LAUREL HILL COUNTY PARK

NATURAL RESOURCE MANAGEMENT PLAN

CHARLESTON COUNTY PARK
& RECREATION COMMISSION

AUGUST 2019

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Charleston County Park and Recreation Commission

Charleston County, South Carolina

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FINAL REPORT: AUGUST 2019

ABSTRACT

This management plan was developed with a primary goal of assessing the condition and needs of Laurel Hill County Park's natural resources. The recommendations and schedules provided within this document provide actionable ways that work to improve the overall health, diversity and vitality of the park's ecology, with emphasis on its predominant plant community – loblolly pine. Furthermore, this plan supports the vision of the property's prior owner John Muller, Jr., who desired to see the park maintained in a natural state for public use and benefit.

An important part of this plan's recommendations involves silviculture systems (i.e. forest regeneration through thinning, seeding and other practices) and the role they provide towards enhancing the park's natural resources, including plant and wildlife communities. Dense forest growth creates a stifling condition for standing trees, preventing sunlight from reaching the forest floor, contributing to tree die-out by stem exclusion/encroachment, and severely impeding the recruitment of a diverse understory plant layer capable of providing sustenance and habitat for wildlife. Aside from supporting the general ecological uplift of the site, silviculture activity works to minimize the risks associated with uncontrolled high-intensity wildfires. By strategically installing fire breaks and removing dead trees, limbs and other materials that can act as fuel, silviculture and forestry best management practices work to alleviate the threat of forest fires.

Surrounded by densely-populated suburban neighborhoods, the park is a prime example of a Wildland-Urban Interface (WUI) transitional zone, where humans and the natural environment can impact each other's behavior and surroundings. Associated WUI issues include wildfires, wildlife intrusions and introduction of invasive species. Examples of these issues are addressed within this document.

While there are challenges associated with resource management in the WUI, there is also great potential in this dynamic. The park's proximity to Dunes West, Park West, Ivy Hall and other Mount Pleasant neighborhoods makes Laurel Hill County Park ideally suited for educating the public about silviculture, wildlife best management practices, impacts of climate change and other beneficial interpretive topics. As such, a Resource Demonstration Area (RDA) is planned to not only educate and bring awareness about these topics, but to also provide park visitors a striking visual experience showcasing different forested landscapes.

Active land management can also have implications for climate change. Dead trees and other decomposing organic matter emit carbon dioxide – a known factor in the issue of global warming. However, strategically implemented land management actions can help offset global warming by sequestering carbon dioxide. In a forest, carbon is stored in the form of woody biomass – in the trees themselves. And the age (and species) of trees has been found to can relate to their effectiveness at sequestering carbon dioxide. For example, young, healthy, and faster-growing trees are more effective at capturing carbon dioxide from the environment than older, more mature trees. Furthermore, a consequence of intense wildfires is the large release of stored carbon dioxide into the atmosphere. By thinning/harvesting trees (especially pine) in accordance

with a schedule, limiting wildfire risk, and providing effective forest regeneration strategies, a forest will work at optimum levels in capturing carbon dioxide.

It is important to note that CCPRC has an active role in the land management and conservation community in Charleston County. CCPRC staff serve (or have served) on committees pertaining to habitat restoration, water quality, wildfire protection, and general land stewardship issues. Through CCPRC's participation on these committees, and by collaborating with agencies and organizations whose missions align with our own, we work to leverage funding for land management efforts. In actively managing park properties our objectives are to improve the natural conditions of park properties, while also enhancing public awareness-of and appreciation-for land management.

Lastly, this plan acknowledges the various partner agencies supporting CCPRC's overall mission and stewardship core value through direct grants, cost-share resources and technical assistance. These supporting agencies include: Ducks Unlimited Inc., The Nature Conservancy, Sewee Longleaf Conservation Cooperative (SLCC), South Carolina Forestry Commission (SCFC), United States Fish & Wildlife Service (USFWS)/ Cape Romaine National Wildlife Refuge, United States Forest Service (USFS)/ Francis Marion National Forest. Where applicable, this management plan seeks to continue our mutually shared missions in preserving and enhancing the region's valuable natural resources.

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Definitions

Artificial Regeneration: A regeneration method by which forests are restocked by planting nursery-grown seedlings, which ensures trees are healthier and better-formed as they mature.

Basal Area (BA): A unit of measurement of the amount of biomass measured in ft^2/acre at breast height (4.5-ft). In general, basal area measurements are used to describe the density of a specific forest area/stand.

Best Management Practices (BMPs) for Forestry: Terminology used to describe methods or techniques generally accepted to be superior to other alternatives. In forestry, these may include recommended methods for crossing streams, constructing access roads, harvesting timber in or near low-lying areas, etc.

Firebreak: A physical barrier, typically a plowed dirt line or road that works to slow and prevent the progress of wildfires and/or prescribed burns.

Mastication (or "Gyro-trac"*): A term used to describe the action of mulching and grinding for clearing woody shrubs and other vegetative growth. (*Gyro-trac is a name-brand manufacturer of mastication/mulching equipment.)

Invasive Species: Animal or plant species that are typically non-native and likely to cause economic or environmental damage due to their ability to spread while displacing beneficial native species.

Natural Regeneration: A regeneration method by which forests are restocked naturally by relying on the seed bank within the soil, and/or by seed from trees left standing on-site post-final harvest. See *Artificial Regeneration*.

Natural Resource Management Plan (NRMP): A plan that provides specific objectives/ activities that manage natural resources (e.g. land, water, soil, plants and animals) for a desired outcome.

Overstocking: The condition of a stand that typically has too many trees per acre as compared to its basal area. A consequence of overstocking is "stem exclusion" (natural die-off of trees) due to lack of available resources.

Prescribed Fire (or "Prescribed Burn"): Ground-level fires that are conducted in accordance with a burn plan and with contingencies, for purposes of regulating understory fuel load and improving ecosystem vitality.

Resource Demonstration Area (RDA): For purposes of this management plan, a defined area wherein strategic management activities are proposed for the purpose of educating the public on natural and cultural resources

Silviculture: The art and science of controlling the establishment, growth, composition, health, and quality of forests and woodlands to meet the diverse needs and values of landowners, including wildlife habitat, timber, water resources, restoration and recreation.

Stand (or "Timber Stand"): A geographic area comprised of trees of similar species or cohort (age group).

Thinning: Forestry term used to describe the process of selectively removing trees to improve the growth rate and health of undisturbed trees.

Wildland-Urban Interface (WUI): Zone of transition between wildland (unoccupied land) and human development.

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Acronyms

AFM – American Forest Management (the trustee's land management consultants)

B&GEPA – Bald and Golden Eagle Protection Act

BA – Basal Area

BMPs – Best Management Practices

CCPRC – Charleston County Park & Recreation Commission

COE – [U.S. Army] Corps of Engineers

CWA – Clean Water Act

DBH – Diameter at Breast Height

DHEC – [South Carolina] Department of Health and Environmental Control

DNR – [South Carolina] Department of Natural Resources

EPA – Environmental Protection Act

ESA – Endangered Species Act

NMF – National Marine Fisheries [Service] (under NOAA)

NOAA – National Oceanic and Atmospheric Administration

RCW – red-cockaded woodpecker

RDA – Resource Demonstration Area

S&W – Sabine & Waters (CCPRC's land management consultants)

SCFC – South Carolina Forestry Commission

SHPO – State Historic Preservation Office

SMZ – Streamside Management Zone

T&E – Threatened & Endangered [Species] (protected under the ESA)

UM – Understory Management

USDA – U.S. Department of Agriculture

USFWS – U.S. Fish and Wildlife Service

WF – Wells Fargo (trustee for the former owner, Mr. John Muller)

WMA – [SC DNR] Wildlife Management Area

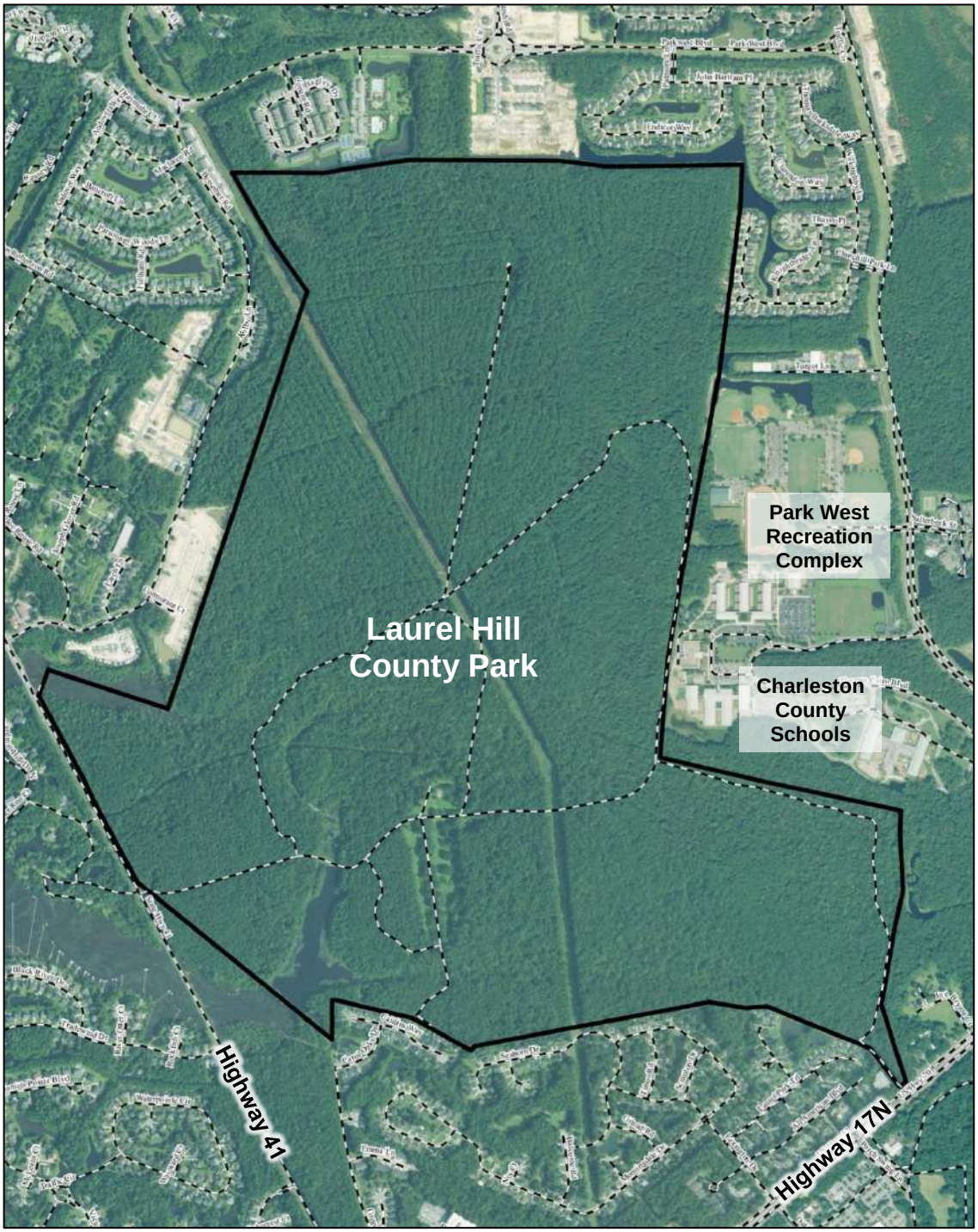

Figure 1-1. Recent aerial image of Laurel Hill County Park property

Chapter One: Property Overview

Laurel Hill [Plantation] County Park (the Property) is an approximately 742-acre property located in the Town of Mount Pleasant in Charleston County, South Carolina. The Property was historically a working plantation in the 1700 and 1800s and has been most recently used for timber production in the form of loblolly pine (*Pinus taeda*) silviculture. The northern half of the property was thinned in the early 2000s and is due for another harvest. Due to the absence of thinning, the southern half of the property is experiencing significant crowding and fuel massing, however a timber harvest is expected to start in 2019.

Historically, the southern half of the Property was converted to a pecan orchard during the first half of the twentieth century (Fig. 1-2). Once abandoned, the pecan orchards were gradually overtaken by faster growing loblolly pine. A recent cursory tree survey of the property revealed that several existing pecan trees are either dead or declining, the result of stress and reaching the end of their natural life cycle. The remaining healthy pecan trees are now considered a part of the park's natural and cultural resources and shall be protected during current and future timber operations.

The landscape surrounding the Property has experienced rapid development in recent years, resulting in the Property acting as an "island" of forested and open space. The Property and surrounding development are an example of the wildland-urban interface

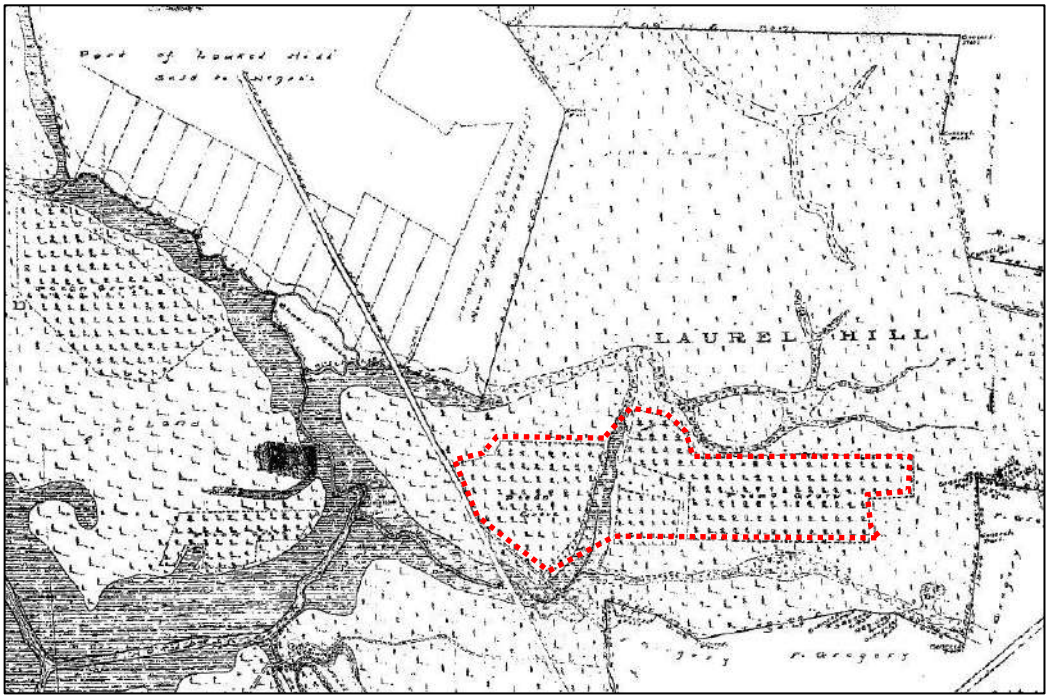

Figure 1-2. 1940 plat of Laurel Hill property, pecan orchard outlined in red
(Source: Phase I Archaeology Report)

(WUI), with the surrounding communities becoming more susceptible to catastrophic wildfire, while conversely negatively affecting the Property's ecology. Other WUI factors include increasing encounters between the public and wildlife (e.g., coyote incursions into local neighborhoods).

The most recent owner of the Property, John Muller, Jr., died in 1984, and left the Property to a trust in his will. He stated in his will, "It is my will and desire that my trustee shall cause said Laurel Hill Plantation to be maintained in a natural state insofar as possible ... and to make it available for the use and enjoyment of various groups." For this reason the Property has remained undeveloped, and continues to be managed for timber production.

Charleston County Park and Recreation Commission (CCPRC) entered into long-term lease agreement with the trustee in 2011 to utilize the Property as a passive park for the enjoyment of the general public. Wells Fargo currently manages the trust, and works in conjunction with American Forest Management (AFM) to manage the timber on the tract. The goal of the trust is to keep the Property in a profitable state (for ongoing forest management) on behalf of the beneficiaries of the trust; while also coordinating with CCPRC to fulfill its obligation to the general public in maintaining the Property as a passive park. This management plan works to balance the stewardship and educational goals of CCPRC, while also enabling the trust to fulfill its obligations to its beneficiaries.

A "Land Management Concept Plan" follows in Figure 1-9 of this management plan.

1.1 Timber Management and Harvesting

While the trust manager must maintain the Property in a "natural state", it must also maintain the profitability of the Property with respect to the perpetual growth and harvesting of merchantable timber. Per the terms of its lease agreement with CCPRC, the trust manager shall coordinate forest management activities with CCPRC staff, as to minimally disrupt the passive use of the Property as a county park. The trust and CCPRC must also coordinate in the development of a management plan for forest resources of the Property; hence CCPRC has commissioned the preparation and production of this Natural Resource Management Plan (NRMP) to guide forest management activities, to the mutual benefit of both parties.

The Property is currently in the implementation stage of a timber sale to thin certain loblolly pine and mixed hardwood-pine stands to a Basal Area (BA) of approximately 70 ft^2/acre. The initial phase of the timber sale is concentrated within the Property's southern half (Fig. 1-3). The stands within this part of the Property are in declining health due to long delayed timber management activities. The expected thinning will work to reduce competition and provide remaining timber additional space and nutrients to continue healthy growth. If timber stands are not periodically thinned they can become overstocked.

Overstocking leads to competition between trees for light and nutrients and can negatively affect growth and tree health.

Loblolly pine is the primary merchantable timber species on the Property, and will continue to be the primary species for intensive timber management. The site is well suited to grow loblolly pine, and the species is favored for timber production due to its fast growth rates. Loblolly pine in this part of the southeast has an approximately 30 year rotation age. Thinning generally occurs around ages 15 and 22, and a final harvest (clear-cut) will occur around year 30. These rotations may be longer or shorter than 30 years depending upon the desired timber product and the productivity of the site and tree genetics. Following the final harvest the site will be prepared and re-planted the following winter. Site preparation may take the form of mechanical or chemical site preparation. Site preparation is often necessary to kill any competing vegetation on the site to give the young seedlings a few years of growth without competition. Proper site preparation is essential to maximize growth and survival rates of the newly planted seedlings.

