forest. Population growth and popularity of the Lowcountry by tourists would also increase pressures for recreation in a forest setting provided by the Francis Marion.

As stated in the Land Use and Ownership section, cumulative effects of population growth and other entities' future plans would likely move the forest away from desired conditions for some resources, depending on the location and scale of development. Infrastructure development on lands of other ownership within the forest in many cases would result in connections being required on the forest

Identifying some existing utility corridors for expansion would allow for some new infrastructure to address new demands, but may not be in needed locations, depending on the sources of power, water or gas supplies. Continued growth would also likely result in the need for additional transportation corridors and other community infrastructure that are not currently known.

3.4.5 Land Use and Ownership

3.4.5.1 Affected Environment

Approximately 259,537 acres of the Francis Marion are located in Berkeley and Charleston counties. The lands program area includes several different activities. Landownership includes

land exchanges, purchases, boundary management, and other activities that are primarily real estate type activities. Special uses activities include authorizations to use NFS lands for non-Federal type uses. These uses can be things such as utility corridors, private and public roadways, churches, communications sites, or signs.

Actions and plans of local communities and their growth and development influence the Francis Marion through land adjustment cases, land exchange concerns, utility needs and development, and residential impacts. These communities are also partners in maintaining and acquiring open space and providing needed services to residents and forest users.

The Forest Service may acquire lands through exchange, purchase, donation or condemnation.

Land exchange and land purchase have been, and would continue to be, the means by which the

Francis Marion acquires key wildland resources and open space areas. Most of the federal lands exchanged are within or near existing communities and the majority of land conveyed to the forest, as a result, is located in more remote areas

Procedures for processing cases and public participation is determined by set policies, rules and regulations outside the forest plan and would apply regardless of the alternative selected.

3.4.5.2 Environmental Consequences

Criteria for land adjustment cases are very similar among all alternatives even though the wording is different. Potential results of the criteria would likely be the same. Public concern about being involved early in land exchange projects and continued support for community needs would be addressed in all alternatives. As a result, the public would be informed of land exchanges early enough to meaningfully contribute to the outcome for the benefit of the community. This would increase trust in the Forest Service's lands program. Due to budgetary constraints, limitations of the plan and community influences, the forest would likely continue to increase in acreage but probably at a small rate throughout the life of the plan.

Under each alternative, the forest would continue to pursue additional acres to add to the existing footprint of the forest. Lands would be evaluated for disposal and acquisition based on criteria developed in the forest Land Ownership and Acquisition Strategy. Emphasis would continue to concentrate on lands with valuable recreation, wildlife habitat or other natural resource attributes. Acreages such as those found in wilderness or other designated sites would not be considered for conveyance.

Alternative 1

The 2005 Land Ownership and Acquisition Plan lists specific attributes and tracts to acquire—many of which have been acquired. However, the list has not been modified to keep up with adjustments. Other acquisition parcels are not listed and, therefore, may not be perceived as high priority. Parcels of importance would change throughout the life of the plan as resource values are discovered (archaeology resources) and identified, interested parties come forward or additional species are listed or conditions change.

Land and Water Conservation Fund priority direction is contained in policy and ranking criteria and this wording is no longer needed in the plan. The criteria of lands to acquire would continue to be effective for determining potential purchase cases instead of a list of priority properties. Because this direction is redundant with Forest Service policy, it does not contribute to effects.

The plan states specific boundary and land line direction, but timeframes do not reflect current limitations in budget and the flexibility of the forest to determine priority work. As a result, this direction would remain unachievable.

Alternative 2

This alternative includes guidelines that would likely result in similar land adjustment opportunities identified in the 2005 Land Ownership and Adjustment Strategy. including conveyance of inholdings that do not possess characteristics that would further the Forest Service mission and increase the ability to acquire non-NFS lands containing habitat for threatened, endangered, or sensitive species and consolidate federal ownership.

Working collaboratively with local governments and communities early on the land exchange projects per the associated management approach may result in land exchanges being developed that meet community and forest needs and parties agreeing to potential tradeoffs of open space values for other resource benefits.

Alternative 2 would continue to allow for conveyance of lands to meet community and public needs and would add loss of wildland character to the list of lands that could be conveyed. This could provide incentives for non-federal neighbors to protect those values to reduce the potential for land exchange or sale. This alternative would also add forestwide emphasis to management approaches for collaboration with private landowners and local governments to protect forest values from adjacent development impacts. This could result in less habitat fragmentation and greater watershed health to forest resources from adjacent non-federal uses by developing buffers on private lands. Characteristics of lands to acquire would be stated in the guidelines and priorities would be set using a ranking system in the Forest Service Handbook.

Boundary survey and encroachments would not be specifically mentioned in Alternative 2, but would still be part of a lands program and would be addressed according to policy and regulation and should not change current management.

Overall, Alternative 2 would not be substantially different from the 1996 plan. However, adjustment guidelines and desired conditions would reflect more succinctly the criteria of lands desired for federal acquisition and those appropriate for conveyance. Values would be included to address local concerns about land exchanges that result in conveyance of NFS lands. Loss of wildland character as a conveyance characteristic would be a good communication tool with adjacent non-federal owners who can work to protect those values, perhaps reducing encroachment cases. This would allow communities to identify important open space, but also to take some responsibility for preserving wildland and resource values. If land adjustment actions are consistent with the guidelines, key resource value properties would be acquired and would result in meeting the desired condition of a mostly contiguous land base that provides for biologically diverse public lands.

Alternative 3

This alternative is similar to Alternative 2 except there would additional congressionally designated wilderness. These acres would be permanently removed from consideration for conveyance.

Cumulative Effects Common to All Alternatives

The cumulative environmental consequences are spatially bounded by an area larger than the Francis Marion National Forest’s proclaimed boundary, generally the area immediately adjacent

to the forest. Continued population growth in the communities within and surrounding the forest, as well as the state of South Carolina, influence landownership adjustment cases, boundary issues and the demand for special uses. This analysis of cumulative effects considers foreseeable activities over the next 10 to 15 years.

Continued population growth in surrounding communities and in the Aoutheast are expected and would add to the demand for additional lands for development purposes, especially infrastructure. Communities that have not planned for additional infrastructure needs would likely request acquisition of NFS lands for infrastructure. As private properties, especially inholdings change from rural or undeveloped land to subdivisions or higher density uses, encroachment into NFS land becomes more frequent, resulting in resource impacts and land survey needs. As communities grow and infill occurs, undeveloped lands and their open space values are converted to residential or commercial uses. This growth would likely result in continued pressures to maintain NFS lands for their open space values. This may also trigger the need to acquire right-of-way in places where informal public access is lost to development.

Cumulatively, continued growth in communities as shown in the census numbers and the resulting demands for acquisition of NFS land tend to move the forest away from desired conditions of natural open space adjacent to communities. As further development occurs, residential encroachments onto the national forest are expected to occur more frequently and degrade wildland character and other resource values. Working with other governmental partners on ordinances and plans could continue to reduce potential impacts to forest resources.

All communities adjacent to Francis Marion recognize the open space and recreational values the forest provides and have developed goals and objectives in their plans to preserve these characteristics. Entities like The Nature Conservancy can assist in acquiring key parcels that would help retain water resources and habitat for desired conditions for fish and other wildlife species. There would continue to be tradeoffs of resource values on the Francis Marion as a result of expanding communities and their needs. There would also continue to be tension between the desires to retain NFS land near communities and the need to provide land for infrastructure for community expansion. Local collaboration expectations with communities and their desire for open space may result in localized exchanges. However, all alternatives acknowledge community needs and the locations where land adjustments are appropriate and minimize impacts to other resources. These cumulative effects would be consistent among all alternatives.

3.4.6 Outdoor Recreation

3.4.6.1 Affected Environment

The Francis Marion is truly the backyard for many local residents. In fact about 70 percent of outdoor recreation visits are made by people who live within 50 miles of the national forests in South Carolina. The forest offers a diversity of terrain and ecosystems for its visitors to explore. The numerous plant and animal communities and a rich cultural history add value to the visitors' experience. Mild winters permit year-round recreation. Fragmented ownership can make typical Forest Service management practices challenging in some places. While the presence of many neighbors allows them easy access to the forest as well as creates a good environment for community partnerships, the structures and activities of nearby dwellings, roads and other development can disrupt a sense of remoteness and naturalness for forest visitors.

The USDA Forest Service Southern Forest Futures Project1 identifies and projects the driving changes for forests in the southern United States over the next 50 years. A finding is given:

"Increasing populations would increase the demand for forest recreation while the availability of land to meet these needs is forecasted to decline." Places for nature-based recreation managed by federal and state governments will probably remain constant. Non-National Forest System land area is expected to decline with conversions from forests and farmlands to cities and suburbs. And the amount of public land acres will not significantly increase. Also noted in the Southern Forest Futures Project, "The density of use of general forest area [on National Forest System land] is expected to rise by 22 to 55 percent as participants substitute national forests for private forest and rangelands that have been reduced by urban development." While Federal acreage changes little over time, population changes greatly.

The recreation opportunity spectrum (ROS) provides a framework for administrators to manage and users to enjoy a variety of recreation environments. ROS is a management objective and provides a way of describing and providing a variety of recreation opportunities (U.S. Forest Service, 1982).

The ROS provides a framework for stratifying and defining classes of outdoor recreation environments, activities and experience opportunities. The settings, activities and opportunities for obtaining experiences have been arranged along a spectrum divided into six classes. Each class is defined in terms of its combination of activity, setting and experience opportunities. Opportunities for experience along the spectrum represent a range from a very high probability of solitude, self-reliance, challenge and risk (i.e., primitive) to a very social experience where self-reliance, challenge and risk are relatively unimportant (i.e., rural or urban) (U.S. Forest Service, 1986).

The forest plan sets the desired ROS; it is used to determine if projects are compatible with forest recreation goals. At the project level, the desired ROS is used to determine if a project is moving toward or away from the desired ROS. In many cases, changes to the transportation system can have the biggest impact on ROS. For example, decommissioning a road may increase remoteness and nonmotorized opportunities, while building a new road to provide access would increase opportunities in a more developed setting. The nature and type of facilities provided in an area also impact the recreation setting. Additional campgrounds could increase the development level and can change the ROS setting. The more facilities that provide for comfort of the visitor, the more this is true. All projects that involve an active stage of construction or landscape alteration would have short-term impacts on the recreation setting, but unless those impacts would be evident over the long term, they would not require a plan amendment. For example, putting in a new toilet would increase the presence of human activities in the short term, but may provide for a larger area with less evidence of human activities in the long term.

Table 3-71. Inventoried ROS class on the Francis Marion

Inventoried ROS Class	Acres	Percent of Forest
Primitive (P)	0	0%
Semi-Primitive, Non-Motorized (SPNM)	9,410	3%
Semi-Primitive, Motorized (SPM)	6,876	2%
Roaded Natural (RN)	242,859	94%
Rural (R)	290	>1%
Total	259,435	100%

In 2014, the Forest Service re-inventoried recreation settings on the Francis Marion and assessed what ROS class best represented these conditions. The re-inventory found that most of the forest was in a condition consistent with roaded natural (RN) settings—more than 94 percent. A much smaller percentage provide remote settings – about five percent.

Primitive (P) is the most remote, undeveloped recreation setting. Primitive settings are generally unmodified, natural environments located at least 3 miles from any open road and are 5,000 acres in size or larger. Interaction between users is very low and motorized use within this area is not permitted. The area is managed so that it is essentially free of evidence of on-site controls and restrictions. There are no lands on the FMNF that meet the inventory requirements for Primitive ROS setting due to proximity to roads and the size of some of the wildernesses.

Semi-primitive non-motorized (SPNM) areas are dominated by a natural or natural appearing environment. Interaction between visitors is low; evidence of other users may exist. They are managed to achieve a sense of remoteness, although SPNM areas can be as small as 2,500 acres and only a half-mile or greater from any open road. These areas are managed to minimize the presence of on-site controls and restrictions. These settings accommodate dispersed, non-motorized recreation. On the Francis Marion, 3 of the wildernesses meets these settings.

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 2% of settings on the national forest. They either buffer SPNM areas or stand alone as tracts of 1,500 acres or larger with a lower road density (less than 1.5 miles of road per 1,000 acres). There is a very small proportion of the forest in SPM. One wilderness, Wambaw Creek, allows motorized boats on the creek and meets the setting of semi-primitive motorized.

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 0.5 miles of a road and usually provide higher levels of development such as campgrounds, picnic areas and river access points.

Rural (R) 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 GIS. Only highly developed complexes on the Francis Marion, including Buckhall and the Sewee Visitor and Environmental Education Center, meet the characteristic of rural setting.

Desired ROS is determined in the forest plan and used at the project level to demonstrate whether a proposed project moves the area away from or toward its desired condition for recreation setting. This process begins with an inventory of the recreation setting on the site. The recreation specialist then determines which ROS class best fits the existing conditions and whether these conditions fit the desired ROS. If they are different, then the specialist would determine based on the outcomes of the project if the setting would be moving toward the desired ROS. If not, they may recommend mitigations or a plan amendment to update the desired ROS. Movement toward desired ROS from existing conditions is not automatic but occurs on a project-by- project basis over time.

For instance, some routes are in areas where the desired ROS specifies a non-motorized experience (such as semi-primitive non-motorized). If there are roads that were designated in travel management in ROS classes that are non-motorized, these roads would not automatically be closed or decommissioned when the plan decision is made. Instead, they would require separate site-specific analysis to determine how much they detract from the recreation setting and the tradeoffs of closing them versus the needs of other desired conditions and resources would be weighed appropriately.

3.4.6.2 Environmental Consequences

Table 3-72. ROS class on the Francis Marion under each alternative

ROS Class[1]	Alt. 1	Percent of Forest	Alt. 2	Percent of Forest	Alt. 3	Percent of Forest
Primitive	13,807	6%	0	0%	0	0%
Semi-primitive non-motorized	0	0%	13,671	5%	34,365	13%
Semi-primitive motorized	21,139	8%	11,198	4%	0	0%
Roaded natural	126,756	51%	234,208	90%	224,691	86%
Rural	81,201	32%	290	<1%	290	<1%
Excluded (Experimental Forest or unique areas)	8,830	3%	0	0	0	0

[1] The acres of ROS class reflect what the land allocation direction of the plan is not necessarily the what actual inventoried acres. The re-inventory of forest lands in 2014 had a more refined information than the previous plan.

Alternative 1

Alternative 1 would continue current ROS designations in the forest plan. Four wilderness areas would remain classified as primitive, more than 13,000 acres in the current plan. The wildernesses would remain within 3 miles of an open road, making their primitive opportunities not optimal. The majority of the recreation opportunity settings would remain roaded natural or rural, more than 87 percent of the forest. More than 21,000 acres of the forest would remain in semi-primitive motorized setting in Management Area 29 (swamps and swampy flats) with an emphasis on linkages between wilderness and more remote opportunities. These settings would continue to provide opportunities for visitors to see and enjoy the forest. There would be limited opportunities for remote settings aside from the wilderness.

Wambaw Creek Wilderness would continue to allow for motorized boating on the creek, which is allowed by certain provisions in that wilderness's establishment. The visitors that have enjoyed the ability to hunt water fowl or fish with small electric boats within the wilderness would continue to do these activities. The majority of visitors in Wambaw Creek Wilderness enjoy the wilderness experience in boats. However, some people may not prefer to participate in wilderness activities where there is motorized boat use.

Alternative 2

Alternative 2 would create a change in ROS settings by increasing the amount of remote semi-primitive motorized settings surrounding 3 existing wildernesses. The areas surrounding Hellhole Bay Wilderness, Little Wambaw Swamp Wilderness and Wambaw Swamp Wilderness would be managed for semi-primitive motorized setting.

Alternative 2 would better manage the effects of roads on recreation and the natural setting in these areas by having more of the forest in SPM ROS class. The effect of this allocation would be to preserve the more semi-primitive setting in these areas. The increase in SPM would not be expected to negatively impact the agency's ability to use machinery and prescribed treatments to meet its ecological restoration goals. Effects in this increase in SPM would be positive for those visitors seeking a more remote experience and less positive for those visitors who prefer a more developed experience with more access on roads. This alternative would also provide a more primitive hunting opportunity in the areas adjacent to wilderness. Road closure often reduces wildlife poaching and litter, as well as access by motorized vehicles. Closing roads increases the satisfaction of visitors who prefer solitude and fewer disturbances (such as dust and noise) by motorized vehicles. Visitors who prefer to access national forest by motorized vehicle would be less satisfied.

The four wilderness areas would be classified as SPNM, semi-primitive non-motorized, over 13,000 acres or five percent of the forest. SPNM describes the actual experience within the wilderness, as they are often bounded by roads. The majority of the ROS settings are roaded natural or rural, more than 88 percent of the forest. This would be similar to the amount of more developed settings (roaded natural and rural) in Alternative 1. These settings would continue to provide opportunities for visitors to see and enjoy the forest with easy access by vehicle.

Wambaw Creek Wilderness would not allow for motorized boating on the creek, a change from Alternative 1. A site-specific decision would be needed to close the wilderness to motorized uses. The visitors that have enjoyed the ability to hunt water fowl or fish with small electric boats within the wilderness would discontinue these activities. Hunting and fishing by non-motorized boats would be allowed; however some visitors would be dissatisfied with this change. The majority of visitors in Wambaw Creek Wilderness would enjoy the wilderness experience in boats. However, some people may not participate in wilderness activities where there is motorized boat use.

Alternative 3

Alternative 3 would create the greatest change by recommending additional acreage to four wilderness areas. The associated recommended road closures and ROS settings increase the more remote semi-primitive non-motorized settings surrounding existing wildernesses, from five percent of the forest to 13 percent of the forest. Effects of this change in settings would be positive for those visitors seeking a more remote experience and less positive for those visitors who prefer a more developed experience. This would also provide a more primitive hunting opportunity. Road closure decreases access by motorized vehicles. Closing roads increases the satisfaction of visitors who prefer solitude and fewer disturbances (such as dust and noise) by motorized vehicles. Changes in travel routes and motorized game retrieval would still be decided for each site specific area through the travel management process. Road closure often reduces wildlife poaching and litter. Fewer roads would be needed under Alternative 3 due to an increase in wilderness areas acres.

3.4.7 National Wild and Scenic Rivers

3.4.7.1 Affected Environment

The Wild and Scenic Rivers Act (Public Law 90-542: 16 USC 1271-1287, October 2, 1968) and its amendments provide for the protection of selected rivers and their immediate environments. To be eligible for designation, rivers must possess one or more outstandingly remarkable scenic,

recreational, geologic, fish and wildlife, historic, cultural or other similar values. Designation preserves rivers in free-flowing condition, protects water quality and protects their immediate environments for the benefit and enjoyment of present and future generations.

Most rivers are added to the National Wild and Scenic Rivers System (National System) through federal legislation, after a study of the river's eligibility and suitability for designation. The Forest Service is required to consider and evaluate rivers on lands they manage for potential designation while preparing their broader land and resource management plans under Section 5(d)(1) of the Act.

Rivers and stream corridors accommodate a lot of different uses such as picnicking, fishing, day hiking and walking for pleasure, primitive camping, boating (canoeing, kayaking, rafting, tubing), swimming and nature study.

Demand for river designation is expressed primarily through public comment and responses to agency proposals. The degree to which the public input favors designation indicates the demand for a wide range of uses, activities and resource qualities associated with river management. Although demand is closely related to the current population and the projected growth of the local area, designation would likely produce increased levels of recreation use in designated and potential corridors.

Designated Rivers on the Francis Marion National Forest. The Francis Marion National Forests does not have any designated wild and scenic rivers.

Non-Eligible/Eligible Rivers. In previous planning efforts, rivers on the Francis Marion National Forest were considered for wild and scenic river eligibility. Several rivers were studied and only the Santee River was found eligible. During the current planning effort, another more comprehensive inventory was done. This inventory included rivers identified on the National Rivers Inventory, the South Carolina Statewide River Assessment (SC Water Resources Commission 1988) and through public involvement. Eleven streams or rivers on the Francis Marion were reviewed for potential eligibility. Of the 11, five were found to be eligible based on their outstandingly remarkable values (ORVs). Rivers/streams must possess at least one ORV to be considered eligible. These streams were classified according to Section 2 of the Wild and Scenic Rivers Act. Table 3-69 shows the rivers that were studied but found ineligible; Table 3-70 shows the rivers that were studied and found eligible.

Table 3-73. Rivers studied for national wild and scenic river system but found non-eligible

Non-Eligible Rivers, Creeks and Streams
Wando River
Hampton Creek
Dutart Creek or other river right feeder tributaries
Chicken Creek
Guerin Creek
Huger Creek and feeder tributaries

Table 3-74. Rivers studied for national wild and scenic river system and found eligible

River	Segment	Miles	Outstandingly Remarkable Value(s)	Preliminary Classification
Awendaw	N/A	12.50	Recreation	Recreational
Echaw Creek	N/A	3.90	Ecological, scenic and recreation	Wild
Lower Santee	I	60.50	Ecological and Cultural	Scenic
Wadboo Creek	I	1.88	Ecological, scenic and recreation	Recreational
	II	12.96	Ecological, scenic and recreation	Wild
Wambaw Creek	I	1.95	Ecological, scenic, recreation and cultural	Scenic
	II	12.09	Ecological, scenic, recreation and cultural	Wild

3.4.7.2 Environmental Consequences

Table 3-75. Miles of Eligible Rivers by Preliminary Classification by Alternative

River	Alt. 1	Alt. 2	Alt. 3
Wild	28.95	28.95	28.95
Scenic	62.45	62.45	62.45
Recreational	14.38	14.38	14.38

The identification of a river for study through the forest planning process does not trigger any protection under the act until designation by Congress. Importantly, identifying rivers as eligible, or eligible and suitable, does not create any new agency authority; rather, it focuses the management actions within the discretion of the Forest Service on protecting identified river values. For eligible rivers, the preliminary (inventoried) classification is to be maintained absent a suitability determination. The recommended classification is to be maintained throughout the duration of the forest plan. Protection of rivers and streams through the forest planning process helps to assure high-quality, free-flowing rivers and streams, as well as river-related recreation opportunities.

Management emphasis for the eligible rivers and their corridors is focused on protection and enhancement of the values for which they were established, without limiting other uses that do not substantially interfere with public use and enjoyment of those values. The establishment values (ORVs) for the rivers on the Francis Marion National Forest include scenic, recreational, geological, fish and wildlife, historical, cultural or other values including ecological.

Most impacts to all rivers come from upland activities outside the river corridor. However forest management would be subordinate to the river's ORVs. Vegetation management, road construction and construction or removal of recreation facilities could cause erosion along the river, sedimentation from soil runoff, visual intrusions or noise from nearby activities. Fire management within the corridor, prescribed fire and fire suppression actions may result in smoke impacts, noise from aircraft, chainsaws and engines, or visual effects from charred vegetation. Search and rescue operations may cause some impact from the use of equipment in the river corridor but these are predicted to be minimal. Increased public interest and use may result in development of additional trailheads and trails and access points to the river to accommodate additional public interest and use of the river. However, increased recreation use due to designation may also result in more river-related activities (boating, fishing, etc.) and cause

localized increases in soil compaction and erosion of stream banks and the need for limited public access.

River sections classified as scenic or recreational are managed with a wider variety of activities allowed within the river corridor. However, forest management would be subordinate to the river's ORVs. Sights and sounds of man's activities would be more apparent. Management activities that have the greatest potential of affecting rivers and their potential suitability for wild and scenic designation are road construction, vegetation management, insect and disease control, special use utility right-of-ways and mineral extraction. Other management activities that also can affect the river resources to a lesser degree are threatened and endangered species habitat management, range management, recreation and administrative site facility construction and wildlife and fisheries management. Classification as wild would therefore be expected to have a smaller range of effects from activities within the river corridor, (e.g. no new roads, no new right-of-ways or wild life openingss).

