



United States Department of Agriculture
Forest Service

Francis Marion National Forest

Draft Forest Plan Assessment

Francis Marion National Forest, Berkeley and Charleston Counties, South Carolina

Section 7_Ecosystem Services: Assessment of Benefits

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**Francis Marion National Forest
Draft Forest Plan Assessment
Berkeley and Charleston Counties, South Carolina**

Lead Agency: USDA Forest Service

Responsible Official: John Richard Lint, Forest Supervisor
Francis Marion and Sumter National Forests

For Information Contact: Mary Morrison, Forest Planner
4931 Broad River Road
Columbia, SC 29212
803-561-4000

Email Comments or Questions to: fmplanrevision@fs.fed.us

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7 Ecosystem Services: Assessment of Benefits

7.1.1.1 Preliminary Findings

1. The Francis Marion provides a wide range of goods and services essential to sustaining life and fulfilling basic human needs and desires. Vital ecosystem services provided by the Forest include clean water and air, natural fibers and wood products, the regulation of natural hazards, and recreational opportunities. In addition to sustaining and improving the quality of life within the Forest's ecoregion, ecosystem services provided by the Francis Marion feed in to larger hydrological, biogeochemical, and carbon cycles which moderate natural phenomena at a global scale.
2. Although continued population growth in the Charleston area has placed additional demand on natural landscapes to provide ecosystem services, various sections of this assessment have identified an array of system drivers which can adversely affect the Forest's ability to provide these life sustaining services. As the region's natural landscape grows increasingly more fragmented and degraded, the provision of ecosystem services by the Francis Marion National Forest will play an even larger role in moderating natural phenomena and sustaining quality of life locally and across the globe.

7.1.1.2 Benefits People Obtain from the National Forest System Plan Area

National forests are productive assets which produce a steady flow of benefits in the form of ecosystem services. Ecosystem services are "components of nature, directly enjoyed, consumed, or used to yield human well-being" (Boyd and Banzhaf 2007). Healthy forests provide an abundance of ecosystem services, including clean water and air, biodiversity and forest products. The United Nations-sponsored Millennium Ecosystem Assessment identified four major categories of ecosystem services: provisioning, regulating, cultural and supporting services. The following key services were identified to be contributed by the Francis Marion National Forest through specialized scoping (other services, including outdoor recreation, range, timber, watershed, and fish and wildlife, are discussed in the "Assessing Multiple Use" section):

- Provisioning Services
 - o Natural Fibers
 - o Food Production
- Regulating Services
 - o Purification of Water and Air
 - o Carbon Sequestration
 - o Pollination
 - o Natural Hazard Regulation
- Cultural Services
 - o Cultural and Heritage Values
 - o Spiritual, Inspirational, and Aesthetic Services
- Supporting Services
 - o Nutrient Cycling

Provisioning Services

Provisioning services are environmental goods which are extracted from ecosystems for human benefit. Initial scoping identified two key provisioning services provided by the Francis Marion National Forest, food production and natural fibers. The provision of these Forest products contributes to the well-being of communities surrounding the Forest.

Natural Fibers. The larger Francis Marion ecoregion is made up of several distinct ecosystems, including upland forests, wetlands, and brackish marshes. There are approximately 1,600 documented species of plants growing within the National Forest, including 32 species of orchids, 22 species of ferns, and 12 species of carnivorous plants. Natural fibers grown on the Forest provide numerous benefits. Pine needles, or straw, drop from the longleaf and loblolly pines on the Francis Marion throughout the year. These fibers provide habitat and forage for wildlife, reduce the erosion and loss of topsoil, and improve soil tilth and decomposition. Straw coverage on the forest floor is also very important for the survival and growth of plants because it contains important nutrients like nitrogen, phosphorus, calcium, and magnesium that return to the soil as the straw breaks down. Partially decayed pine straw also helps lock in moisture and insulates soil from temperature extremes.

Although significant demand for pine straw has been shown by local landscapers and Gullah-Geechee¹ basket weavers, over harvesting pine straw is known to cause adverse effects to the ecological health and function of the Forest. Forest management has tried in the past to make pine straw a viable forest product on the Francis Marion National Forest, but issues with administering permits and the wide spread abuse of permits to harvest quickly grew to be a major problem. While straw is abundant in pine stands across the Forest, illegal raking and stressors and drivers of Longleaf and Loblolly Pine ecosystems threaten straw coverage on the Francis Marion. For a discussion of trends and system drivers see section 1 “Terrestrial Ecosystems.”