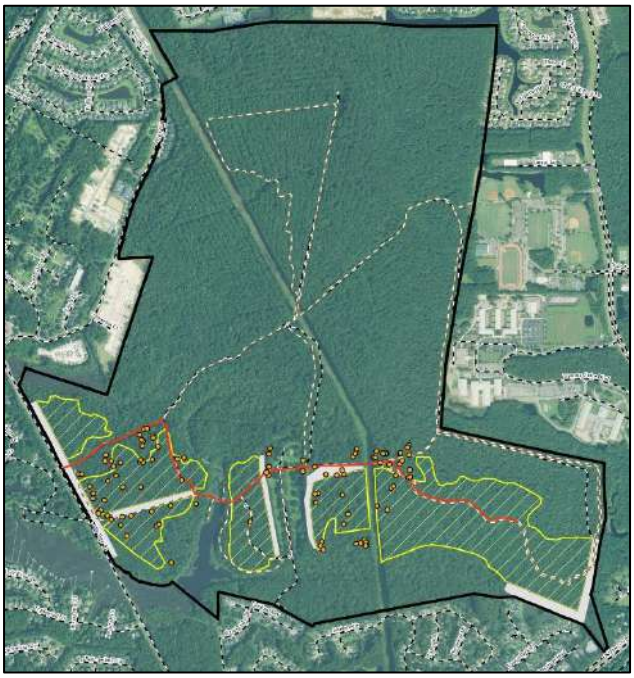

Figure 1-3. Phase 1 of the 2019 timber sale focuses on the southern half of the property, but may extend to the north area if conditions and schedules allow.

Longleaf pine (*Pinus palustris*) is native to the southeast United States, but its range was greatly reduced by the exclusion of fire as well as deforestation caused by agriculture and other land use changes (See *Chapter Five: Longleaf Pine Life History and Management*). Conversion to loblolly pine plantation silviculture also led to the decline of longleaf pine forests. Historically longleaf pine was likely present in the some capacity on the Property. It is unlikely, however, that the Property was dominated by longleaf pine. The Property likely had a mix of loblolly pine and native hardwoods before conversion to planted loblolly pine plantation. While some longleaf pine may have been present, the Property lacks large areas of the well-drained sandy soils in which longleaf pine thrive. The Property's overall characteristics are more suitable for loblolly pine production, although suitable areas for longleaf are present and will be further discussed within the proposed "Resource Demonstration Area" (RDA) (See *Chapter Three: Resource Demonstration Area*).

Aside from the Property's soil restrictions, longleaf pine's slow growth rate limits its harvest value until it reaches maturity. The difficulties surrounding prescribed fire on the Property is an additional reason to limit large scale longleaf conversion. Fire is a key part of longleaf pine management, especially in the younger years while it is in the "grass stage" and is highly susceptible to competition. Due to these reasons, the majority of the Property will be managed primarily as loblolly pine silviculture.

During timber harvests the managing forester should avoid impacting archaeological sites, healthy mast producing oak and hickory species, including historical pecan trees, and should plan skid trails to avoid these areas. Timber harvesting operations should also take care to avoid impacts to any ecologically sensitive areas such as wetlands and bottomland drains. If any threatened or endangered species are found on the property federal and state regulations should be adhered to when conducting timber harvest operations.

The managing forester is obligated to work closely with CCPRC on proposed sale areas and type of harvest, as well as notifying the general public and neighbors of the upcoming timber harvest. Care should be taken to minimize public access to the Property during active harvests to reduce the risk of injury or harm to the public from felled trees, logging trucks and other heavy equipment. All timber harvesting that occurs on the Property should be conducted under the supervision of a South Carolina Registered Forester, and in accordance with South Carolina Best Management Practices (BMPs).

1.2 Understory Fuels Management

Prescribed fire is a method of using controlled fire to mimic the benefits of natural fire. Prescribed fire is an integral part of forest management in the southeast. Fire naturally occurred through lightning strikes and was able to burn unimpeded across vast areas. Fires would burn until they reached a natural firebreak, such as a bottomland hardwood swamp or a river, or until rain or other weather events extinguished fires. Today, fire still occurs from natural causes, but these fires are typically quickly suppressed to prevent property damage and for public safety.

Prescribed fire serves two primary purposes in forest management. First, it removes fuel from the forest floor and understory to lessen the probability of a catastrophic wildfire; second, it removes undesirable species and woody plants from the forest understory and promotes grasses and early successional vegetation for wildlife. Prescribed fire is also an important part of certain ecosystems. The longleaf pine ecosystem evolved from the benefit of fire, and fire is crucial to natural regeneration in the ecosystem.

The Property can greatly benefit from prescribed fire, but the logistics for conducting a prescribed burn in proximity to development are challenging. The main risk factor when conducting prescribed fire is the smoke produced from the fire. The prescribed fire

manager conducting the burn is responsible for not only the fire itself, but the smoke produced from the fire. Given the Property's proximity to development and Highways 41 and 17, smoke management will be challenging. Due to this, it would be necessary to conduct prescribed burns in small sized blocks (less than 20 acres) on days with high ventilation rates to ensure smoke dissipates quickly, well before an inversion in the evening or night. Nighttime inversion can cause smoke to settle on roads and low lying areas, causing low visibility and increasing the chance of vehicle accidents. On a day with suitable weather a prescribed fire manager may choose to burn multiple burn blocks if the prescribed fire can be conducted safely and complies with SC smoke management guidelines. Highways 41 and 17 will be especially susceptible to potential inversions because of the high amount of daily traffic on the road. All prescribed fire should be conducted by a South Carolina Prescribed Fire Manager and with a proper burn plan and approval by the SCFC. Local fire departments, law enforcement, and local communities, including nearby homeowner's associations should be notified in advance for any scheduled prescribed burns. Additional educational opportunities provided through handouts, websites, social media, public talks, and hosting of related events may work to significantly promote the benefits of prescribed burns within the Property.

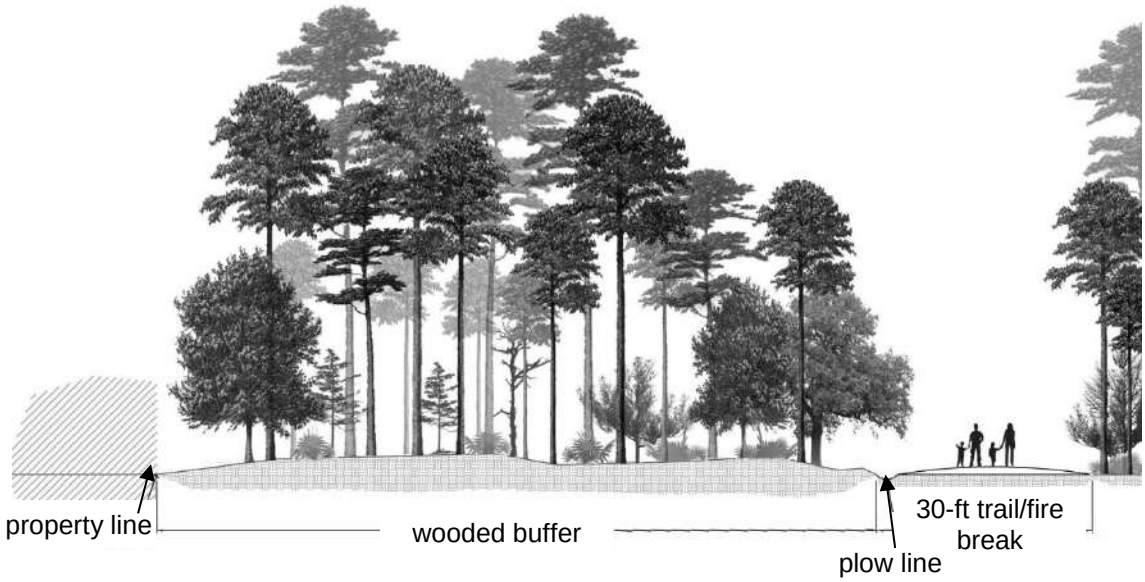

Figure 1-4. Illustrative cross-section of proposed 30-ft perimeter trail/fire break (Source: CCPRC)

Due to the close proximity of development, a wildfire could prove catastrophic if allowed to spread to adjacent homes. The reduction of fuels on the Property will make wildfires less intense and easier to contain if they occur. CCPRC, in conjunction with grants from the South Carolina Forestry Commission (SCFC), plans to construct a 30-foot wide firebreak around the northern perimeter of the Property (Fig. 1-4). To allow for construction of this firebreak a forestry mulching machine ("Gyro-trac") will be used to clear unwanted vegetation from the firebreak area. The firebreak will then be installed

using a SCFC bulldozer and fire plow. The firebreak should be flat bladed to allow it to be used as an access road and walking trail as well. The perimeter firebreak will start in the north east corner of the property tying into the existing road on the eastern boundary. From there the firebreak will be constructed to the west and south until it has been completed to surround the property. This process may take a few years, and work will be completed as grant money is available.

This firebreak will offer added protection to the adjacent development in the event of a wildfire, as well as provide additional access around the perimeter of the Property. A portion of this firebreak will be constructed and designated as a walking trail to add to the network of walking trails already on the Property. This firebreak will be part of a larger 100-ft (+/-) buffer that CCPRC will establish around the perimeter of the property. This buffer will receive minimal silvicultural maintenance activities as-needed, and will be maintained as a vegetated buffer area in perpetuity. This buffer will provide a visual buffer from the Property to the surrounding development, as well as offer the surrounding public a visual buffer for ongoing silviculture and land management activities on the Property. CCPRC believes that this buffer is an integral part of improving and maintaining the solitude and wooded atmosphere of the park, as well as improving and maintaining relationships with the surrounding community. The buffer and incorporated firebreak will help to lessen the effects of WUI on both the Property and the surrounding urban areas. The urban areas will experience reduced fire risk and the park will experience less negative impact to wildlife and aesthetic values. Both parties will mutually benefit from unwanted audio and visual effects from the other party.

Firebreaks will need to be maintained on an annual basis to ensure they do not become overgrown and/or lose their ability to be effective in stopping a fire. It will also be necessary to eventually construct interior firebreaks to delineate burn blocks. Existing roads and trails may be used as firebreaks, or firebreaks may be constructed using machinery such as a tractor and disk or bulldozer. All firebreaks should be constructed to expose bare mineral soil, and should be maintained regularly.

The RDA will be the top priority for burning on the Property. This area will contain the only longleaf pine on the Property, and it will be very important to ensure the longleaf is burned every two to three years when practicable. If prescribed burning is not practicable some years (or ever), the understory of the longleaf pine blocks should be masticated. While fire is less critical to the vitality of loblolly pine, the other areas of the Property that are dominated by loblolly would benefit from prescribed fire on a similar schedule. If prescribed burning is desired in these areas, they should be subdivided into approximately 20-acre burn blocks separated by firebreaks. The different burn areas will vary greatly in necessary wind direction to burn, but all of the suggested burn blocks should have at least one suitable wind direction for burning. It will be up to the Forester managing the

prescribed fire on the Property to monitor weather conditions throughout the burning season to ensure adequate burning occurs to meet the management goals.

1.3 Roads and Trails

The Property currently contains a road and trail system (Fig. 1-5), but work should be done to improve the roads for future use. Due to the lack of roads certain areas of the Property are virtually inaccessible by vehicle. Spur roads should be constructed off of existing roads to reach inaccessible areas, and should end approximately 1,200 feet from the property line. This will allow a logging crew to create a log deck at the end of the road allowing access within the majority of the Property.

Figure 1-5. Existing unimproved road network

When constructing roads care should be taken to plan their locations on the highest elevation possible. This will ensure proper drainage and offer better all-weather access to the Property. Constructing roads in well drained, high elevation areas of the Property will presumably need less long term maintenance. Roads should contain a side ditch on at least one side, and should be crowned to allow for adequate surface run-off. If necessary to cross a wetland, ditch, or stream, a culvert should be placed under the road to allow water to move freely. The culvert should be properly sized for high rain events, and should allow water to flow freely without the occurrence of ponding on the upstream side of the road. Any and all wetland crossings should be constructed in accordance with SC BMPs for Forestry, including culvert and pipe size recommendations.

CCPRC has developed a conceptual plan for developing an event parking area near the oak allee. The new parking area will need to be clearcut and grubbed to make it function for the intended use. Plans include a vegetative buffer around the parking area to help limit visual and noise nuisance. A new road will need to be constructed, or existing road improved, to allow vehicle access to this parking area on high traffic days when events are taking place. Any new roads constructed on the Property should be in accordance with SC BMPs.

1.4 Wildlife Management

The Property has a unique opportunity to provide important habitat and sanctuary for wildlife as it exists as a forest surrounded by development. Currently, hunting does not take place on the Property. CCPRC and the trust have expressed interest in enhancing wildlife habitat and food sources for wildlife, with a focus on managing primarily for eastern whitetail deer (*Odocoileus virginianus*) and eastern wild turkey (*Meleagris gallopavo*). With the exception of the powerline right-of-way (ROW) that bisects the Property, there are very few forest openings (Fig. 1-6).

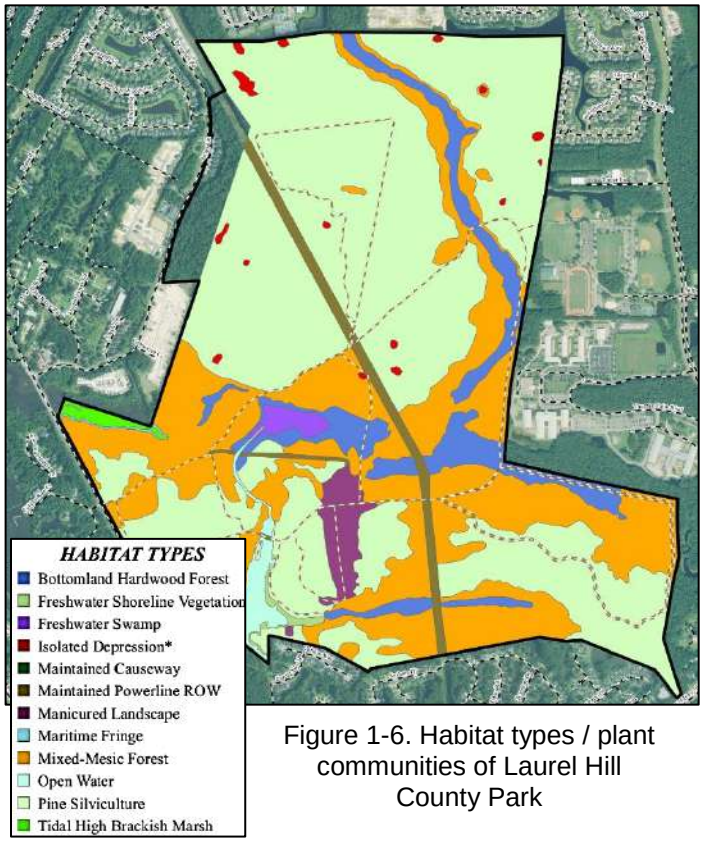

Figure 1-6. Habitat types / plant communities of Laurel Hill County Park

It is recommended to plant food plots in the open area of the power line. This food plot can be planted with annual wildlife mixes, or with native warm season grasses, and will provide supplemental nutrition to wildlife species on the Property. Annual wildlife mixes will primarily benefit whitetail deer and turkey.

Native warm season grasses will primarily benefit pollinators and butterflies. Pollinator species are an extremely important part of an ecosystem, and having a healthy population of pollinators will greatly improve all native plant life. A mix of native warm season grasses and annual wildlife mixes in a few small plots is recommended, and will help to promote diversity and benefit multiple species.

Creating several small groves of mast producing trees will also be especially beneficial to wildlife. These groves should consist of 5-10 trees and should be strategically located within the resource demonstration area. These groves should consist of native fruit trees, or other native mast producers such as oak *(Quercus spp.)* or hickory (*Carya spp.*) species. Planting pecan trees would not only provide wildlife sustenance, but also serve an interpretive purpose by linking to the Property's prior use as a pecan orchard. South Carolina Department of Natural Resources provides good examples for utilizing pecan trees within food plots at their various wildlife management areas. Consultation with DNR is highly recommended prior to any implementation.

Wildlife food plot with associated pecan orchard, located at Santee Coastal Reserve WMA, Georgetown County, SC

1.5 Protected Species Potentially Occurring at Laurel Hill

Table 1-1 is a list of federally threatened and endangered (T&E) animal and plant species that are known to occur in Charleston County, South Carolina, and whose suitable habitat requirements overlap with those that currently exist on the Property. These species are not necessarily known to occur on the Property at the time this plan was prepared, and more research is needed to determine the benefit and means-of attracting T&E species.

Table 1-1. Plant and Wildlife Species Potentially Occurring at Laurel Hill

Common Name	Scientific Name	Plant/ Wildlife	Federal Status	State Status
Northern Long-Eared Bat	*Myotis septentrionalis*	Wildlife	Threatened	Threatened
Bald eagle	*Haliaeetus leucocephalus*	Wildlife	B&GEPA	–
Wood stork	*Mycteria americana*	Wildlife	Endangered	Endangered
Red-cockaded woodpecker	*Picoides borealis*	Wildlife	Endangered	Endangered
Frosted Flatwoods salamander	*Ambystoma cingulatum*	Wildlife	Threatened	Endangered
Pondberry	*Lindera melissifolia*	Plant	Endangered	Endangered
Canby's dropwort	*Oxypolis canbyi*	Plant	Endangered	Endangered
Chaffseed	*Schwalbea americana*	Plant	Endangered	Endangered

1.6 Wetlands

An approximate wetlands boundary map is provided in Figure 1-7. CCPRC utilizes and overlays this and other mapping information (infrared, topography, LiDAR elevation, etc.) in GIS to help identify opportunities and constraints related to land management activities and future park development.