Non-eligible Rivers: Rivers determined to be not eligible may be managed on the Francis Marion National Forest under a variety of management areas, geographic zone and special designations. These prescriptions will allow a wide variety of activities within the river corridor. Management activities may include road construction, vegetation management, insect and disease control, special use utility right-of-ways and mineral extraction. Other management activities that also can affect the river resources to a lesser degree are threatened and endangered species habitat management, recreation and administrative site facility construction and wildlife and fisheries management.

All Alternatives

Direct and Indirect Effects. Under all alternatives, the five eligible wild and scenic rivers would have their eligibility maintained in accordance with Forest Service manual and handbook direction until they are evaluated for their suitability and either designated or released. This means that they would be maintained in their free-flowing condition and their identified ORVs would be retained.

3.4.8 Wilderness and Inventoried Roadless Areas

3.4.8.1 Affected Environment

Wilderness: Congressionally designated wilderness areas are protected by the Wilderness Act (P.L. 88-577 (16 U.S. C. 1131-1136)) and valued for their ecological, historical, scientific and experiential resources. Outdoor recreation is one of the benefactors of wilderness and is one of the drivers of wilderness demand and management. According to trend data collected from 1965 to 1994, the trend in recreation visits to national forest wilderness areas has paralleled designations and use has increased over time. In addition to outdoor recreation in wilderness, a non-user component that values American wilderness also exists and is important to understand when analyzing areas that may be suitable for wilderness allocations.

Wilderness is valued for preserving representative natural ecosystems and local landscapes. The very existence of wilderness is valued by the American public as part of the natural heritage of the country.

The Francis Marion National Forest is home to four designated wilderness areas: Hellhole Bay (2,125 acres); Wambaw Swamp (4,815 acres); Little Wambaw Swamp (5,047 acres); and Wambaw Creek (1,825 acres) (see Table 3-72). The combined acreage for all four wilderness

areas is 13,812 acres. On the Francis Marion National Forest this represents about five percent of the total forest acreage. Annual wilderness use for both the Francis Marion and Sumter National Forests is about 11,590 visits per year, or about one percent of total visitor use

Table 3-76. Existing Designated Wilderness Areas

Name	Acres
Hellhole Bay	2,125
Wambaw Swamp	4,815
Little Wambaw Swamp	5,047
Wambaw Creek	1,825

The existing wilderness areas should maintain the areas' natural characteristics. Four qualities of wilderness help describe wilderness character,

1. Untrammeled. Wilderness is essentially unhindered and free from modern human control or manipulation.
2. Naturalness. Wilderness ecological systems are substantially free from the effects of modern civilization.
3. Undeveloped. Wilderness is essentially without permanent improvements or modern human occupation.
4. Outstanding opportunities for solitude or a primitive and unconfined type of recreation. Wilderness provides outstanding opportunities for people to experience solitude or primitive and unconfined recreation, including the values of inspiration and physical and mental challenge.

Inventoried Roadless Areas: Inventoried roadless areas are designated areas under the Roadless Area Conservation Rule (RACR, 36 CFR Part 294). The Forest Service first inventoried these areas in 1972, as part of the Roadless Area Review and Evaluation phase I (RARE I). A second inventory was completed for RARE II in 1977 and then in the RACR in 2001.

The Francis Marion National Forest has 2 inventoried roadless areas on the forest: Hellhole Bay Extension (890 acres) and Little Wambaw Swamp Extension (530 acres) (see Table 3-73). Both were identified in the 1996 forest plan and then again in the 2001 RACR. On the Francis Marion, inventoried roadless areas are adjacent to existing wilderness.

Table 3-77. Inventoried Roadless Areas, approximate GIS acreages

Roadless Area	Acres
Hellhole Bay Extension	890
Little Wambaw Swamp Extension	530

Areas that May be Suitable for Wilderness Allocation: The first step in the evaluation of areas that may be suitable for wilderness allocation is to identify and inventory all areas that satisfy the definition of wilderness. Direction can be found in Section 2 (c) of the 1964 Wilderness Act and Forest Service Handbook 1909.12, Chapter 70 – Wilderness Evaluation.

The Forest Service must evaluate lands that meet the inventory criteria for areas that may be suitable for wilderness during plan revision and, from the information gathered in that evaluation, consider alternatives for recommending wilderness. A new inventory was conducted as a part of the plan revision process. The inventory indicates that the Francis Marion National Forest has six areas that may be suitable for wilderness allocation, totaling approximately 31,188 acres. Recommended areas would be managed to maintain their wilderness character until they are officially designated by Congress and added to the National Wilderness Preservation System.

Table 3-78. Six areas on the Francis Marion that may be suitable for wilderness allocation

Area that May be suitable for Wilderness Allocation	Acres
Wambaw Creek Addition Area	5,747
Little Wambaw Swamp Additional Area	6,859
Wambaw Swamp Additional Area	2,306
Hellhole Bay Additional Area	4,535
Area A	6,643
Area B	5,098
TOTAL	31,188

The Forest evaluated areas that may be suitable for wilderness allocation (See Appendix D). Based on this information, the planning team considered alternatives with varying amounts of recommended wilderness study area as well as potential increases in semi-primitive motorized (see Table 3-75 and Table 3-76). Recommended areas would be managed to maintain their wilderness character until they are officially designated by Congress and added to the National Wilderness Preservation System.

Under Alternatives 1 and 2, no areas are recommended. Under Alternative 3, Hellhole Bay Extension, Little Wambaw Swamp Extension and Wambaw Swamp Extension areas are recommended.

Table 3-79. Summary Recommendations by Alternative

Existing Area	Alternative 1	Alternative 2	Alternative 3
Grand Total Wilderness or Wilderness Study Area	13,812	13,812	36,927
Wilderness Study Area	0	0	16,351
Roadless area	1,420	1,420	0
Semi Primitive, Motorized	0	11,139	0

Note: GIS acres are approximate.

Table 3-80. Detailed Recommendations by Alternative

Existing Area	Recommended Area	Alternative 1	Alternative 2	Alternative 3
Wambaw Creek Wilderness		1,825	1,825	1,825
	Wilderness Study Area	0	0	5,747
	Semi-primitive, Motorized	0	0	0
Total Wilderness or Wilderness Study Area		1,825	1,825	7,572
Wambaw Swamp Wilderness		4,815	4,815	4,815
	Wilderness Study Area	0	0	1,745
	Semi-primitive, Motorized	0	1,745	0
Total Wilderness or Wilderness Study Area		4,814	4,815	7,560
Little Wambaw Swamp		5,047	5,047	5,047
Roadless Area		530	530	0
	Wilderness Study Area	0	0	4,854
	Semi-primitive Motorized	0	4,324	0
Total Wilderness or Wilderness Study Area		5,047	5,047	9,901
Hellhole Bay Wilderness		2,125	2,125	2,125
Roadless Area		890	890	0
	Wilderness Study Area	0	0	4,540
	Semi-primitive Motorized	0	3,650	0
Total Wilderness or Wilderness Study Area		2,125	2,125	9,080
	Area A	0	0	0
	Area B	0	0	3,814
Total Wilderness or Wilderness Study Area		0	0	3,814

Note: GIS acres are approximate.

3.4.8.2 Environmental Consequences

Wilderness has many positive effects. As stated previously, wilderness preserves natural systems and provides places of solitude for visitors. However, there are environmental effects within wilderness from many sources. Four previously defined wilderness characteristics are considered for effects:

1. Untrammeled;
2. Naturalness;
3. Undeveloped; and
4. Outstanding opportunities for solitude or a primitive and unconfined type of recreation.

Recreational use can negatively impact the four wilderness characteristics, especially the opportunity for solitude and naturalness. Some of these negative impacts, especially on naturalness, include the following:

1. Soil compaction;
2. Vegetation loss, disturbance and/or replacement by non-native species such as noxious weeds on trails and campsites caused by recreation use;
3. Deterioration of water quality from improper disposal of human waste and waste water; and
4. 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.

All Alternatives

All alternatives carry forward the need for wilderness patrols, wilderness rehabilitation of any impacted sites, wilderness education and wilderness-specific management plans. These effects are common to Alternatives 1, 2 and 3.

There would be no negative effects to the roadless character of inventoried roadless areas on the forest from these alternatives. All of these areas have a recreation opportunity setting of semi-primitive motorized (SPM) or semi-primitive non-motorized (SPMN) and would continue to implement the direction from the 2001 Roadless Area Conservation Rule (RACR) on limiting road construction and tree cutting in these areas.

Alternative 1

Wilderness and Recommended Wilderness: Alternative 1 would not recommend any new wilderness study areas on the Francis Marion. Some guidance for wilderness in Alternative 1 would remain redundant with existing law, regulation and policy. Alternative 1 includes little to no restoration activities that encourage improvement in wilderness character.

The 1996 forest plan does not restrict group size in the wilderness which can decrease the opportunity for solitude and increase the opportunity for crowding in some places.

Fire management may continue with appropriate wilderness protection measures. Fire suppression of all human-caused wildfires would minimize the potential effects on wilderness values; however, fires in these areas would likely become larger in size than they would under current management because of the restrictions on motorized equipment such as dozers. Under emergency situations, mechanized equipment and motorized transport, use of helicopters, air tankers and other aircraft may be approved by 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, may benefit some types of 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.

Management-ignited fires that mimic the role of natural fire can benefit fire-dependent ecosystems and the naturalness of the area. Occasionally, reducing hazardous fuels can have negative results in wilderness through changes in vegetation types, impacts to wilderness visitors and experiences, water quality and habitat within wilderness. At the same time, it can benefit

wilderness by reducing fuel loadings to acceptable levels such that naturally ignited fires may be returned to the wilderness or wilderness study area. Fire prevention strategies applied in the urban interface area on private land can reduce the need for management-ignited fires.

Inventoried Roadless Areas: Alternative 1 would continue to allocate both inventoried roadless areas to Management Area 29, which emphasizes a smaller degree of human disturbance as well as a semi-primitive motorized experience. Management-ignited fire could be used to maintain fuel loadings and mechanized equipment and motorized vehicles could be used. Vegetation composition and structure may be manipulated resulting in a greater diversity of age-classes among forest types.

Opportunities for solitude and remoteness may decrease. Sights and sounds of man's activities may be more obvious. Noise levels and soil erosion may increase. Air and water quality may decrease although water quality would meet state and federal standards. There would be no negative effect to the roadless character of inventoried roadless areas on the forest from this alternative. The areas have a ROS setting of semi-primitive motorized (SPM) and would continue to implement the direction from the 2001 RACR on limiting road construction and tree cutting in these areas.

Alternative 2

Wilderness and Recommended Wilderness: Alternative 2 would not recommend any new wilderness areas. However, Alternative 2 would increase the area of semi-primitive motorized ROS by more than 11,000 acres adjacent to 3 existing wilderness areas. In the areas proposed for semi-primitive motorized ROS, site-specific decisions would close some roads in these areas. These road closures would increase the opportunity for solitude and remoteness as well as opportunity for primitive and unconfined recreation due to road closures and prohibiting motorized use. Non-motorized dispersed recreation activities such as hiking, horseback riding, camping, fishing and hunting would continue.

Use levels would decrease in areas where vehicular access was previously the main means of transport. However, road closures would result in decreased access for some activities. A decrease in recreation opportunities requiring motorized transport or mechanized equipment would result. Motorized use, as well as some other vehicular dependent activities would be displaced to other areas. Some portions of the 3 existing wildernesses would have improved naturalness as roads in adjacent areas are closed. The effects of this change would be positive for those visitors seeking a more remote experience and less positive for those visitors who prefer a more developed experience with more access on roads. This alternative would also provide a more primitive hunting opportunity in the areas adjacent to hunting. Road closures often reduce wildlife poaching and litter. Road closures would decrease access by motorized vehicles. Closing roads would increase the satisfaction of visitors who prefer solitude and fewer disturbances (such as dust and noise) by motorized vehicles. Visitors who prefer to access to the national forest by motorized vehicle would be less satisfied.

Also, an objective in this alternative would close Wambaw Creek to motorized uses. The effects of this closure would be considered in site-specific analysis.

Inventoried Roadless Areas: Alternative 2 would allocate both inventoried roadless areas to semi-primitive motorized special area. Management-ignited fire could be used to maintain fuel loadings; mechanized equipment and motorized vehicles could be used on existing roads. Ecosystems would be restored and vegetation composition and structure may be manipulated.

There would be no negative effect to the roadless character of inventoried roadless areas on the forest from these alternatives. All of these areas have a recreation opportunity setting of semi-primitive motorized (SPM) and would continue to implement the direction from the 2001 RACR on limiting road construction and tree cutting in these areas.

Alternative 3

Wilderness and Recommended Wilderness: Alternative 3 recommends 16,351 wilderness study areas acres, see Table 3-76.

Designation of areas as wilderness study areas would preserve additional lands, which would be managed to allow natural processes to occur, provide for solitude and primitive recreation and minimize the impacts of man and his activities on the land. The highest priority for management would be to manage for wilderness character (untrammeled, naturalness, undeveloped and outstanding opportunities for solitude and a primitive and unconfined type of recreation.) These areas would be managed much the same as designated wilderness until a final determination is made by Congress as to whether they would be added to the National Wilderness Preservation system.

Direct effects of managing wilderness study areas include maintaining soil, hydrologic and atmospheric conditions prevailing within the areas. Roads would be closed, rehabilitated or allowed to return to natural state. Water quality and air quality should remain high and the imprint of man's influence would not increase or would diminish over time. On some occasions there may be restoration of degraded resources in the wilderness study area, i.e. non-native invasive eradication or control. However, visual and experiential contrasts between wilderness study areas and other forest service lands would increase.

Opportunities for solitude and remoteness would increase as would the opportunity for primitive and unconfined recreation due to road closures and prohibiting motorized use. Non-motorized dispersed recreation activities such as hiking, horseback riding, camping, fishing and hunting would continue. The use levels of some activities would decrease in areas where vehicular access was the main means or transport. Additional acreage for wilderness study would allow wilderness user impacts to be dispersed across a larger area providing an increase in wilderness visitor satisfaction. However, road closures would result in decreased access for some activities. A decrease in opportunities for bicycling and other forms of recreation requiring motorized transport or mechanized equipment would result. Bicycle and motorized use, as well as some other vehicular dependent activities would be displaced to other areas.

Maintenance of trails and facilities would be done using hand tools only and access would be made using non- mechanized/non-motorized means. Wambaw Creek Wilderness would be closed to motorized boat use. Non-motorized boat use would continue for hunting and other non-consumptive uses.

Research indicates that visitation and economic benefits resulting from tourism would increase in the surrounding local communities from more wilderness. However, economic benefits associated with the management, harvesting, manufacturing and retail sale of timber products from the wilderness study areas would decrease since management activities would not be allowed in these areas. Opportunities to recover commercial minerals and mineral exploration and development would be hindered.

Little or no mineral development or its associated impacts would be expected under any alternative. Federal oil or gas leases or other Federal mineral leases are non-existent in the areas

recommended for wilderness study. The potential for energy mineral and other leasable or common mineral development is estimated to be low. These areas would be administratively unavailable for federal oil and gas and other federal mineral leases, pending final Congressional action and would not be available for for commercial purposes. Administrative use of mineral materials would be allowed but use and impacts would be extremely low.

Educational opportunities for the scientific study of natural ecological processes would increase in Alternative 3 with increase acres in wilderness or wilderness study.

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 would favor area-sensitive and disturbance-sensitive species. Existing old fields, wildlife openings and other habitat improvements for fish and wildlife would not be maintained in prescriptions areas recommended for wilderness study. These early successional habitat areas would succeed to forest. New permanent wildlife openings would not be created. These factors would reduce habitat for early successional species. Fish stocking in these areas would be restricted to reestablishment or maintenance of indigenous, threatened, endangered or native species. Species traditionally stocked before wilderness designation may be considered for stocking if species is likely to survive.

Fire management could continue with appropriate wilderness protection measures. Fire suppression of all human-caused wildfires would minimize the potential effects on wilderness values; however, fires in these areas would likely become larger than they would under current management because of the restrictions on motorized equipment such as dozers. Under emergency situations, mechanized equipment and motorized transport, use of helicopters, air tankers and other aircraft may be approved by the Forest Supervisor 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, may benefit some types of recreation by opening up the forest, reducing fuel loading to acceptable levels and maintaining fire-dependent vegetation. Negative impact to air quality, visual aesthetics and possibly water quality would be short term.

Management ignited fires that mimic the role of natural fire can benefit fire-dependent ecosystems and the naturalness of the area. Occasionally, reducing hazardous fuels can have negative results in wilderness through changes in vegetation types, impacts to visitors and experiences, water quality and habitat. It can however benefit wilderness by reducing fuel loadings to acceptable levels such that naturally ignited fires may be returned to the wilderness or wilderness study area. It also may benefit some types of recreation by opening up the forest and maintaining fire-dependent vegetation. Fire prevention strategies applied in the urban interface area on private land can reduce the need for management-ignited fires.

In all recommended wilderness study areas, administrative motor vehicle use would be allowed to continue until:

1. Congress acts upon the agency’s recommendations;
2. The area is incorporated into the National Wilderness Preservation System; or
3. Motorized use does not compromise the area’s wilderness character.

Forest Service and permitted facilities would not be expanded, except in cases where they could be maintained in a manner appropriate to wilderness management within these areas. Hunting and scouting would be non-motorized in the recommended wilderness study areas, resulting in reduced hunting access for mobility impaired individuals. Mechanized uses such as mountain biking would continue until designation unless they resulted in long-term effects to wilderness values. As a result, these areas would have interim management that would protect wilderness character over the long term, but may still allow for the sights and sounds of limited motorized and mechanized use. This would result in some visitors experiencing a setting that is consistent semi-primitive motorized recreation classes, depending on the timing of their visit.

Additional effects to wilderness study areas would be similar to those found in wilderness such as soil compaction; vegetation loss or disturbance, non-native species, crowding and loss of solitude, deterioration of water quality from improper disposal of human waste and waste water; and loss of or threats to biological/ecological processes and biodiversity through human disturbance

Inventoried Roadless Areas - In Alternative 3, both inventoried roadless areas would have a ROS of semi-primitive non-motorized because they would be recommended for wilderness designation. Inventoried roadless areas that are recommended for wilderness would meet the recommended wilderness plan guidance, which would manage the areas to retain their primitive and undeveloped character, while limiting motorized vehicle activity to administrative use until these areas were congressionally designated and added to the National Wilderness Preservation System. This would retain the roadless character of the areas.

3.4.9 Scenery

Scenery plays a major role in any visit to the Francis Marion National Forest. Many recreation activities like hunting, fishing or camping are dependent on the forest setting; all visitors benefit from the forest's high scenic quality. Most visitors to the Francis Marion are satisfied with the scenery as they recreate, according to NVUM (2008). Development on neighboring lands generally negatively impacts the scenic resource by diminishing the natural scene. This impact will expand as surround communities grow. Understanding the value of national forest scenery to the local community is important as it affects real estate values and quality of life.

3.4.9.1 Affected Environment

In addition to other natural resources, scenery must be cared for and managed for future generations. Scenic resources vary by location and by existing natural features such as vegetation, water features, landform, geology and human-made elements. All forest visitors' activities are experienced in a scenic environment defined by the arrangement of the landscape's natural elements combined with components of the built environment. Scenery combines all the ecological features and human elements; the composition of these attributes is what gives a landscape its character or image.

Currently, the forest's scenic resources are managed using the visual management system that allocates visual quality objectives (VQOs) to NFS lands. VQOs are a combined measurement of the scenic quality of the landscape and the public's level of concern for that scenic quality.

Management of multiple resources has, to varying degrees, altered the natural landscape character over the short and/or long term including, but are not limited to:

1. Vegetation management;

2. Construction and maintenance of roads and trails;
3. Recreation sites;
4. Wildlife habitat enhancement; and
5. Fire management (e.g., suppression and prescribed burning).

The most visible portions of the Francis Marion are seen from roads, trails or waterways. The more scenic landscapes are generally associated with or occur adjacent to lakes, rivers and streams, the frequently burned and relatively open long leaf pine ecosystems, or highly developed recreation areas and trails. Views beyond the immediate foreground are influenced by terrain as well as vegetation type. The Francis Marion is a flat coastal plain, occasionally interspersed with private ownership. This flatter terrain has fewer vistas (occasional ones from Santee River bluffs) and open views along the intercostal waterway.

Of the seven land-use themes described in the Scenery Management System, the Francis Marion's landscapes can be grouped predominantly into 3: Natural evolving, natural appearing and rural-forested. (Landscape Aesthetics, A Handbook for Scenery Management, Agricultural Handbook Number 701, p. 1-3). The vast majority of the forest (approximately 259,000 acres) is characterized as natural appearing. Designated wilderness and recommended wilderness study areas are lands where ecological processes predominate are characteristically natural evolving landscapes. Rural-forested is a smaller category where small communities intersperse ownership with the forest.

Landscape character is a reflection of the physical, biological and cultural attributes in the landscape and the beliefs, values and attitudes that people assign to these attributes. The landscape character has its origins in and is informed by early settlement patterns and land uses that have taken place over the years. These early and continuing influences affect the attitude toward landscape uses today. It is the physical appearance and cultural context of a landscape that gives it an identity and a "sense of place" (see the process record for descriptions of the Francis Marion's landscape character).

The Visual Management System (VMS) determines the scenic resource management direction. From that system, VQOs describe the degrees of alteration (including vegetative manipulation) that is acceptable on the landscape. Preservation is the least altered; maximum modification is the most altered (The Francis Marion National Forest did not have any acres of maximum modification in the 1995 Forest Plan). In 1995, the Scenery Management System (SMS) replaced the VMS. The scenic resource has been re-inventoried to comply with the new terminology and the newer system (see Landscape Aesthetics, A Handbook for Scenery Management, Agricultural Handbook Number 701). To see how the 2 systems relate, see the crosswalk between the older and the newer systems (Table 3-77).

Table 3-81. Crosswalk between VQOs (VMS) and Scenic Integrity Objectives (SIOs) (SMS)

VQOs	SIOs
Preservation (P)	Very High (VH)
Retention (R)	High (H)
Partial Retention (PR)	Moderate (M)
Modification or Maximum Modification (M)	Low (L) or Very Low (VL)

In the environmental consequences section below, the acres will be expressed and effects discussed, using the crosswalk in the newer system (see Table 3-77).

3.4.9.2 Environmental Consequences

The scenic resource is affected by management activities that alter the appearance of what is seen in the landscape. Short-term scenic effects are usually considered in terms of degree of visual contrast with existing or adjacent conditions that result from management activity. The scenic landscape can be changed over the long term or cumulatively by the alteration of the visual character. Management activities that affect scenery can result in visual alterations inconsistent with the assigned SIO, even with mitigation. Those that have the greatest potential of affecting scenery include the following:

1. Road construction;
2. Vegetation management;
3. Insect and disease control;
4. Special use utility rights-of-ways; and
5. Mineral extraction.

Other management activities that also can affect the scenic resource include:

1. Threatened and endangered species habitat management;
2. Prescribed burning;
3. Fire suppression;
4. Land exchange;
5. Old-growth forest management;
6. Recreation;
7. Administrative site facility construction; and
8. Wildlife management.

Table 3-78 displays SIO allocation by alternative as follows.

Table 3-82. SIO Acres by Alternative

	Alt. 1[1]	Alt. 2	Alt. 3
Very High	13,812	13,653	34,369
High	18,663	92,156	49,779
Moderate	101,076	57,563	60,807
Low	170,466	95,973	114,380
Not inventoried, excluded	6,076	0	0

[1] Alternative 1 is based on the SIO prescribed by a crosswalk of the existing allocations and the prescriptions. GIS acres for all alternatives are approximate.