Food Production. The Francis Marion National Forest provides habitat for an abundance of aquatic and terrestrial life. Many of the species found on the Francis Marion are commonly hunted and fished. Commonly hunted species include: white-tailed deer, eastern wild turkey, woodcock, squirrel, opossum, fox, black bear, raccoon, rabbit, wild boar, waterfowl, morning dove, ruffed grouse and quail. Commonly fished species include: bass, bluegill, catfish, crappie and trout.

While the majority of hunters and anglers in the U.S. participate for sport, many individuals continue to hunt for subsistence. Subsistence hunting and fishing are important to the economies and cultures of families and communities in rural America. Those hunting and fishing for subsistence do so strictly to provide food for themselves and their families. Wild fish, game and non-game animals harvested from national forest system lands often supplement meager food dollars and accounts for a significant portion of the meat consumed by these households. In this manner the provisioning services of the Francis Marion National Forest provide local families and communities with a secondary income which may partially offset low wages and alleviate poverty in the rural areas surrounding the Francis Marion. For a discussion of current conditions of and trends in wildlife populations which support opportunities for subsistence hunting and fishing see information specific to hunting in section 9 and chapter 8.3 “Fish and

¹ Gullah Geechee (\ 'gə-lə\ \ 'gē-chē \) is a sovereign African-American nation whose boundaries stretch along the Atlantic coast Sea Islands and Lowcountry from Jacksonville, North Carolina, to Jacksonville, Florida. The Gullah people are direct descendants of Africans who were brought to the United States and enslaved for generations. Their culture is manifested in a system of practices/principles that emerge from: (1) their diverse African (primarily West Africa) origins, (2) the intense interaction among people from different language groups, and (3) generations of isolation in settings where enslaved Africans and their descendants were the majority population. Gullah-Geechee weave native pine straw and sweetgrass into coiled baskets that resemble those crafted by the Wolof people in Senegal.

Wildlife”. For a discussion of stressors and drivers affecting wildlife on the Francis Marion National Forest see section 3 “System Drivers.”

Regulating Services

Regulating services are the benefits provided by ecosystem processes that moderate natural phenomena. Initial scoping revealed that the Francis Marion provides a number of regulating services, including: purification of water and air, carbon sequestration, pollination, and natural hazard regulation. While these processes occur within the Forest’s ecoregion, benefits from the Francis Marion National Forest’s regulating services contribute to moderation of natural phenomena, including natural disasters, at a global scale.

Water Purification (filtration). Forests act as natural reservoirs, treatment plants, and stormwater management systems. Physical, chemical, and biological processes enable forest vegetation and soil to filter and absorb surfacewater, replenishing underground aquifers and moderating runoff during rainstorms. America’s forests act as living filters, processing nearly two-thirds of the nation’s water supply. In their natural and healthy state forests have been proven to be highly effective at removing metals, sediment, and excess nutrients. Research has shown that riparian areas can reduce nitrogen concentrations in runoff and floodwater by up to 90 percent and phosphate concentrations by 50 percent (Gilliam 1994) and that wetlands can remove between 70 and 90 percent of entering nitrogen and up to 80 percent of total phosphorus (Reilly 1991; Gilliam 1994; Peterjohn and Correll 1984; Richardson 1985; Gale et al. 1994; Walbridge and Struthers 1993).

Water filtration services provided by well-functioning ecosystems help maintain the integrity of the watersheds and provide local communities with clean drinking water and water suitable for industrial uses, recreation, and wildlife habitat. By filtering out pollutants upland forests, riparian areas, and wetlands help keep base loads within reasonable levels which reduce municipal water treatment costs and alleviates demand for costly infrastructure. It has been estimated that the nearby Congaree bottomland hardwood swamp removes roughly the same amount of pollutants each year as a \$5 million water treatment plant (U.S. EPA 1993). By managing for the health of forest ecosystems the Francis Marion National Forest directly contributes to regional water quality and helps reduce financial costs associated with municipal water supplies. For information on baseline water quality see section 2.2.4 “Water Quality”; for information on stressors and drivers affecting the Forest’s watershed see section 3 “System Drivers.”