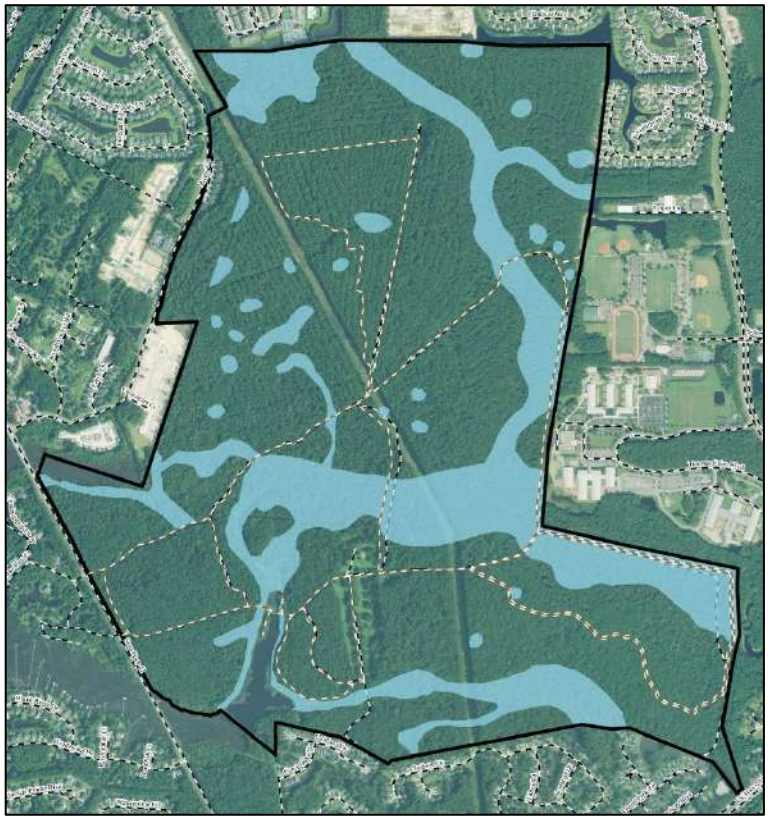

Figure 1-7. Wetland approximation* of Laurel Hill County Park (*wetland boundaries illustrated are not final and are subject to change by the U.S. Army Corps of Engineers)

Although CCPRC always tries to avoid wetlands when planning and designing parks, if wetland impacts are necessary, they will engage in the regulatory permitting process. It's important to note the map reveals approximate wetland boundaries, however final boundary determination is subject to United States Army Corps of Engineers (USACE). The majority of the Property's wetland boundaries are associated to the natural tidally influenced hydrology of Horlbeck Creek. Interior isolated wetlands are found primarily in the park's north and north-west areas and will be duly considered within the context of future trail, road and park infrastructure development.

1.7 Soils

There are 12 soil types found on the Property (Fig. 1-8). The dominant soil types are Charleston (27%), Hockley (22%), Meggett (4%), Stono (13%), Wadmalaw (8%), Wagram (5%) and Yonges (13%). The Charleston, Hockley, and Wagram soil series comprise the majority of the upland areas on the Property, and therefore are the well-drained soils. Hockley and Wagram are deep well drained soils, and Charleston is a deep moderately well drained soil. These soil types make up the majority of the property that has been historically used for loblolly pine silviculture. Portions of these soil types are suitable for longleaf pine production. The highest, most well drained portions of these soils are located in the middle of the property where the forest demonstration area will be

established. Although these soils are classified as well drained, after review on site many of these mapped soil areas are more poorly drained than an ideal longleaf pine site. This is not to say that longleaf pine cannot grow in these areas, but they are not best suited for longleaf pine. For this reason and several others previously mentioned large scale longleaf pine conversion will not take place. Longleaf pine will be included in the forest demonstration area. When planning the forest demonstration area, care was taken to plan the longleaf pine portions on the most well drained portions of these soil types to facilitate the best possible site conditions for growth.

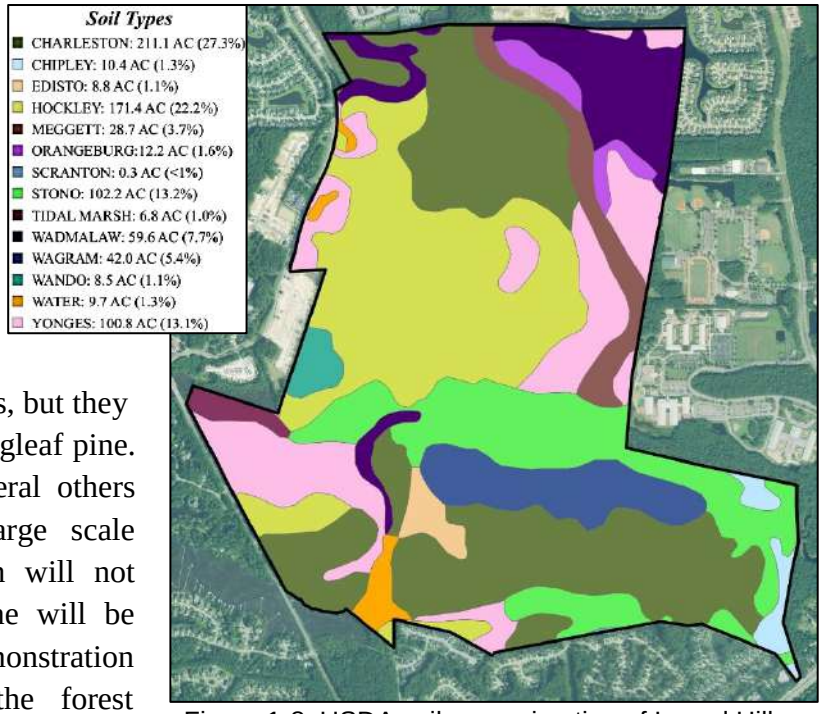

Figure 1-8. USDA soil approximation of Laurel Hill County Park

Meggett, Stono, Wadmalaw, and Yonges make up the poorly drained soils on the property. These soils are all classified as poorly drained, and comprise the majority of the wetland areas on the Property. These soil types are dominate the bottomland hardwood and mixed hardwood pine stands. The Property also contains small deposits of the Chipley, Edisto, Orangeburg, Scranton, and Wando soil types.

1.8 Archaeological Sites

There are several archaeological sites on the Property, some dating as far back as the prehistoric woodland period. In 2013, at the request of CCPRC, a Phase 1 archaeological survey was conducted by New South Associates. The survey identified 19 archaeological sites on the property ranging from the prehistoric woodland era to the eighteenth-nineteenth century colonial period settlements, enslaved graveyards, and various artifact scatterings. When conducting forest management activities, and planning for increases in recreational and silvicultural infrastructure, care should be taken to avoid impacting these area. Accordingly, a thorough review of the Phase I archaeological survey should be undertaken to understand specific site types, locations, significance and associated recommendations.

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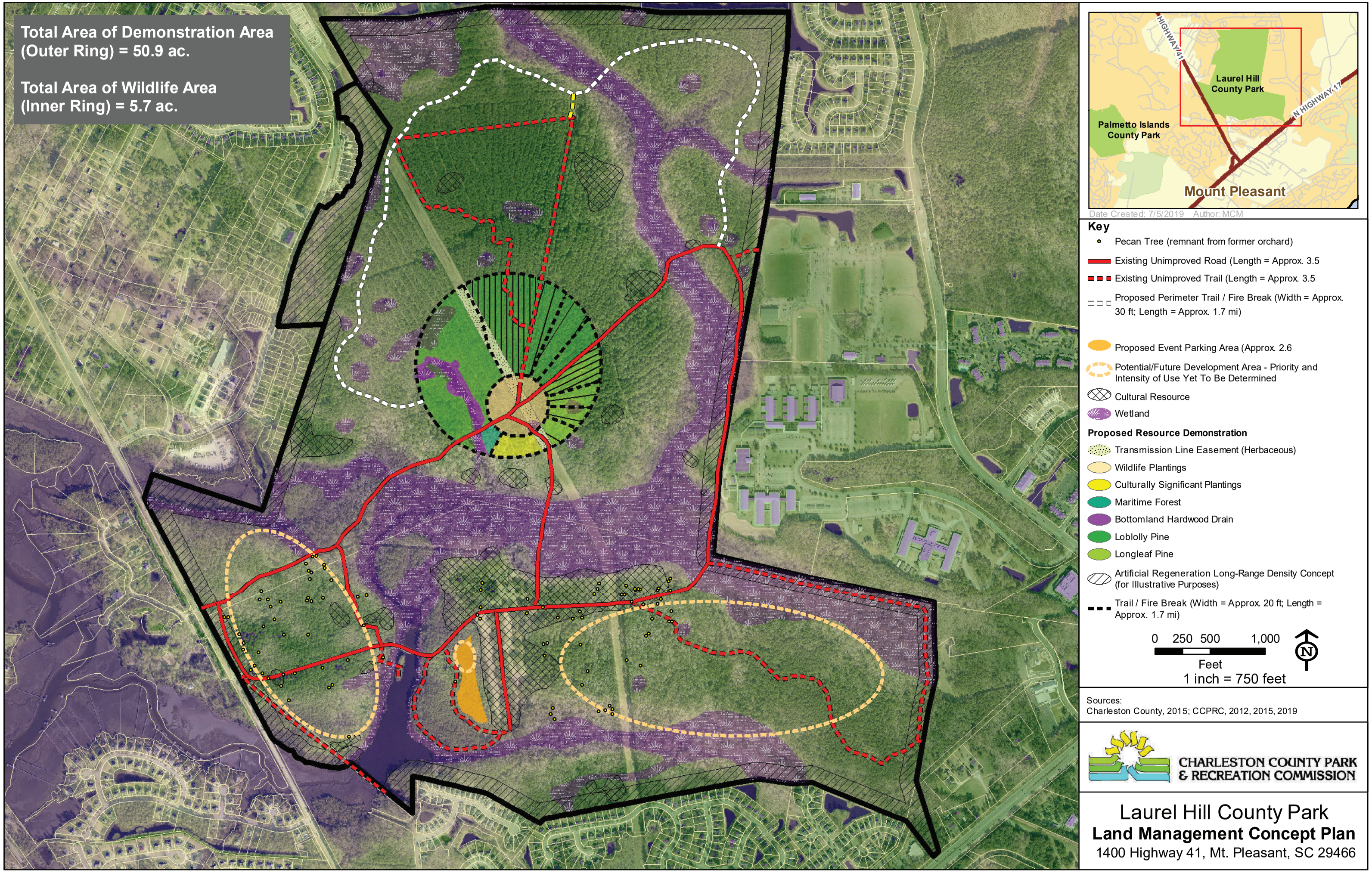
Figure 1-9 Land Management Concept Plan for Laurel Hill County Park



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Chapter Two: Forest Stand Descriptions and Recommendations

A "timber stand" is a geographic area that contains similar forest composition – in terms of age, species composition, or both. Stand boundaries for the Property are illustrated in Figure 2-1.

Loblolly pine plantations on the Property will benefit from thinning. Currently the trustee's land manager has a pine thinning operation planned on approximately 115 acres of the southern half of the Property. This thinning will reduce BA to approximately 70 ft^2/acre, roughly half of its current BA. The thinning will focus on improving forest health by removing poorly formed and/or diseased, dying, or suppressed trees. During the thinning any healthy mast-producing hardwoods (e.g., live oak, pecan, hickory) should be preserved and "day lighted" by removing pines and other woody vegetation within 25-30 ft of their canopies. This will provide various oak and hickory species more sunlight and allow room to grow to sustain mast production for wildlife. The thinning will also allow more light to the forest floor. This additional light, coupled with prescribed burning and/or other understory treatments as feasible, will promote the growth of more grasses and other early successional vegetation for wildlife, and can improve the overall aesthetics of the Property.

In order to continue timber production on the Property, within future timber harvest cycles stands – or portions of stands – will be clearcut (or potentially thinned to +/-10 trees per acre for aesthetic reasons, subject to recommendation of the trustee's land manager) and replanted with loblolly pine. Stands should only be clearcut once they have reached maturity, and clearcuts should be kept to less than 50 acres. Incremental clearcutting will also be necessary for the establishment of the resource demonstration area (RDA). In order to implement the RDA, the necessary portions should be clearcut concurrently with each thinning cycle. Although clearcuts are not initially aesthetically pleasing they are a necessary forest management process for providing productive timber management. Clearcut stands also provide early successional food and eventually important cover and nesting habitat for a variety of wildlife. (*Although CCPRC accepts clearcutting as an acceptable silvicultural treatment, in accordance with its agency-wide Natural Resource Management Plan, CCPRC does not typically practice clearcutting or production-driven forestry on park properties under CCPRC ownership. CCPRC's Natural Resource Management Plan is available at: https://www.ccprc.com/NaturalResourceManagement.*)

The hardwood dominated stands on the property should be excluded from the timber harvest schedule. These areas are generally located on poorly drained soils and not disturbing these areas will be important in maintaining water quality throughout the Property. These stands should be allowed to continue to grow, and harvesting should not

take place in the areas unless a natural event such as a hurricane takes places and a salvage harvest is necessary to remove downed trees to clean up the hardwood dominated stands. If such an event happens the managing forester will make the decision to conduct such a harvest.

Recommended management activities per stand are summarized in Table 2-1 at the end of this chapter.

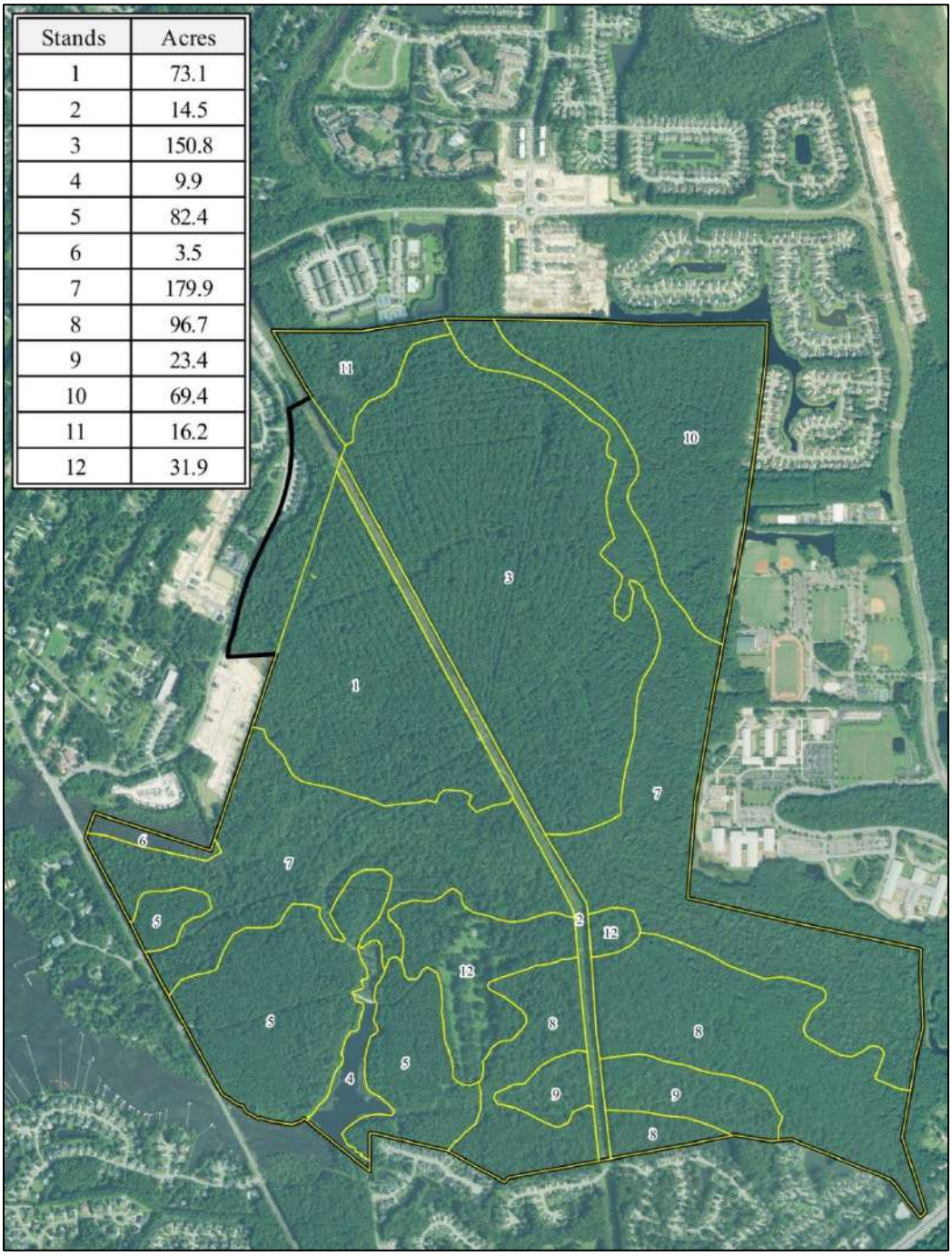

Figure 2-1. Stand boundaries map of Laurel Hill County Park

Stand 1

Acres: 73.1
Timber Type: Loblolly pine (*Pinus taeda*), mixed hardwood
Understory: Grasses, sweet gum (*Liquidambar styraciflua*), wax myrtle (*Morella cerifera*), giant cane (*Arundinaria gigantea*), loblolly bay (*Gordonia lasianthus*)
Basal Area: 100 ft^2/acre
Average DBH: Variable DBH 6"-16"
Soil Type: Hockley

Description/Recommendation

Stand One (1) is a loblolly pine stand with pockets of mixed hardwood throughout. The hardwood is composed primarily of live oak (*Quercus virginiana*), white oak (*Quercus alba*), willow oak (*Quercus phellos*), and sweet gum. The hardwood is mostly composed of larger diameter, saw timber size, trees. The stand has a relatively sparse understory due to the mostly closed canopy. There are several depressional wetlands throughout the stand that mainly occur in the form of small gum ponds. The stand should be thinned to a BA of approximately 70ft^2/acre in approximately five years. This thinning should favor the dominate trees in the stand, and should daylight the crown of healthy mast producing hardwoods. Like typical loblolly pine stands, Stand 1 would benefit from prescribed fire on a two to three year rotation to control understory vegetation. Whether implemented by prescribed fire or other means, understory management will be especially beneficial following the recommended thinning.

Stand 2

Acres: 14.5
Timber Type: N/A
Understory: Grasses
Basal Area: N/A
Average DBH: N/A
Soil Type: Charleston, Hockley, Stono, Wagram

Description/Recommendation

Stand Two (2) is a power line right of way (ROW). This ROW serves as the largest open area on the property. The ROW is dominated by a mix of grasses and early successional vegetation. The ROW is maintained by Dominion Energy, formerly South Carolina Electric and Gas (SCE&G), and the vegetation is controlled periodically using mechanical cutting and herbicide. The ROW will serve as good area to establish food plots for wildlife. The ROW has been integrated within the proposed forest demonstration area to provide both food and habitat to wildlife, but also provide the public a visual representation of a clearcut forest and/or open meadow.