Effects of All Alternatives

In all alternatives there would be little to no change in the **landscape character themes** of natural appearing and natural evolving or rural forested. Wilderness and recommended wilderness always have a high or very high SIO. Alternatives 2 and 3 would have the highest acreage in SIOs very high, high and moderate. Alternative 1 has the most acreage assigned to low SIO. Many of these impacts would be avoided by implementing mitigation measures.

- Alternatives 2 and 3 would result in more protection and enhancement to the scenic resources than Alternative 1, which has fewer acres assigned to the higher SIOs.

All alternatives propose **prescribed burning**, in both dormant and growing seasons. Drifting smoke and blackened vegetation and charred tree trunks would be the main negative visual effect. Visual contrast from fire line construction would also be evident. The contrast levels and duration vary with fire intensity. Blackened vegetation usually lasts a short time, but charring of trees may be evident for many years. Frequent burning in fire-adapted ecosystems increases overall visual diversity, which results in an herbaceous understory with many native flowering species and, when repeated over time, produces stands with open understories allowing views farther into the landscape.

- Alternative 1 would have the least impacts to scenery from prescribed burning.
- Alternatives 2 and 3 would have the most impacts to scenery from prescribed burning.

Insect infections and diseases can cause strong, unattractive contrasts in the landscape. Management efforts to control insect infestations and diseases can minimize or reduce effects. However, control efforts that include removal of infected trees and buffer areas often appear as clear-cutting to forest visitors. These impacts can occur in areas of high scenic value.

- Alternative 1 would have the most risk for scenery impacts from insects and disease.
- Alternative 2 would have the least risk for scenery impacts from insects and disease.
- Alternative 3 would have moderate risk to scenery.

Utility rights-of-way (ROW) have high potential to affect the scenic resource for a longer duration. ROWs contrast in form, line, color and texture when compared to the natural appearing landscape. There are no large differences in ROW management between alternatives therefore the impacts of ROW's to scenery would be similar in all 3 alternatives.

Minerals management and development activities can involve major landform alteration, as well as form, line, color and texture contrasts, causing substantially adverse scenic impacts. Most lands would be suitable for mineral in all alternatives. Therefore, the impacts from mineral management would be similar in all 3 alternatives.

Road construction, reconstruction and maintenance, including rights-of-way maintenance, affect scenery. In addition, mowing frequency and timing alters the appearance of the landscape. Road construction introduces unnatural visual elements into the landscape and causes form, line, color and texture contrasts. Road management controls how much of the landscape is seen by having roads open or closed.

- Alternative 1 would have the most impacts from ROW maintenance and road construction and reconstruction.
- Alternative 2 would have moderate impacts.

- Alternative 3 would have the least impacts from ROW maintenance and road construction and reconstruction.

Vegetation management has the potential to alter the landscape and impact the scenic resource. Vegetation management practices can cause long-term effects on scenery by altering landscapes through species conversion, reduction in species diversity, manipulation of the prominent age class and alteration of opening size, location and frequency. The potential effects may be positive or negative, depending on their consistency with the desired future condition of the landscape.

Table 3-83. Vegetation management (acres) by alternative

	Alternative 1	Alternative 2	Alternative 3
Regeneration (even aged)	8,826	28,257	23,631
Thinning	49,998	17,864	27,506
Herbicide Use (for site prep)	4,457	22,757	19,797
Mechanical Use (for site prep)	937	4,562	3,964

Of the management applications listed in Table 3-79, **even-aged management** may be the most impactful because of the highest visual contrasts it creates by removing the most forest canopy and creating openings. These openings would vary in their effects on scenery depending on size, shape, location and nearness to other openings. Openings that repeat the size and general character of surrounding natural openings and the landscape character would impact scenery the least.

- Alternative 1 would have the least impacts from even-aged management.
- Alternatives 2 and 3 would have the most impacts from even-aged management.

All impacts from **timber harvest (thinning)** would be short-term because of rapid vegetation growth. Therefore, the impacts of thinning on scenery would be minimal in all 3 alternatives.

Site preparation activities (herbicide/mechanical uses) affect scenery by exposing soil and killing other vegetation. These effects are generally short-term. Site preparation usually improves the appearance of the harvest area by removing the un-merchantable trees and most of the broken stems. Stand improvement work can affect scenery by browning the vegetation which reduces visual variety through elimination of target species.

- Alternative 1 would have the least impacts from timber site preparation activities.
- Alternatives 2 and 3 would have the most impacts from site preparation activities.

Recreation facilities are also deviations from the natural landscape that can have long-term effects. However, Forest Service recreation facilities are designed to blend into the landscape without major visual disruption. Trail construction introduces some unnatural visual elements into the landscape and causes form, line, color and texture contrasts.

- Alternatives 1 and 3 would have the least impacts from recreation facility and trail construction activities.
- Alternative 2 would have the most impacts from recreation facility and trail construction activities.

Insect and diseases can kill large numbers of pine and hardwood trees during outbreaks. Insect and disease outbreaks can cause strong, unattractive contrasts in the landscape. Management efforts to control insect infestations and diseases can minimize or reduce effects. Control efforts that include removal of infected trees and buffer areas often appear as clear-cutting to forest visitors. These impacts can occur in areas of high scenic value.

- Alternative 2 would have the least acres susceptible to insect and disease impacts. Alternative 1 would have moderate effects.

Alternative 3 has the most acres susceptible to scenery impacts from insects and disease outbreaks.

3.4.10 Cultural Resources

3.4.10.1 Introduction

The prehistoric culture history of a region is usually presented as a chronological sequence of developmental or evolutionary stages. The earliest widely recognized period, the Paleoindian Period, began sometime around 12,000 years ago. Paleoindian (10000-8000 BC) adaptations appear to have been characterized by focal large-game hunting economies, low population densities and large territorial ranges. The succeeding Archaic Period (8000-1000 BC) exhibits a gradual shift toward hunter-gatherer adaptations involving the exploitation of secondary resources (i.e., nuts, seeds, greens, fish, shellfish, etc.). Territorial ranges appear to have contracted and population levels are thought to have increased during this period. The following Woodland Period (1000 BC-AD 1100) saw the development of horticulture and other intensive forms of subsistence technologies and provided the basis for semi-sedentary and sedentary village life. Population levels were greater than those of the Archaic Period and territorial ranges continued to contract. The final prehistoric period in the Southeast is known as the Mississippian Period (AD 1100-1500). Mississippian groups were characterized by sedentary village life, intensive corn agriculture, regional chiefdom societies and platform-mound ceremonialism. These cultures rapidly declined with the entry of the Spanish and other Europeans in the sixteenth and seventeenth centuries.

The British Crown began open competition with Spain to settle the Southeast in 1629. This land was initially referred to as Carolana. After the Restoration in 1660, a group of noblemen who eventually put a claim on King Charles II to grant them possession of the province of Carolina in 1663 (Edgar, 1998). These were the Lord’s Proprietors and they held rights to make war and peace, establish towns and ports, raise and maintain armies, collect taxes and duties, impose penalties and grant both pardons and grant “title of honors.” It was not until 1669 that the Lord’s Proprietors decided to take an active role in the colonization. One of the proprietors, Lord Ashley, took the lead in this endeavor and supplied 3 ships for 100 English men and women to immigrate to Carolina. Because land was scarce, the colony quickly attracted settlers from the West Indies, particularly Barbados.

The settlement of Charles Town, named after the king, soon took shape. A steady influx of new settlers was drawn from a diverse European population. Included in the mix of settlers besides the English were, in order of popularity, Scots, Irish, Welsh, German, French, Dutch and Swedish. The early French settlers were Huguenots, who first immigrated in 1680 and were fleeing religious persecution. Many of the Huguenots settled locations north of Charleston along the Santee and East Branch of the Cooper River and became successful rice planters. Planting, in fact, served as the impetus to move away from Charles Town and out into the countryside along

the major rivers (Kovacik and Winberry, 1987). Land was variably fertile and the first plots settled were the “Indian old fields” formerly cultivated by the native population.

Owing to its deep harbor, Charleston rapidly became a major port city in the Americas and an influential and wealthy mercantile class emerged. The early export economy was driven by Indian trade, in particular the deerskin industry (Kovacik and Winberry, 1987). Approximately 64,000 skins were exported annually to England at the end of the seventeenth century (Edgar, 1998). Other important industries at the end of the seventeenth century included naval stores (i.e., pine pitch, rosin and turpentine), lumber and livestock. Naval stores products were used in the shipbuilding industry, but export levels reached a premature ceiling due to England’s reluctance to buy the products. Nevertheless, by 1720 South Carolina had become the leading exporter of naval stores in the British Empire (Edgar, 1998). By the 1740s, this industry was well in decline. However, the rice industry was so profitable that its labor force could not be sacrificed to produce tar and turpentine. The main market for pine and cedar planking and shingles was the West Indies. The lumber industry maintained viability throughout the Colonial period. Barreled beef and pork were also exported in great quantities to the West Indies (Kovacik and Winberry, 1987).

The agricultural industry was slow to develop beyond subsistence farming. Sugar cane was unsuccessfully grown, as were a number of other tropical crops grown in the West Indies. Rice ultimately became the colony’s main cash crop. In the earliest years, it was only grown on dry sites; planters gradually developed techniques to grow it in freshwater upland swamps, which greatly increased production and profits. These early rice plantations were built on the backs and experience of West African slaves, who were quite proficient in clearing swamps, building dikes and preparing rice seeds for planting.

Settlement outside Charleston continued throughout the eighteenth century. A section of the James Cook map of 1773 shows the extent of this migration into the area in and around the Francis Marion just prior to the Revolutionary War. The Cook map is the most detailed and accurate map of the period (Cumming, 1958). Especially evident are the line of plantations between Georgetown Road and the coast in Christ Church Parish and the Huguenot residences along the lower Santee River. Dwellings ranged from impoverished shelters called “potato houses” to refined mansions (Edgar, 1998). Potato houses were made of branches and dirt and were generally constructed to provide temporary shelter during the initial stages of settlement. The settlements depicted by Cook were likely more substantial. Rudimentary domestic structures consisted of the following: dirt-floored, single room log cabins; sturdier hewn-log cabins; and wood frame houses. Finer homes consisted of either wood frames or brick walls and mimicked English floor plan styles, particularly central halls with flanking rooms. Many of the planters throughout the backcountry also had finer residences in Charleston. Enslaved Africans were generally charged with constructing their own dwellings. Consequently, they generally followed West African traditions (Ferguson, 1992). These houses were small and made of wattle and daub or hand-made clay brick. Thatched roofs were steep to promote drainage.

The Lowcountry figured prominently in the Revolutionary War (Kovacik and Winberry, 1987). The British attacked Charles Town in June 1776; they were met with stern resistance and forced to withdraw. Charles Town served as an important link in the continental supply system thereafter. Rice and indigo were exported to the French West Indies to finance supplies for the war. However, not everyone in the colony sympathized with the patriots. A large faction of Tories occupied the backcountry, but the British were not adept at mustering their support (Lambert, 1987). In 1780, the city was captured. Resistance to the British occupation of the colony was primarily conducted as guerilla warfare during the occupation. One of the most famous partisan

leaders was Francis Marion, who launched attacks against the British from his stronghold in the swamps around Charles Town. The British did not withdraw from the colony until 1782.

The colony sustained a great deal of destruction during the war. Plantations were destroyed and nearly 30,000 slaves vacated. This destruction actually stimulated the development of tidal rice cultivation in the Lowcountry (Edgar, 1998). This technique required a much greater capital investment than traditional inland swamp fields due to the need for extensive dam and dyke systems. Tidal rice cultivation produced five to six times the rice per enslaved worker, a fact which quickly led to the transformation of the Lowcountry's agricultural landscape. Many of the inland swamp plantations were abandoned. By 1839 South Carolina produced three-quarters of the rice in the United States. Mills' 1820 map of Charleston District shows very little change in the forest area since the Cook map was drafted. However, it is interesting to note that the routes of the major roads used today were already established by the 1820s.

The first skirmish of the Civil War occurred in 1861 when Confederate gun batteries opened fire on Fort Sumter in Charleston Harbor. The tensions that had initially emerged during the formation of the Union over slavery ultimately led to the secession of the Southern States.

The Civil War ended the plantation system throughout the South. The agricultural economy of the Lowcountry declined and was replaced by small subsistence farms, phosphate mining and timbering. The average farm size in South Carolina in 1880 was 143 acres, a fourfold reduction from the 1860 average (Kovacik and Winberry, 1987). The Union supplied very little help to the freed slave population, which ultimately returned to farming through a new system of farm labor called tenancy. Settlements became widely scattered across the Lowcountry rather than being aggregated at plantation sites. Post-bellum agriculture was primarily focused on cotton and corn production. In the twentieth century, tobacco and soybeans also became important crops. All of these crops, with the exception of tobacco, were more productively grown in the upstate than in the Lowcountry.

Timbering activities shifted from the Great Lakes region to the South in the late nineteenth century (Hester, 1997). Industrial timbering companies purchased large tracts of land, built mills and commenced lumbering vast timber stands in the Southern pine belt. By 1918, in spite of cooperation with government foresters, private timbering companies had nearly depleted mature stands of trees. The Clarke-McNary Act of 1924 allowed the federal government to acquire lands for timber production. In 1928, the National Forest Reservation Commission approved the purchase of 2 tracts in South Carolina— a 75,000 acre tract on the Sampit and Black Rivers and the Wambaw purchase unit corresponding to the modern area of the Francis Marion National Forest. Most of the Wambaw unit, which consisted of about 100,000 acres, was held by the North State, Atlantic Coast, Dorchester and Tuxbury lumber companies. Purchase of the Wambaw unit finally occurred in 1933, resulting in the formation of Francis Marion National Forest. Most of the original facilities and roads associated with the forest were built by the Civilian Conservation Corps in the 1930s.

3.4.10.2 Affected Environment

Known Historic and Cultural Resources that May be Affected by the Plan

Although the Charleston area has a long history of archaeological research, very little investigation occurred within the Francis Marion National Forest. It was not until the mid-1970s that the Forest Service began a systematic inventory of cultural resources in compliance with the National Historic Preservation Act. In 1981 the forest published a comprehensive overview of

investigations conducted through 1980 (Anderson and Logan, 1981). More recent cultural resource work on the forest expands our knowledge on the prehistory and history of the forest area (Cable, 2012; Southerlin, 2014).

All cultural resources are, to some degree, important. Site locations can help in understanding past human land uses over time. However, depending on their conditions and other factors, not all cultural resources are managed as significant historic properties. Site significance is usually defined in terms of eligibility for listing in the National Register of Historic Places (NRHP). Historic contexts, similar to culture histories, are written to develop research questions or define characteristics used to evaluate their eligibility.

Intensive, systematic archaeological inventory of the forest now exceeds 110,000 acres or approximately 42 percent of National Forest System lands. As of 2014, more than 2,300 archaeological sites, four historic buildings and 2 historic fire lookout towers are recorded on the Francis Marion National Forest. To date more than 60 sites are eligible for listing in the NRHP while another 1,300 cultural resources remain unevaluated, but are managed as if they were eligible for listing in the NRHP. The remaining 940 cultural resources are ineligible for the NRHP and are not actively managed by the forest. Only the Sewee Shell Ring is listed on the NRHP.

Thousands of archaeological sites within the plan area have survived 3 centuries of extensive land modification. Agriculture was the primary source of wealth from the colonial period onward. The landscape was modified to accommodate the various cash crops; rice in the swamps and wetlands; various row crops in the dryer uplands. Livestock grazed in both the fields and forests.

The dawn of the twentieth century saw the introduction of intensive timber harvesting by large lumber companies throughout the plan area. The Forest Service acquired much of these former lumber company lands to form the core area that became the Francis Marion National Forest. Since the mid-1930s, the area was subject to decades of modern land management activities conducted by the Forest Service.

In the late 1990s the national heritage resources program sought greater accountability and visibility (National Heritage Strategy, 1999). The result was the creation of a national heritage database to track all activities, both legal compliance support to other resources and heritage resource program activities. Greater emphasis on plan level monitoring of archaeological sites and historic buildings improved efforts to track and document administrative and field procedures which provided information on sufficiency of Forest Service efforts to protect cultural resources. The heritage program developed new accomplishment measures as part of the national objective of a heritage program managed to standard. Together the new database and program measures increased forest accountability in cultural resource management.

3.4.10.3 Environmental Consequences

Almost all land and resource management activities have the potential to affect cultural resources. Because most of the forest's cultural resources are archaeological sites, the greatest potential comes from activities associated with soil movement, mixing, or compaction. The plan proposes the ecological restoration of National Forest System lands and the reduction of hazardous fuels through a combination of prescribed fire, mechanical treatment of vegetation and grazing livestock. All of these management approaches include activities that involve some degree of soil disturbance.

Activities associated with the improvement of hydrologic function within several watersheds could impact historic embankments constructed for water impoundments and rice culture. These

cultural landscape features are part of a vernacular, agricultural landscape exhibiting the combined works of nature and man and have been in place for more than 2 centuries.

Activities associated with dispersed recreation can affect cultural resources particularly trail construction associated with the expansion of existing trails. Such activities provide for greater public access which, in turn, can result in increased potential for vandalism of archaeological sites and historic buildings.

All Alternatives

Direct and Indirect Effects.

National Historic Districts: In Alternatives 2 and 3, national historic districts are proposed – primarily in the Coastal Resource Integration Zone. Alternative 1 (1996 Forest Plan) protects cultural resources as well as provides opportunities for education and interpretation. The creation of multiple NRHP districts in Alternatives 2 and 3 affords greater recognition to the resources within them and emphasizes the desire to protect and enhance them.

Prescribed Fire: All 3 alternatives emphasize prescribed fire as an important management tool for ecosystem restoration and hazardous fuels reduction. Of particular concern are direct effects caused by activities associated with control and suppression using heavy equipment. The use of fire plows, dozer blades and disks can affect an archaeological site's integrity. Most archaeological sites on the forest lack combustible features and are not threatened by low- to moderate-intensity burning. However, both prescribed fire and wildfire can have indirect effect of making cultural resources more visible and thus susceptible to unauthorized and illegal collecting of artifacts.

The major difference between the 3 alternatives is the number of acres to be burned. Alternative 1 proposes the fewest acres while Alternative 2 has the greatest number of acres followed by Alternative 3. As the burn acres increases, the potential effects to cultural resources from the construction of control lines increases.

Mechanical Treatments: In addition to prescribed fire, all 3 alternatives propose mechanical treatments as a management tool for ecosystem restoration and hazardous fuels reduction. Again it is heavy equipment use that has the potential to affect cultural resources as well. Activities that have the potential to impact cultural resources include harvesting, skidding and yarding of timber. Access to harvest areas may require the construction or reconstruction of roads.

Again, the difference between the alternatives is the number of acres to be mechanically treated. Alternative 1 proposes the fewest acres while Alternative 2 has the greatest number of acres followed by Alternative 3. As the number of mechanically treated acres increases, the potential effects to cultural resources from associated activities increases.

Herbicide Use: All 3 alternatives proposed to use herbicide treatments for site preparation and improvement of stand composition. While herbicides may be used to reduce hazardous fuels in Alternatives 1 and 2, Alternative 3 proposes the greatest use of herbicides to reduce hazardous fuels. This treatment would have little or no potential to effect cultural resources.

Livestock Grazing: The Forest Service ended livestock grazing on the Francis Marion National Forest in the early 1950s. Until then cattle and hogs were turned out to graze annually, a tradition that began as soon as people began settling the forest area in the late seventeenth and early eighteenth centuries.

Livestock are attracted to areas with high amounts of forage and access to water. While Alternative 2 would allow the use of livestock grazing to reduce hazardous fuels, Alternative 3 places a greater emphasis on the use of livestock as a method to reduce hazardous fuels. Pathways created by livestock and areas where they congregate would have the potential to affect cultural resources.

Restoration of Hydrologic Function: Alternative 1 (1996 forest plan) has very little direction on restoring hydrologic function. Alternatives 2 and 3 propose restoration of hydrologic function that would be focused primarily in the 3 priority watersheds: Guerin Creek, Headwaters Wambaw Creek and Turkey Creek. Activities associated with improving hydrologic function within forested wetlands, riparian areas and streams could impact cultural resources, particularly cultural landscape features like historic embankments constructed for water impoundments and rice culture. Activities associated with restoration work are ground-disturbing and include plugging ditches, smoothing ruts and installing or replacing culverts to improve waterflow and aquatic passage. Similar to the ground-disturbing effects described above, Alternatives 2 and 3 have the greatest potential to affect cultural resources.

Recreation: Increased public access and use of National Forest System lands would have the potential to affect cultural resources, particularly activities associated with off highway vehicle use and camping. With greater public use comes the potential for vandalism of both archaeological sites and historic buildings and structures. On the other hand, wilderness designation carries with it restrictions on the use of mechanized equipment and motorized vehicles resulting in a lower risk of adverse effects to cultural resources.

Alternative 1 would reduce the potential adverse effects of recreation to cultural resources as it maintains four existing wilderness areas and 2 inventoried roadless areas but does not expand them. Developed recreation would be restricted as well; however, public access to these areas would still be possible. Pedestrian uses of these areas would be unlikely to adversely affect cultural resources.

Alternative 2 would reduce potential adverse effects to cultural resources as it maintains existing wilderness and inventoried roadless areas thus restricting management activities that involve ground-disturbing activities, such as timber harvestin. The addition of semi-primitive areas does not add any potential protection of cultural resources because mechanical management activities that are ground-disturbing would be allowed. Although developed recreation would be restricted, public access to these areas would still be possible. New trail construction to connect existing trails to improve connections within the forest trails system could affect cultural resources. Pedestrian uses of these areas are unlikely to adversely affect cultural resources.

Not only would Alternative 3 maintain the 4 existing wilderness areas, but it would recommend additional wilderness areas and afford the greatest protection for cultural resources In the wilderness areas and the recommended wilderness the nature of management activities are restricted, particularly mechanical. Developed recreation would be restricted in the wilderness areas, as well as the recommended wilderness areas; however, public access to these areas would still be possible. Pedestrian uses of these areas would be unlikely to adversely affect cultural resources.

Cumulative Effects. Unlike many natural resources, cultural resources are nonrenewable. Damage to or the destruction of archaeological sites is characteristically permanent. It means the loss of information important to the understanding of the unwritten record of human history and

the loss of opportunities for scientific research as well as interpretive opportunities for the public. The cumulative effects are the same under all 3 alternatives.

Sea-level rise has the potential to impact cultural resources near the coast, particularly the Sewee Shell Mound. Climate change impacts, notably more intense storms and more hurricanes making land fall, would also have the potential to impact cultural resources near the coast. The cumulative effects of sea-level rise and climate change are the same under all 3 alternatives.

Partnerships created through the National Historic Districts proposed in Alternatives 2 and 3 offer the greatest potential for interpretation and education of cultural resources. These national historic districts would highlight historic sites on the forest and increase opportunities for tourism over Alternative 1.

3.4.11 Tribal Relations

Francis Marion National Forest personnel conducted formal face-to-face consultation with Catawba Indian Nation concerning the development of this forest plan revision. The Catawba Indian Nation is the only federally recognized tribe in South Carolina. The tribe has not identified any concerns about the forest plan direction being developed or the specific management activities that may be proposed to achieve forest plan direction.

It is important to consider the history of Indian people within the forest area. The Catawba Nation is the result of coalescence among a number of individual tribes living in South Carolina. By the end of the Yamassee War in 1718 the Catawba included remnants from as many as 30 other Indian tribes including surviving members of coastal tribes with direct association with the forest area. Others remained in the lower coastal plain and survived by forming small bands of Indian people and taking refuge in areas away from the colonial settlements in areas colonist did not find attractive for settlement. Those unfortunate individuals that did not migrate away from colonial settlements along the central South Carolina coast were enslaved and removed from the region.