Air Purification. Air is essential to sustaining life and forests play an important role in replenishing and purifying the oxygen on Earth. Forest vegetation harnesses energy from the sun and converts carbon dioxide and water into sugars through photosynthesis. This conversion process provides plants with the essential building blocks needed to grow leaves, flowers, fruits, and seeds, and causes plants to release clean air into the atmosphere as a byproduct. On average, a healthy, mature tree produces 260 pounds of oxygen per year. With the average person consuming 386 pounds of oxygen a year it takes approximately 1.5 mature trees to support one person for a year.

Forests filter out a number of air pollutants and toxic gases which have been associated with adverse health and environmental effects, such as respiratory infections and acid rain. Leaves act as highly effective filters, capable of capturing fine particulates less than 10 microns in size. In addition to filtering particulates and absorbing carbon dioxide, forest vegetation can reduce ground-level ozone, carbon monoxide, nitrogen oxides, sulfur dioxide, and lead. Research has shown trees significantly improve air quality. Tree cover in a 212 hectare urban park was found to be capable of removing 48 pounds of particulates, 9 pounds of nitrogen dioxide, 6 pounds of sulfur dioxide, 2 pounds of carbon and 100 pounds of carbon a day. One 12-inch-diameter sugar maple can remove 60 milligrams cadmium, 140 milligrams of chromium, 820 milligrams of nickel and 5,200 milligrams of lead in a single growing season (Coder

1996). Large trees are capable of absorbing 10 pounds of air pollution a year, including 4 pounds of ozone and 3 pounds of particulates.

By maintaining the Forest's wildlands in their natural state the Francis Marion National Forest acts as a large filter for the region's airshed, absorbing thousands of pounds of air pollution each year. The Forest can be directly attributed with improving regional air quality and mitigating the adverse effects on human and natural systems. The Francis Marion's role in maintaining regional air quality has become increasingly important as rapid development in the Charleston area continues to contribute to diminishing regional air quality. For information on current air quality conditions and stressors affecting the airshed see sections 2.2.2 and 3.4.

Carbon Sequestration. Carbon dioxide is a naturally occurring greenhouse gas which is recycled through a complex set of natural processes which continuously create and use carbon dioxide. Carbon sequestration is the process by which trees, grasses, and other plants absorb atmospheric carbon dioxide through photosynthesis, "locking" carbon dioxide in biomass and soils for long-term storage. Trees act as reservoirs holding sequestered carbon in trunks, branches, foliage, and roots, slowly releasing its carbon stock through the decaying process at the end of its life cycle or permanently storing carbon in the durable goods created from timber products. Young trees are capable of absorbing carbon dioxide at a rate of 13 pounds per tree annually, with 1 acre of young forest sequestering nearly 2.5 tons of carbon on annual average. Although trees become most effective at sequestration after about 10 years, increasing carbon dioxide absorption from 13 pounds to 48 pounds per year, carbon uptake in mature forests is balanced by carbon released from decaying vegetation. The U.S. Forest Service estimated that forests in the United States captured a combined total of 309 million tons of carbon annually between 1952 and 1992 (USDA Forest Service Pamphlet #R1-92-100).

The movement of carbon in and out of Forest's trees and soils is part of the Earth's global carbon cycle. While carbon dioxide is naturally consumed and released by healthy ecosystems, human activity significantly contributes to carbon dioxide emissions. Carbon dioxide is a byproduct of nearly all human activity, including breathing, driving cars, turning on a light, and by heating or cooling our homes. Natural carbon sequestration helps offset carbon emissions associated with human activities, including deforestation, forest fires, and the extraction and burning of fossil fuels. Forests store large amounts of carbon play an active role in mitigating the carbon footprint of human activity. Between 1952 and 1992 sequestration by U.S. forests offset nearly 25 percent of manmade carbon emissions (USDA Forest Service Pamphlet #R1-92-100), and carbon removed from the atmosphere by forest growth or stored in harvested wood products offset 12 to 19 percent of U.S. fossil fuel emissions (Ryan et al. 2010).