Stand Two

Stand 3

Acres: 150
Timber Type: Loblolly pine, mixed hardwood
Understory: Grasses, loblolly pine, sweet gum, wax myrtle, giant cane
Basal Area: 120 ft^2/acre
Average DBH: Pine 15", Hardwood 18"
Soil Type: Charleston, Hockley, Yonges

Description/Recommendation

Stand Three (3) is a loblolly pine dominated stand containing scattered hardwood. Along the northeast edge of stand three there is a wetland transitional zone to stand seven. This transition zone is an area of hardwoods composed of mostly hickory (*Carya spp.)* white oak, willow oak, and water oak (*Quercus nigra*) located between the higher pine dominated sections of the stand, and the seasonally flooded bottomland hardwood wetland of stand seven. The stand is predominantly composed of loblolly pine with some mid story hardwood consisting of mostly sweet gum and red maple (*Acer rubrum*). The stand also contains scattered live oaks throughout. The stand is not included in the upcoming timber sale area. The proposed forest demonstration area is included in a portion of this stand, and the presence of the demonstration area will affect future management decisions of the stand. The portions of the stand not included in the forest demonstration are should be thinned at the same time as stand one to a BA of approximately 70 ft^2/acre. Like typical loblolly pine stands, Stand 3 would benefit from prescribed fire on a two to three year rotation to control understory vegetation. Whether implemented by prescribed fire or other means, understory management will be especially beneficial following the recommended thinning.

Stand Three

Stand Three (transitional zone)

Stand 4

Acres: 9.9
Timber Type: N/A
Understory: N/A
Basal Area: N/A
Average DBH: N/A
Soil Type: N/A

Description/Recommendation

Stand Four (4) is a pond. The pond has a water control structure located on the southwest boundary of the pond adjacent to the tidal marsh and Horlbeck Creek. The water control structure has recently been upgraded through a grant from Ducks Unlimited. The pond will be managed for a variety of ducks and other wading birds. Please refer to the pond management section of this management plan (*Chapter 9: Water Impoundment Management*) for more specific recommendations.

Stand 5

Acres: 82.4
Timber Type: Loblolly pine
Understory: Wax myrtle, sweet gum, dwarf palmetto (Sabal minor)
Basal Area: 150 ft2/acre
Average DBH: 10”
Soil Type: Charleston, Hockley

Description/Recommendation

Stand Five (5) is a loblolly pine stand containing mostly pulpwood and chip-n-saw size timber, with a few saw timber size trees located in the western portion of the stand. Due to the closed canopy and high BA the stand has a sparse understory. There are some scattered hardwoods throughout the stand, including water oak, red oak (*Quercus falcata*) and white oak. The stand is recommended for thinning to a BA of approximately 70ft^2/acre. The crowns of healthy mast producing hardwoods should be day lighted during the thinning. Approximately 2-3 acres of the stand bordering the historic oak alley have been identified by CCPRC to be clearcut within a planned thinning project. The main purpose of the clearcut is to provide event parking. Appropriate buffers ranging between 80-100 ft. will be maintained around the allee side of the clearing to provide visual aesthetics and reduce noise impacts. Like typical loblolly pine stands, Stand 5 would benefit from prescribed fire on a two to three year rotation to control understory vegetation. Whether implemented by prescribed fire or other means, understory management will be especially beneficial following the recommended thinning.


Stand Five

Stand 6

Acres: 6
Timber Type: N/A
Understory: Marsh grasses
Basal Area: N/A
Average DBH: N/A
Soil Type: Tidal Marsh

Description/Recommendation

Stand Six (6) is a tidal marsh. The stand should be left undisturbed and maintained intact to help preserve water quality in the adjacent creek. Silvicultural activities should maintain a +/-100’ buffer on this stand.

Stand 7

Acres: 179.9
Timber Type: Bottomland hardwood, scattered lobolly pine
Understory: Dwarf palmetto, grasses, wax myrtle, giant cane
Basal Area: 120 ft^2/acre
Average DBH: Highly variable from small pulpwood to large saw timber
Soil Type: Meggett, Stono, Yonges

Description/Recommendation

Stand Seven (7) is a bottomland hardwood stand with some scattered loblolly pine occurring on higher elevation micro sites. The stand contains primarily red maple, sweet gum, willow oak, swamp laurel oak (*Quercus laurifolia*), water oak, swamp chestnut oak (*Quercus michauxii*), southern magnolia (*Magnolia grandifolia*), and sugarberry (*Celtis laevigata*). The understory of the stand is highly variable due mostly to elevation and seasonal flooding. The areas of the stand that receive the most flooding have a sparse understory, while the slightly higher areas have a thick understory dominated by switch cane, grasses, and dwarf palmetto. The stand contains the main wetland drain that occurs through the Property, and should not be harvested and kept intact to maintain water quality on the Property.

Stand 8

Acres: 96.7
Timber Type: Loblolly pine
Understory: Grasses, giant cane
Basal Area: 150 ft^2/acre
Average DBH: Variable 6”-20”
Soil Type: Charleston

Description/Recommendation

Stand Eight (8) is primarily a loblolly pine stand with some mixed hardwood throughout. The hardwood mainly consists of white oak, water oak, willow oak, swamp chestnut oak, southern magnolia and sweet gum. Due to the high basal area and closed canopy the understory in the stand is sparse. Japanese climbing fern (*Lygodium japonicum*) is present in the stand. Japanese climbing fern is an invasive species, specific treatment recommendations are outlined in the invasive species section. The stand should be thinned to a residual BA of approximately 70ft^2/acre. Like typical loblolly pine stands, Stand 8 would benefit from prescribed fire on a two to three year rotation to control understory vegetation. Whether implemented by prescribed fire or other means, understory management will be especially beneficial following the recommended thinning.

Stand 9

Acres: 23.4
Timber Type: Hardwood, scattered loblolly pine
Understory: Grasses, giant cane, dwarf palmetto, wax myrtle
Basal Area: 80 ft^2/acre
Average DBH: Variable 6”-20”
Soil Type: Hockley, Stono, Yonges

Description/Recommendation

Stand Nine (9) is a mixed hardwood stand containing mostly hickory and swamp chestnut oak. The stand is typical of a low lying hardwood stand, but does have some loblolly pine throughout on the higher portions. The understory is primarily composed of dwarf palmetto, but grasses, wax myrtle, and giant cane are also present. The stand should be excluded from the timber harvesting plan for the Property. The wet nature of the stand will make timber harvesting challenging, and the stand contains many mast producing hardwoods that are beneficial to wildlife on the Property.

Stand Nine

Stand 10

Acres: 69.4
Timber Type: Loblolly pine, mixed hardwood
Understory: Grasses, loblolly pine, sweet gum, wax myrtle
Basal Area: 140 ft^2/acre
Average DBH: Pine: 16”, Hardwood: variable 6”-20”
Soil Type: Orangeburg, Wadmalaw, Yonges

Description/Recommendation

Stand 10 is a loblolly pine dominated stand with mixed hardwood throughout. The loblolly pine is mostly saw timber size, while the hardwood varies in size from pulpwood to large saw timber. The hardwood species in the stand include sweet gum, red maple, water oak, white oak, and live oak. There are several small seasonally flooded depressional wetlands throughout the stand that are dominated by sweet gum, black gum (Nyssa sylvatica), and red maple. The BA of the stand is very high and is approaching being overstocked. In addition, the trees have mostly reached maturity and based on this would be a good candidate for a final harvest followed by reforestation of loblolly pine. If a final harvest does occur a buffer should be maintained along the north and east property lines where the stand borders the adjacent development, and any large, healthy mast producing hardwoods should be retained for wildlife benefits. The final harvest should also avoid the depressional wetlands in the stand. If the managing forester decides that the stand should not be clearcut then it should be thinned at the same time as stands one and three to the same residual BA of 70 ft2/acre. Like typical loblolly pine stands, Stand 10 would benefit from prescribed fire on a two to three year rotation to control understory vegetation. Whether implemented by prescribed fire or other means, understory management will be especially beneficial following the recommended thinning. .

Stand Ten

Stand 11

Acres: 16.2
Timber Type: Loblolly pine, mixed hardwood
Understory: Grasses, sweet gum, wax myrtle, switch cane
Basal Area: 120 ft^2/acre
Average DBH: Pine: 13", Hardwood 8"
Soil Type: Charleston, Wadmalaw

Description/Recommendation

Stand 11 is a loblolly pine stand that contains a large depressional wetland in the north-west corner. The depressional wetland is dominated by black gum and due to seasonal flooding has very little understory vegetation. The stand contains a range of diameter classes of loblolly pine from pulpwood to saw timber. The midstory throughout the stand is composed primarily of hardwood and includes species such as hickory, sweet gum and water oak. The understory is patchy due to the relatively closed canopy and where present contains primarily sweet gum, switch cane and wax myrtle. The stand should be thinned at the same time as stands one and three, to a residual BA of approximately 70 ft^2/acre. Care should be taken when thinning the stand to not negatively affect the wetlands. Like typical loblolly pine stands, Stand 11 would benefit from prescribed fire on a two to three year rotation to control understory vegetation. Whether implemented by prescribed fire or other means, understory management will be especially beneficial following the recommended thinning.

Stand 12

Acres: 31.9
Timber Type: Loblolly pine, mixed hardwood, house site, oak allee
Understory: Grasses
Basal Area: N/A
Average DBH: N/A
Soil Type: Charleston, Wagram

Description/Recommendation

Stand 12 contains the site of the historical plantation house and oak allee. The majority of the stand is a maintained lawn that is mowed frequently by CCPRC. Portions of the stand are included in the upcoming timber sale area. The wooded portions of the stand around the edge of the lawn should be thinned lightly. Following thinning it would greatly improve the aesthetics of this stand to mulch the logging slash and stumps with a forestry mulching machine. The mulched area can be subsequently maintained with a tractor and bushhog mower. This area serves as the main focal point of the property, and can continue to be managed for aesthetic value and as an event space.

Table 2-1. Forest Management Recommendations by Stand and Year

Laurel Hill County Park - Forest Management Recommendations by Stand and Year													
Forest Stand Descriptions	Starting Basal Area	Proposed Basal Area (Post-thinning)	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**
1* -Loblolly	(100 ft²/acre)	(60-70 ft²/acre)	Thin		(UM)		Thin		(UM)		(UM)		(UM)
2- ROW (N/A)	-	-	-	-	-	-	-	-	-	-	-	-	-
3*	*See Resource Demonstration Area Diagram*												
4- Pond (N/A)			-	-	-	-	-	-	-	-	-	-	-
5- Loblolly	(150 ft²/acre)	(60-70 ft²/acre)	Thin		(UM)		(UM)		(UM)		(UM)		(UM)
6- Tidal Marsh (N/A)	-	-	-	-	-	-	-	-	-	-	-	-	-
7- Bottomland hardwood (N/A)			-	-	-	-	-	-	-	-	-	-	-
8- Loblolly	(150 ft²/acre)	(60-70 ft²/acre)	Thin		(UM)		(UM)		(UM)		(UM)		(UM)
9- Hardwood (N/A)			-	-	-	-	-	-	-	-	-	-	-
10- Loblolly	(140 ft²/acre)	(60-70 ft²/acre)	(UM)		(UM)		Thin		(UM)		(UM)		(UM)
11- Loblolly	(120 ft²/acre)	(60-70 ft²/acre)	(UM)		(UM)		Thin		(UM)		(UM)		(UM)
12- Loblolly/Grass	varies	varies	Thin		(UM)		(UM)		(UM)		(UM)		(UM)

* Stands 1 & 3 includes a large section of the RDA. See applicable RDA management recommendations
**Understory Management (UM) to include mulching, herbicide application and/or prescribed burning when conditions permit.

The term "basal area" (BA) is used to describe the average amount of woody biomass at breast height per acre occupied by tree stems. BA measurements are a useful index for understanding forest density and corresponding forest health. In general, forest stands with a basal area greater than **100 sq. ft. per acre** are considered in poor condition and will start experiencing declines in overall tree growth/health. Furthermore, overly dense forest stands prevent sunlight, moisture and nutrients from reaching the ground, impeding understory growth and limiting wildlife habitat. Typically, a basal area range of **60 to 70 sq. ft. per acre** provides an optimal balance for promoting healthy forest stands. Accordingly, the majority of Laurel Hill's forest stands will be thinned within that recommended range.

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Chapter Three: Resource Demonstration Area

In conjunction with CCPRC's plan to use the Property as a passive park for recreation and education, a "resource demonstration area" (RDA) is designated on a portion of the Property (see Fig. 3-1 and Fig. 3-2).

The primary goal of this RDA is to educate and provide an understanding to the public on the importance of forestry to the state and local economy, best management practices for both silviculture and wildlife, to exhibit different forest types and help introduce the park's cultural resources. Recognizing the need to maintain revenue these blocks will be actively managed in perpetuity and considered part of the Property's working forest. When properly implemented over the course of several decades, the intended effect should provide the public with a powerful visual experience illustrating the difference between blocks of planted loblolly and longleaf pine, potentially variations in understory fuel management, and blocks with various forest types, maturity and harvest and recruitment treatments. A management schedule for the RDA is included in this section (Table 3-1).

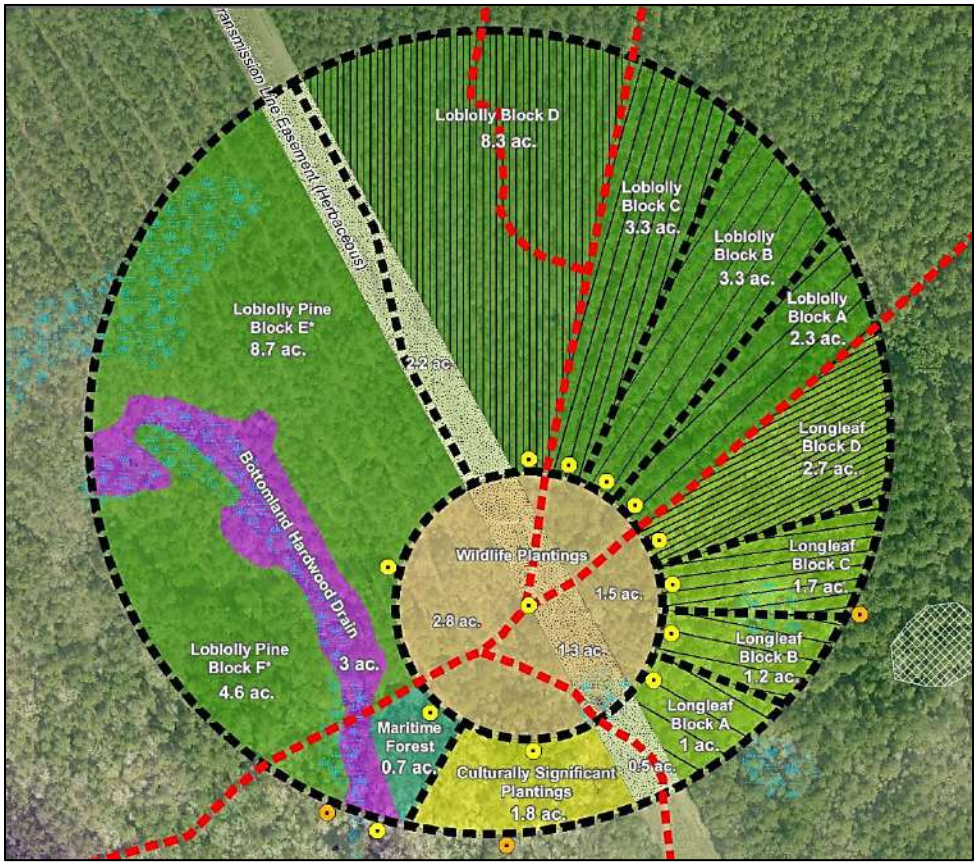

Figure 3-1. Proposed "Resource Demonstration Area" of Laurel Hill County Park

3.1 Outer-Ring

The designated site for the RDA is located within Stands One and Three and takes advantage of existing roads, elevations and forest types resulting in a circular shaped (outer-ring). The Outer-Ring encompasses approximately 50.9 acres and is encircled by a one-mile (circumference) trail/firebreak. Interior radial spoke trails/firebreaks- totaling approximately 0.75 miles- provide the public a unique side-by-side comparison of the differences between the respective block treatments. Within the outer-ring there are 14 proposed forest blocks ranging in size from 0.5 to 8.7 acres. The proposed blocks in the RDA include: 1) 1ongleaf blocks A through D = 6.6 ac., 2) loblolly blocks A through D = 17.2 ac., 3) loblolly blocks E & F = 13.3 ac., 4) bottomland hardwood drain = 3 ac., 5) maritime forest = .7 ac., 6) culturally significant plantings = 1.8 ac., 7) transmission line easement (existing) = 2.7 acres.

3.2 Inner-Ring

The inner-ring of the RDA encompasses approximately 5.7 acres, and is exclusively dedicated to providing food sources to wildlife. Approximately, 1.3 acres of existing transmission line easement is included within this block. Forested areas within the inner-ring are proposed to be clearcut and planted strategically with mast producing trees, such as pecan (*Carya illinoinensis*) (historically relevant to the Property), serviceberry (*Amelanchier arborea*), persimmon (*Diospyros virginiana*), beneficial grasses, forbs and shrubs to provide sustenance and habitat to wildlife. The inner-ring circumference provides an additional 1/3 mile of trails/firebreaks for public enjoyment.

3.3 Resource Interpretation

To support educational and public outreach goals, each block is proposed to include interchangeable interpretive waysides that narrates/illustrates present managed conditions, future managed rotation and how the block is following forestry best management practices. Waysides sited along the inner-ring will speak to the block's specific natural resources and forest management conditions. Waysides sites along the outer-ring will educate the public on nearby cultural resources.

3.4 Block Management Recommendations

Longleaf Pine Blocks A-D

Longleaf pine blocks are strategically located on the highest elevations of the demonstration area, most appropriate for longleaf pine production. These blocks will be actively managed on a 10-15 year rotation cycle (opportunistically, when timber harvests are planned elsewhere on the site to maximize economies of scale) and planted at various widths to provide a distinct visual experience to the public. Ideally, these stands would be

burned on a two to three year rotation, however, it is likely that regular mechanical/herbicidal application may be necessary in some or all blocks to minimize understory woody vegetation. No other blocks in RDA are recommended to be treated with prescribed fire. Should prescribed burning be implemented within these blocks, the effect would provide a striking visual to the public, while demonstrating the beneficial impacts controlled burns provide towards a healthy forest ecology. Aside from future timber revenue opportunities, these blocks may also provide revenue in the form of highly desirable longleaf pine straw.