The Catawba Indian Nation is located west of Rock Hill, South Carolina approximately 200 miles from the national forest. The subsequent isolation of tribal members and the distance to former homelands has led to the loss of traditional cultural ties to the Lowcountry. There are no known tribal members practicing traditional cultural activities on the forest and no sacred sites are known to exist on the forest. Therefore, there would be no direct, indirect or cumulative effects on tribal relations across all 3 alternatives.

3.4.12 Recreational Fisheries Management

Presidential Executive Order 12962 provides the primary direction for managing the forest's recreational fishing resources. In compliance with this mandate, forest management activities are implemented in a manner to provide quality recreational fishing opportunities to the public.

3.4.12.1 Affected Environment

The Francis Marion National Forest contains more than 15 manmade ponds totaling more than 41 acres of water. These impoundments range in size from 1 to 10 acres. The original purpose for the construction of many of these impoundments was for road building material. Others were constructed primarily for recreational purposes. These impoundments were stocked with largemouth bass (*Micropterus salmoides*), bluegill (*Lepomis macrochirus*), redear sunfish (*Lepomis microlophus*), channel catfish (*Ictalurus punctatus*) and grass carp (*Ctenyopharyngodon*

idella), all of which now provide recreational fishing benefits. The Forest Service manages most of the forest's ponds that are larger than one acre for sustainable recreational fishing.

Recreational fishing is one of the most popular outdoor activities in the state. The SCDNR is responsible for managing and improving the state's fisheries resources. The Forest Service cooperates with its efforts to improve the fisheries resources on national forest lands. National forest ponds are managed to support balanced, productive self-sustaining recreational fisheries that are capable of meeting current and projected demands. Target species associated with fishing include: largemouth bass (indicator species), bluegill, redear sunfish and channel catfish (*Ictalurus punctatus*). Maintenance and restoration efforts cooperate with all program areas to achieve the desired conditions.

The forest strategy for maintaining and enhancing ponds emphasizes maintaining and improving water quality and healthy populations of desired species. Fisheries management is practiced on the Francis Marion to provide fishing opportunities to the public. Management practices include liming and fertilization, fish habitat improvement, aquatic weed control, angler access improvement, fish population management and nuisance animal control.

Largemouth bass is the principal predator in most forest ponds. As the principal predator, largemouth bass presence/absence strongly influences the population structure of other fish species in a pond. For this reason, largemouth bass was selected as the indicator species to represent the effectiveness of Forest Service recreational fisheries management activities. The effects of recreational fisheries management (directly related to this species) is discussed below.

Liming: Many forest impoundments are slightly acidic with poor buffering capacity. Tannic acid from leaves and pine needles from the surrounding forested watershed is washed into the ponds, which results in limited productivity and fish growth. Good water quality is necessary to maintain a healthy fish population in ponds (SCDNR, 2014). Fish in acidic water with low alkalinity are more likely to get sick, especially during times of stress such as spawning season or periods of rapid temperature change. Rapid pH fluctuations can cause stress, making fish more vulnerable to disease and hindering growth. Lime would enhance the water quality and productivity of these ponds.

Fertilization: Many fish and wildlife agencies in the South practice pond fertilization. The addition of some nutrients to ponds can yield positive results as long as the added nutrients are in the appropriate balance and amount. Fertilization enhances the productivity of the fish population and improves the quality of the fishing experience.

Ponds that receive heavy fishing pressure may be at risk of overharvest or poor fishing. Fertilization can increase the abundance of fish to compensate for heavy fishing (SCDNR, 2014).

Spawning Habitat Improvement: Good spawning sites are limited in many forest ponds because natural spawning areas have become covered with silt and muck over the years. Placement of spawning beds enhances the productivity of the fish population and improves the quality of the fishing experience. Where possible, structures can be added to increase spawning success and concentrate sport fish for angling.

The availability of suitable nesting substrate has been recognized as a major factor affecting reproductive success of bass, bluegill and redear. Although they will use the best habitat available, these fish prefer gravel substrate for spawning material. Willis (2005) examined 75 random locations in a 330-acre lake in South Dakota where 15 bluegill spawning sites were

identified. All the locations contained four types of substrates (muck, sand, gravel, rock). However, all 15 bluegill colony spawning sites were built on gravel substrate.

Fish Attractors: Natural fish cover is absent or inadequate in many forest ponds because during their construction, the basins were cleared of trees and brush. Even standing trees that were left have decomposed over the years and become ineffective as fish cover. In addition, any trenches or habitat structures scattered through the bottoms have silted in over time, providing little or no irregular bottom features that attract fish.

The purpose of fish attractors is to provide a type of structure that otherwise does not or will not exist in sufficient quantity within the pond bed. Fish attractors are used on the forest to improve fish cover.

Shoreline Deepening: Many of the forests' ponds contain areas of excessively shallow water (less than 3 feet deep). This is the outcome of years of natural silt deposition along the shoreline and upper ends of the ponds, resulting in limited access for both bank and boat anglers. It has also promoted excessive aquatic weed growth reducing the predator/prey interaction needed to maintain fish population balance.

Aquatic Weed Control: Many of the forests' ponds contain areas of excessive aquatic weed growth reducing the predator/prey interaction needed to maintain fish population balance. This excessive aquatic weed growth is the result of vast areas of shallow water less than 3 feet deep.

The right species of aquatic plants in the right quantities and at the right location are very beneficial to a pond environment. However, if they are the wrong species, too abundant or in the wrong location, they become noxious weeds that can be detrimental to the fisheries and recreational pond use.

Aquatic weeds present a constant challenge. They can greatly reduce a pond's carrying capacity by using the nutrients normally available to phytoplankton. They can restrict water flow and often interfere with fishing and recreational boating. Aquatic weeds also can contribute to the stunting of game fish through reduced predator/prey interaction; they can also destroy fish habitats. When aquatic weeds die, silting can be accelerated, while oxygen levels become reduced.

Angler Access Improvement: Fishing piers and boat ramps are provided at some locations on the Francis Marion.These structures enable the pond sport fish population to be managed for optimal recreational benefits. Access to angling opportunities should increase with the installation of these structures.

Fish Population Management: Fish populations in ponds are managed to produce enhanced recreational fishing opportunities. We are currently monitoring fish ratios and augments with correct fish as determined appropriate.Fish populations of the proper species mix, the correct ratios and the right sizes can provide a quality fishing experience. However, when the opposite occurs, a poor fishing experience is the result. A healthy pond has a balance between predator and prey populations. In ponds of at least one acre, largemouth bass and bluegill provide this balance better than any other species. Other species such as redear sunfish and channel catfish can add variety to the fishing opportunities.

Nuisance Animal Control: Beavers, muskrats, nutria, otters and alligators can be a nuisance or even cause damage. Burrowing and damming can cause dam failure or flood adjacent landowners. Angler access and fish habitat improvements can also be flooded. A family of otters

can virtually eliminate catchable-size fish in a small pond. Alligators can present a safety concern in pond with swimming. Trapping and removal will be practiced to maintain nuisance animal populations at acceptable levels. APHIS does trap animals on the forest.

The Francis Marion National Forest's strategy for maintaining and enhancing ponds emphasizes maintaining and improving water quality and healthy populations of desired species. Fisheries management is practiced on the forest to provide public fishing opportunities. Management practices include liming and fertilization, fish habitat improvement, aquatic weed control, angler access improvement, fish population management and nuisance animal control.

3.4.12.2 Environmental Consequences

Public Recreational Fishing

Alternative 1

Direct, Indirect and Cumulative Effects. Ongoing fisheries management would continue to improve public recreational fishing opportunities under Alternative 1 and would have the following direct and indirect effects:

1. Improved water quality (buffered pH and increased total alkalinity)
2. Increased productivity from fertilization
3. Improved spawning habitat
4. Improved fish cover
5. Improved and increased angler access
6. Reduced aquatic weed problems
7. Reduced nuisance animal problems
8. Balanced and healthy fish populations

The cumulative effects of these activities would be improved recreational fishing opportunities for the public. Angler catch rates would increase resulting in improved angler satisfaction. Suitable habitat for aquatic threatened and endangered species (T&E) does not occur in the forest's ponds or immediately downstream; therefore, T&E species' habitat should not be affected by proposed management actions. The proposed management activities do not contribute to other unconnected actions within the vicinity that would create unacceptable levels of cumulatively negative impacts.

Alternatives 2 and 3

Direct, Indirect and Cumulative Effects. Fisheries management would be conducted in Alternatives 2 and 3 to improve public recreational fishing opportunities; it would have the following direct and indirect effects:

1. Improved water quality (buffered pH and increased total alkalinity)
2. Increased productivity from fertilization
3. Improved spawning habitat
4. Improved fish cover

5. Improved and increased angler access
6. Reduced aquatic weed problems
7. Reduced nuisance animal problems
8. Balanced and healthy fish populations

The cumulative effects of these activities would be improved recreational fishing opportunities for the public. Angler catch rates would increase resulting in improved angler satisfaction. Suitable habitat for aquatic T&E species does not occur in the forests' ponds or immediately downstream; therefore, it should not be affected by proposed management actions. The proposed management activities do not contribute to other unconnected actions within the vicinity that would create unacceptable levels of cumulatively negative impacts.

Direct and Indirect by Activity

There is no variation in recreation fisheries management by Alternative, so these effects apply to all alternatives.

Liming: Liming is the addition of agricultural lime, primarily calcium carbonate (CaCO3) to neutralize acidic waters and buffer them from rapid pH fluctuations. Generally, ponds in the Southeast are limed in conjunction with a fertilization program. Based on individual situations such as manpower, budgets, size of pond, flushing rate, etc., one type of lime may be more efficient than the other.

The direct effect of liming of ponds is increased total alkalinity of the water. The threshold of whether lime is needed is 20 parts per million (ppm) or 20 milligrams per liter (mg/l) of total alkalinity. Less than 20 ppm indicates a need for lime in conjunction with a fertilization program (Boyd, 1990).

Agricultural lime is made of particles of differing size taking several months to dissolve and increase the total alkalinity to the desired level. Approximately 3 to 5 tons per acre every 3 to 5 years is needed to raise and maintain total alkalinity at the desired level. Liming rates above this will not do any harm; the lime will just last longer. Only the lime surface will react with the water and go into solution. Higher rates will give a thicker coat of lime causing the initial lime application to last longer. As freshwater enters the pond from water runoff over the un-limed watershed, the concentration of lime will continue to react with the water. This allows a slow release of lime over a number of years. Generally, a five-ton-per-acre lime rate will last approximately 10 exchanges of water volume. Coating the bottom of a pond with agricultural lime protects or buffers the nutrients in the water from being absorbed by ions in the bottom mud and allows them to be more readily available for phytoplankton. Phosphorus is a key element that mud absorbs from the water and is the most critical for good fish growth.

Another direct effect of lime is neutralizing acidic water. The ability of agricultural lime to neutralize acidic water is based on the relative neutralizing value. Relative neutralizing value is an expression of agricultural lime effectiveness based on the combined effect of the calcium carbonate equivalent and fineness of grind.

The first indirect effect from increase in total alkalinity is increased availability of phosphorus, which, in turn, leads to increased phytoplankton productivity, which, in turn leads to increased fish production and growth. The second indirect effect from increase in total alkalinity is increased availability of carbon dioxide, which, in turn, is used for photosynthesis by

phytoplankton. The last indirect effect from increase in alkalinity is increased buffering capacity (resist rapid fluctuations in pH) of the water.

There are no anticipated cumulative effects on the environment from the use of agricultural lime or from hydrated lime within the pond it was applied or downstream. The retention time of both types of lime is based on the flushing rate or amount of water flow through the pond.

Fertilization: Several types of fertilizer are be used, and all can be effective if the pond total alkalinity is at the desired level. Fertilizers used are in liquid, granular, and powdered forms. Liquid fertilizers dissolve most readily, followed by powders, then granular types. The key ingredient in each of these types of fertilizer is phosphorus. Phosphorus is the element most needed for phytoplankton growth. Typical formulations for each type are:

- Liquid – 10-34-0 and 11-37-0[4]
- Powdered – 12-49-6 and 10-52-4
- Granular – 0-46-0 and 0-20-0

Based on individual situations such as manpower, budgets, size of pond, flushing rate, etc. one type of fertilizer may be more efficient to use than the other.

A direct effect of the addition of fertilizer to ponds is the stimulation of growth of microscopic plants, called phytoplankton. Phytoplankton makes the water turn green, or bloom.

One indirect effect from increased phytoplankton productivity is increased fish production and growth. Phytoplankton forms the base of the food chain, and small animals eat these small plants, which serve as food for bream (bluegill and redear), which in turn are eaten by bass. Proper fertilization significantly increases the total weight of fish produced in a pond, often by as much as 3 to 4 times. Phytoplankton blooms also shade the bottom which tends and discourage submersed aquatic weed growth.

The potential negative effect of fertilizer is that if used improperly a dense phytoplankton bloom can form. During periods of cloudy weather or after a heavy rain the phytoplankton bloom can die causing an oxygen depletion which can lead to a fish kill. However, with the following protective measures and guidelines implemented, fertilization should have no negative effects:

Liquid fertilizer should be applied at a rate of 0.5 - 1 gallon per surface acre per application. Powdered fertilizer should be applied at a rate of 2 – 8 pounds per surface acre per application. Granulated fertilizer should be applied at a rate of 4 - 12 pounds per surface acre per application. Secchi disc visibilities should be maintained between 18 inches and 24 inches on non-swimming ponds, and between 24 and 30 inches on ponds with swimming.

There are no anticipated cumulative effects on the environment from the use of fertilizer within the pond it was applied or downstream. There are concerns of agricultural fertilizers on the eutrophication (nutrient loading) of stream communities. However, when compared to inputs of nutrients from large-scale agriculture, pond fertilization contributions are minimal.

Spawning Habitat Improvement: Ponds with poor spawning habitat can be enhanced by the placement of gravel. The mechanical action of fish fanning the beds, however, makes the gravel

[4] The three-number sequence for fertilizer formulation reflects the percentages of nitrogen, phosphorous, and potassium respectively.

spread out laterally over time, causing it to become thin and ineffective. Therefore, gravel spawning beds should be constructed or boxed in. Spawning beds can vary in size, averaging 20 feet by 20 feet and approximately 12 inches deep. The actual size of each bed will depend on the amount of level ground available at each spawning bed site.

A direct effect of creating gravel spawning beds is that the gravel improves water circulation allowing more oxygen to get to the bottom of the egg mass, resulting in higher hatch results from each egg mass. In addition, Bain and Helfrich (1983) found that survival of bluegill larvae was directly correlated with the proportion of coarse substrate in the nest. Substrate with larger particles provided interstitial space that allowed bluegill larvae to escape predation.

Gravel spawning bed construction sometimes requires the use of mechanical equipment to level sloped areas and to deliver gravel to the site. This construction may involve some soil disturbance. Any soil erosion resulting from this activity would be temporary and would be minimized by the installation of erosion control measures such as temporary vegetation around the shoreline until the pond is flooded.

There are no anticipated cumulative effects on the environment from spawning habitat improvement within the pond or downstream.

Fish Attractors: One of the best ways to enhance the fishing experience is to provide cover or structures at strategic locations. Fish such as largemouth bass, bluegill, and redear sunfish are attracted to cover or shelter of all types (Managing Mississippi Ponds and Small Lakes 2011).

A variety of structures can serve as fish attractors such as submerged trees, rootwads, ledges and channels, rock piles, and artificial structures.

The direct effect of fish attractors in ponds is that they provide adequate refuge cover for fish. Largemouth bass are ambush predators and prefer to hide in cover and ambush their prey.

- **Submerged trees and rootwads** provide interstices for smaller fish to hide in and attachment sites for aquatic invertebrates. A major advantage to using submerged trees is low cost. These structures are readily available around most of the Forests' ponds. Species of trees used is important. Cedar and oak tend to last longer than pine. All submerged trees, however, will deteriorate with age, so fish use will decrease over time. The rate of deterioration is dependent upon the trees exposure to air. Those exposed periodically from fluctuating water levels will deteriorate more rapidly than those that are not.
- **Ledges and channels** provide irregular features in pond bottoms that are attractive to fish. Ledges and channels are not to be confused with the availability of deep water. While it is true that ledges and channels will, by their very definition, provide deeper water, it is the fact that this deeper water is immediately adjacent to significantly shallower water that makes ledges and channels such an important addition to fisheries habitat. Fish will tend to congregate around this structure at various depths at different times of the year. While it is expected that ledges and channels may slowly deteriorate with age due to sediment deposition, these structures are anticipated to last at least 20 years.
- **Rockpiles** provide irregular features in pond bottoms that are attractive to fish. They also provide interstices for aquatic invertebrates and smaller fish to hide in. Rockpiles are

usually made of rip-rap, large boulders, or broken concrete/brick. These structures deteriorate very little if any, and should last indefinitely.

- **Artificial structures** provide interstices for smaller fish to hide in and provide attachment sites for aquatic invertebrates. A major advantage to using artificial structures is durability. These structures deteriorate very little if any, and should last indefinitely. Artificial structures vary in configuration and size and are constructed from some of the following materials: PVC pipe, rubber tires, plastic streamers, wooden pallets, and wooden stakes. Another advantage is that lures tend not to snag on them as much as submerged trees and brush. Disadvantages are that commercially produced structures can be expensive and prone to vandalism during exposure in ponds with fluctuating water levels.

The indirect effect of fish attractors is improved fishing opportunities. Fish are attracted to the structures by the presence of cover and food, and they are concentrated so that anglers can better harvest them. Additionally, ledges and channels at the right location can attract or lead fish toward adjacent shorelines, which will be convenient for bank anglers, potentially making for some great fishing opportunities. Boxrucker (1983), Cofer (1991) and Glenn (1983) reported increased angler catch rates of largemouth bass, crappie, bluegill, and channel catfish around fish attractors.

Fish attractor placement or construction sometimes requires use of heavy equipment when ponds have been drained. During this process, some soil may be disturbed. Any soil erosion resulting from this activity would be temporary and would be minimized by the installation of erosion control measures such as temporary vegetation around the shoreline until the pond is flooded.

There are no anticipated cumulative effects on the environment from fish attractors within the pond treated or downstream.

Shoreline Deepening: The purpose of shoreline deepening is to reduce the amount of shallow water. This process deepens the pond edge in selected places by taking the current shoreline that is silted and rebuilding it with sediment deposits from the pond bed. This not only rebuilds the shoreline but also deepens the water next to the shoreline so that the depth drops quickly to 3 feet. This deepening process also includes the shallow flats located primarily in the upper end of ponds, where the excess soil is formed into islands.

The direct effect of shoreline deepening in ponds is the reduction of shallow water that contributes to aquatic weed growth. Aquatic weeds need sunlight to grow. In most waters, sunlight is filtered out by 3 feet of depth.

Shoreline deepening requires use of heavy equipment when ponds have been drained. During this process, some soil will be disturbed. Loose soil that is exposed along the shoreline, islands, and land access piers would be mulched and seeded to establish temporary vegetation to reduce erosion. The minimal soil erosion that does occur would be temporary and contained with the pond basin.

Section 404 of the Clean Water Act requires a permit from the U.S. Army Corps of Engineers before dredged or fill material may be discharged into the waters of the United States. Before the permit is issued, the U.S. Army Corps of Engineers ensures that the proposed project has taken steps to avoid wetland impacts, or minimize potential impacts on wetlands. This permit is an essential part of protecting wetlands.

The indirect effect of shoreline deepening is improved fishing opportunities. The reworked shoreline extends on average 10 to 20 feet farther out in the pond and the depth of water increases approximately 1 to 3 feet. In addition, land piers are constructed from the excess soil extending bank angler access farther out in the pond near deeper water.

There are no anticipated cumulative effects on the environment from shoreline deepening within the pond deepened or downstream.

Aquatic Weed Control: There are four categories of aquatic weed control methods: chemical, mechanical, biological, and habitat manipulation. At the time when aquatic weed control is needed, the control method chosen will depend on type of plants, quantity of plants, area of coverage, control methods available, funding, work force, and managers choices. Aquatic weed control will be conducted where applicable.

The direct effect of aquatic weed control in ponds is the reduction of nuisance aquatic weeds. This is expected to cause no significant effects. The following discussion discloses the specific effect of each control method.

- **Chemical control** involves the use of aquatic herbicides that have met strict Environmental Protection Agency standards for use in an aquatic environment. Improper use of chemicals could result in serious environmental damage, fish kills, contaminated water supplies, and danger to human health. If chemical treatment is used, the shallow water conditions conducive to aquatic vegetation growth would remain and the vegetation would become a problem again in 2 or three years. Therefore, a consistent treatment with chemicals would be required to keep the nuisance aquatic weeds under control. Low dissolved oxygen levels can result from the natural decay of treated (killed) aquatic weeds. Fish kills may result if the dissolved oxygen level becomes too low. However, with the following protective measures and guidelines implemented, chemical control should have no negative effects.

  Herbicides will be applied according to guidelines, rates, and restrictions specified on the label. Rates and methods of application would be controlled in order to prevent non-target species from exposures. Any herbicide used in swimming or fishing areas will be labeled for that use. A certified applicator will supervise application. Equipment and containers will be cleaned or disposed of according to label instructions. To avoid dissolved oxygen depletions, no more than half of the pond should be treated at one time.

- **Mechanical control** is the actual removal of aquatic weeds by tools or machines. Mechanical removal of aquatic weeds is a very short term treatment. Most methods of mechanical control fragment aquatic vegetation and may in fact increase the problem in the future, since many species of aquatic vegetation reproduce vegetatively. Mechanical control is usually slower and more costly than other methods of control. There may be some significant biological impacts. Plant fragments left in a water body may deplete dissolved oxygen if they die and decompose. Dissolved oxygen depletion in turn may cause a fish kill. If mechanical treatment is used, the shallow water conditions conducive to aquatic weed growth would remain and the weeds would become a problem again in 2 or 3 years.

- **Biological control** measures have potential for effective, economical, and permanent control of aquatic weeds. Biological controls are not intended to eliminate nuisance plant species but rather to reduce them to a non-nuisance density. Control is successful if the predator and nuisance plant reach a state of equilibrium. Grass carp (*Ctenopharyngodon*

idella) is a non-native species of fish that consumes vegetation almost exclusively after they reach 10 inches in length. During warm weather, grass carp can consume 30 to 40 percent of their body weight in aquatic vegetation every day. When stocked at the proper rate, these fish can provide effective control of most types of submerged aquatic weeds. Compared to other methods of aquatic weed control, the grass carp is relatively inexpensive and may provide long-lasting effects. Unlike the common carp (*Cyprinus carpio*) found in South Carolina waters, grass carp feed primarily on submersed vegetation and do not stir up bottom mud. The possibility of grass carp having an adverse environmental impact on native aquatic plant communities is contingent upon their reaching streams, spawning successfully and the young surviving in large enough numbers to bring about harmful changes. Reproduction, however, normally does not occur in ponds because these fish need flowing water to successfully spawn. When stocked at recommended rates, displacement of or interference with existing fish species should not occur. With the following protective measures and guidelines implemented, grass carp should have no negative effects:

Only certified triploid (sterile or non-reproducing) grass carp from licensed distributors will be stocked into Francis Marion National Forest ponds. Grass carp should only be used at the specific recommendation and guidance of a fisheries biologist.