Forest carbon stocks fluctuate over time as the forest grows and recovers from varying levels of natural and human disturbances. Although the Francis Marion National Forest was a source of atmospheric carbon for a short period after Hurricane Hugo, the Francis Marion National Forest generally serves as a large carbon sink. For decades prior to, and over the most recent two decades since Hurricane Hugo, Forest growth has enabled the Francis Marion National Forest to sequester large amounts of carbon. Recent inventories indicate that the Francis Marion National Forest serves as one coastal South Carolina's largest carbon sinks, accumulating 14 percent of carbon over a 5-year period. Although the Francis Marion National Forest captures and stores carbon dioxide within the Forest's airshed, sequestration by the Francis Marion is part of a larger global recycling process known as the carbon cycle, which helps lower global stocks of greenhouse gases. For a detailed discussion of trends and drivers affecting carbon stocks see section 4 "Carbon Assessment."

Pollination. Pollination is the fertilization of flowering plants through the transfer of pollen from the male part of the flower to the ovaries of the same species. Although some plant species are able to pollinate themselves, or may be pollinated by the wind, the vast majority of flowering plants need

pollinators to help move pollen from the male to female parts of the plant. Pollinators come in many forms and include a number of invertebrate and vertebrate species which can be found on the Francis Marion National Forest. The Francis Marion is home to a large number of the region's pollinators since it provides ideal nesting grounds and food supplies for a variety of species. Pollinators commonly seen on the Forest include: bees, moths, butterflies, birds, deer, bears, rabbits and rodents. Since these national forest system lands account for a significant share of wildland habitat in the region, the Francis Marion plays a critical role in maintaining regional biodiversity by ensuring the production of seeds required to maintain natural plant communities.

Natural Hazard Regulation. Some natural processes can be destructive to human and natural systems initially, but beneficial to ecosystems over the long run. These processes are known as natural hazards and may include floods, fires, and other natural events with the potential to cause harm. The severity of hazardous events can vary from nuisance to catastrophic, where extreme events cause such devastation that their aftermath is better known as a natural disaster. The degree to which people are exposed to these hazards, the magnitude of hazardous events and communities' ability to cope with and recover from their occurrence is largely dependent upon the condition of the surrounding ecosystem.

Hazardous events shape the physical landscape of U.S. forests and contribute to the overall health of these productive ecosystems. Healthy forests provide encroaching development with a physical buffer and facilitate a wide range of natural processes that moderate the intensity and frequency of extreme events. While natural hazards are often associated with injury, death, and damage to property in nearby communities, these events stimulate biodiversity and support ecological functions which reduce the risk of catastrophic disasters in the future. Like many forests, the Francis Marion is located is part of a larger fire-dependent ecosystem which contains numerous rivers and streams that are prone to flooding during severe weather events. Although wildfires and storm related flooding regularly threaten communities surrounding the Forest, the Francis Marion helps alleviate flooding by reducing run-off and moderating stream flows during heavy storms, prevents soil erosion than can cause slope instability and landslides, and reduces the likelihood of catastrophic wildfires by maintaining characteristic vegetation and fuel conditions consistent with the region's natural fire regime.

In their natural state, the Francis Marion National Forest's wildlands directly contributes to the region's resilience to hazardous events and greatly diminishes the risk of natural disasters affecting communities surrounding the Francis Marion. The Forest's ability to regulate and mitigate risks of natural hazards is directly related to the health of Forest ecosystems. The degradation of natural systems greatly diminishes their ability to complete ecological functions that reduce the frequency and severity of natural disturbances. Changes in ecosystem function are caused by ecological drivers and stressors. Drivers are major environmental forces that have large scale influences on the natural system (e.g., climate, hydrology, and major natural disturbances); stressors, which are also drivers, are the human induced perturbations which have large or regional-scale influences on the natural system (e.g., water management, contaminants, exotic species) (Ogden et al. 2005). Section 3 discusses trends in natural disturbances, including wildfires and climate and weather events and the effects of natural disturbances on specific resources is discussed in chapters 1, 2, and 4.

Cultural Services

Cultural Services relate to the nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences (Millennium Ecosystem Assessment 2005). In relation to Forest ecosystems, these services are generally what people hold most dear and influence the way people view and value other goods and services provided by the Forest. Initial scoping identified that the Francis Marion supported a number of cultural services which benefited people, including: cultural and heritage and spiritual, inspirational, and aesthetic values.