The contrast between blocks of existing loblolly pine and the introduction of longleaf pine blocks will help familiarize the public on their physical, ecological, and economical differences and similarities, and thus help to educate on the contributions of each species to the landscape of South Carolina.

In order to implement the desired visuals for the proposed longleaf blocks, managed rotation practices should coincide with the upcoming (and other future occurring) timber harvests, starting with a clearcut and re-planting of Block D and progressing with clearcut, planting and thinning every ten years through Block A. Should it be determined that prescribed fire is not a viable tool for managing understory fuels, strategically spaced planted seedlings will allow for fuel management through mowing, mastication and other mechanical means. In some instances the effects of routine mowing may provide for a longleaf "savannah" condition, an increasingly rare ecosystem in South Carolina. In addition, any clearcut will add volume to the current timber sale and generate revenue for reforestation. The timber harvesting, site preparation and replanting should be conducted under the supervision of an SC Registered Forester.

Loblolly Pine Blocks A-D

Loblolly pine blocks A-D consists of existing forest conditions composed primarily of loblolly pine and associated understory vegetation. The management and interpretive intent for these blocks is to provide exhibit a planted loblolly ecosystem and highlight its central role as a dominant role forest product. The proposed clearcut and planting of Block D in the upcoming thinning is to be followed by subsequent actions to B, C & D over 10-15 year increments. For example, after an initial clearcut and planting, 10-15 years after planting when Block D's loblolly pine is old enough for a first thinning, it will be necessary to clearcut Block C, replant and continue the pattern. Mechanical and herbicide application will primary management option for limiting woody vegetation. Following the timber harvest as new growth becomes present in the spring and early summer all harvested blocks should be treated with a chemical site preparation herbicide and planted the following planting season (December-March). Chemical site preparation mixes should be tailored to control the re-sprouting vegetation on the site, as well as to not harm the species of pine to be planted on the site.

Loblolly Pine Blocks E & F

Loblolly pine Blocks E & F are of similar forest compositions to the other loblolly blocks. These blocks are intended to clearcut and thinned per the management schedule. However, the intent of these blocks is to demonstrate a natural regeneration vs. planted loblolly growth. Accordingly, their management and maintenance will be less intense. Through the natural regenerative process these blocks can provide important wildlife habitat for birds and small mammals, while offering a strong visual contrast to adjacent blocks and park land.

Bottomland Forest Drain Block

The bottomland hardwood drain is located primarily in a lowland floodplain comprised of wetlands and alluvial soils that promote growth of different trees species including mixed hardwoods of gum, oak, bald cypress and magnolias. The block is proposed to be selectively thinned and enhanced with new tree and understory vegetation. Opportunities for building raised boardwalks within the block will offer a unique experience to the public.

Maritime Forest Block

Maritime forest is typically composed primarily of oaks, magnolia, cedar and other salt tolerant vegetation. While maritime forest serves as a transitional area between salt marsh and upland areas, this block will include artificial establishment offer park visitors a glimpse of a forest ecology that dominate the State's coast. Selective thinning and enhancement with appropriate trees and related understory vegetation is the proposed management treatment.

Culturally Significant Plantings Block

Cultural plantings are intended to highlight and provide opportunity for interpretation of vegetation that played a role in the Property and area's historical development. Potential plantings may include indigo, cotton, sweetgrass, crops, and other vegetative types that speak to the Property's past. Additional ideas for the block may include interpretation of natural resources related to brick making, a dominant industry in the area during the 19th century. Prior to implementation, collaboration with CCPRC's interpretive and stewardship staff shall be conducted to ensure that any cultural interpretive goals and objectives are clearly defined and met.

Wildlife Plantings Block

The primary purpose of the wildlife planting block is to support wildlife through the creation of forest food plots supported by mast producing trees and other beneficial vegetation. This block will look to follow and replicate food plots established on SC DNR's Wildlife Management Areas (WMAs). Ranging between 1-3 acres the open areas will be defined by selective plantings of fruit trees to support small mammals and whitetail deer. Planting of selected warm season grasses, forbs and shrubs will help support game birds and pollinating insects and butterflies. The block will require annual mowing to limit

invasive plants and woody vegetation. Any plantings proposed within the transmission line that bisects the block will require consultation and approval from Dominion Energy.

Transmission Line Easement

Transmission lines are ideally permanently maintained as herbaceous vegetation. This area constitutes the final element in the RDA and is proposed to remain intact in its current form and function. The easement does provide a pleasant open space contrast to the adjacent evolving forest blocks. A proposed mowed path within the easement will offer park users a unique meadow like experience. The addition boxes/homes supporting various bat species, blue birds, owls and/or purple martins is recommended along the edges of the transmission line. The construction of these habitats can be excellent collaborative activity with local schools and civic clubs. Consultation with Dominion Energy should be initiated prior to any proposed management activities.

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Table 3-1. Resource Demonstration Area Timber Management Rotation Schedule

Resource Demonstration Area Timber Management Rotation Schedule					
Blocks	**2019**	**2029**	**2039**	**2049**	**2059**
Loblolly A	Thinned	Thinned	Thinned	Clearcut & Planted	Thinned
Loblolly B	Thinned	Thinned	Clearcut & Planted	Thinned	Thinned
Loblolly C	Thinned	Clearcut & Planted	Thinned	Thinned	Thinned
Loblolly D	Clearcut & Planted	Thinned	Thinned	Thinned	Clearcut & Planted
Loblolly E	Thinned	Thinned	Thinned	Thinned	Thinned
Loblolly F	Thinned	Thinned	Thinned	Thinned	Thinned
Longleaf A	Thinned	Thinned	Thinned	Clearcut & Planted	Thinned
Longleaf B	Thinned	Thinned	Clearcut & Planted	Thinned	Thinned
Longleaf C	Thinned	Clearcut & Planted	Thinned	Thinned	Thinned
Longleaf D	Clearcut & Planted	Thinned	Thinned	Thinned	Clearcut & Planted
Bottomland Hardwood Drain	Enhancement/ Planting	Maintain	Maintain	Maintain	Maintain
Maritime Forest	Thinned & Planted	Thinned & Planted	Maintain	Maintain	Maintain
Culturally Sig. Plantings	Clearcut & Planted	Maintain/Enhance/ Mow annually	Maintain/Enhance/ Mow annually	Maintain/Enhance/ Mow annually	Maintain/Enhance/ Mow annually
Wildlife Plantings	Clearcut & Planted	Maintain/Enhance/ Mow annually	Maintain/Enhance/ Mow annually	Maintain/Enhance/ Mow annually	Maintain/Enhance/ Mow annually
Transmission Line Easement	Maintain/ Mow path annually	Maintain/ Mow path annually	Maintain/ Mow path annually	Maintain/ Mow path annually	Maintain/ Mow path annually

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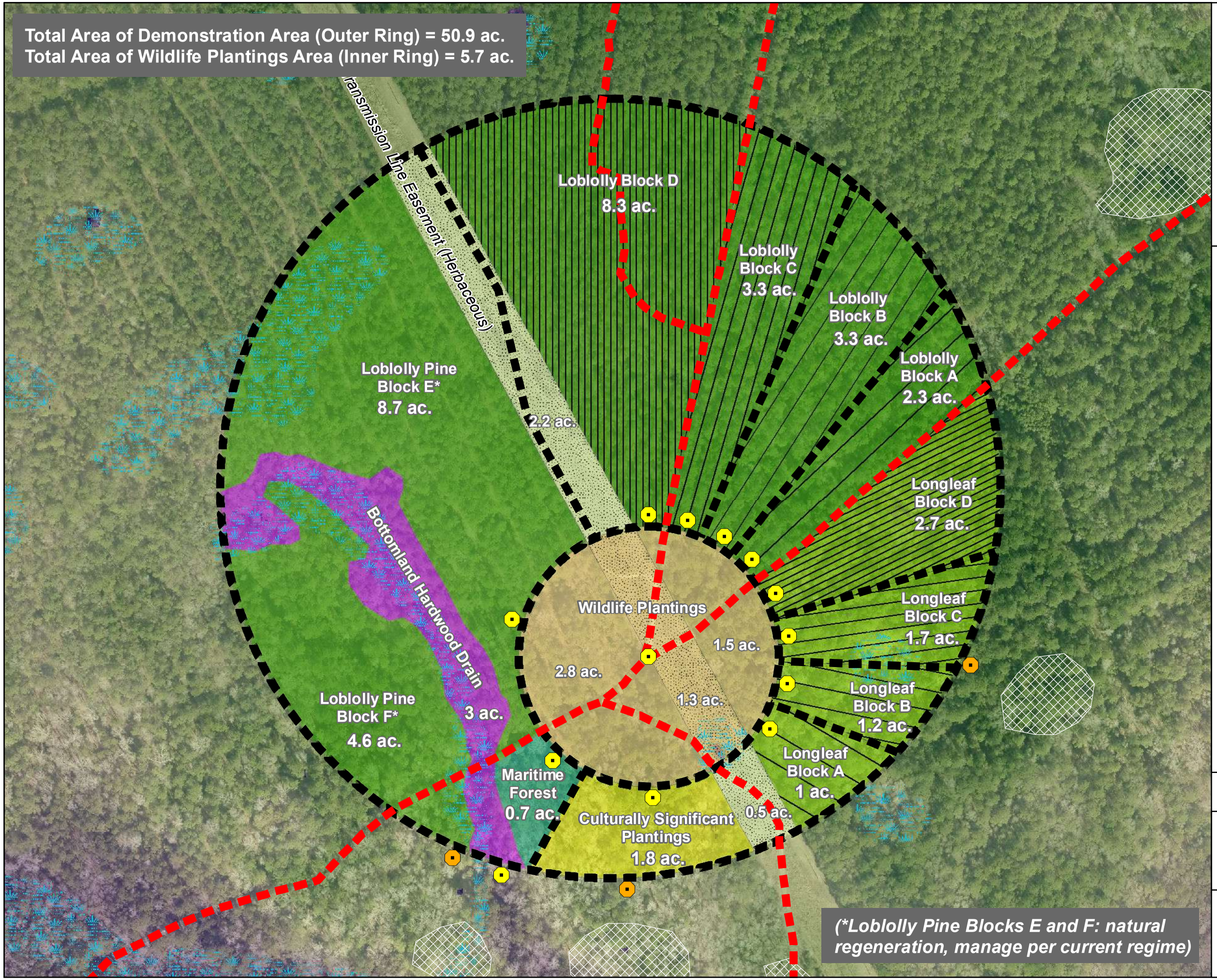
Figure 3-2 Proposed Resource Demonstration Area- Contextual Map



Date Created: 6/18/2019 Author: MCM

Key

- Existing Trails
- ArchSites
- Wetland

Proposed Demonstration Area

- Cultural Resource Wayside
- Natural Resource Wayside
- Transmission Line Easement (Herbaceous)
- Wildlife Plantings (Establish)
- Culturally Significant Plantings (Establish)
- Maritime Forest (Establish)
- Bottomland Hardwood Drain (Enhance)
- Loblolly (Manage on Rotation)
- Longleaf (Establish, Manage on Rotation)
- Artificial Regeneration Long-Range Density Concept (for Illustrative Purposes)
- Trail / Fire Break (Width = Approx. 20
  Trail / Fire Break Length:
  - New Outer Ring = 1 mile
  - New Inner Ring = 1/3 mile
  - New Radial "Spokes" = 3/4 mile (total)

0 100 200 400
Feet
1 inch = 200 feet

Sources:
Charleston County, 2015; CCPRC, 2012, 2015, 2019

CHARLESTON COUNTY PARK & RECREATION COMMISSION

Laurel Hill County Park
Resource Demonstration Area
1400 Highway 41, Mt. Pleasant, SC 29466

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Chapter Four: Silvicultural Systems and Regeneration Methods

A *high-forest system* refers to stands originating from seed. The regeneration comes from sexual reproduction by the parent trees whether it be from natural seeding (including the release or even the sprouting of preestablished advance growth), artificial seeding, or planting.

Even-aged systems are stands consisting of trees of the same or nearly the same age. Arbitrarily, a stand is even-aged if the range of tree age does not exceed 20% of the rotation length. Age is usually measured from the time the trees are first open to the sky and thus able to grow in height without restriction. Even-aged systems are usually harvested by a clearcut method, a seed-tree selection or a shelterwood method.

Even-aged loblolly pine stand (Source: S&W)

Clearcutting is a method of timber removal requiring the removal of the entire stand in one cutting. Following the cut, timber regeneration is the result of reseeding by artificial means, replanting, or by natural seeding from adjacent stands, or from trees cut in the clearing operation. In the silvicultural sense, it usually refers to regeneration operations in which virtually all woody vegetation is removed from the site before establishment of new trees. Sometimes the terms "clearfelling" or "silvicultural clearcutting" are used to insure this particular meaning. Unfortunately, "clearcutting" has also been commonly used to describe cutting operations in which only the utilizable trees are cut. If residual trees remain, such cutting can usually be described as a crude variant of one of several different kinds of partial cutting, including thinning. Such terms as "high-grading" or

Mature loblolly stand post-thinning (Source: S&W)

"economic clearcutting" are often appropriate to these variants.

Seed-tree method of timber cutting refers to the removal of the stand in one cutting, except for a small number of trees left singly, in small groups, or narrow strips, as a source of seed for natural regeneration. This method is distinguished from shelterwood cutting by the fact that the seed trees do not cover enough ground to provide any significant shelter to the new trees, a matter that depends more on the width of the crowns of the seed trees than upon their number. This method is sometimes viewed merely as a variant of clearcutting.

S*helterwood method* of timber removal results in the establishment of a new, essentially even-aged, stand from the release of new trees started under the old stand. The essential characteristic is that the new stand is established naturally or artificially before the last of the old one is entirely removed. In its most intensive development, the shelterwood method may involve a series of three different kinds of cutting: (a) a *preparatory cutting* designed to foster the potential seed producers or speed decomposition of litter; (b) a *seed cutting* which is the true regeneration cutting and is aimed at getting the new crop established; and (c) one or more *removal cuttings* to release the newly established crop or to harvest the remaining old trees.

Regeneration by the release of natural advance growth is sometimes regarded as a form of *clearcutting* but the terms *one-cut shelterwood* or *overstory removal* are less ambiguous and preferable because they focus attention on the nature of the source of regeneration.

There are often reasons to delay removal of the overstory, such as the provision of longer protection to the new crop or the gaining of additional growth on the overstory trees. If this sort of delay induces irregularity in height growth of the new stand, the variant is called *irregular shelterwood cutting*. This regeneration procedure may have some of the attributes of selection management, but differs in that the new stand is essentially even-aged. Also, *shelterwood* cutting can be laid out *uniformly* throughout a stand, or in groups or strips which are rather quickly extended through the whole stand.

In *uneven-aged systems*, the stands created or maintained include three or more distinctly different age classes. Stands with two age classes are ordinarily not regarded as uneven-aged because the condition tends to be a temporary one likely to be identifiable with the shelterwood or seed tree methods. Since virtually all trees regenerate after some sort of disturbance and grow in even-aged aggregations most of their lives, the concept of the uneven-aged stand is really a device of convenience for administrative and scientific purposes.

The *selection method* is designed to create or maintain uneven-aged stands. Such systems usually remove old trees in groups or in strips wide enough to allow new trees to start and remain free to grow in height. It can also be done by removing large individuals in the *single-tree selection method*. In the latter cases, success usually depends on progressively

enlarging the openings through subsequent cuttings. Under the selection system, the stand always has some relatively old trees. New regeneration is established by periodic partial cuttings. This method requires regular entries into the indefinite future. Some of the cuttings may be intermediate in immature age classes rather than true regeneration cuttings.

Coppice or low-forest systems are stands originating from vegetative sprouting by the trees that are harvested (stump sprouts, root suckers, and naturally rooted layers). Coppicing usually involves short rotations with dense stands of short trees. In *simple coppice cutting*, the stands are kept almost perfectly even-aged. This method of regeneration is most often used in hardwood stands. If used as a clearcut it generally results in the shade intolerant species being favored. These quite often are the more valuable economic species.

4.1 Intermediate Cuttings

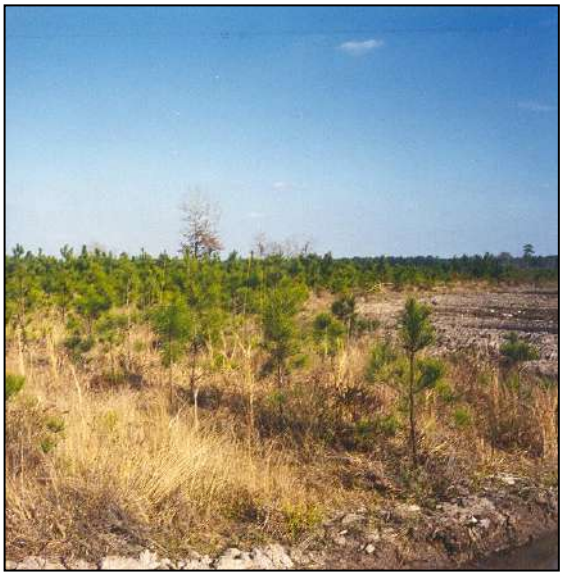
- *Intermediate cuttings* are treatments conducted to modify or guide the development of an existing crop of trees, but not to replace it with a new one. They involve the selective removal of some vegetation to allow the expansion of the crowns and root systems of remaining plants. Vacancies created in the growing space are not large or permanent enough to allow height growth of any new trees that become established.
- *Release cutting* includes all operations designed to regulate the species composition or improve the growth of very young stands, ordinarily those not past the sapling stage. When the trees removed are of the same age as those favored, it is called *cleaning*, when the trees removed are older than those released, the term *liberation cutting,* applies. The term *weeding*, is usually reserved for *cleanings* that are so intensive that virtually all undesirable species are removed.

Mature loblolly stand (post-thinning) with natural seedling regeneration (Source: S&W)

- *Improvement cutting* is a term for partial, nonregenerative cuttings in stands older than the sapling stage. They might ideally have been done as release cuttings when the desirable trees were in the seedling or sapling stage. Most improvement cuttings are done in mixed stands that are being put under silvicultural management for the first time and are quite similar to *thinnings*. In fact, the same kind of cutting applied

to a pure, even-aged aggregation of trees would clearly be a *thinning*, often a *selection thinning*.