- **Habitat manipulation** limits plant growth by altering one or more of the physical or chemical factors critical to growth, such as, light, or physiological processes factors of the plant. Fertilization is an effective method of control for submersed aquatic weeds. Organic turbidity caused by increasing fertility increases phytoplankton and reduces visibility and water clarity which shades the submerged plants so they cannot photosynthesize. The effects of fertilization are discussed in the fertilization section. Water level manipulation is an effective method of control for rooted species of aquatic weeds. Drawdowns during the fall and winter can expose the aquatic weeds to drying winds and freezing temperatures thus reducing it to acceptable levels. A winter drawdown would have the least significant impact because: 1) fishing during this time of year would be at a minimum; 2) there would be greater predator-prey interaction in the pond because of concentration of fish. Flooding may reduce certain species of rooted aquatic vegetation if the water is raised and kept above the plants exposed leaf zone. If water level manipulation is used, the shallow water conditions conducive to aquatic weed growth would remain and the weeds would become a problem again in 2 or 3 years.

  There are no anticipated cumulative effects on the environment from aquatic weed control within the pond treated or downstream.

Angler Access Improvement: Fishing piers and boat ramps may be provided. These structures enable the pond sport fish population to be managed for optimal recreational benefits. Access to angling opportunities should increase with the installation of these structures.

The direct effect of installing fishing piers and boat ramps in ponds is that they improve angler access. Fishing piers provide bank anglers with access to deeper water. Many wooden piers in recreation area ponds are constructed to allow use by physically challenged anglers. Boat ramps are constructed to allow anglers to launch boats on trailers with minimal difficulty.

The construction of fishing piers and boat ramps sometimes requires use of heavy equipment when ponds have been drained. During this process, some soil may be disturbed. Any soil erosion resulting from this activity would be temporary and would be minimized by the installation of

erosion control measures such as temporary vegetation around the shoreline until the pond is flooded.

There are no anticipated cumulative effects on the environment from angler access improvement within the pond receiving the improvements or downstream.

Fish Population Management: There are 3 means of fish population management: stocking, removal, and harvest restrictions. At the time when fish population management is needed, management method chosen will depend on current population assessment, funding, work force, and managers choices.

The direct effect of fish population management in ponds is the establishment and maintenance of the proper species balance and size structure.

- **Stocking** – Renovated ponds or newly constructed ponds are typically stocked with a combination of largemouth bass, bluegill, redear, and channel catfish. In addition, species such as threadfin shad and fathead minnows are sometimes stocked to provide additional forage for largemouth bass.

  Supplemental stocking involves replacing a segment of the fish population that is absent. In some instances, a species may experience poor recruitment of young fish into the population. This would require supplemental stocking to replace that missing year-class of fish.

- **Removal** – This involves removing part or all of the fish population in a pond to restore balance. In some instances a non-native invasive species or an undesirable species has become established and all the fish in the pond will need to be eradicated and the pond restocked with desirable species. Eradication of the entire population may also be needed when it has become unbalanced beyond recovery. Partial removal may be needed when a particular species has become overabundant thus impacting the rest of the fish population.

  Electrofishing may be used for partial removal. This will require an electrofishing boat with 2 people dipping fish and a boat operator. The pond would be periodically electrofished until the desired population balance and size structure is achieved. Shocker efficiency, depth of the target species within the pond, underwater visibility, and sheer numbers of the target species present will all play a role in removal success. It is unlikely that more than twenty percent of the target species population would be removed. Negative impacts to sportfish would be minimal; however, some sportfish would be lost. No downstream areas would be impacted.

- **Harvest Restrictions** – This involves the use creel and length limits for designated species of fish to maintain balanced fish populations and quality fishing. Forest Supervisor Orders provide for flexible creel limits and closures based upon the management needs of each individual body of water.

Nuisance Animal Control: Beavers, muskrats, nutria, otters, and alligators can be a nuisance or even cause damage. Burrowing and damming activities can cause dam failure or flood adjacent landowners. Angler access and fish habitat improvements can also be flooded. A family of otters can virtually eliminate catchable-size fish in a small pond. Alligators can present a safety concern in ponds with swimming. Trapping and removal will be practiced to maintain nuisance animal populations at acceptable levels.

There are no anticipated direct, indirect, or cumulative effects on the environment from nuisance animal control within the pond treated or downstream.

3.4.13 Huntable and Fishable Species

3.4.13.1 Affected Environment

Hunting and fishing are 2 of the most popular recreational activities pursued on the Francis Marion National Forest. Both activities play a vital role in social and economic sustainability. Hunting was the number one activity selected by respondents as the main purpose of their forest visit during the 2008 Francis Marion and Sumter Visitor Use Report (page 20). Furthermore, the Francis Marion is documented by the SCDNR as having high hunter use.

The National Forest Management Act requires that national forests be managed to sustain native plant and animal diversity in the plan area. The Francis Marion is within South Carolina's Lowcountry and is a mix of swamps, bays and dry sand landscapes of longleaf and loblolly pine. This setting provides an abundance of diverse native vegetation that serves as food for many wildlife species. The Francis Marion fills a specific niche by providing older forest conditions and open grassy/forb habitat, both of which are less likely to occur on adjacent private forestland.

Much of the privately owned property surrounding the forest is rural with residential areas scattered amongst agriculture fields and production forestlands. Vegetation types on the forest include soft and hard mast producing trees as oaks, hickories, cherries and persimmon, but other forage as grapes, berries, succulent stems and herbaceous plants are abundant for wildlife species. The forest also provides critical and essential habitat components such as snags, stumps, stumps holes, dens and downed wood which provide cover, nesting and/or denning opportunities for many wildlife species.

Wildlife Demand Species: Due to the diversity of habitats found on the Francis Marion, hunters are able to pursue game animals such as white-tailed deer (*Odocoileus virginianus*), wild turkey (*Meleagris gallopavo*), bobwhite quail (*Colinus virginianus*), waterfowl and other small game species. All areas open to hunting on the Francis Marion are enrolled in the South Carolina Wildlife Management Area (WMA) program. The Francis Marion and Sumter National Forests are vital components of the WMA program in South Carolina. Forest Service lands account for approximately 60 percent (629,906 acres) of the roughly 1.1 million acres enrolled in the WMA program. The Francis Marion manages approximately 324 acres of waterfowl impoundments and green-tree reservoirs.

Effects to game species habitat are influenced by the amount of early successional habitat, availability of mast and the impacts of human disturbance (primarily roads and motorized trails) on brood rearing habitat. SCDNR and the Francis Marion will continue their cooperative relationship in the management of WMAs providing a wide choice of habitats for game species in all 3 alternatives.

3.4.13.2 Environmental Consequences

Effects to Wildlife Demand Species

The **white-tailed deer** population on the Francis Marion has been recovered from its near extirpation at the turn of the century, primarily due to the increase in hunting, restoration of forest lands and the ability of the species to adapt to fragmented habitats. This species was traditionally hunted for its meat and hides by Native Americans, and later by European settlers, which led to

its near extirpation in the Southeast. Today the white-tailed deer is the most heavily hunted game animal in the Southeast and on the Francis Marion. White-tailed deer are primarily browsers, feeding on leaves and twigs of a variety of plants, acorns (other seeds or hard mast), fruits (soft mast) and herbs. They prefer a mixture of young and older forests, old fields and croplands. Forest management practices such as prescribed burning and timber thinning treatments are essential to improving habitat for this species.

The **wild turkey** population on the Francis Marion is currently stable to increasing, which is a recovery from its near extirpation in the mid-1900s. This recovery is due to restoration efforts by SCDNR and the National Wild Turkey Federation. These efforts were followed by an increase in hunting regulations and intense harvest monitoring. In addition, this success could be attributed to the presence of forested conditions and open woodland habitats on national forest lands and adjacent privately owned lands. This species has traditionally been hunted across the Southeast for its meat and feathers; today it is a very popular game species.

Turkeys prefer forests with openings, burned areas and savannas. These areas support low herbaceous or grassy ground cover and insects needed for brood-rearing. Even though acorns are a favorite, a wide array of insects, fruits, seeds, buds, grasses, green vegetation, other mast and small animals are consumed regularly. Growing season burns may negatively impact nesting activities of individuals, but would not likely offset the local population. Additionally, the numerous acres of improved habitat after a prescribed growing season burn greatly outweigh any loss. These birds would typically recover from such a disturbance by re-nesting shortly after an event. Forest management practices, such as as prescribed burning and timber thinning treatments are essential to improving habitat for this species.

Bobwhite quail inhabits, and is very much dependent on, early successional and open woodland habitats. Early successional habitat was more prevalent on the landscape in the early to mid-1900s due to the abundance of agriculture. This habitat is found less often today. Furthermore, research has shown this species to be declining within its historical range and this is likely due to this lack of habitat. Today, quail are often hunted in open woodland situations, similar to that of the longleaf pine forest found historically across the Southeast and the Francis Marion. Traditionally this species was hunted for its meat and its feathers.

Two management actions that vary by alternative and would affect this species habitat are:

1. The creation of early successional habitat (0 to 10 year old forest); and
2. The amount of prescribed fire to maintain open woodlands.

Forest management practices such as prescribed burning and timber thinning treatments are essential to improving habitat for this species. Growing season burns may negatively impact nesting activities of individuals, but would not likely offset the local population. Additionally, the numerous acres of improved habitat after a prescribed growing season burn greatly outweigh any potential loss. Bobwhite quail would typically recover from such a disturbance by re-nesting shortly after an event.

The **waterfowl** population on the Francis Marion is somewhat stable, but the demand for these species seems to be increasing. Traditionally these species were hunted for their meat and feathers, but today it may be mostly for the recreational experience. Of the wildlife demand waterfowl species, the wood duck (*Aix sponsa*) is the primary hunted species. On occasion other waterfowl game species may pass through. Most waterfowl species are migratory, only spending a short period of time on the Francis Marion then moving on, but wood ducks nest and raise their

young on the forest. This species is not dependent on early successional habitats or open woodland habitats, but prefers bottomland hardwood swamps, wooded sloughs, marshes or forested riparian areas.

Other **small game** species which are demands species include, but are not limited to: Eastern gray squirrel (*Sciurus carolinesis*), Eastern cotton-tailed rabbit (*Sylvilagus floridanus*) and mourning dove (*Zenaida macroura*). Even though these species and other small game species are not pursued as heavily as white-tailed deer or wild turkey they do have a local hunting populous. While these species are unique and have some independent habitat requirements, they also have an increased ability to adapt to disturbance.

Table 3-84. Estimated Total Acres (Total for 1st Decade) of wildlife habitat by Alternative

Type of Game Habitat	Alt 1	Alt 2	Alt 3
Upland Hardwood			
Wildlife Openings	665	665	565
Early Successional Forest Habitat	9,238	28,257	23,631

Note: Early Successional forest habitat includes even age treatments.

Alternative 1

Direct, Indirect Effects. Alternative 1 would likely have no direct effects; however, it would have indirect effects to all the wildlife demand species expect the waterfowl species since there would be minimal creation of early successional and oak mesic habitats. Furthermore, hunting opportunities would decrease as the Francis Marion and landscapes move further away from habitat types these species require.

Alternative 2

Direct, Indirect Effects. Alternative 2 would likely have no direct effects; However, it would have an indirect benefit since there would be an increase in early successional and the restored oak mesic habitats to the wildlife demand species except the waterfowl species. Additionally, it would likely increase opportunities for hunting experiences which are dependent on early successional and restored oak mesic habitats. Ecological restoration activities would generally produce more early seral stage forest in the first decade. Table 3-80 displays the conditions by alternative that would improve hunting. Increases in hunting habitat would increase user satisfaction for visitors; therefore, effects on hunters would generally be positive.

Some specific areas on the forest would provide more remote experiences and increase areas with closed roads; this would affect some hunters more negatively by decreasing access to certain places. This would have positive effects on other hunters who prefer a more remote experience and less vehicular disturbance.

Alternative 3

Direct, Indirect Effects. Alternative 3 would likely have no direct effects; it would have an indirect benefit to the wildlife demand species except the waterfowl species since early successional and restored oak mesic habitats would increase. Additionally, opportunities would increase for hunting experiences which are dependent on early successional and restored oak mesic habitats. Ecological restoration activities would generally produce more early seral stage forest in the first decade. Table 3-80 displays the conditions by alternative that would improve

hunting. Increases in hunting habitat would increase user satisfaction for visitors; effects on hunters would generally be positive.

In Alternative 3, more wilderness areas are recommended—more than 33,000 acres. These areas would be open to hunting, but access would be decreased as some roads and a few wildlife openings would be closed. This may affect some hunters more negatively by decreasing roaded access to certain places. This would have positive effects on other hunters who prefer a more remote experience and less vehicular disturbance.

Cumulative Effects

The current status of these wildlife demand species is good, but improved habitat would greatly benefit most of these species. Hunting decreases the satisfaction of some other users, especially some trail users, due to safety concerns. Effects may include a decrease in use on certain trails during the hunting season to avoid safety concerns. It is not expected that private landowners will restore or manage to maintain significant amounts of these desired habitats for the wildlife demand species. Decreases in populations of these species are expected on private lands due to the continued loss of forested habitats and increased development.

Effects to Visual Demand Species

Due to the diversity of habitats and the associated flora and fauna found on the Francis Marion, many observers travel to the forest to hike, drive through, take pictures or simply observe. These individuals may visit to view wildlife species (e.g, birds, frogs, or dragonflies) and plant species including wild flowers, pollinators, orchids as well as open woodland and savannas or mature Southern pine forest habitats.

Alternative 1

Direct, Indirect Effects. Alternative 1 would likely have no direct effects; however, there would be indirect effects to many of the visual demand species since creation of early successional and oak mesic habitats would be minimal. This alternative would allow for the lower amount of treatments, thus resulting in fewer acres of improved habitats for a diversity of species. Furthermore, viewing opportunities would decrease as the Francis Marion matures and landscapes move further away from the diversity of early successional habitat types.

Alternative 2

Direct, Indirect Effects. Alternative 2 would likely have no direct effects; however, there would be an indirect benefit to the visual demand species since in early successional and the restored oak mesic habitats would increae. Also, opportunities for viewing experiences which are dependent on the diversity of habitats would likely increase. Restored longleaf Increases in the viewing habitat would increase user satisfaction and effects on this user group would generally be positive.

Some specific areas on the forest would provide more remote experiences and areas with closed roads; this would affect some of this user group more negatively by decreasing the access to certain places. It would also positively affect others who prefer a more remote experience and less vehicular disturbance.

Alternative 3

Direct, Indirect Effects. Alternatives 3 would likely have no direct effects; however there would be an indirect benefit since the diversity of habitats would increase. Additionally, opportunities

for viewing experiences which are dependent on diverse habitats would increase. More viewing habitat would increase user satisfaction and effects on this user group would generally be positive.

Alternative 3 would recommend more than 33,000 acres in wilderness that would be open to viewing. However, access would decrease as some roads and wildlife openings would be closed. This may affect some individual users more negatively by decreasing roaded access to certain places. However, it will positively affect others who prefer a more remote experience and less vehicular disturbance.

Cumulative Effects

The current status of these visual demand species is good, but improved habitat would be beneficial to most all of these species. Hunting decreases the satisfaction of some other users, especially some trail users, due to safety concerns. Effects may include a decrease in use on certain trails during the hunting season to avoid safety concerns. It is not expected that private landowners will restore or manage to maintain significant amounts of diverse habitats for the visual demand species. Decreases in populations of these species are expected on private lands due to the continued loss of forested habitats and increased development.

3.4.14 Social Demographics

3.4.14.1 Affected Environment

Located 140 miles east of the Forest Supervisors' Office in Columbia and 40 miles north of Charleston, the Francis Marion National Forest (FMNF) includes the communities of Awendaw, Huger, Jamestown, and McClellanville. While few people live within the forest boundaries, numerous nearby communities have longstanding social and economic ties to the natural and cultural resources of the FMNF. Since neighboring communities may be affected by forest management decisions on the FMNF, it is important to examine existing socioeconomic conditions of a broader region in order to establish a baseline in which potential impacts can be measured against. To more effectively examine the linkages between Forest Service lands and the local communities they serve, the geographic scope of this analysis has been expanded beyond FMNF boundaries to encompass a broader social and economic study area.

Communities within Berkeley, Charleston, Clarendon Dorchester, Georgetown, Horry, Orangeburg, and Williamsburg counties were recognized as having the strongest social and economic ties to the FMNF. While FMNF visitors travel from far and wide, residents of these eight counties were identified as having stronger ties and are most likely to be affected by changes in forest management because of their reliance on forest resources to sustain the social, cultural, and economic well-being of their communities. To more accurately measure the economic contributions and potential impacts resulting from changes in budget expenditures associated with management actions on the forest, the economic study was further extended to include Lexington, Richland, and Calhoun counties which surround the Supervisors Office in the capital of Columbia, SC. The following Affected Environment section provides an overview of trends and current conditions related to the social and economic environment within these areas study areas, including: population and demographic changes, potential environmental justice populations, and employment and income conditions. Additional Affected Environment information, relevant to the effects analysis, is provided in Appendix F. To ensure large scale impacts are addressed without masking changes in smaller regions, this analysis uses a multidimensional approach to analyze trends at the state, aggregated study area, and individual

county levels. In addition, existing conditions and effects are portrayed for the Resource Integration Zones (Coastal, Wando, Wambaw and Santee).

The Forest is located within the Gullah-Geechee Cultural Heritage Corridor, a congressionally designated National Heritage Area created to preserve the unique African-based heritage and culture of slave-descendants along the Southern Atlantic Seaboard. Gullah communities within the proclamation boundary are small heir property[5] communities which developed a unique culture that blends African traditions with the cultures they encountered before and after emancipation. These rural communities share a common history rooted in farming, fishing, and slavery, and have sustained strong ties to the people and lands associated with their ancestors. Because of their relative isolation and strong sense of community, Gullah communities have retained high levels of their African heritage emphasizing its importance for their community. Their ability to continue to live off the land and pass down the language, traditions, and way of life of their ancestors is essential to preserving the Gullah ethnic identify and unique sense of place within South Carolina's Lowcountry.

Population and Demographics. This section highlights population and demographic trends in the area surrounding the FMNF. Population is an important consideration in managing natural resources. In particular, population structure (size, composition, density, etc.) and population dynamics (how the structure changes over time) are essential to describing the consequences of forest management on the social environment (Seesholtz et al. 2004).

Population Growth. Population growth can be an indicator of a region's desirability to live and work. As displayed in Table 3-81, the rapid population growth in South Carolina and the eight-county study area over the last thirty years suggests that this area is highly desirable to current and prospective residents. While the total U.S. population grew by 36 percent between 1980 and 2010, the state's population increased by 48 percent and total population within the study area increased by 60 percent (U.S. Census, 2010).

Growth within the eight-county study area exceeded the state and nation over the last thirty years, growing by 2 percent on annual average. While the population of the eight-county study area grew rapidly between 1980 and 2010, the rate of growth varied considerably between counties included in the study area. Over this thirty year period population growth within the study area was highly concentrated in Berkeley, Dorchester and Horry counties, while the population of Williamsburg slowly declined. On average these counties grew by 3, 4, and 5 percent respectively while Williamsburg decreased by less than 1 percent annually (U.S. Census, 2010).

Amenities (the natural, cultural, and social characteristics of an area) have played an increasing role in U.S. migration (see discussion of migration in Appendix F that augments population data above). Areas characterized as having high levels of natural amenities (unique land and water features, mild temperatures, scenic quality, and recreation opportunities of a geographic region) have been shown to experience greater population growth than areas with fewer natural amenities (Rudzitis and Johansen 1991, Johnson and Beale 1994, Johnson and Beale 1998, McGranahan1999, Hunter et. al 2005, Frentz et. al 2004), and that this growth occurs increasingly at the boundaries of public lands (Hansen et. al 1998, Radeloff et. al 2001). In recent years communities surrounding the Francis Marion, like those in Dorchester and Horry counties, have become increasingly attractive to many Americans because of their proximity to open spaces and

[5] Heir property is land that is jointly owned by descendants of a deceased person whose estate was never handled in probate. These descendants (heirs) have the right to use the property, but they do not have clear or marketable title to the property since the estate issues have not been resolved.

natural settings which provide residents with easy access to recreational opportunities year round. As a steward of South Carolina's public lands, a portion of population growth in this region can be attributed to the scenic beauty and outdoor recreation supported by the FMNF.

Table 3-85. Population Totals: Current and Historic

	1980	1990	2000	2010	% Change 80-10
United States	226,545,805	248,709,873	281,421,906	308,745,538	36%
South Carolina	3,121,820	3,486,703	4,012,012	4,625,364	48%
8 County Area	722,308	847,298	962,760	1,155,951	60%
South Carolina Counties					
Berkeley	94,727	128,776	142,651	177,843	88%
Charleston	276,974	295,039	309,969	350,209	26%
Clarendon	27,464	28,450	32,502	34,971	27%
Dorchester	58,761	83,060	96,413	136,555	132%
Georgetown	42,461	46,302	55,797	60,158	42%
Horry	101,419	144,053	196,629	269,291	166%
Orangeburg	82,276	84,803	91,582	92,501	12%
Williamsburg	38,226	36,815	37,217	34,423	-10%

Source: U.S. Census Bureau, 1990, 2000, 2010.

Racial and Ethnic Composition. South Carolina's population tends to be more racially diverse than the general U.S. population. While 74 percent of the country's population identifies themselves as White, Whites only account for 67 percent of the state's population. Historically African American populations in South Carolina have accounted for a large share of the state's population. In 2010 roughly 28 percent of South Carolina residents identified themselves as Black or African American. While individual shares are small, Native Americans, Asians, Pacific Islanders, and individuals identifying with some other or multiple races account for nearly 5 percent of the state's population (U.S. Census Bureau, 2010).

Minority populations make up an even larger share of the population within the eight-county study area. While shares of Native Americans, Asians, Pacific Islanders, and individuals identifying with some other or multiple races only make up 5 percent of the region's population, African Americans account for nearly 30 percent of the region's population (U.S. Census Bureau, 2010). As a shown by Figure 3-36, there is considerable variation in the racial composition of study area counties.

Figure 3-36 shows county, state, and national populations broken down into racial groups' share of total population. Within the study area Horry County was the least racially diverse, with roughly 80 percent of the population identifying themselves as White alone; while Williamsburg was the most diverse with Whites accounting for only 32 percent of the population. The area surrounding the FMNF has a large African American population, with African Americans making up 50 percent or more of the population in Clarendon (50%), Orangeburg (63%) and Williamsburg (66%).