Cultural and Heritage Value. While the physical and cultural landscape of the Francis Marion has evolved over time, past cultural ties have left a lasting impression on the Forest's uplands, swamps, and marshes. Located in South Carolina's Lowcountry region, the Francis Marion National Forest boasts a rich history which includes prehistoric, colonial, and military significance. First settled by prehistoric Native Americans, these lands were later occupied as early colonial settlements and plantations and played a role in both the Revolutionary and Civil wars. While present occupation of the Francis Marion is limited to a few small communities and inholdings, its landscape still holds "memories" of the past which serve as a reminder of the collective and individual roots of many Americans. The historic features which hold these memories possess heritage values which help people form attachments to places and provide an understanding of their place in the natural and cultural environment. These heritage values are a source of civic pride and contribute to the local sense of community.

The Francis Marion is located almost entirely in a nationally recognized heritage area which extends along the southeastern coast of the United States. Known as the Gullah Geechee Corridor this heritage area is home to one of the country's most unique cultures and languages. The Gullah Geechee culture is a byproduct of the retention and fusion of West African beliefs, traditions, and skills by enslaved black immigrants along the southeastern coast of the United States. The relative isolation of these people enabled the unique traditions, beliefs, and languages of West Africa's coastal rice-producing region to remain intact, allowing them to be passed down through generations. Modern descendants of these immigrants, known as the Gullah Geechee, continue to live and celebrate their rich African and American heritage in communities surrounding the Francis Marion National Forest.

According to a 2006 inventory of the Corridor's historical, cultural, and natural resources, three of the four towns located within the Francis Marion National Forest contained cultural landscapes and ethnographic resources that increased the understanding and awareness of Gullah Geechee people, culture, and history (Gullah Geechee Cultural Heritage Corridor Commission 2012). The Forest-dependent communities of Awendaw, Huger, and McClellanville were attributed with helping the Gullah tell their story by supporting six primary interpretive themes: origins and early development; the quest for freedom, equality, education, and recognition; global connections; connection with the land; cultural and spiritual expression; and Gullah Geechee language.

Comments received during specialized scoping to identify ecosystem services indicated that Forest users believed the Francis Marion National Forest was an important part of the cultural heritage of the Lowcountry and that the public had attached cultural and heritage values to many of its sites. By preserving and facilitating the interpretation of these resources the Francis Marion National Forest ensures that the cultural legacy and heritage values of the Francis Marion's lands will be passed on to present and future generations. For a discussion of current conditions, trends and stressors affecting cultural and historical resources and uses see section 13.

Spiritual, Inspirational, and Aesthetic Services. For centuries humans have recognized that Forests possessed an intrinsic value which exceeded the benefits they received from consumptive uses. In addition to providing sustenance, Forest landscapes provide aesthetic enjoyment, artistic and spiritual inspiration, and emotional comfort. Although the modern world has become increasingly centered around cities, the mental, physical, and spiritual well-being of people continues to have strong ties with the natural environment. Undeveloped landscapes offer a refuge from the modern world, a place where people can reconnect with nature and escape the stresses of everyday life. Many people retreat to forests because they foster a sense of oneness with nature which can stimulate contemplation and bring about inner peace.

While specific sites may be used in religious rituals, forests are often described as spiritual landscapes because they provide an experience of being related to, or in touch with, an 'other' that transcends their

individual sense of self and gives their life a deeper meaning beyond an intellectual level (Schroeder 1992). Spiritual experiences in nature are generally intuitive or emotional and tend to create a sense of being caught up or carried away. Opportunities to explore and enjoy the scenic beauty of the natural environment have been known to fill and inspire people with a feeling, an idea, or a creative impulse. Forests have long served as inspiration for a wide range of artistic and cultural expressions, including: film, literature, photography, paintings, sculptures, music and dance, fashion, folklore, national symbols, and even architecture and advertisement (Rudolph de Groot et al. 2005).