- *Thinnings* are partial cuttings in even-aged stands. They are designed to improve future growth by regulating stand density. Sometimes trees are harvested that might otherwise be lost to suppression of trees. Thinnings can be classified in two different ways. In *commercial thinnings*, some or all of the wood harvested is put to use. Thinnings without utilization are *precommerical*. Thinnings are also grouped according to the crown classes of trees removed and reserved within the canopy stratum being thinned.
- *Low thinning* is the practice of imitating or accelerating natural suppression losses by harvesting trees of the lower-crown classes and leaving those of upper classes. The heavier the thinning, the higher the removals progress into intermediate and codominant crown classes.
- *Crown thinning* is the direct stimulation of crowns of the dominant trees. Codominant trees are removed. Overtopped and intermediate trees are left to die or be removed in subsequent thinnings. *Crown thinning* has sometimes incorrectly been called "thinning from above," but this is too easily confused with *selection thinning.*
- *Selection thinning* is that in which dominant (and sometimes some codominant) trees are removed. Trees of lower-crown classes remain. Often the purpose is removal of malformed or otherwise undesirable dominants. Sometimes it is to limit the harvest to the larger and more valuable trees which may or may not constitute "high-grading," depending on judgements about subsequent stand development.



Clearcut with row planted seedlings
(Source: S&W)

- *Geometric or mechanical thinning* is the removal of some trees to leave others in a predetermined spacing or pattern such as strips and groups. Row thinning is a special kind of geometric thinning in which whole rows of planted trees are removed.
- *Salvage cutting* is the harvest of dead, dying, damaged, or deteriorating trees primarily to put the wood to use before it becomes worthless.
- *Sanitation cutting* is the removal of the same kind of tree, as well as those susceptible to attack, but for the purpose of reducing the spread of biotic pests.

- *Salvage and sanitation cuttings* are likely to resemble open or more forms of regeneration or intermediate cutting. They may differ only in their intent or purpose rather than the resulting development of the remaining vegetation. If the agent leading to death or damage is merely suppression by overtopping trees, the removal of the trees involved is best regarded as low thinning.

4.2 Stand Regeneration

Selecting a Method

Successful regeneration projects require well-researched, site-specific prescriptions. A complete prescription will respond to physical and biotic site requirements and to specific management objectives. Increasingly, state forest practice laws and agency regulations direct prompt reforestation of both private and public and public lands after timber harvest. Significant financial investments in site preparation, genetically improved planting stock, and actual planting place a premium on correct and cost-effective treatments.

By describing a target stand that meets the owner's management objectives, the experienced forester thereby defines a regeneration need. Species composition and spacing requirements dictate the choices of regeneration method. Sometimes it is desirable to replace a mature stand with an identical younger one. More often, the regeneration stage provides an opportunity to create a new stand with greater growth capacity, better financial return, more suitable match to the owner's goals, and a predictable range of benefits.

It is important to know the following stand and site characteristics to select species and regeneration methods:

Present Vegetation

- Are trees currently in the stand, or in adjacent stands, of good phenotypic quality, or have they been degraded by past cutting practices?
- What is the probability of a seed crop within the prescribed regeneration period?
- Will the site preparation be effective long enough?
- What are the silvical characteristics of present seed sources? Do they lend themselves to the environment that will follow harvest?
- Will the desired future stand composition include seral species needed for wildlife benefits?

Site Conditions Specific to Regeneration

- What is the climate - total precipitation, summer drought, frost occurrence, frost heave potential, insolation rates, ice storms, cold air drainage, snow loads, and movement?
- What is the topography - slope, exposure, elevation, and relief as it effects air drainage, and wind patterns?

- What are the characteristics of the soils? What is the parent material, texture, depth, rock content, compaction and water repellency potentials, surface organic matter, mycorrhizae?
- What animals inhabit the area?
- Are diseases such as root rots, rusts, and damping-off organisms common in the area?

Logistics

- Is access available when needed?
- What site preparation alternatives can be considered? Are there limitations to yarding disturbance, mechanical, chemical, fire?
- How will the timing needed for site preparation effect seeding, and/or planting?
- Is the labor and stock available for the regeneration effort?

The choice between artificial and natural regeneration methods involves a number of trade-offs and risks. The initial costs of artificial regeneration may buy a shorter effective rotation or lower stand tending costs. Yet, natural seedlings descend from already adapted parent trees, frequently develop superior initial root systems, and tend to be more disease resistant. The most intensively managed forests are usually promptly regenerated by planting on well-prepared sites.

4.3 Seeds and Seeding

Seed should be collected only from good to heavy seed crops. That collected in poor years is usually of low quality and infested by insects. Observance of sound programs for seed source identification is critical. Regional, state, and local seed rules and zone maps are available at most state forestry offices. Typically, transfer of reproductive material is limited to a degree of latitude, less than 1000 ft difference in elevation, and within specified local topographic and natural vegetation groups.

Mature loblolly stand with planted seedlings
(Source: S&W)

Seeding operations are often restricted by regulation of pesticides used to control seed-eating rodents and birds. High costs and the large volumes of seed needed also deter aerial seeding projects.

- Site selection for seeding should be those where natural regeneration would occur if an adequate seed source were available. Sites should be freshly prepared with mineral soil exposed. Generally, north- to northeast- facing moderate slopes and large flat areas with good air draining are best for seeding.
- Protection of seed from predators usually means temporary chemical control. Pesticide use regulations vary greatly and are in a constant state of flux. Foresters should check with the appropriate county agents before planning any pesticide seed protection work.
- Seeding techniques include broadcasting (aerially, on the ground with a cyclone seeder, or by hand), spotting (placement of one or more seeds into a prepared spot by hand), and drilling (placement of seed with garden drills in plowed furrows).

Grass stage longleaf pine (Source: S&W)

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Chapter Five: Longleaf Pine Life History and Management

Longleaf pine (*Pinus palustris*) once covered 70 to 90 million acres in the southeastern United States. These acres stretched from east Texas to southern Virginia (Fig. 5-1). It was once the most extensive forest ecosystem in North America. Today only about two million acres still support longleaf forest. Much of the loss of longleaf habitat is a result of fire suppression policies.

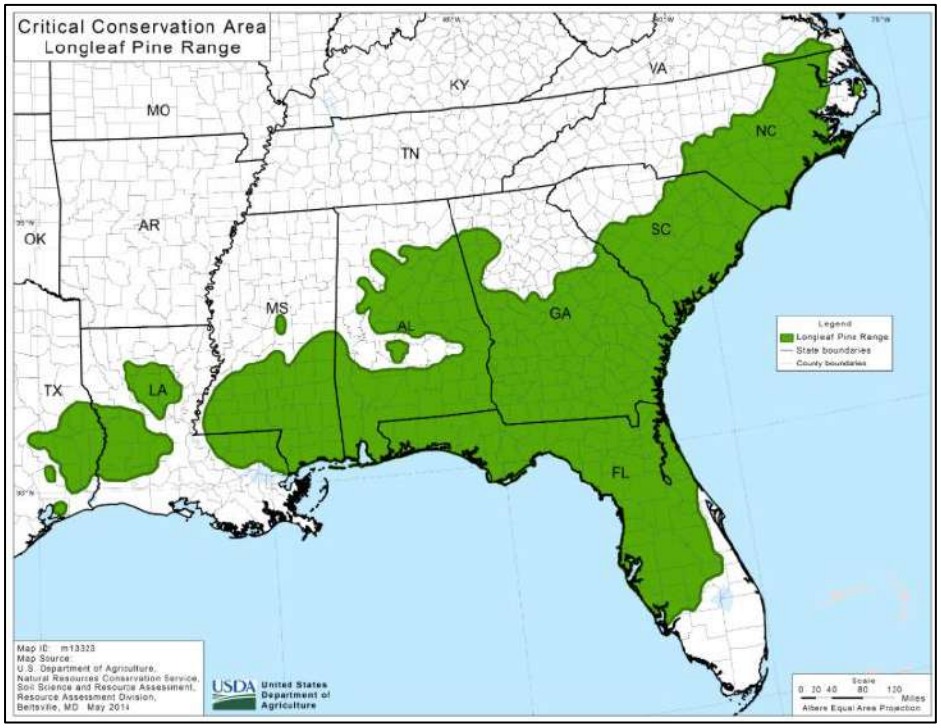

Figure 5-1. Historic range of longleaf pine (Source: USDA)

The longleaf ecosystem exists because of fire and is dependent on frequent ground cover fires to survive. Lightning was the only source of fire in the natural system. Most fires occurred during the spring and summer when convectional thunderstorms increase the frequency of lightning strikes. Fires started this way generally occurred every one to five years before man entered the system. Most of the fires originated with longleaf pine snags being struck by lightning. Some information suggests that snags may be struck more often than live trees.

Longleaf pine has evolved to withstand damage from the frequent fires in its natural environment. This adaptation includes thick bark, large seed size, inconsistent seeding, fall seed sprouting and slow growth during the seedling's early years. Some ecologists believe that longleaf pine and its plant associations are not only fire resistant, but may also promote fire. The longleaf plant

community thrives with a regular fire, which maintains an open ground cover. If fire is excluded, competitive grass and woody shrubs species start to compete and dominate the forest understory. Shrubs and hardwoods that were controlled by fire grow taller and thicker, depleting nutrients and shading the valuable grass layer. They actually start to flame proof the stand by providing less flammable oak leaves that burn cooler and less readily.

In the past the natural forest was primarily uneven-aged. Longleaf regenerated in small even-aged groups in openings created by the death of one or a few mature trees caused by lightning strikes, windstorms and bug kills. The opening allowed light to penetrate the overstory and there by elicit a response for the seed and seedlings.

Typically, longleaf begins to reproduce at about 20 to 30 years of age. Conelets are pollinated in the spring and mature about 19 months later in the following fall. The cones generally mature in mid September through mid November and release their seeds. Cone and seed production is highly variable from tree to tree and year to year. Longleaf produces large seed crops sporadically, every 3 to 8 years on average. Most seeds, which are winged, fall within 100 feet of the parent tree. The seeds require bare soil to germinate and usually sprout within two weeks.

Seedlings grow over the first year into stemless young saplings that resembles grass, commonly referred to as the "grass stage". The grass stage may last two to several years as the sapling develops an extensive root system. The terminal bud of the grass stage seedling is surrounded by a thick sheath of green needles. This sheath protects the bud from the fires. Once the tree diameter at the ground reaches one-third of an inch in diameter it is resistant to fire. This usually takes about a year and a half.

Post-burn longleaf seedling at CCPRC's Future McClellanville County Park (October 2018)

Mid to late spring fires generally encourage the sapling to leave the grass stage when the root collar is about one inch in diameter. Once it leaves the grass stage, the sapling grows very quickly, as much as three to four feet a year in favorable sites. On good sites with minimal competition, the sapling can grow to 20 feet within seven to ten years after leaving the grass stage.

The largest longleaf pines in the virgin forest were 35 to 40 inches in diameter and about 120 feet tall. They can live 350 to 400 years. Southern pine beetles are rarely a problem for healthy longleaf

pine, but will attack low vigor trees. Low vigor can result from trees weakened by excessive competition. This competition comes from a heavy ingrowth of hardwoods where fire is excluded from the longleaf system.

The biggest advantage longleaf pine has over other southern yellow pine species is the growing of quality forest products. The species is slower growing, but by age 40 to 60 years on most sites superior sawtimber and poles will be in abundance. It is not unusual for 50 % of the stems in a longleaf stand to be poles as compared to 15% in loblolly and slash stands. Poles generally bring 40% more than sawtimber when harvested. In addition to quality timber products, longleaf also provides superior pine straw that is highly desired for landscaping mulch. Planted stands can often be raked as early as 8-10 years with annual incomes ranging $50-$300 per acre.

The significance of longleaf extends beyond its role in fire ecology and forestry products. Established longleaf ecosystems also provide habitat for diverse flora and fauna, including: red cockaded woodpecker, gopher tortoise, indigo snake and flytraps, each of which are considered threatened and/or endangered species.

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Chapter Six: Prescribed Fire

Fire has played a major role in determining the distribution of plants and animals in southern forests. Some communities such as the longleaf pine-wiregrass association require periodic fire to survive. The natural occurrence of fire from events such as lightning results in upland burns every three to five years. Other habitats, such as cypress and gum ponds, may only burn in periods of drought every ten years or longer. However, the basic premise of fire ecology is that the fire is neither innately destructive nor constructive. It is an agent of change.

Forest understory showing benefits of prescribed burn with abundant ferns and grasses (Source: S&W)

Change is a biologically necessary component of a healthy ecosystem. Early man learned to use fire as a tool for hunting and clearing land for crop production. Today's resource managers have learned to use fire to manipulate change in order to meet the needs of plant and animal communities. Its prudent use can achieve a variety of habitat changes depending on the timing, frequency and intensity of the fire.

A single prescribed burn can produce multiple impacts. The fire can be used to reduce wildfire hazard by reducing the fuel load on the ground, improve access and improve wildlife habitat. Proper use and application of prescribed fire requires knowledge of how fire affects vegetation, wildlife, soil, water and air. Burning techniques can be varied to achieve different results.

Fire may injure or kill part or all vegetation depending on the intensity and duration of exposure to high temperatures. Bark thickness and stem diameter will influence vegetation's susceptibility to damage. In general, small trees of any species are more easily damaged by fire than large ones. On average, hardwood trees are more susceptible to fire damage than pine trees. Pine tree are better adapted to surviving higher intensity fire through their thicker and consequently better insulating bark. Pine tree needles however are very susceptible to temperatures above 135^{o}F. Pine needles will survive temperatures of 130^{o}F for about five minutes. Fortunately, the high temperatures generated by the forest floor fuels cool rapidly from the flame zone. Adequate wind

can help dissipate the heat before the needles are scorched. Southern pine will usually survive complete crown scorch as long as the terminal bud is not damaged. A dense layer of needles surrounds the terminal bud to prevent its loss during fire. Severe needle scorch, while not killing the tree, may retard growth for a year or more and can make it more susceptible to drought and beetle attack.

Successful prescribed burn on the "big island" located at Meggett County Park

Resource managers can use the kill and scorch qualities of fire to achieve a variety of results. Understory vegetation can be kept low with frequent fires and some species can be removed from the stand by burning during the growing season. Mast producing species can be maintained close to the ground where they are more available to wildlife. Longleaf pine seedlings are often stimulated to grow from the grass stage into saplings with fire. Invasive non-native species are often fire intolerant and can be controlled effectively and inexpensively with prescribed burns. In addition, many rare and endangered species of plants are fire dependent for a portion of their reproductive cycle. These species can be reintroduced into an area and maintained with the correct timing and frequency of fire.

Prescribed burning of grass fields at CCPRC's Edisto Red Top property (October 2018)

Prescribed burning is also a very effective practice used in marsh and moist-soil management. Prescribed burning accomplishes several objectives including: maintaining successional stages such that desirable annuals are more abundant than herbaceous perennials and woody species; removing matted vegetation produced in previous growing seasons and releasing nutrients thereby encouraging the germination of valued food plants; increasing seed availability in dense

vegetation; and facilitating and improving the effectiveness of mechanical manipulations (Whitman and Meredith 1987).

Prescribed fire can also be used to discourage weeds or invasive plants from taking over by killing off their early growth and giving native plants a chance to compete. Cattails occasionally spread aggressively and can completely choke a wetland. A winter or early spring burn following a drawdown can reduce cattail cover in a pond, temporarily creating an open water area. However, by the end of summer the cattails will have returned unless the burned area can be flooded with 3-4 feet of water during spring and early summer.

Various National Wildlife Refuges (NWR) such as Mackay Island National Wildlife Refuge in northeastern North Carolina and southeastern Virginia, Lee Metcalf National Wildlife Refuge in Montana, and Arthur R. Marshall Loxahatchee National Wildlife Refuge in Florida utilize prescribed burning in their moist-soil management practices.

Selecting the proper size, frequency and timing of burns is crucial to the successful use of fire to improve wildlife habitat. Experienced prescribed fire managers should be able to predict the changes that will occur in the vegetative composition of the stand. Planning and implementing prescriptions should also integrate wildlife management considerations by scheduling burns around breeding and nesting times for various game birds and whitetail deer.

Proper planning is not only important when considering fuel hazard reduction and vegetative manipulation, but also is crucial to controlling the detrimental effects of fire, including the reduction in air quality from smoke. Wind direction and speed are critical to maintaining control of the intensity and duration of the fire as well as determining the direction and impact of smoke. Potential off-site impacts such as downstream water quality should also be carefully considered as well as on-site impacts to soil and aesthetics. Public opinion must also play an essential role in the wise use of fire.

Road with plowed firebreak edge at CCRPC's Edisto Riverside property (March 2019)

Control of the limits of the fire's extent is generally accomplished through the careful and planned placement of firebreaks. Permanent firebreaks can be used as access roads and wildlife strips, especially if they are seeded with wildlife food. Weather conditions must also be monitored prior to and during the fire. Wind direction and speed are critical to maintaining control of the intensity

and duration of the fire as well as determining the direction and impact of smoke. Humidity levels and fuel moisture levels are crucial to determining how hot the fire becomes and how much fuel is consumed. Low humidity levels can create “spot over” problems that may lead to fire control issues. Post fire weather conditions must also be monitored to avoid problems of flare-ups and smoke settling on highways or urban areas because of an inversion.

Chapter Seven: Wildlife Management

Good habitat conditions for wildlife can be created while conducting timber operations. In considering improvements during land management operations it is important to be aware of the requirements of wildlife. Wildlife has four basic needs: cover, food, water, and space. The quantity and quality of these components determine the carrying capacity of the land, meaning the number of animals that can be supported in good condition throughout the year.

Cover is the protective component of an animal's habitat. An easy way to establish cover is to allow vegetation to grow undisturbed. When land management practices completely disturb soil and vegetation in areas greater than 20 acres, additional care should be taken to preserve cover areas for wildlife. Cover should be in close proximity to wildlife feeding areas.

The availability of quality food is often the habitat factor that limits wildlife populations on a particular tract. Enhancement of food resources is probably the most important management practice used by land managers. Consideration should be given to producing a diversity of plants that provide both food and cover during all times of the year. Water is a necessary requirement for wildlife survival. Watersheds should be protected by maintaining at least a 50-foot vegetative buffer strip on all sides of ponds and forested wetlands during timber operations. Marsh and wetland areas provide excellent feeding and resting areas for waterfowl and other wildlife.