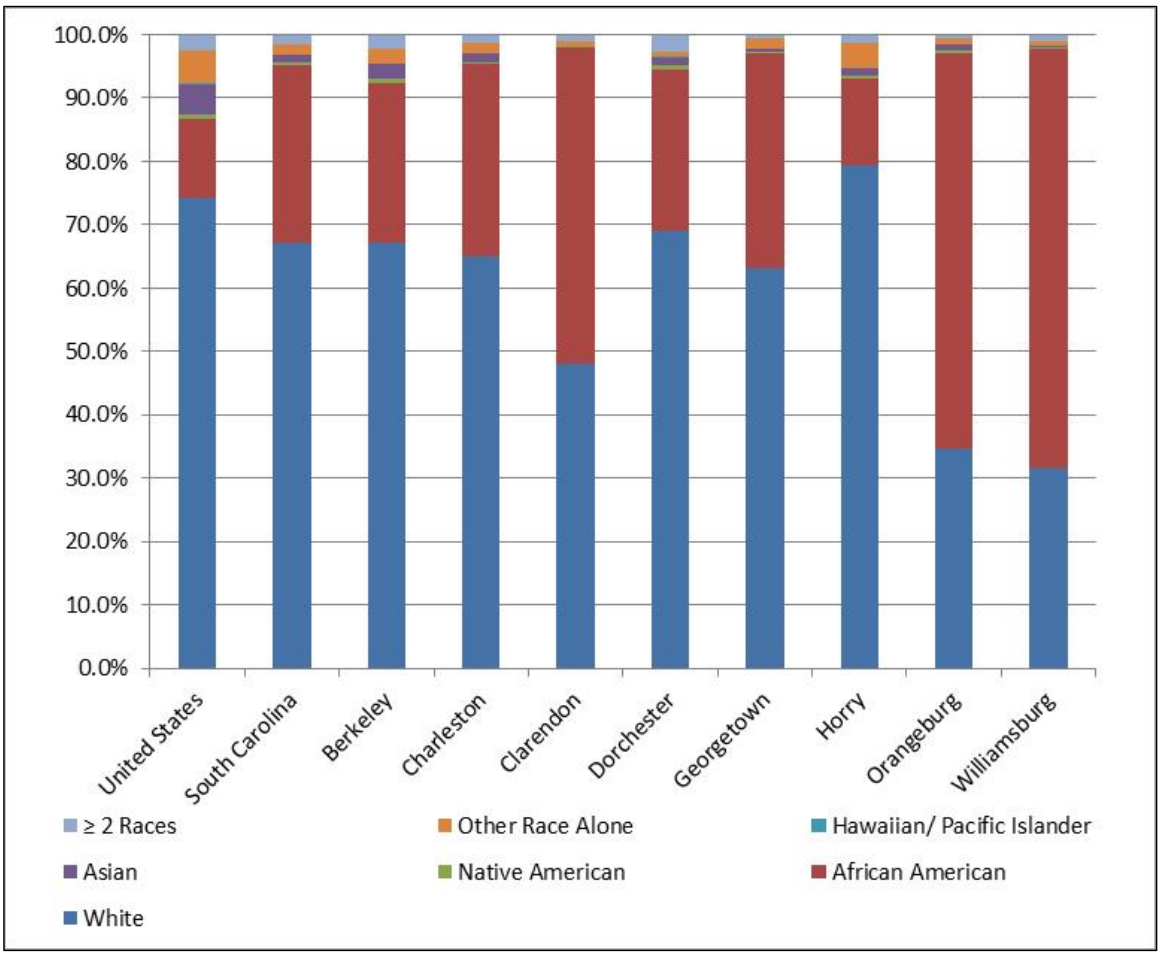

Figure 3-40. Racial Composition, 2010

Source: U.S. Census Bureau, 2010: Table QT-P6

Many Americans identify with, and are proud of, the cultural heritage from which they descend. Although Americans may appear to look White, Black, Asian, or belonging to some other racial group, they often continue to speak the native language, and follow cultural traditions, from the regions where their families originated. In 2010 roughly 17 percent of Americans described their family ancestry as being Hispanic, Latin, or Spanish. While these cultures have a noticeable presence in the United States, only 5 percent of the state and study area's population reported being of Hispanic descent. Even though Hispanics accounted for a slightly greater share of the population in Berkeley (6%) and Horry (6%) counties Hispanic cultures are less predominate in this region of the country relative to the United States as a whole (U.S. Census Bureau, 2010).

Employment and Income. The previous section discussed demographics and population trends in counties surrounding FMNF relative to the state and nation. The following section will focus on economic conditions within the study area to further develop a baseline on which potential impacts can be measured against.

Employment and Specialization. The local economy examined in the analysis of the Francis Marion is diverse and supports employment in more than 300 industries. In general these industries are identified as being either Services related or Non-services related. Services related

sectors include: Utilities, Wholesale Trade, Retail Trade, Transportation & Warehousing Information, Finance & Insurance, Real Estate & Rental & Leasing, Professional, Scientific, & Tech., Mgmt. of Companies & Enterprises, Administrative & Support Services, Educational Services, Health Care & Social Assistance, Arts, Entertainment, & Recreation, Accommodation & Food Services, and Other Services, while Non-services related sectors consist of the following sectors: Mining, Construction, Manufacturing, and Agriculture, Forestry, Fishing, and Hunting.

Total employment in the eight-county study area increased from 348,044 to 377,939 jobs between 1998 and 2010. Though job creation is perceived as desirable, much of this growth can be attributed to growth in Services related industries which generally pay lower wages than those in Non-services sectors. Study area jobs in Service related sectors paid on average 36 percent less than jobs in Non-Services related fields (Bureau of Labor Statistics, 2012). Between 1998 and 2010 employment in Non-Services related sectors declined by 28 percent while employment in Services related sectors increased by18 percent. In 1998 Services related sectors supported 79 percent of regional employment, with Services related employment growing to 86 percent of total employment in the eight counties surrounding the Francis Marion by 2010 (Bureau of Labor Statistics, 2012). Although increases in Services related employment relative to Non-services employment may have a negative effect on wages in the region, employment in the Service sector may play an important role in increasing labor participation of the area's minority or underserved populations. In general, Services related sectors provide greater employment opportunities for women and minority racial groups than industries in the Non-service sector.

Economic diversity generally promotes stability and offers greater employment opportunities. Highly specialized economies (i.e., those that depend on a few industries for the bulk of employment and income) are prone to cyclical fluctuations and offer more limited job opportunities. Assessing employment by sector helps identify industries which are important to the local economy surrounding the FMNFFigure 3-37 shows local employment in aggregated sectors as a share of total employment (IMPLAN 2012). In 2012 the Government (16%), Retail Trade (12%), and Accommodation & Food Services (11%) sectors were the largest employers within the eight-county study area, accounting for 39 percent of total study area employment. A portion of employment in many industries can be directly or indirectly attributed to the FMNF but not all employment in Figure 3-37 is attributable to the FMNF; employment contributions provided by the FMNF are discussed below in the Forest Users and Contributions to Social and Economic Sustainability section below.

The Interior Columbia Basin Ecosystem Management Project identified communities that were specialized with respect to employment. Employment specialization can be examined using the ratio of the percent employment in each industry in the region of interest (eight-county study area) to the percent of employment in that industry for a larger reference region (the state of South Carolina). For a given industry, when the percent employment in the analysis region is greater than in the reference region, local employment specialization exists in that industry (USDA Forest Service 1998). Applying this criterion to 2012 employment data for the FMNF study area reveals that the region is specialized with respect to the Accommodations & Food Services (+2.9%), followed by the Real Estate & Rental sector (+2.0%) and the Arts, Entertainment & Recreation sector (+1.2%), Retail Trade (+0.7%), Professional Services (+0.2%), and Transportation and Warehousing (+0.4%).

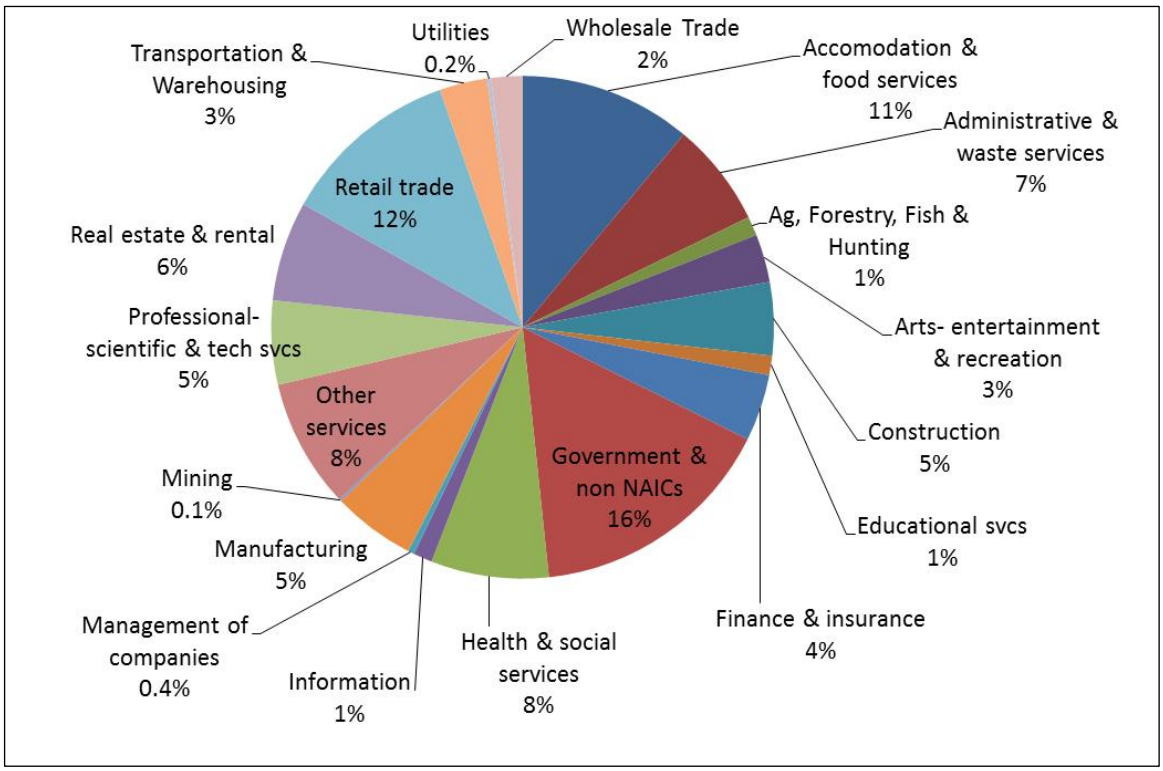

Figure 3-41. Employment by Industry, 2012

Employment specialization is of particular interest when specialization occurs in sectors related to forest management. A portion of employment in the sectors shown in Figure 3-38 can be attributed to forest management, timber production[6] and recreation on the FMNF. The government sector includes all federal, state and local employment, while a portion of employment in the Accommodations & Food Services, Arts, Entertainment & Recreation, Retail Trade, and Passenger Transportation sectors is specifically attributed to tourism and recreation (Marcouiller and Xia 2008). Relative to the state of South Carolina, the eight-county study area is not specialized in sectors related to forestry and is specialized in service related sectors which support recreation and tourism. Specialization in the four recreation- related sectors highlights the importance of tourism and recreation to the local economy. While the Charleston area provides an abundance of recreational opportunities, the unique recreational experiences of the FMNF are attributed with attracting outdoor recreationists to the Charleston area. For a more detailed discussion of the forest's recreation-related employment contributions see the "Recreation" Section included in "Forest Contributions."

[6] Sectors related to timber include: Forestry & Logging (IMPLAN sectors 15, 16, 19, 335), Primary Forest Products Manufacturing (IMPLAN sectors 31, 95, 96, 98, 105), and Secondary Forest Products Manufacturing (IMPLAN sectors (97, 99, 100, 102, 106, 107, 108, 109, 110, 111, 112, 295, 297, 301, 302) (BBER 2010).

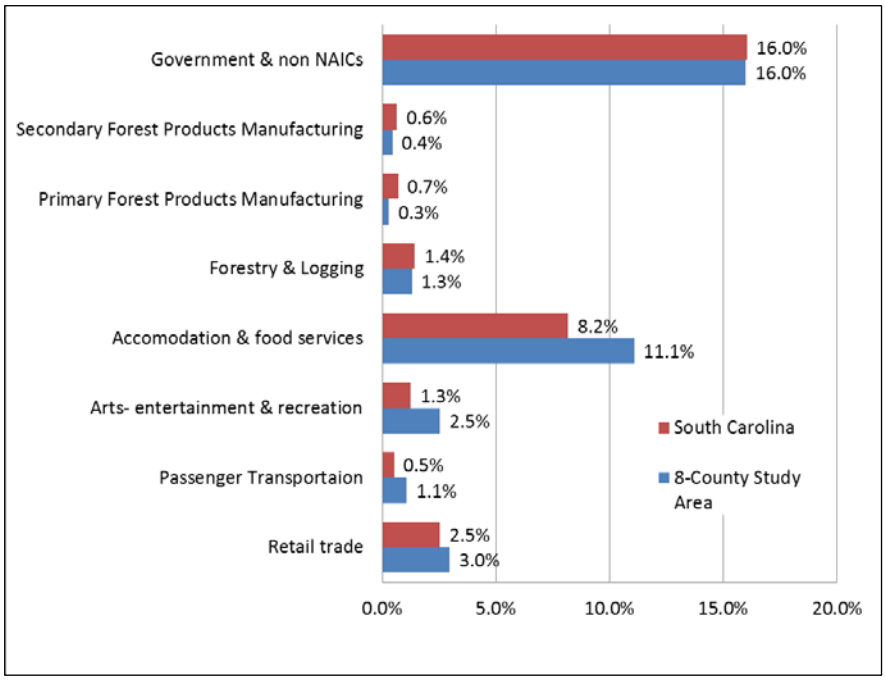

Figure 3-42. 2012 State and Study Area Employment Distribution for Forest Related Sectors

Source: IMPLAN 2012

Personal Income. Personal income is an indicator of the economic well-being of a county and provides a measure of all sources of income within the FMNF study area. High personal income may be a signal of greater job opportunities, highly skilled residents, greater economic resiliency, and well-developed infrastructure; while low personal income is often a reflection of the poor economic conditions and relatively few economic opportunities available within a region. Total personal income (TPI) in the study area exceeded $41.3 billion dollars in 2011, with Charleston County accounting for more than a third of the study area's TPI. Personal income in the study area has grown much more rapidly than TPI across the state. Between 2000 and 2011 total personal income in South Carolina grew by 18.6 percent while TPI within the eight-county study area grew by 30.4 percent (adjusted for inflation and reported in 2011 dollars) (Bureau of Economic Analysis, 2012a).

Per capita personal income (PCPI) measures average income per person in a region. Historically PCPI in South Carolina and much of the region surrounding the FMNF has been lower than that across the country. As shown by Table 3-82, PCPI across the state and country has steadily increased between 1990 and 2011. While PCPI at the state level grew at a slightly slower rate than that of the nation, per capita personal income across the study area occurred much more rapidly. On average PCPI rose by 32 percent across the study area between 1990 and 2011, with sluggish growth in Horry County (+9%) and very rapid growth in Georgetown County (+51%). Though personal income in the region has increased, average PCPI within the study area remains below that of the state and the country (Bureau of Economic Analysis, 2012b).

Table 3-86. Per Capita Income, 1990 & 2011 (adjusted for inflation and reported in 2011 dollars)

	1990	2011	*% Change 1990-2011*
United States	$33,309	$41,560	25%
South Carolina	$27,268	$33,388	22%
Berkeley	$24,402	$33,184	36%
Charleston	$30,400	$41,656	37%
Clarendon	$18,998	$24,431	29%
Dorchester	$27,251	$33,468	23%
Georgetown	$25,420	$38,403	51%
Horry	$26,698	$29,148	9%
Orangeburg	$22,663	$28,965	28%
Williamsburg	$18,630	$27,263	46%

Source: Bureau of Economic Analysis, 2012

There are 2 major sources of personal income: (1) labor earnings or income earned through employment and (2) non-labor income. Labor earnings, or wages, were supported by a wide range of industrial sectors and represented 63 percent of the study area's TPI in 2011. Although wages can fluctuate between counties and across industries, average annual wage in the FMNF study area remain well below those of the state and the nation. In 2011 the average annual wage in the eight-county study area was $34,716, ranging from $27,885 in Clarendon County to $43,744 in Berkeley County (Table 3-83). On average, study area jobs in Service related sectors paid 36 percent less than jobs in Non-Services related fields.

Table 3-87. Average Annual Wages, 2011

	Average Annual Wage		
	All Sectors	Services	Non-Services
United States	$49,049	$46,983	$57,397
South Carolina	$39,231	$35,731	$49,030
Berkeley	$43,744	$38,522	$59,027
Charleston	$42,354	$37,417	$58,982
Clarendon	$27,885	$22,930	$31,223
Dorchester	$33,109	$26,416	$53,621
Georgetown	$34,815	$27,604	$49,792
Horry	$29,089	$25,999	$38,162
Orangeburg	$33,419	$ 26,611	$39,793
Williamsburg	$33,316	$26,958	$40,369

Source: U.S. Bureau of Labor Statistics, 2012.

While the local economy surrounding the FMNF supports a large share of lower paying service jobs, the unique natural and cultural amenities of the forest may provide addition benefits which help offset these low wages. Living in close proximity to NFS lands provides residents with greater access to open spaces, wildlands and a wide range of recreational opportunities. While local residents may forego higher paying jobs in areas with fewer natural amenities, they gain personal enjoyment from the outdoor experiences they have on the FMNF. Natural amenities, often provided by public lands, have been found to influence population and employment changes

in amenity rich communities (Knapp and Graves 1989, Clark and Hunter 1992, Treyz et al. 1993, Mueser and Graves 1995, McGranahan 1999, Lewis et al. 2002). As a steward of coastal South Carolina's unique natural and cultural amenities, the FMNF increases the attractiveness of local communities and increases regional well-being.

Personal income also includes non-labor income that individuals receive from sources other than an employer. In general there are 2 categories of non-labor income, investment income (dividends, interest, and rent payments) and transfer payments from the government to individuals (Retirement & disability insurance, medical payments, welfare assistance, unemployment, and veteran's benefits). Non-labor income's share of TPI has grown drastically in recent years. In 1970 non-labor income accounted for nearly 18 percent of TPI within the study area and the state of South Carolina. By 2011 non-labor income had grown to represent more than 37 percent of TPI in these regions (Bureau of Economic Analysis, 2012a).

Poverty. Poverty is an important indicator of both economic and social well-being. Individuals with low incomes are more vulnerable to a number of hardships which may negatively affect their health, cognitive development, emotional well-being, school achievement and promote socially unacceptable behavior (Williams 1984, Haan et. al 1986, Battistich et. al 1995, Farrington 1995, Chung 2004, Booth and Caan, 2005, and Hopson and Lee 2011). Following the Office of Management and Budget's Directive 14, the Census Bureau uses a set of income thresholds that vary by family size and composition to detect who is poor. If the total income for a family or an individual falls below the relevant poverty threshold, then the household members are classified as being "below the poverty level."

Table 3-88. Poverty Rates, 2011

	People Below Poverty	Families Below Poverty
United States	14%	10%
South Carolina	17%	13%
Berkeley	14%	11%
Charleston	17%	12%
Clarendon	21%	16%
Dorchester	12%	10%
Georgetown	21%	14%
Horry	17%	12%
Orangeburg	25%	20%
Williamsburg	33%	27%

Source: U.S. Census Bureau 2012.

Relative to the general U.S. population, South Carolina and the eight-county study area had a slightly larger share of residents and families living below the poverty line in 2011 (Table 3-84). Poverty rates were exceptionally high in Clarendon, Georgetown, Orangeburg, and Williamsburg counties, and exceeded rates at both the state and national level (U.S. Census Bureau 2012). In general, low income individuals tend to rely more heavily on natural resources and depend more directly on NFS lands for sustenance and home heating. Since these individuals will be more vulnerable to changes in the management of local resources, it is important for forest management to understand how these forest users may be affected by restricting forest uses.

Forest Users and Contributions to Social and Economic Sustainability. National forests are productive assets which contribute to sustaining the viability of national, regional, and local communities. Uses, products, services, and visitor opportunities supported by NFS lands produce a steady flow of benefits which contribute to the robustness and sustainability of local communities. While robustness implies diversity, sustainability refers to the community's capacity to maintain a certain level of function within the social, ecological, and economic systems it encompasses. Sustainability is a complex idea focused around intergenerational equity. This concept relates to the maintenance and enhancement of resources in order to meet the needs of current and future generations.

Sustainability is difficult to measure since the concept lacks a universally agreed upon definition. The most widely accepted definition of sustainability was developed by the United Nation's Brundtland Commission and has since been incorporated into the2012 Planning Rule, where sustainability is defined as the capability to meet the needs of the present generation without compromising the ability of future generations to meet their needs (36 CFR 219.19). The rule's objective states that plans are to guide management so that forests and grasslands are ecologically sustainable and contribute to social and economic sustainability, as well as to have the capacity to provide people and communities with ecosystem services and multiple uses that provide a range of social, economic, and ecological benefits for the present and into the future. Consequently a framework for evaluating contributions to social and economic sustainability needs to incorporate contributions to beneficiaries of ecosystem services.

For the purposes of examining current social and economic contributions to sustainability, and environmental consequences under the alternatives, criterion #6 of the Montréal Process is used. Criterion #6 and its indicators can be useful for purposes of evaluating social and economic sustainability under the 2012 USFS planning rule (Ng 2014; Ng and Miller 2014). Criterion #6 deals with the maintenance and enhancement of long-term multiple socio-economic benefits to meet the needs of societies (MPWG 2009). Indicators under criterion #6 are mostly discussed qualitatively for communities of interest and quantitatively in the Forest Economic Contributions section. Criterion #6 indicators are:

6.1 Production and consumption

- Volume of wood production
- Total and per capita consumption of wood production
- Non-wood forest product produced or collected
- Total and per capita consumption of non-wood forest produced or collected

6.2 Investment in the forest sector

- Investment and expenditure in forest-related research, extension and development, and education

6.3 Employment and community needs

- Employment in the forest sector
- Resilience of forest-dependent communities
- Area of forest used for subsistence purposes

6.4 Recreation and tourism

- Area of forest available and/or managed for public recreation and tourism

- Number of visits attributed to recreation and tourism

6.5 Cultural, social and spiritual needs and values

- Area of forest managed primarily to protect the range of cultural, social and spiritual needs and values
- The importance of forests to people

Montréal Process (MP) indicators are incorporated into the discussion below of communities of interest and in the section below on Forest Economic Contributions in order to establish a baseline for evaluation of environmental consequences under the alternatives.

Communities Interested in FMNF Management. The long-term viability of communities is dependent upon the social, cultural, and emotional attachments people form with places. Although communities are often thought of in terms of geographical boundaries, communities within the Francis Marion's eight-county study area can be described by their physical place and by their connections to the local landscape. This distinction is best characterized as the difference between communities of place (i.e., people who are bound together because of where they reside, work, visit or otherwise spend a continuous portion of their time) and communities of interest (i.e., people who share a common interest or passion, regardless of their location or degree of interaction) (Patterson et al., 2003). The geographically based community refers to physical or political boundaries and not to the relationships among people who reside within these boundaries. Brown and Duguid describe communities of interest as ―communities-of-communities (Brown and Duguid 1991); they provide unique opportunities to explore the linkages between people and public land that may transcend the geographically defined community. The distinction between place and interest is not mutually exclusive; in fact many communities share location and values, beliefs, and attitudes because community members choose to live near like-minded people.

Uses, products, services, and visitor opportunities supported by National Forests produce a steady flow of benefits, or ecosystem services, which contribute to the sustainability of forest dependent communities. While contributions to communities of place can be measured in terms of the economic activity forest resources support in the local economy (discussed in the "Forest Economic Contributions" section), the social and cultural links between the forest and communities of interest often transcend the boundaries of a physical place. These communities of interest are also beneficiaries of many ecosystem services. People, or beneficiaries, derive well-being from the components of nature they enjoy, consume, or use (Boyd and Banzhaf 2007). Thus communities of interest provide a means of examining connections between communities and ecosystem services that transcend geography. Communities of interest are described below as beneficiaries (in terms of the ecosystem goods and services that they benefit from) and other interests outside the scope of ecosystem services not captured in economic considerations discussed in the "Forest Economic Contributions section."