Comments collected during public involvement indicated that Forest users highly valued the Francis Marion for contributing towards their mental and spiritual well-being. Numerous respondents reported relying on the Forest to decompress from daily stress and that the ability to reconnect with nature and rural life improved their quality of life. Other users disclosed that they valued the Forest as a spiritual resource and that its mere existence gave them great pleasure. The spiritual, inspirational, and aesthetic services supported by the Forest's natural landscape provide mental clarity and inspiration, and is attributed with improving the overall quality of life in surrounding communities.

Supporting Services

Supporting services are the underlying natural processes which sustain ecosystems and enable the production of all other ecosystem services. Initial scoping identified nutrient cycling as a key supporting services provided by the Francis Marion. While nutrient cycling on the Francis Marion National Forest takes place at an ecoregional level, nutrient cycling on the Forest feeds into global biogeochemical cycles.

Nutrient Cycling. Nutrient cycling is nature's way of recycling old life into new. Many nutrients, including water, carbon, nitrogen and phosphorus are stored, transformed, and cycled through the Forest's soil via natural feedback loops. These feedback loops capture, store and convert energy and nutrients from decomposing organic and inorganic matter into new plant forms. The decomposition of organic forest matter replenishes soil nutrients and supports the natural fire regime by reducing the density of fuels. Nutrient cycling on the Francis Marion National Forest filters potential water pollutants in soil, and promotes soil biodiversity and fertility. The maintenance of soil fertility is a supporting service for the production of food, timber, fiber, and fuel. Current conditions and trends related to soil on the Francis Marion National Forest can be found in section 2.2.2, Soils."

7.1.1.3 Trends and Drivers

The Forest's ability to produce these beneficial services is largely influenced by its ability to complete ecological processes. System stressors and drivers affect ecological functions on the Forest and can have positive or negative effects on the Forest ecosystems. Drivers are major environmental forces that have large-scale influences on the natural system (e.g., climate, hydrology, and major natural disturbances); stressors, which are also drivers, are the human induced perturbations which have large or regional-scale influences on the natural system (e.g., water management, contaminants, exotic species) (Ogden et al. 2005). Chapter 3 "System Drivers" identifies and provides information regarding the primary system drivers and stressors on the Francis Marion National Forest. Drivers identified in this section included climate change, insects and disease, wildland fire/fuels, invasive species, natural vegetation succession, natural disturbances, and human disturbances.

As system drivers move Forest resources closer to or farther from desired conditions, these influences may improve or inhibit the ecological functions which facilitate ecosystem services. While the discussion of ecosystem services may provide a brief overview of factors influencing ecological trends on the Forest, a more thorough discussion of current conditions, trends, and system stressors affecting the provision of these services is included the sections referenced throughout this chapter.

In addition to the human disturbances discussed in section 3, rapid growth discussed in section 6 “Social and Economic Assessment” is also a very strong system driver. South Carolina’s coastal Lowcountry, which includes the Francis Marion National Forest, is an amenity rich region whose historically rural landscape is becoming increasingly urbanized. Sprawling growth extending from the Charleston urban area has rapidly transformed the landscape of Charleston and Berkeley counties from minimally developed wildlands into large suburban communities. The Francis Marion has become an urban forest whose inholdings and adjacent tracks provide a unique opportunity to live in a natural setting surrounded by the great outdoors while maintaining an easy commute to the Charleston Metropolitan area. The continued conversion of rural and wild lands surrounding the Forest has fragmented and degraded the natural landscape and altered the social and economic landscape of local communities.

These open spaces, natural settings, and ecosystem goods and services provided by the Francis Marion continue to grow in importance as the State transitions from a rural to an increasingly urban environment. Recent trends have shown more and more people are moving from metropolitan areas to rural areas along the wildland-urban interface. Rapid development occurring in these ex-urban areas—rural areas beyond the built-up urban and contiguous suburban area—has caused significant losses in habitat and ecosystem services. Reductions in the quantity and quality of goods, services, and visitor opportunities provided by non-national forest lands creates greater demand for those provided by the Francis Marion, making it increasingly more difficult for the Forest to provide access to natural settings while sustaining organisms and processes across its landscapes. As communities surrounding the Francis Marion National Forest continue to grow, conflicts between human development and ecosystem health and productivity are likely to arise. Increased use of Forest resources may have adverse effects on the quantity and quality of ecosystem services the Forest is able to provide.