Each species of wildlife requires a certain amount of space to move about, feed, reproduce and rest. The quantity and quality of food, cover and water found on an area determine the amount of space required. Carrying capacity can often be increased by increasing the quantity and quality of the wildlife habitat components. Forest management operations that affect habitats include harvesting, site preparation, forest regeneration practices, and intermediate stand treatments. Each of these forestry practices will affect habitats by altering certain characteristics of the property. Some of the habitat characteristics that influence wildlife are the following:

Edge

Edge is an area where different plant communities meet, such as where a pine plantation meets a hardwood bottom or where a forest meets a field. These areas have the greatest varieties, numbers and selection of food plants. Edges share characteristics of both plant communities; therefore, wildlife species can find a greater selection of habitat components necessary to meet their requirements. Edges are attractive to a wide variety of wildlife. The amount and condition of edges will have an effect on both quantity and quality of wildlife habitat.

Diversity

A variety of plant and animal life should be found within a forest. A forest containing a wide variety of plant-life provides habitats for many kinds of wildlife. The greater the plant

diversity in a habitat, the easier it is for wildlife to find the types of cover and food that they require year-round.

Succession

Plant communities go through a progression of change over time as they develop, mature, and eventually decline. Each of the different successional stages of an area provide different habitats for many species of wildlife. Usually, wildlife species prefer one successional stage over another.

Stand Arrangement

Stand arrangement refers to how the forest stands are located in relation to each other. For quality wildlife habitat, forest stands providing habitat components must be available within the home range of the wildlife species that is to be managed. Proper arrangement of food, water and cover can often determine the use and value of these habitat components to wildlife.

Size and arrangement of forest stands largely determine the quantity of edge and total forest diversity that is created. A mixture of brush land, woodland, and non-forested land creates more diversity and edge than does a large block of one timber type, as characterized in a monoculture (Yarrow, 1989).

7.1 Non-Game Species

Butterflies

Butterflies are insects. They have three main body parts (head, thorax, and abdomen), three pairs of legs, one pair of antennae, and four wings. Butterflies are advanced insects that go through complete metamorphosis. This means they have four distinct life stages; egg, caterpillar, chrysalis, adult.

The adult female must choose the correct type of plant to lay her eggs on since the larva or caterpillar will only eat certain plants. She finds the correct plant by smelling with her antennae and tasting with her feet. Once she finds the correct plant she glues the egg to the plant. A very small caterpillar will hatch from the egg in four to ten days.

Black Swallowtail
(Source: Keith McCullough/CCPRC)

Monarch Butterfly
(Source: Keith McCullough/CCPRC)

The butterfly life cycle lasts for three to four weeks. The newly hatched caterpillars sometimes eat their eggshell first and then begin eating the plant on which they were placed. Their main occupation while they are a caterpillar is to eat, defecate and grow. As the caterpillar grows it will shed its exoskeleton, as it becomes too tight. The caterpillar will molt three to four times.

The next stage in the life cycle is the chrysalis. The chrysalis is a non-mobile, non-feeding stage that is usually attached to plant material by silk pads or strands. The chrysalides are usually well camouflaged and usually appear to be parts of the plant - leaves, stem, or dried-up leaves. During this stage the muscles are made ready for flight. After one to two weeks the adult butterfly will emerge.

The adult butterfly usually lives two to three weeks. During this time they mate and lay eggs. The female may lay hundreds of eggs. The adults feed on nectar from flowers, receiving carbohydrates to give them the energy to fly. Adult butterflies may also take liquid from dung, rotten fruit, carrion, or moist soil. Some males imbibe liquid from soil, extracting minerals that are used in their sex pheromones.

Butterfly Management

Butterflies are looking for two things when they enter a garden: nectar, the food that adult butterflies need, and host plants, the place where the female will lay her eggs.

Nectar plants are plants with flowers that produce the sweet fluid that butterflies use as food. Many of our native butterflies prefer nectar plants with bright colored flowers such as pinks, reds, yellows, and oranges. Butterflies appear to be attracted to areas with large masses of a single color. Groups of similar colored clumps rather than individually.

Butterflies are active from early spring through frost and so would benefit from a variety of plants that flower throughout this time. Both butterflies and the plants they prefer like sunny areas protected

Orange Sulphur
(Source: Keith McCullough/CCPRC)

from high winds. Areas with at least six hours of sun a day (morning to mid-afternoon) seem to work best.

Providing host plants will also attract butterflies. Most species of caterpillars are very particular about the food that they eat. Because the tiny caterpillars can't travel very far to find the correct food the female butterfly must locate it for them. She lays her eggs on only the type of plant that the caterpillar can use as food. If the egg is not placed on the correct plant, the caterpillar hatching from that egg is not likely to survive. There are a variety of host plants that can be planted that will attract many of our native butterflies.

Butterflies often gather in groups on wet sand or mud--called puddling. They do it to obtain the minerals that are found in the soil. Puddling areas can be created by placing a shallow pan in the soil, filling it with coarse sand, and keeping it moist. Salt can be added at a rate of ½ to ¾ cup salt (table salt or rock salt) to one gallon of sand, mix well and moisten.

Butterflies are cold-blooded and so on cool mornings they need to warm their bodies before they can become active. To do this, they often sit on a reflective surface such as a flat stone, spread their wings and turn their backs to the sun. Creating gravel paths or placing basking rocks about will provide areas for them to warm up. Avoid using chemicals and insecticides, as this will kill many butterflies and their caterpillars.

Table 7-1. Butterfly species potentially occurring at Laurel Hill, with respective host plants

Butterfly Species	Host Plant(s)
Black Swallowtail (*Papilio polyxenes*)	Carrot (*Daucus carota*), fennel (*Foeniclum vulgare*), parsley (*Petroselinum crispuim*), dill (*Anethum graveolens*)
Giant Swallowtail (*Papilio cresphontes*)	Prickly ash (*Zanthoxylum americanum*), hoptree (*Ptelea trifoliata*), (*Citrus* spp.)
Palamedes Swallowtail (*Papilio palamedes*)	Sassafras (Sassafras occidentalis), red bay (Persea borbonia)
Eastern Tiger Swallowtail (*Papilio glaucus*)	Cherry laurel, black cherry, wild plums, (*Prunus* spp.), poplar (*Poplus* spp.)
Cloudless Sulphur (*Phoebis sennae*)	Wild senna (*Cassia* spp.)
Sleepy Orange (*Eurema nicippe*)	*Cassia* spp.
American Lady (*Vanessa virginiensis***)**	Pearly everlastings (*Antennaria,* Anaphalis, *Gnaphalium*)
Painted Lady (*Vanessa virginiensis*)	Thistles (*Asteraceae*), hollyhock and mallow (*Malvaceae*), and various legumes (Fabaceae)
Buckeye (*Junonia coenia*)	Snapdragon (*Antirrhinum* spp.), gerardias (*Gerardia* spp.), plantains (*Plantago* spp.), toadflax (*Linaria* spp.)
Viceroy (*Limenitis archippus*)	Elm (*Ulmus* spp.), willows (*Salix* spp.)
Carolina Satyr (*Hermeuptychia sosybius*)	Grasses (*Poaceae*)
Little Wood Satyr (*Megisto cymela*)	Grasses (*Poaceae*)
Red-banded Hairstreak (*Calycopis cecrops*)	Fallen leaves of wax myrtle (*Myrica cerifera*), dwarf sumac (*Rhus copallina*), staghorn sumac (*Rhus typhina*), and several oaks
Gulf Fritillary (*Agraulis vanillae*)	Passion vine (*Passiflora* spp.)
Pearl Crescent (*Phyciodes tharos*)	Asters (*Asteraceae*)
Monarch (*Danaus plexippus*)	Milkweed (*Asclepias* spp.)
Red Admiral (*Vanessa atalanta*)	False nettle (*Boehmeria cylindrica*), pellitory (*Parietavia* spp.*)* nettles (*Urtica* spp.)
Red-spotted Purple (*Limenitis arthemis astyanax***)**	Tulip tree (*Liriodendron tulipifera*), cherry (*Prunus* spp.) willows (*Salix* spp.)

Non-Game Birds

Forest management practices can be conducted in a manner that will enhance habitats for forest birds. Birds are associated with numerous habitat parameters, such as number of vertical foliage layers, total foliage volume, foliage density near the ground, overstory hardwood/pine mixture, habitat patchiness, successional stage of stand and moisture gradient (USDA, 1978).

Female Painted Bunting
(Source: Keith McCullough/CCPRC)

Bottomlands are normally moist for at least part of the year. The greater moisture on most bottomland sites usually allows more understory vegetation and should increase bird density. Long-term flooding and standing water reduces or eliminates foliage layers on the ground. This condition will reduce ground nesting birds and over wintering ground foragers such as the white-throated sparrow, but may provide some protection from predators for colonial nesters such as herons, egrets and red-winged blackbirds. Bottomland hardwoods have dense bird populations during the winter months (USDA, 1978). Moist bottomland hardwoods in the South support an abundance of breeding birds. Some birds, such as the cardinal and Carolina wren are ubiquitous in habitat distribution, while other species are more restricted to deciduous bottomland hardwood stands.

The main threat to birds that inhabit bottomland hardwoods is the conversion of forests to agricultural lands and reservoirs. A diversity of tree species and age classes should be maintained. Mature bottomland stands produce an abundance of decayed wood that provides food and nesting opportunities.

Mixed pine hardwood stands are extremely important to many birds. A full vegetative complement including mature and dead standing trees, full understory and shrub layer and wide edges is necessary to maintain diverse breeding bird populations. Plant species compositions, age-classes and spatial coverage of stands are the most easily manipulated. Communities should be delineated based on plant species dominance, age and stocking level. This type of management will benefit most bird species.

Harvesting methods in pine stands will ultimately determine the nature of non-game bird habitats. Generally, seed tree and shelterwood cutting will lower the carrying capacity for overstory species but may raise it for understory birds. Carrying capacity for overstory birds species will be governed by the heaviness of the cut while carrying capacity for understory bird species will be regulated by the vegetation response, which in turn will be regulated by nutrient and moisture availability. Pine warblers will be abundant in these stands in all seasons of the year. With a developing understory, yellow throats will be common. Spring and summer birds may include summer tanager, great-crested flycatcher, prairie warbler, and blue grosbeak. Clearcutting followed by intensive site preparation and planting has the most dramatic impact on forest bird habitat. Clearcutting generally eliminates bird habitat for a short period of time. The overstory is completely removed in the harvest and the remaining vegetation destroyed during site preparation. Clearcutting with natural regeneration has a much less destructive effect. There is a drastic impact on overstory species, however understory species may be enhanced. Successional vegetation will provide foraging, nesting and escape cover for many bird species. During the sapling stage, the bird communities will be quite complex and will provide for a large population of non-game birds. In short rotation systems, the bird niche diversity and niche space is at the highest point that will occur in the life of the stand in intensive management situations. Closing of the overstory is accompanied by a drastic decrease in bird niche diversity and carrying capacity. During this stage, most of the bird activity will occur along the edges of the stand.

Mississippi Kite located at Laurel Hill County Park
(Source: Keith McCullough/CCPRC)

Prescribed burning has three impacts on bird habitat: 1) control of the understory keeps niche diversity low, 2) reduction of litter exposes seeds that would not otherwise be available for forage and 3) destruction of dead trees which eliminates niches for dead trees feeders and cavity nesters. Burning during the spring and summer months may destroy nests of ground nesting birds as well as those of birds nesting in low understory. To minimize adverse impacts, the objective should be to control understory rather than to eradicate it. Burning more often than every three years tends toward the removal of shrubs and hardwoods and greatly lowers bird niche diversity.

Seventeen cavity nesters use dead trees in the longleaf/slash pine timber type. Birds use snags for a variety of purposes. Woodpeckers, chickadees, nuthatches and brown creepers commonly use

dead trees as forage substrate. Flycatchers, shrikes, red-headed woodpeckers, bluebirds and hawks regularly use open-area snags as perches to watch for prey. Primary cavity nesters, such as woodpeckers, typically excavate their own nest and roost cavities in snags. Natural cavities and woodpecker excavations are also used by animals other than birds. A dead tree stocking of one stem per acre would be highly desirable. Dead pine trees may stand for five to 15 years and be heavily used for 80 to 90 percent of this time (USDA, 1978).

Neotropical migratory bird species (NTMB) are birds that breed in this area and winter in tropical areas (i.e. South America). Listed are a few species that could occur on the on the property. The Prothonotary Warbler (*Protonotaria citrea*) is a fairly common summer resident to the area. The Summer Tanager (*Piranga rubra*) is another common summer resident. The Indigo Bunting (*Passerina cyanea*) is a common summer resident as well as the Painted Bunting (*Passerina ciris*).

Neotropical communities are determined by local habitat factors as well as landscape composition. At a landscape level the single most important consideration is to maintain large areas in breeding and wintering forest habitats to provide for large NTMB populations and minimize numbers of cowbirds and predators associated with agricultural, suburban, and urban land uses. At the habitat level the most basic management step is to maintain native ecosystems. A high priority in southeastern forests is to protect existing old-growth stands and corridors, and to allow new old-growth stands to develop. Restoration and maintenance of natural ecosystems that have been substantially reduced or altered, such as longleaf and oak-gum-cypress forests, should be accelerated. Unless specific concerns dictate otherwise, both selection cutting and even-aged management should be used to create small openings for gap species, large openings for early successional forest migrants, and a balanced age-class distribution to maintain sufficient mature forest habitats. Other stand level practices that will maintain NTMB community viability include retaining live cavity trees and snags when stands are regenerated, and maintaining both coniferous and deciduous components of mixed stands (Pashley and Barrow 1993).

Painted Buntings are a species of high priority. They face such threats as loss and degradation of breeding habitat, nest parasitism by Brown-Headed Cowbirds, and hundreds are captured every year as cage birds. Variations in climate from year to year and the lateness in which Buntings breed suggest that Buntings could be affected by global climate change as well (Hunter, Peoples, Collazo, 2001).

Along the South Atlantic coast, edges of maritime woodlands and shrub-scrub provide important habitat for the Painted Buntings and probably support the majority of breeding pairs. Eastern Painted Buntings are associated with maritime shrub-scrub habitat mixed in a woodland setting. The species is mostly absent from forests with no understory development and from large patches of scrub-shrub habitat separated from large woodland patches. Grassy fields may also be important for post-breeding foraging adults and fledglings. Because the Painted Bunting is an edge species, populations may be more vulnerable to increased nest parasitism by Brown-Headed Cowbirds and nest depredation (Hunter, Peoples, and Collazo, 2001).

7.2 Game Species

Eastern Wild Turkey

Prior to and during early colonial times, the wild turkey occurred in large numbers over most of South Carolina. As settlement of the state increased, detrimental land use practices and market hunting resulted in the near extinction of the turkey over many sections of the state, especially the Piedmont. The statewide turkey population level slowly but steadily declined until about 1960, when the Wildlife and Marine Resources Department's turkey restoration work began to produce rapid increases in local numbers of turkeys (Bevill, 1978). In more recent times, poor nesting seasons since 1987 combined with widespread loss of habitat to logging and Hurricane Hugo have slowed the growth of turkey populations (SCW, 1993).

Wild Turkey (Source: S&W)

Wild turkeys are flocking animals and spend most of the year in close association with other turkeys. Suitable turkey habitat includes a scattering of mature mast producing hardwoods, mainly oaks, with smaller hardwoods coming in to replace those becoming over mature. Also needed is a mixture of understory plants, like dogwood and wild cherry that provide food and cover. Turkeys need water almost daily and must have easy access to permanent water sources. In good quality turkey habitat, the areas will safely support one bird per 30 acres or one flock to about 640 to 800 acres. Some principal wild foods of turkeys include acorns, beechnuts, fruits of dogwood, grape, black gum, wild cherry, blackberry and huckleberry. Acorns are considered to be the most important, because they are available during the fall and winter when most other foods are scarce (Yarrow, 1992).

Management of eastern wild turkeys requires the retention of extensive natural stands of mixed hardwoods, pines, relatively open understories, scattered clearings and well-distributed water. Site disturbance should be avoided March through June. Management should be for sawtimber rotation and thinning should favor oaks, beech and other turkey mast. Fifteen percent or more of the habitat should be retained in mast-producing key areas with at least 20-50 percent of the basal area in oak and beech. Pine stands should be burned at three to five year intervals, December through February. Shrubs bearing fruits and soft mast should be protected in selected areas. About ten percent of the overall acreage should be maintained in some type of opening (Yarrow, 1992).

To supplement native foods, such mixtures as fuscue-landino clover, crimson clover rye grass, bahia grass-clover or velvet grass-white clover could be planted (Wenger, 1984). Of all supplemental foods specifically planted for turkeys, chufa, a nut sedge, is perhaps the most favored. Chufa does best on “new ground” or sites that have not been cultivated in the recent past.

Chufa should be planted in plots one acre or larger. Turkeys that have never scratched for chufa may need help finding it. This can be done by running a disk across the plot to expose some of the tubers. To make it easier for the turkeys, pull up and scatter several clumps from the patch from about November until the turkeys discover them (Yarrow and Yarrow, 1999).

Fox Squirrel

In South Carolina, many of the fox squirrel populations currently in existence occur in "habitat islands". This condition exists where a relatively small expanse of habitat is surrounded by a large expanse of habitat that will not accommodate the animal. Examples include Island Green Golf Course in Horry County and Friendfield Plantation in Georgetown County. Other populations exist on the islands isolated by geographic barriers. Examples include North Island and Cat Island in Georgetown County and Bull Island and Isle of Palms in Charleston County (Wood, 1988).

Fox Squirrel (Source: S&W)

The fox squirrel spends most of its foraging time one the ground in very open-grown forest stands or park-like areas. The two primary forest types in which these features are common are longleaf pine-turkey oak and maritime forest communities. Both of these forest types develop on deep sandy soils that are usually excessively well drained. Although old growth stands are not essential, mast production and stand structure improve with age and are best in the older age classes. Ideal forest habitats for fox squirrel are scarce, disjunct and widely scattered. It was found that fox squirrels are very vulnerable to predation (particularly by raptors) and burning. Also, in the case where "island" population exist at low numbers, inbreeding depression may jeopardize the future of these populations (Wood, 1988).

The fox squirrel's habitat requirements should be taken into careful consideration when planning and conducting forestry operations and when expanding or improving public facilities.