While each community of interest may have a unique character and unique priorities related to natural resource use, the forest contributes to the livelihood of these communities by facilitating shared values, beliefs, and attitudes associated with the forest's resources. In this manner, The FMNF can be attributed with contributing to the long-term sustainability of several communities of interest. Social sustainability refers to the maintenance of vibrant communities through the ne2rk of relationships, traditions, culture, and activities that connect people to each other and to the land (36 CFR 219.19).). Based on scoping, discussions with forest staff and other input

received from the public communities of interest associated with the FMNF were identified. These communities include:

- Cultural community of interest - protection and access to resources
- Educator, student and researcher community of interest
- Government, Municipal and Residential community of interest
- Non-Use Values community of interest (those who derive benefits from the existence and bequest values of resources, including wildlife, a diverse ecosystem, viewsheds, carbon sequestration and certain designated areas)
- Recreational community of interest - consumptive, including hunting, fishing and food pickers/gathers
- Recreational community of interest - non-consumptive, including art (writing, painting, photography) connecting with history and wildlife viewing
- Recreational community of interest - water (boaters, waders, swimmers and divers)
- Recreational community of interest - Regional and local contributions and effects
- Timber and forest products community of interest - Regional and local contributions and effects
- Subsistence community of interest

A description of each community of interest is provided in Appendix F. Relevant components of social and economic sustainability are also included for each group, consistent with definitions and requirements under the 2012 Planning Rule, applied within the Montréal Process framework described above.

Forest Economic Contributions. The Francis Marion is managed in accordance with the Multiple-Use Sustained-Yield Act of 1960 (16 U.S.C. 528–531) (MUSYA) to sustain the multiple uses of its renewable resources while maintaining the long-term health and productivity of the land. The FMNF's resources are managed for the long-term social and economic benefit of human communities. In addition to tangible and nontangible human benefits, multiple uses mandated under the MUSYA are often economic drivers in rural communities surrounding NFS lands. Economic contributions associated with managing forest resources are generally measured in terms of the jobs and income which they support in forest related industries. In addition to employment and income contributions directly supported by forest expenditures and employment, the forest's resources directly contribute to economic activity in the local Recreation & Tourism and Timber industries which in turn stimulates economic activity in supporting and non-forest related sectors. Employment and labor income generated in these seemingly unrelated sectors are known as the secondary, or indirect and induced effects of economic activity supported by the forest.

Descriptions of economic contributions to the study from Recreation, Timber & Forest Products, Forest Expenditures & Employment and Payments to States & Counties are provided in Appendix F. Relevant components of economic sustainability are also included for these forest uses, consistent with definitions and requirements under the 2012 Planning Rule, applied within the Montréal Process framework described above.

3.4.14.2 Environmental Consequences

The previous sections assessed social and economic conditions and trends in order to establish a baseline in which potential consequences could be measured against. The following section will

consider the potential consequences of alternative management scenarios on the social and economic environment.

Methodology. The following economic impact analysis quantifies changes in local employment and labor income levels as a result of alternative management strategies. These impacts were estimated using a customizable input-output model known as IMPLAN Professional Version 3.0 and the Forest Economic Analysis Spreadsheet Tool (FEAST), with 2012 data. This model provides a snapshot of the local economy, from 2012, and uses forest inputs (resource outputs, recreation visits, etc.) so that effects can be isolated.

In addition to economic impacts, management of the FMNF may also have social consequences not reflected in employment and labor income effects from IMPLAN and FEAST. Potential social impacts are discussed for communities of interest, as they relate to key ecosystem services, identified as part of the assessment process, input received from the public and internal discussions with forest staff.

Effects also address how the alternatives may affect the social and economic sustainability of communities of interest and from forest economic contributions. This method, utilizing criterion #6 of the Montréal Process is discussed above in the affected environment since current trends are presented as context for evaluation under the alternatives. Indicators under criterion #6 are mostly discussed qualitatively for communities of interest and quantitatively in the "Forest Economic Contributions" sections.

Assumptions. The following list presents the basic assumptions related to the social and economic analysis of potential impacts resulting associated with management of the FMNF under the alternatives.

- The economic analysis assesses economic impacts (net changes to the region's economy attributable to the resource outputs projected under each alternative) and does not provide measures for social welfare which could be interpreted as economic benefits or costs.
- Regional economic impacts are estimated on the basis of the assumption of full implementation of each alternative. The actual changes in the economy would depend on individuals taking advantage of the resource-related opportunities that would be supported by each alternative. If market conditions or trends in resource use were not conducive to developing opportunities, the impact on the economy would be different than estimated here.
- Resource specialists projected annual resource outputs based on the best available information and professional judgment. The purpose of the economic analysis is to compare the relative impacts of the alternatives and should not be viewed as absolute economic impacts.
- Salary and non-salary related expenditures associated with administering the Francis Marion are assumed to be allocated to different economic sectors based on spending profiles developed by the U.S. Forest Service. It is difficult to project future salary and non-salary forest expenditures since congressional appropriations vary each year. The Forest's annual budget was assumed to remain constant under all alternatives since the FMNF exhausts its annual budget each year and changes in management are unlikely to effect the amount of funds the Forest receives to cover operating costs.
- This analysis does not address livestock grazing. The Francis Marion has not had an active range program since 1970, and there have not been any special use requests to use

the Forest for grazing or to designate allotments since 2005. Although prescribed grazing has been proposed as a tool to reduce hazardous fuels in non-riparian areas, lack of existing infrastructure and necessity for specialized browsers would prohibit this method from being cost effective.

Effects Common to all Alternatives

Implementation of all alternatives will comply with valid existing rights, federal regulations, Forest Service policies, and other requirements. While implementing alternative management strategies on the Francis Marion has the potential to impact local businesses and industrial sectors, the contribution of the FMNF to the local economy, and the relative differences between the alternatives, would not be large enough to cause measurable changes to local economic diversity (the number of economic sectors) or economic dependency (which occurs when the local economy is dominated by a limited number of industries). Shifts in emphasis are likely to occur over the next 20 years; however these changes would not result from actions implemented under this forest plan.

Population Growth and Density: As mentioned in the "Affected Environment" section, a portion of population growth in this region can be attributed to the scenic beauty and outdoor recreation supported by the FMNF. Communities surrounding the Francis Marion have become increasingly attractive as places to live because of their proximity to open spaces and natural settings which provide residents with easy access to recreational opportunities year round. Under all the alternatives, these open spaces and natural settings would continue to support quality of life for area communities and a portion of population growth. For communities where rural to urban transition is feared, for Gullah Geechee example, in the Wando, Wambaw and Santee Resource Integration Zones, the FMNF will continue to act as a buffer to these changes. This buffering effect will foster continued social sustainability for Cultural communities of interest, Non-Use Values community of interest and the consumptive recreation community of interest.

Forest Expenditures and Employment: Overall trends show that annual budgets for National Forests across the US have been declining. Since congressional appropriations that support salary and non-salary forest expenditures have become increasingly variable, it is difficult to forecast the Francis Marion's future fiscal capabilities with any certainty. Future salary and non-salary expenditures associated with administering these NFS lands are anticipated to continue to exhaust the Forest's budget each year, and would be allocated between resource programs based on priorities identified through adaptive management.

Under all alternatives, field support for the FMNF would continue to come from the District Ranger's Office in Huger, while additional financial and administrative support will be provided by the Forest Supervisor's Office (SO) in Columbia, SC. Annual salary and non-salary expenditures associated with administering these lands will fluctuate based on amount of funds allocated to the Francis Marion by the SO, and are anticipated to be fully exhausted each year. Management actions implemented under the alternatives are not expected to have an effect on annual funding allocations to the Forest. Consequently, total forest expenditures (including salary and non-salary expenses) will be constant across the alternatives.

If future expenditures remained relatively constant, forest spending would support 148 jobs (direct, indirect and induced) and approximately $9.8 million in local labor income on annual average. These economic contributions would be distributed across the eleven (Berkeley, Calhoun, Charleston, Clarendon, Dorchester, Georgetown, Horry, Lexington, Orangeburg, Richland, and Williamsburg) counties which surround the FMNF and its SO (IMPLAN 2012).

Fluctuations in future forest spending may affect future economic contributions, but are unlikely to affect overall economic diversity or dependency of surrounding communities.

Payments to States and Counties: Although the future of receipt-sharing and per acre federal land payment programs is uncertain, the Twenty Five Percent Fund Act of 1908 guarantees South Carolina a 7-year rolling average of receipts from the FMNF. A portion of which, will be returned to Berkeley and Charleston counties to fund local schools and roads. In addition to 25-percent payments, Berkeley and Charleston counties will receive PILT payments through FY15. No precise dollar figure can be given in advance for each year's PILT authorized level.

State and county payments associated with the FMNF would continue to help fund schools, roads, public services such as law enforcement and emergency services. The PILT program may or may not continue to be funded, and Congress could initiate new discretionary or non-discretionary federal land payment programs over the next twenty years. State and county federal land payments, in whatever form they take on, will continue to be essential to balancing tight local budgets. As these revenues are invested in the maintenance and improvement of local infrastructure and public services, they will contribute to the sustainability and health of local communities by supporting a portion of the valuable services these local governments provide. In addition, employment opportunities in both the public and private sectors would continue to be supported.

Cumulative Effects Common to All Alternatives

Population Growth and Density: Future population projections suggest that migration will likely play an increasing role in population changes as national, state, and county populations grow. As shown in Table 3-85, South Carolina and the eight-county study area are projected to grow faster than the general U.S. population. Projections indicate that Berkeley, Dorchester and Horry counties will continue to experience high levels of population growth while Williamsburg County is expected to experience further population loss (South Carolina Budget and Control Board, 2013). These forecasts show that study area growth is anticipated to remain concentrated in communities which offer residents relatively easy access to recreation, open space and wildlands provided by the FMNF.

These population projections reflect continued urban, suburban, and ex-urban development, enabling counties surrounding the FMNF to become more densely populated. Growth within these counties is unlikely to be distributed evenly among local communities and can cause some areas to become more urban while others become increasingly more decentralized. Though residents, community officials, and government agencies have been working together to mitigate the effects of continued urban growth in the region, the region surrounding the FMNF is anticipated to become increasingly more urban. Even assuming urban development would slow, the urban area surrounding the Charleston Metropolitan area is predicted to triple by 2030 (Allen and Lu 2003).

Table 3-89. Population Projections 2015-2030

	2015	2020	2025	2030	Growth Between 2010 and 2030
United States	321,363,000	333,896,000	346,407,000	358,471,000	16.1%
South Carolina	4,823,200	5,020,800	5,235,500	5,451,700	17.9%
8 County Area	1,218,500	1,280,800	1,344,500	1,408,400	21.8%
South Carolina Counties:					
Berkeley	187,800	197,700	208,400	219,100	23.2%
Charleston	360,600	370,900	383,800	396,700	13.3%
Clarendon	35,600	36,300	37,400	38,600	10.4%
Dorchester	152,000	167,400	178,800	190,200	39.3%
Georgetown	61,300	62,500	63,800	65,100	8.2%
Horry	294,600	319,900	345,800	371,700	38.0%
Orangeburg	92,800	93,000	93,500	94,100	1.7%
Williamsburg	33,800	33,100	33,000	32,900	-4.4%

Source: U.S. Census Bureau 2012, South Carolina Budget and Control Board, 2013.

Growing populations and the encroachment of human development will place greater demand on forest resources and may affect the natural aesthetics, uses and values of multiple FMNF communities of interest presented above. Forest management can expect to be tasked with maintaining the quality of visitors' experiences while providing forest products and unique cultural and recreational experiences to a greater number of people. The pressure of native landscapes to adapt to these conflicting pressures threatens the forest's sense of place and the quality of life in communities surrounding the forest (Stedman 2003). For communities of interest across the planning area these pressures may have detrimental effects on quality of life that may be alleviated by presence of forest service land shielding communities from increased urbanization. For example, the southwest portion of the Francis Marion is near one of the most rapidly urbanizing areas in South Carolina; FMNF land may buffer communities in the Wando Resource Integration Zone from this urbanization.

Alternative 1

Effects.

Cultural Community of Interest - Protection and Access to Resources: Traditional cultural practices would continue to be supported under existing management but would not be enhanced through targeted management, under the other alternatives, to reduce fuels and improve early successional habitats important in the provision of forest products (such as sweetgrass, mushrooms, etc.). As a result this alternative would contribute less to important cultural practices that rely on these products; thereby contributing less to their resilience and social and economic sustainability as a forest-dependent community.

As mentioned above cultural practices depend on water from the FMNF. Continued cultural benefits would be provided under this alternative however cultural communities of interest would not benefit from direction targeted to improve hydrologic function included under the other alternatives. Direction under this alternative on threatened and endangered species would continue to protect species of cultural importance however, additional at risk species have been identified that were not included in the 1996 Forest Plan. Thus this alternative would not support

the same levels of protection as provided by the other alternatives important for cultural communities of interest. The lack of additional direction to improve hydrologic function and additional threatened and endangered species would contribute less to cultural communities' quality of use and appreciation of these resources. In turn the contribution to their resilience and sustainability would be less under this alternative than the other alternatives.

Areas designated for management play an important role in the social and economic sustainability of cultural communities of interest. Under this alternative areas on the forest are not currently managed to meet the specific needs of the Gullah Geechee or other cultural communities of interest. Under the other alternatives, Resource Integration Zones would be specifically managed to protect the range of cultural, social and spiritual needs and values of these crossroad communities and would thus contribute more to social and economic sustainability.

Educator, Student and Researcher Community of Interest: Existing opportunities for this group of beneficiaries are dependent on wilderness opportunities to understand, communicate and educate. As a result these designated areas play an important role in the social sustainability of this community of interest. Opportunities and management of existing wilderness would continue to benefit this group (such as trail use within current Wilderness) however, educators, student and researches would not benefit from the increased opportunities associated with additional acres being recommended for wilderness designation, as in Alternative 3. As a result this alternative would contribute less than Alternative 3 to their social sustainability with fewer opportunities to understand, communicate and educate.

Water resources are important for educators, students and researchers. For example, these groups use the Hydrologic lab at Santee Experimental Forest and Outfitter/guides use rivers and streams for environmental education. Continued benefits would be provided under this alternative however educators, student and researches would not benefit from direction targeted to improve hydrologic function under the other alternatives. Existing opportunities to understand, communicate and educate would be supported by existing direction on threatened and endangered species however, additional at risk species have been identified that were not included in the 1996 Forest Plan. Thus, this alternative would not include the additional opportunities provided by additional species protection under the other alternatives. The lack of additional direction to improve hydrologic function and additional threatened and endangered species would contribute less to the quality of use and appreciation of these resources for this community of interest. In turn the contribution to their resilience and sustainability would be less under this alternative than the other alternatives.

Government, Municipal and Residential Community of Interest: Direction under the 1996 Forest Plan, on protection of riparian areas and wetlands, would continue to protect infrastructure and property values important to local governments, municipalities and private land owners. However, these groups would not benefit from targeted direction, under the other alternatives, on restoration of hydrologic function.

Government, municipalities and private landowners would continue to benefit from current management that controls the buildup of hazardous fuels adjacent to communities and infrastructure. However, these beneficiaries would not benefit from additional direction under the other alternatives addressing smoke effects with and other benefits from Community Wildfire Protection Planning. As a result this alternative would provide less of a sense of protection and quality of life for these beneficiaries than the other alternatives.

Non-Use Values Community of Interest: Management of existing wilderness would continue to benefit non-use values held by the non-use community of interest that derive benefits from the existence and bequest values of wilderness that people may not use but recognize value in their importance of forests. These beneficiaries would find satisfaction with not losing an available resource but they would not accrue additional benefits from the additional acres being recommended for wilderness designation under Alternative 3. As a result, this alternative would contribute less to the range of cultural, social and spiritual needs imbedded in non-use values held by this community. In this manner contributions to their well-being and sustainability would be less than Alternative 3.

Existing protection of threatened and endangered species would support existing non-use values associated with T&E species however, additional at risk species have been identified that were not included in the 1996 Forest Plan. Thus this alternative would not support additional non-use values provided by species protection under the other alternatives.

Recreational Community of Interest: Continued consumptive and non-consumptive recreation benefits would be provided under this alternative given the benefit to scenery, resource integrity and associated recreation experiences supported by prescribed burning to restore longleaf pine on dry upland sites. However, the lack of targeted management, compared to the other alternatives, to reduce fuels and improve early successional habitats would not support increases in benefits to consumptive recreation uses, such as improvements in habitats important for foragers, pickers and hunters. As a result this alternative would contribute less to recreational uses that support community sustainability by contributing less to their range of cultural and social needs and values.

Direction under the 1996 Forest Plan, on protection of riparian areas and wetlands, would continue to protect water resources and expected experiences important for boating, recreational fishing and commercial fishing resources. However, this community of interest would not benefit from direction, under the other alternatives, on restoration of hydrologic function. The lack of additional direction to improve hydrologic function would contribute less to the quality of experience, use and appreciation of water resources on the FMNF. In turn the contribution to their resilience and sustainability would be less under this alternative than the other alternatives.

Management of existing wilderness would continue to benefit non-consumptive recreation uses; specifically those that value opportunities for inspiration (such as writing, painting or photogrophy), wildlife viewing and connecting with history. These beneficiaries would not experience the increased benefits from the additional acres being recommended for wilderness designation under Alternative 3. As a result, this alternative would contribute less to the range of cultural, social and spiritual needs of wilderness recreationists. In this manner contributions to their well-being and sustainability would be less than Alternative 3.

Timber and Forest Products Community of Interest: Contributions important to local economies, businesses and people, from non-timber forest product resources, would continue to be supported under existing management but would not be enhanced through targeted management, under the other alternatives, to reduce fuels and improve early successional habitats important in the provision of forest products (such as sweetgrass, mushrooms, etc.). As a result this alternative would contribute less to the local economy, businesses and people that rely on these products; thereby contributing less to their resilience and social and economic sustainability as a forest-dependent community.

Subsistence Community of Interest: Effects to subsistence users of the FMNF are covered under Environmental Justice considerations

Recreation Related Economic Effects: Under this alternative, current management would continue to provide existing recreational opportunities, largely for dispersed use, including hunting and fishing and trail use, both motorized and non-motorized. With unanticipated changes to future population and unknown changes in recreation use patterns recreation specialists estimated a range of visitation use based on population projections for the study area over the period from 2010 to 2030. Under this alternative, anticipated increases in recreation visits from just population change (no change in recreation management) are expected to be from 5 to 10 percent over current annual visits. As a result of these increases, an additional 6 to 12 jobs would be added to the study area economy, in addition to the 116 jobs currently supported (see Table 3-86 and Appendix F discussion). In addition, from $196,000 to $392,000 in labor income would also be added to the study area economy as a result of these increases, in addition to the $3.9 million currently supported (IMPLAN 2012).

Table 3-90. Employment and Labor Income Effects from Recreation

	Alt 1 min	Alt 1 max	Alt 2 min	Alt 2 max	Alt 3 min	Alt 3 max
Jobs (full- and part-time)	6	12	12	23	6	12
Labor Income (2015 dollars)	$195,952	$391,903	$391,903	$783,806	$195,952	$391,903

As noted in “Affected Environment” section, trends suggest that the economic base of nearby communities is shifting towards service businesses that rely, in part, on outdoor recreation. Under this alternative, the FMNF would continue to contribute to economic sustainability, by supporting local and non-local recreation opportunities that contributes to the tourism industry. While these contributions are small relative to the size of recreation related industries within the 8 county study area (less than 1 percent) they are more important for smaller gateway communities and individual businesses. In this way the recreation supported by the FMNF would continue to contribute towards sustainability and the resilience of forest-dependent communities.

Timber & Forest Products Related Economic Effects: Under this alternative current management would continue to provide timber and forest products to the study area economy. Projected wood sale quantity under this alternative is far greater than current yields given productivity increases anticipated within the sustained yield limit. As noted in the Forest “Products/Timber Harvesting” section, data indicate that proposed harvest levels are very sustainable and that over the last 2 years the FMNF has grown approximately 28 million board feet (MMCF) per year. As a result of this growth projected wood sale quantity, over the first decade would be 98.6 MMCF per year (Table 3-59 in the “Forest Products/Timber Harvesting” section). Harvest and processing of this material, in the 8 county study area, would add 333 jobs and $13.2 million in labor income in addition to the 57 local jobs and $2.5 million currently provided (see Table 3-87 and Appendix F for further discussion of current contributions to the timber industry) (IMPLAN 2012). This increase is due to anticipated increases over the life of the plan with maturation of trees, established after Hurricane Hugo devastated the South Carolina coast in 1989. These trees have grown to a merchantable size and anticipated levels of harvest are expected to increase supporting large increases in employment supported by material from the FMNF.

Table 3-91. Employment and Labor Income Effects from Timber & Forest Products

	Alternative 1	Alternative 2	Alternative 3
Jobs (full- and part-time)	333	323	339
Labor Income (2015 dollars)	$13,198	$13,096	$13,712

These may not be new jobs or income, but rather jobs and income that can be attributed to this plan. Existing capacity at existing wood product processing facilities would process much of this material. New jobs are created from 2 principal sources; local unemployment and in-migration. It is impossible to estimate the levels of inmigration or filled unemployment resulting in new income. Regardless these jobs would contribute to forestry, logging and primary and secondary wood processing sectors in the 8 county study area. While these contributions are small relative to the size of the manufacturing and agriculture sectors in the 8 county study area (less than 1 percent) they are more important for smaller communities and individual businesses. In this way the timber and wood product volume from the FMNF would continue to contribute towards sustainability and the resilience of forest-dependent communities under this alternative.

Cumulative Effects. Cumulative effects under this alternative are discussed under the section on Cumulative Effects Common to All Alternatives.

Alternative 2

Effects.

Cultural Community of Interest - Protection and Access to Resources: Traditional cultural practices would be enhanced through targeted management of fire-adapted human communities in Resource Integration Zones. Management would focus on reducing fuels and improving early successional habitats that are desired. For example, early successional habitats important in the provision of forest products (such as sweetgrass, mushrooms, etc.) would continue to be made available and resource availability could improve with targeted management. As a result, this alternative would contribute more to important cultural practices that rely on these products; thereby contributing more to their resilience and social and economic sustainability as a forest-dependent community.

Under this alternative, cultural benefits would be enhanced from direction targeted to improve hydrologic function not included under Alternative 1. This direction would improve the quality of cultural practices that depend on water and practiced on the FMNF. Direction under this alternative on threatened and endangered species would continue to protect species of cultural importance, included in the 1996 Forest Plan, and would provide management direction for additional at risk species. Thus this alternative would support greater levels of protection than Alternative 1. The additional direction to improve hydrologic function and additional direction for threatened and endangered species would contribute more to cultural communities' quality of use and appreciation of these resources. In turn, the contribution to their resilience and sustainability would be more under this alternative than the other alternatives.

***Educator, Student and Researcher Community of Interest*:** Opportunities and management of existing wilderness would continue to benefit this group (such as trail use within current Wilderness) however, educators, student and researches would not benefit from the increased opportunities associated with additional acres being recommended for wilderness designation under Alternative 3. As a result, this alternative would contribute less to the social sustainability of this group than Alternative 3.

Educators, student and researches would benefit from additional direction under this alternative, which is targeted to improve hydrologic function. In addition, opportunities to understand, communicate and educate would be further supported by additional direction on threatened and endangered species not identified in the 1996 Forest Plan. Thus, this alternative would support additional opportunities provided by additional species protection than Alternative 1. The additional direction to improve hydrologic function and additional protection for threatened and endangered species would contribute more to the quality of use and appreciation of these resources for educators, students and researchers. By protecting water resources and habitats, the FMNF contributes to sustaining communities' interests for current generations and providing opportunities to pass knowledge down to future generations. In turn, the contribution to their resilience and sustainability would be more under this alternative than Alternative 1.

Government, Municipal and Residential Community of Interest: Under this alternative, targeted direction on restoration of hydrologic function would protect infrastructure and property values important to local governments, municipalities and private land owners. This direction would go beyond that provided under Alternative 1 which focuses only on protection of riparian areas and wetlands, and not on restoration of hydrologic function. Threats on adjacent land (such as fire, insect and pest invasion) would be less under this alternative through targeted management of fire-adapted human communities in Resource Integration Zones. Management would focus on reducing fuels and improving early successional habitats that are desired. As a result, this alternative would contribute more to the sense of security for this community of interest; thereby contributing more to their resilience and social and economic sustainability of local government, municipalities and residents.

Under this alternative, the community of interest would experience improvements over alternative 1 in smoke management and treatment of fuels using alternative methods for maintaining fire-adapted human communities in Resource Integration Zones. Improvements would be realized with alternative fuels reduction techniques (such as mechanical, chemical, and biological) with no additional smoke production (see "Fire Adapted Human Communities" section for further information. In addition, the combination of prescribed fire and non-smoke producing treatments, under this alternative, would reduce fuel loading in proximity to human communities, which could result in less severe wildfire and less associated smoke than Alternative 3 (section 3.2.3 Air Quality). As a result, this alternative would provide more of a sense of protection and quality of life for these beneficiaries than the other alternatives.

Non-Use Values Community of Interest: Effects to this community of interest would be the same as discussed under Alternative 1.

Additional species protection, for T&E species identified but not included in the 1996 Forest Plan, would provide additional non-use value, over Alternative 1, for these beneficiaries who derive benefits from the existence and bequest values of wildlife and a diverse ecosystem. As a result, this alternative would contribute more to the range of cultural, social and spiritual needs imbedded in non-use values held by this community. In this manner contributions to their well-being and sustainability would be more than Alternative 1.

Recreational Community of Interest: Forest product resources, important for commodity based recreation (food pickers and gathers), would be enhanced through targeted management in Resource Integration Zones to improve desired-early successional habitats. For example, berries, mushrooms and animal habitats would continue to be made available and resource availability could improve with targeted management. As a result, this alternative would contribute more to

recreational uses that support community sustainability by contributing more to their range of cultural and social needs and values.

Under this alternative, targeted direction on restoration of hydrologic function would protect water resources and expected experiences important for boating, recreational fishing and commercial fishing resources. This direction would go beyond that provided under Alternative 1 which focuses only on protection of riparian areas and wetlands, and not on restoration of hydrologic function. The additional direction to improve hydrologic function would contribute more to the quality of experience, use and appreciation of water resources on the FMNF. In turn the contribution to their resilience and sustainability would be more than under Alternative 1.

Effects to the non-consumptive recreation community would be the same as described under Alternative 1.

Timber and Forest Products Community of Interest: Non-timber Forest product resources would be enhanced through targeted management of fire-adapted human communities in Resource Integration Zones to reduce fuels and improve early successional habitats that are desired (such as sweetgrass, mushrooms, etc.). For example, material for basket weaving would continue to be made available and resource availability could improve with targeted management under this alternative. As a result, this alternative would contribute more to the local economy, businesses and people that rely on these products; thereby contributing more to their resilience and social and economic sustainability as a forest-dependent community.

Subsistence Community of Interest: Effects to subsistence users of the FMNF are covered under Environmental Justice considerations.

Recreation Related Economic Effects: Under this alternative, management would focus on collaborative efforts and partnerships. Trails and dispersed recreation opportunities would increase with management in four distinct zones that help focus recreation opportunities. In addition, four rivers would be eligible for wild and scenic designation. As a result, anticipated increases in recreation visits are expected to be from 10 to 20 percent over current annual visits. As a result of these increases, an additional 12 to 23 jobs would be added to the study area economy, in addition to the 116 jobs currently supported (see Table 3-87 and Appendix F discussion). In addition, from $392,000 TO $784,000 in labor income would also be added to the study area economy as a result of these increases, in addition to the $3.9 million currently supported (IMPLAN 2012).

As noted in the “Affected Environment” section, trends suggest that the economic base of nearby communities is shifting towards service businesses that rely, in part, on outdoor recreation. Under this alternative, the FMNF would continue to contribute to economic sustainability, by supporting local and non-local recreation opportunities that contributes to the tourism industry. While these contributions are small relative to the size of recreation related industries within the 8 county study area (less than 1 percent) they are more important for smaller gateway communities and individual businesses. In this way the recreation supported by the FMNF would continue to contribute towards sustainability and the resilience of forest-dependent communities under this alternative.

Timber & Forest Products Related Economic Effects: Alternative 2 would have approximately 10,000 acres more than Alternative 1 of lands suitable for timber production. However these additional acres are not as productive as under Alternative 1. As noted under Alternative 1, projected wood sale quantity under this alternative is far greater than current yields given

productivity increases; over the last 2 years the FMNF has grown approximately 28 MMCF per year. As a result of this growth projected wood sale quantity, over the first decade would be slightly greater than Alternative 1 at 98.6 MMCF per year (see Table 3-59 in the "Forest Products/Timber Harvesting" section). While overall yields would be greater than Alternative 1 decreases are anticipated for harvest of material that would be processed as sof2od pulp and hardwood sawtimber. These decreases result in fewer anticipated jobs and labor income than Alternative 1. Regardless of this decrease this alternative would result in an additional 324 jobs and $13.1 million in labor income in addition to the 57 local jobs and $2.5 million currently provided (see Table 3-87and appendix aa for further discussion of current contributions to the timber industry)(IMPLAN 2012).

These may not be new jobs or income, but rather jobs and income that can be attributed to this plan. Existing capacity at existing wood product processing facilities would process much of this material. New jobs are created from 2 principal sources; local unemployment and in-migration. It is impossible to estimate the levels of inmigration or filled unemployment resulting in new income. Regardless these jobs would contribute to forestry, logging and primary and secondary wood processing sectors in the 8 county study area. While these contributions are small relative to the size of the manufacturing and agriculture sectors in the 8 county study area (less than 1 percent) they are more important for smaller communities and individual businesses. In this way the timber and wood product volume from the FMNF would continue to contribute towards sustainability and the resilience of forest-dependent communities under this alternative.

Cumulative Effects. Cumulative effects under this alternative are discussed under the section on "Cumulative Effects Common to All Alternatives."

Alternative 3

Effects.

Cultural Community of Interest - Protection and Access to Resources: Same as discussed under Alternative 2.

Educator, Student and Researcher Community of InterestL: Educators, student and researches would receive additional benefits from the increased opportunities associated with the acres being recommended for wilderness designation under this alternative. Additional protection for Threatened and Endangered species and hydrologic function under this alternative over Alternative 1, would also increase opportunities to understand, communicate and educate. By managing additional areas suitable for wilderness designation and protecting habitats, the FMNF contributes to sustaining communities' interests for current generations and providing opportunities to pass knowledge down to future generations. As a result this alternative would contribute more to their social sustainability, than the other alternatives.

Government, Municipal and Residential Community of Interest: Benefits from improved hydrologic function and targeted management of fire-adapted human communities in Resource Integration Zones would be the same as discussed under Alternative 2.

Under alternative 3, less smoke from prescribed fire would be appreciated by adjacent government, municipal and residential communities. However, more smoke over longer periods of time, than alternative 2 could result from wildfires starts in untreated fuels (section 3.2.3 Air Quality). As a result this alternative would provide less of a sense of protection and quality of life for these beneficiaries than Alternative 2.

Non-Use Values Community of Interest: Additional non-use value, over the other alternatives, would be experienced from additional acres recommended for wilderness designation in Hellhole Bay Extension, Little Wambaw Swamp Extension and Wambaw Swamp Extension. As a result, this alternative would contribute more to the range of cultural, social and spiritual needs imbedded in non-use values held by this community. In this manner contributions to their well-being and sustainability would be more than Alternative 2.

Benefits from additional species protection, for T&E species identified but not included in the 1996 Forest Plan, would be the same as discussed under Alternative 2.

Recreational Community of Interest: Effects to recreation uses and boating opportunities, from targeted management in Resource Integration Zones and improved hydrologic function, would be the same as discussed under Alternative 2.

Non-consumptive recreationist would experience additional benefits, over the other alternatives, from additional acres being recommended for wilderness designation in Hellhole Bay Extension, Little Wambaw Swamp Extension and Wambaw Swamp Extension. Wilderness recreationists would also experience additional benefits from the additional acres recommended for wilderness designation under Alternative 3. As a result, this alternative would contribute more to the range of cultural, social and spiritual needs of wilderness recreationists. In this manner contributions to their well-being and sustainability would be more than Alternative 2.

Timber and Forest Products Community of Interest: Effects to this community of interest from effects to non-timber Forest product resources are discussed under Alternative 2

Subsistence community of Interest: Effects to subsistence users of the FMNF are covered under Environmental Justice considerations

Recreation Related Economic Effects: Under this alternative, additional acreage would be recommended for wilderness designation. There would be no increase in developed sites or land-based trails. Recreation opportunities would be managed in 3 distinct zones and four rivers would be eligible for wild and scenic designation, as under Alternative 2. As a result, anticipated increases in recreation visits are expected to be from 5 to 10 percent over current annual visits. As a result of these increases, an additional 6 to 12 jobs would be added to the study area economy, in addition to the 116 jobs currently supported (see Table 3-86 and Appendix F discussion). From $196,000 to $392,000 in labor income would also be added to the study area economy as a result of these increases, which is in addition to the $3.9 million currently supported (IMPLAN 2012).

As noted in the “Affected Environment” section, trends suggest that the economic base of nearby communities is shifting towards service businesses that rely, in part, on outdoor recreation. Under this alternative, the FMNF would continue to contribute to economic sustainability, by supporting local and non-local recreation opportunities that contributes to the tourism industry. While these contributions are small relative to the size of recreation related industries within the 8 county study area (less than 1 percent) they are more important for smaller gateway communities and individual businesses. In this way the recreation supported by the FMNF would continue to contribute towards sustainability and the resilience of forest-dependent communities under this alternative.

Timber & Forest Products Related Economic Effects: Alternative 3 would have approximately 17,000 acres fewer than Alternative 2 of lands suitable for timber production; mostly due to the

additional acres being recommended for wilderness . However, there would be an increase in pine lands managed for loblolly pine, instead of longleaf pine, and an increase of lands allocated to management Area 2 (with more frequent rotations) than under the other alternatives. As a result of this growth, projected wood sale quantity, over the first decade would be greater than the other alternatives at 100.4 MMCF per year (Table 3-59 in the "Forest Products/Timber Harvesting" section). These increases result in an additional 340 jobs and $13.7 million in labor income in addition to the 57 local jobs and $2.5 million currently provided (Table 3-87 and appendix aa for further discussion of current contributions to the timber industry) (IMPLAN 2012).

These may not be new jobs or income, but rather jobs and income that can be attributed to this plan. Existing capacity at existing wood product processing facilities would process much of this material. New jobs are created from 2 principal sources; local unemployment and in-migration. It is impossible to estimate the levels of inmigration or filled unemployment resulting in new income. Regardless these jobs would contribute to forestry, logging and primary and secondary wood processing sectors in the 8 county study area. While these contributions are small relative to the size of the manufacturing and agriculture sectors in the 8 county study area (less than 1 percent) they are more important for smaller communities and individual businesses. In this way the timber and wood product volume from the FMNF would continue to contribute towards sustainability and the resilience of forest-dependent communities under this alternative.

Cumulative Effects. Cumulative effects under this alternative are discussed under the section on "Cumulative Effects Common to All Alternatives."

3.5 Other Effects

3.5.1 Environmental Justice

3.5.1.1 Affected Environment

In 1994, President Clinton issued Executive Order 12898. This order directs federal agencies to focus attention on the human health and environmental conditions in minority and low-income communities. The purpose of EO 12898 is to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects on minority and low-income populations.

Environmental justice (EJ) is the fair treatment and meaningful involvement of people of all races, cultures, and incomes, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. The goal of environmental justice is for Federal agencies to identify impacts that are disproportionately high and adverse with respect to minority or low-income populations and identify alternatives that will avoid or mitigate those impacts.

Census data presented in previous sections describing the demographics and economic conditions of communities surrounding the FMNF indicate that there is a concentration of minority and low-income populations within the planning area. These EJ populations are most prevalent outside of Charleston in the area known as the Cainhoy peninsula. Located at the confluence of Charleston and Berkeley counties, this area includes nearly 2 dozen small communities that create the contiguous communities of Cainhoy, Wando and Huger. These are primarily heirs' property communities where land, purchased by former slaves after emancipation, has been passed down from generation to generation without formal wills. In the absence of official documentation,

these lands have remained in communal ownership outside the jurisdiction of any one entity for hundreds of years.

The area known as Cainhoy lies within the Gullah-Geechee Cultural Heritage Corridor, a congressionally designated National Heritage Area created to preserve the unique African-based heritage and culture of slave-descendants who continue to live along the Southern Atlantic Seaboard. Communities within this corridor share a common history rooted in farming, logging, and slavery; and take great pride in their culture, sense of place, and strong devotion toward family. Residents of Cainhoy are primarily African Americans who identify themselves as "Gullah" or "Geechee," who continue to carry on the language, arts, crafts, religious beliefs, folklore, rituals and food preferences of their African and African American ancestors. Although many historic Gullah communities have transitioned from agriculture and bartering to a more cash and services based economy, many residents of these rural areas maintain strong ties to the land and rely on subsistence farming, fishing, hunting, bartering and small-scale marketing of subsistence and artisan products for a portion of their income.

3.5.1.2 Environmental Consequences

As discussed in the Affected Environment, EJ populations exist within the 8-county planning area. Populations most at risk of experiencing disproportionately high and adverse human health or environmental effects include low-income households and African Americans who identify ethnically as Gullah Geechee. These populations are not mutually exclusive and have been identified as being dispersed throughout the planning area. Although census data for crossroad communities is unavailable, EJ populations are likely most concentrated in the small, unincorporated, crossroad communities scattered across the socioeconomic study area.

In addition to supporting subsistence lifestyles, these lands are directly attributed with helping to sustain the unique ethnic identity, cultural heritage, and African based traditions of the Gullah Geechee people. Gullahs who continue to live within the socioeconomic study area gather sweet grass to practice the ancient African art of basket making; farm the land settled by their emancipated ancestors; pay homage to their West African traditions by keeping alive folk traditions and beliefs; and continue to make a living fishing, shrimping and harvesting oysters using handmade nets in the same coastal waters as generations before them.

Under all the alternatives continued management of the Francis Marion's ecosystems for ecological integrity and healthy, plant, fish and wildlife populations will contribute to the resilience of these forest-dependent communities. These contributions are a vital part of Gullah Geechee community and will continue to contribute to their community sustainability under all the alternatives.

The forest has developed a land ownership adjustment strategy that prioritizes exchanges and acquisitions of national forest lands. Lands that have lost their national forest character or are isolated tracts are a priority for conveyance. Lands that consolidate national forest and connect ecological systems are a priority for acquisition. Land acquisition near crossroad communities may buffer these changes and increase community resilience and sustainability under the alternatives. Land conveyance near crossroad communities may decrease community resilience and community sustainability under the alternatives. Future site specific decisions need to examine each land tenure decisions relative to uses and lifestyles of area Environmental Justice communities.

Cumulative Effects

Lands and natural resources administered as the FMNF enable current generations to reconnect with the values, traditions, and lifestyles of their ancestors. Although the Gullah Geechee are working hard to preserve and pass on the values, traditions, and lifestyles of their African ancestors, rapid coastal development and soaring coastal property values will continue to threaten the unique sense of place of crossroad communities and push Gullah families off ancestral lands under alternatives.

3.5.2 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 was analyzed using an EXCEL spreadsheet model (See Appendix B), to ensure that the minimum standards could be met. The alternative was changed if some aspect did not meet any of the minimum standards. Through this analysis, long-term productivity of the national forest's ecosystems is assured for all alternatives.

As stated earlier, the effects of short-term or long-term uses are extremely complex, and depend on management objectives and the resources that are emphasized. No alternative would be detrimental to the long-range productivity of the Francis Marion National Forest.

The effects of implementing the Forest Plan will be monitored at the forest level. Broad-scale monitoring will focus on changes in the environment that may affect resources on the Francis Marion National Forest. Evaluation of the monitoring data collected will determine if standards for long-term productivity are being met, or if management practices need to be adjusted. A monitoring plan is included in Chapter 4 of the Forest Plan.

3.5.3 Irreversible and Irretrievable Commitment of Resources

Irreversible and irretrievable commitments of resources are normally not made at the programmatic level of a Forest Plan. Irreversible commitments are decisions affecting non-renewable resources such as soils, minerals, plant and animal species, and cultural resources. Such commitments of resources are considered irreversible because the resource has been destroyed or removed, or the resource has deteriorated to the point that renewal can occur only over a long period of time or at a great expense. While a Forest Plan can indicate the potential for

such commitments, the actual commitment to develop, use, or affect non-renewable resources is normally made at the project level.

Irretrievable commitments represent resource uses or production opportunities, which are foregone or cannot be realized during the planning period. These decisions are reversible, but the production opportunities foregone are irretrievable. An example of such commitments is the allocation of management prescriptions that do not allow timber harvests in areas containing suitable and accessible timber lands. For the period of time during which such allocations are made, the opportunity to produce timber from those areas is foregone, thus irretrievable.

A oil and gas leasing is not made due to the lack of industry interest and the low potential for oil and gas resources. If the circumstances change, then a leasing decision would be made at that time. Actual extraction of oil and gas would be considered an irreversible commitment, since oil and gas are non-renewable resources. Any site-specific decisions to actually permit this extraction will occur following receipt of an Application for Permit to Drill.

3.5.4 Effects on Wetlands and Floodplains

No significant adverse impacts on wetlands or floodplains are anticipated. Wetlands values and functions would be protected in all alternatives through the implementation of the Riparian Management Zones and following South Carolina's Best Management Practices for Forestry. Under the requirements of Executive Order 11990 and Clean Water Act, Section 404, wetland protection would be provided by ensuring that new construction of roads and other facilities would not have an adverse effect on sensitive aquatic habitat or wetland functions. In addition, wetland 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 direction in the Rivers and Streams ecosystems. The direction of this ecosystem is embedded in all other ecosystem groups. Executive Order 11988 also requires site-specific analysis of floodplain values and functions for any project occurring within the 100-year floodplain zone, and prior to any land exchange involving these areas. Effects to wetlands are also discussed in Section 3.2.4 Climate Change, Section 3.2.5 Water Resources, 3.3.1 Ecological Systems, 3.3.2 Threatened and Endangered Species and 3.3.3 Forest Health.

Protective measures for riparian areas include the delineation of riparian management zones on perennial and intermittent streams. Management activities within the riparian management zone must comply with the previously mentioned 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.

3.5.5 Unavailable or Incomplete Information

The Francis Marion National Forest has used the best available scientific information (BASI) 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.

Chapter 4. List of Preparers and Distribution

The following individuals contributed to this Draft Environmental Impact Statement.

Bill Hansen	Contract Hydrologist
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Jason Jennings	Forest Soil Scientist
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4.1 Mailing List for the DEIS

Francis Marion's mailing list is as follows.

Dominick Giordano	Jeff Glitzenstein/Donna Streng	The Family Riders Attn: Current President
David P. Baumann Woodlands Wildlife Services,LLC	George Nelson	Mike Ratledge
Will Carlisle Unit Wildlife Biologist, SCDNR Dennis Wildlife Center	Don Watts Charleston Nat. History Society	SC Coastal Conservation League Dana Beach
USDA –NRCS	Pete Peterson	Roy P. Pipkin
James Clyburn House of Representatives	Dr. Julian Harrison	Sarah Francisco Southern Envt.Law Center
Southern App. Forest Coalition Attn: Hugh Irwin	Quail Unlimited Nelson Huggins	SCDNR-Regional Coordinator Sam Chappelear
Mr. Jerry Henderson	Andrew G. DuPre	South Carolina Native Plant Society Dr. Bill Stringer
Town of Jamestown Attention : Mayor	Town of Awendaw Attn: Mayor's Office	South Carolina Native Plant Society John A. Brubaker, Chairman Issues Committee
Town of McClellanville Attn: Mayor's Office	Wild South	Santee Coastal Reserve
Jim Cubie	Cape Romain NWR Sarah Sawyer– Refuge Manger	Win Taylor, FPC Wildlands Engineering, Inc
Keith Bustraan Interim County Administrator - Charleston County	Town of Moncks Corner Attention: Mayor	SEWEE Association
Randy Moorman Earth Justice Legal Defense Fund	C. W. "Butch" Henerey Sheriff-Berkeley County	Lonnie Carter (President & CEO) Santee Cooper
James Alton Cannon, Jr Sheriff- Charleston County	SCE&G - William R. Argentieri	Elaine Morgan CEO- Berkeley Co. Chamber of Commerce
Dr. Jean Everett Dept. of Biology/College of Chas.	SC DNR Headquarters	William W. "Bill" Peagler, III Berkeley County Supervisor
Robert Dobson, Superintendent National Park Service –Fort Sumter	Colin Martin - Director	Cecil Campbell Regional Forester SC Forestry Commission
William Johnson Forester SCFC	Craig LeShack Director of Conservation Program/ Ducks Unlimited	Tom O'Rourke Executive Director Charleston Park & Recreation Commission
Sarah Hartman Director of Land Protection TNC	Palmetto Conservation Foundation Nancy Stone-Collum	Willie Murphy Chapter Chairman Quail Unlimited

Tim Hall Field Supervisor Ecological Services USFWS	Making Tracks Coordinator National Wildlife Turkey Federation	Ollie Buckles
Morgan Baird Park Manager Hampton Plantation	Sen Tim Scott	Director of SC Refuges Sarah Dawsey – Project Leader
Sen Lindsey Graham	Congressman James E. Clyburn	Sen Lawrence K. Grooms
Robin D. Coller-Socha U.S. Army Corps of Engineers	Congressman Mark Sanford	Gary M. Peters Biologist, NWTF

4.2 Francis Marion Plan Revision Email List 02/22/2015

The Francis Marion plan revision email list is as follows.

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Colette	Degarady
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Rob	Devlin
Troy	Diehl
Darin	Dinsmore
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Tommy	Dooley
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Jean	Everett
Blaine	Ewing
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David	Finley
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Steve	Hutton
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Steve	Livingston
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Tim	Long
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Dickie	Schweers
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Darrell	Shipes
Brett	Sims
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Marcus	Sizemore
Bo	Song
Eddy	Southard
Vaugheu	Spearman
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Jennie	Stephens
Ina	Stevens
Pete	Stone
Andrea	Stoney
David	Stoney
Johnny	Stowe
Pat & Clay	Sutton
Nathan	Swab
Billy	Swails
Billy	Swalls
Chandler	Taylor
Greg	Taylor
Greg	Taylor
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Sudie	Thomas
Noel	Thorn
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Andrew	Walker
Bill	Wallace
Tim	Walter
Craig	Watson
Don	Watts
William	Wenerick
Rickie	White
TL	White
Ben	Wigley
David	Wilkins
Tom	Williams
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Matt	Winter
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Phil	Wolf
Martine	Wolfe-Miller
Larry	Wood
Larry	Wood
LaKeshi	Wormley
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4.3 FM Plan Revision EIS Mailing list-Required Federal Agencies

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Rural Utilities Service	Washington	DC	20250-1548
National Environmental Coordinator, NRCS	Washington	DC	20250
Acquisitions & Serials Branch	Beltsville	MD	20705
Habitat Conservation Division	St. Petersburg,	FL	33701
U.S. Army Corps of Engineers	Atlanta	GA	30303-8801
US EPA, Region 4	Atlanta	GA	30303-3104
U.S. Coast Guard, Commandant CG-47	Washington	DC	20593
Regional Director, Southern Region	East Point	GA	30320
SC Division Federal Highway Administration, Division Administrator	Columbia	SC	29201
Director, NEPA Policy & Compliance, DOE	Washington	DC	20585
NOAA Office of Policy and Strategic Planning	Washington	DC	20230
Director OEPC	Washington	DC	20240

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