White Tailed Deer

White-tailed deer (*Odocoileus virginianus*), members of the family *Cervidae*, are common residents of Laurel Hill. In general, deer require brushy hardwood and pine forests that provide an abundance of leaves, shoots, twigs and fruits. Good forest management practices will benefit deer as well as other native game and nongame species. Pure stands of pine timber generally provide poor deer habitat because of the low quality forage occurring there and the scarcity of mast producing hardwoods. Dense stands and closed canopies reduce browse and fruit yields. Primary management efforts in this forest type should be directed toward increasing browse production. Intermediate thinning of pine stands is recommended to open the overstory and encourage desirable understory vegetation. Thinning should be sufficient to achieve a basal area of 50 to 60

square feet per acre prior to stand regeneration. The pine/hardwood stands generally provides good deer habitat and are important for mast, fruit and browse production. These stands should be thinned frequently to lower limits of tree stocking, to renew understory forage and to hasten early mast yields. Where possible, retain the valuable hardwood mast component. A good balance between the white and red oak groups is desired to provide consistent mast production. Bottomland hardwood wetlands containing oak, gum and ash provide good deer habitat. These areas normally provide high quality browse, however, they are subject to flooding which may somewhat reduce available food supplies. Mast production is generally good in these wetlands but as with the mixed pine-hardwood type, red and white oaks must be retained. If available, carry a 50 percent composition of a variety of mast trees to rotation in this forest type is desired (Moore and Bevill, 1978).

White tailed Deer (Source: S&W)

Forest stands should be regenerated in 40 to 120 acre size units. Seedlings should be planted at ten foot by ten foot spacing or wider. Burning should be favored over mechanical means to retain root crowns of browse plants. Existing timber stands should be thinned at eight to ten year intervals to a basal area of approximately 75 square feet per acre. A wide variety of fruit and mast trees should be maintained in the understory. Water areas, old orchards, natural openings and old home sites should be maintained. Temporary openings, such as clearcut areas, from one to two acres in size should be created at 20 acres per 640 acres. If practicable, water holes on dry ridges should be created at one half mile intervals (Wenger, 1984). Uneven age stands, even age stands in small blocks and recent clearcuts provide an abundance of high quality forage. Soft and hard mass producing species should not be spared, whenever possible, particularly along floodplains, ditch banks, hedgerows, field borders, access roads and old house sites (Bara, 1979).

Wildlife food plantings are beneficial to a variety of wildlife. Several factors must be taken into consideration before planting. Wildlife plantings should be scattered across the entire tract of land and should comprise approximately one to five percent of the total acreage. Good locations for wildlife plantings include odd areas in and along the edges of fences, ditch banks, rights-of-way, logging roads, edges of woods roads, firebreaks, abandoned fields, forest openings and forest regeneration areas (Yarrow, 1992). Plantings should be long and irregular in shape, from one to five acres in size (for deer) and should not be visible from public roads or rights-of-way.

Native plant species on the property that provide food for deer are American hornbeam, Alabama supplejack (vine), black cherry, blackberry, dewberry, blueberry, dogwood, wild grape, greenbrier,

hickories, hollys (dahoon, gallberry, American, and yaupon), oaks, poison ivy, red maple, sugarberry, sweetbay and tupelo.

Although an overabundance of deer is assumed to be present on the property, approximate numbers are unknown. Population control is of vital importance to a successful management plan. Most southeastern forest habitats can support pre-hunting season populations of 20 deer per square mile or one deer per 32 acres. With a good interspersion of woodland and agricultural lands, 30 deer per square mile, or one deer per 21 acres is typical. Up to 20 percent of the standing crop can be harvested each year (Bara, 1979), but selectively hunting for bucks may results in a disproportionate adult sex ratio and heavy hunting pressure on the bucks. Risks of herd health problems, declining deer quality and losses from natural mortality are often unacceptably high.

Waterfowl

The coast of South Carolina is characterized by vast expanses of tidal wetlands. A recent inventory of these by Tiner (1977) revealed a total of 201,778 hectares, comprised of 66 percent salt marsh, 14 percent diked marsh, 13 percent fresh marsh and seven percent brackish marsh. South Carolina is an important wintering area for waterfowl of the Atlantic Flyway, particularly for dabbling ducks (*Anas sp.*). Based on U.S. Fish and Wildlife Service Midwinter Waterfowl Survey data for 1970-1986, 51 percent of the dabbling ducks estimated present in the Atlantic Flyway segment of USFWS Region 4 (NC, SC, GA, FL) were observed in South Carolina. South Carolina harbored 25 percent of all dabbling ducks present in the entire Atlantic Flyway during the same period, including 54 percent of the northern shovelers, 35 percent of the mallards, 32 percent of the northern pintails, 32 percent of the American wigeon, and 31 percent of the gadwall. The coastal wetlands are of critical importance to all these species (Whitman and Meredith, 1987).

Wood Duck (Source: Keith McCullough/CCPRC)

Wood Ducks in flight (Source: Keith McCullough/CCPRC)

The wood duck is the only migratory duck to breed in all geographic locations of South Carolina. Wood ducks begin the search for appropriate nesting sites in late winter. Nest initiation

typically occurs from late January through July, however, the peak of nesting activity takes place in late March through April. Wood duck hens incubate their eggs for approximately 28 days. Predation by raccoons, largemouth bass and wading birds as well as other species represents a natural aspect of wood duck ecology. Wood duck breeding habitat is characterized by predominantly woody vegetation including shrub and larger trees where there is a ratio of 50 percent open water to 50 percent vegetation. Mature shrubs, rising approximately two feet above the water surface with overhanging branches provide space beneath the canopy to allow ducks to swim freely, as well as providing optimum escape cover. Important components of the shrub community include buttonbush, willows, and alder. Although natural cavities commonly occur in forested wetlands frequented by wood ducks, the density of cavities providing suitable nesting sites may be limited. Suitable natural cavities include the following general characteristics: a tree with DBH of at least eleven inches, a four to twelve-inch horizontal entrance hole located at least six feet above the water or ground surface, a cavity depth of four to 78 inches and a cavity diameter of eight to 15 inches. Suitable natural cavities cannot contain water or be utilized by competing species such as bees, hornets, and squirrels. In large coastal plain river swamps natural cavities frequently occur in bald cypress; whereas in upland habitat throughout the state cavities often occur in various species of oaks, and hickories as well as other hardwood trees.

In addition to shrubs and a limited number of trees, herbaceous emergent vegetation is a significant component of suitable brood rearing habitat. An approximate ratio of 75 percent cover (40 percent emergents, 30 percent shrubs and 5 percent trees) to 25 percent open water is believed to provide optimum brood rearing conditions.

Wood ducks utilize a variety of habitat types during the fall and winter seasons. One of the most important habitats is semi-permanently flooded bottomland hardwood areas where ducks feed extensively on abundant supplies of acorns and other hard mast crops. In freshwater coastal marshes, wood ducks feed on the seeds of smart weeds, Asiatic dayflower, soft-stem bulrush, arrow-arum, white water-lily and other natural occurring grasses and herbs.

The installation of wood duck nest structures is a principal management technique utilized to enhance local wood duck production. It is important that the existing wood duck boxes are properly maintained. Annual box maintenance including replacement of nesting material is strongly recommended. In order to evaluate the effectiveness of nest box programs, boxes should be checked monthly during the nesting season and maintain detailed records of nesting activities maintained.

Wood ducks utilize many different habitat types throughout the year to meet various biological requirements. For example, ponds with abundant shrubs and persistent herbaceous vegetation provide excellent brood rearing and roosting habitat but may be utilized only on a limited basis as fall and winter feeding sites. Conversely, shallow ponds with herbaceous seed producing plants and overhanging mast producing trees provide excellent winter feeding habitat but are less valuable as brood area. Managed freshwater impoundments provide for excellent wood duck

habitat as well. Wood duck habitat requirements should be considered in timber management plans involving forested wetlands. Adequate densities of species representing important habitat components (bald cypress, oaks and willows) should be maintained throughout stands (Prevost).

Chapter Eight: Protected Species

As provided in *Chapter One: Property Overview*, the following is a list of federally threatened and endangered animal and plant species that are known to occur in Charleston County, South Carolina, and whose suitable habitat requirements overlap with those that currently exist on Laurel Hill Plantation, although they are not necessarily known to occur on site at the time this plan was prepared.

Table 8-1. Plant and Wildlife Species Potentially Occurring at Laurel Hill

Common Name	Scientific Name	Plant/ Wildlife	Federal Status	State Status
Bald eagle	*Haliaeetus leucocephalus*	Wildlife	B&GEPA	–
Canby's dropwort	*Oxypolis canbyi*	Plant	Endangered	Endangered
Chaffseed	*Schwalbea americana*	Plant	Endangered	Endangered
Frosted Flatwoods salamander	*Ambystoma cingulatum*	Wildlife	Threatened	Endangered
Northern Long-Eared Bat	*Myotis septentrionalis*	Wildlife	Threatened	Threatened
Pondberry	*Lindera melissifolia*	Plant	Endangered	Endangered
Red-cockaded woodpecker	*Picoides borealis*	Wildlife	Endangered	Endangered
Wood stork	*Mycteria americana*	Wildlife	Endangered	Endangered

8.1 Bald Eagle

The bald eagle (*Haliaeetus leucocephalus*), while no longer on the endangered species list, is still protected under the Bald and Golden Eagle Protection Act (BGEPA).). Bald eagles prefer to build nests in large trees, preferably pine, near areas of open water. Open water habitat provides availability of fish to hunt. Although no bald eagles have been observed on the Property, suitable habitat exists around the pond and salt marsh areas.

The bald eagle is primarily associated with coasts, rivers and lakes, usually nesting near bodies of water where it feeds. An opportunistic predator, the bald eagle feeds primarily on fish but also takes a variety of birds, mammals and turtles (both live and as carrion) when fish are not readily available.

The breeding season of bald eagles varies with latitude. Nesting in the Southeast occurs in three primary areas: peninsular Florida, coastal South Carolina and coastal Louisiana, with sporadic

breeding in the rest of the southeastern states. Otherwise, bald eagles occur throughout the Southeast as migrating or over-wintering birds (USFWS 1989).

In the Southeast, the bald eagle nesting period is usually from October 1 to May 15. Egg laying begins as early as late October and peaks in late December. The female does most of the nest construction, but the male assists. The typical nest is constructed of large sticks with softer materials such as dead weeds, cornstalks, grasses, and sod added as nest lining. Bald eagle nests are very large, up to six feet in width and weighing hundreds of pounds. In the Southeast, nests are constructed in dominant or co-dominant pines or bald cypress trees. Individual pairs return to their same territories year after year, and often territories are inherited by subsequent generations. Eagles are most vulnerable to disturbance early in the nesting period, i.e. during courtship, nest building, egg laying, incubation and brooding (usually the first twelve weeks of the nesting cycle). Disturbance during this critical period may lead to nest abandonment and/or chilled or overheated eggs or young. Human activity near a nest later in the nesting cycle may cause premature fledging thereby lessening the chance of survival. Although bald eagle nests are federally protected, a nest in and of itself, from a biological perspective, is relatively inconsequential to a given pair of eagles. It is the nest site that originally attracted the pair that is of critical importance. It is not uncommon for nests to be blown from trees by storms, after which the resident pairs typically re-nest on the same sites, often in the same trees. Therefore in the instances where nests, and even nest trees, are lost, management guidelines should continue to apply in their absence for a period extending through at least two complete breeding seasons subsequent to the loss. Bald eagles use alternate nests in different years. Although all nests used by a given pair are situated in the same general vicinity, several nests go unused for several consecutive years and thereby may appear abandoned. Even a solitary nest can go unused for several years, often due to the death of one member of the resident pair, and then be re-occupied by either the original pair of one member of the original pair with a new mate. Even in instances where both members of a pair have died, the site would likely be taken over by another pair if no habitat degradation occurs. For these reasons, management guidelines should apply to apparently "abandoned" nests for a period extending at least through five consecutive breeding seasons of non-use (USFWS 1989).

Management Zones

A. Primary Zone: This is the most critical area and must be maintained to promote acceptable conditions for eagles.

   1. Size: Except under unusual circumstances, the primary zone should encompass an area extending from 750 to 1500 feet outward from the nest tree. The precise radius distance between these two extremes would be dependent upon the proximal and spatial configuration of the critical elements (nest tree (s), feeding area, roost trees, etc.) within a particular nesting area, or other compelling factors.

   2. Recommended Restrictions:

a. Close proximity of the following activities to bald eagle nests are likely to have detrimental impacts on eagle nesting and, therefore, should not occur within the primary management zone at any time:

(1) Residential, commercial or industrial development, tree cutting, logging, construction and mining; and,

(2) Use of chemicals toxic to wildlife.

b. The following activities would likely be detrimental while eagles are present and, therefore, should be restricted in the primary zone during the nesting period, but not necessarily during the non-nesting season:

(1) Unauthorized human entry; and,

(2) Helicopter or fixed-wing aircraft operation within 500 feet vertical distance or 1,000 feet horizontal distance from a nest.

B. Secondary Zone: Restrictions in this zone are needed to minimize disturbance that might compromise the integrity of the primary zone and to protect important areas outside the primary zone. The secondary zone should be arranged so as to be contiguous with feeding areas and provide a protected access between nests and the feeding area. In some cases, that would involve extending a corridor from the primary zone to a particular feeding area, with that corridor requiring the same restrictions as the secondary zone.

1. Size: The secondary zone should encompass an area extending outward from the boundary of the primary zone, a distance of 750 feet to one mile. The precise distance will be dependent upon site-specific circumstances.

2. Recommended Restrictions:

a. Certain activities within the secondary zone are likely to be detrimental to bald eagles and in most cases should be restricted. These activities include, but are not necessarily limited to:

(1) Development of new commercial and industrial sites;

(2) Construction of multi-story buildings and high density housing developments between the nest and the eagles' feeding area;

(3) Construction of new roads, trails, and canals which would tend to facilitate access to the nest; and

(4) Use of chemicals toxic to wildlife, such as herbicides or pesticides.

b. Other activities may take place in the secondary zone, but only during the non-nesting period. Even intermittent use or activities of short duration during nesting are likely to constitute disturbance. Examples are logging, land clearing, construction, seismographic activities employing explosives, mining, oil well drilling, and low-level aircraft operations. Minor activities such as hiking, bird watching, fishing, camping, picnicking, hunting, and recreational off-road vehicle use may be permitted in the secondary zone at any time.

Feeding

These guidelines are designed to enhance the quality of bald eagle feeding areas and eliminate or minimize human disturbance.

- The use of toxic chemicals in watersheds and rivers where bald eagles feed should be prohibited.
- Alteration of natural shorelines where bald eagles feed should be prevented or limited. Degraded shorelines should be rehabilitated where possible.
- Water quality in eagle feeding areas should be monitored and remedial steps taken when needed.

Roosting

These guidelines are designed to help preserve present roosting sites and provide future habitat.

- Within the primary management zone, no trees, living or dead should be removed.
- Within the secondary management zone, as many large trees as possible living or dead, should be retained as roost and perch trees. Characteristically, these should be the large trees in the stand. Trees with open crowns and stout lateral limbs are preferable.

The major factor leading to the decline of the bald eagle was lowered reproductive success following the introduction of the pesticide DDT in 1947. DDT residues caused eggshell thinning which lead to broken eggs. Use of DDT was suspended in 1972, and by the late 1970s eagle populations began to show signs of recovery. Currently, the most significant factor to affect the recovery of the bald eagle in the Southeast is habitat destruction and disturbance by humans. Additional threats are illegal shooting, electrocution, impact injuries, and lead poisoning (USFWS 1989).

8.2 Canby's Dropwort

Canby's dropwort (*Oxypolis canbyi*) is a perennial herb, which grows 0.8 to 1.2 meters tall. The "quill-like" leaves are slender, terete, hollow and septate. The compound umbels of small five parted flowers appear from mid-August to October with white petals and pale green sepals (USFWS 1990). The plant resembles a mature Queen Anne's lace and has a slight dill fragrance.

Typical habitat for Canby's dropwort includes wet meadows, wet pineland savannas, ditches, sloughs, and around the edges of cypress ponds (USFWS 1992). The largest and most vigorous

populations have been found to occur in open bays or ponds that are wet throughout most of the year but which have little or no canopy cover (USFWS 1990). The depressional wetlands present in many of the pine dominated stands on the Property could serve as suitable habitat for Canby's dropwort; however, no Canby's dropwort was observed on the Property.

8.3 Chaffseed

Chaffseed (*Schwalbea americana*) is a herbaceous perennial that stands stiffly erect with very hairy, usually unbranched stems 30 to 60 centimeters tall. Leaves are alternate along the stem, long (2-5 centimeters) and narrow (0.8 centimeters), entire with no leaf stalks. Each leaf has three prominent veins. Yellow flowers are in a loose, leafy terminal cluster and arise from reduced leaves near the top of the stem (Coop. Ext. Ser./Univer. Ga. 1992). Flowering occurs from May to June.

Chaffseed occurs in sandy, acidic, and seasonally moist to dry soils. Habitats where it most commonly occurs include open, moist pine flatwoods, fire-maintained savannas, ecotones between peaty wetlands and xeric sandy soils, and other open grass-sedge systems (USFWS 1995). Chaffseed is dependent on factors such as fire, mowing, or fluctuating water tables that maintain the open, early successional conditions required. Under the current management regime habitat for chaffseed is not likely to exist. With thinning and the introduction of fire recommended in this management plan, it is possible for favorable conditions for chaffseed to be created.

8.4 Frosted Flatwoods Salamander

Optimum habitat for the flatwoods salamander (*Ambystoma cingulatum*) is open, mesic woodland of longleaf/slash pine flatwoods maintained by frequent fires (USFWS 1997). Breeding sites are isolated pond cypress, blackgum, or slash pine dominated depressions, which dry completely on a cyclic basis. They are generally shallow and relatively small. Suitable habitat for the Frosted Flatwoods Salamander does not currently exist on the property and is unlikely to unless management changes drastically. The isolated nature of the property also makes it very unlikely for the salamander to be found on the property, due to the fact that it would need to migrate from an adjacent property.

8.5 Northern Long-Eared Bat

The northern long-eared bat (*Myotis septentrionalis*) is a medium-sized bat with a body length of 3 to 3.7 inches but a wingspan of 9 to 10 inches. Their fur color can be medium to dark brown on the back and tawny to pale-brown on the underside with particularly long ears. During the summer, northern long-eared bats roost singly or in colonies underneath bark, in cavities or in crevices of both live trees and snags, while in the winter they prefers caves (USFWS 2015).

Northern long-eared bats emerge at dusk to feed. They primarily fly through the understory of forested areas feeding on small insects. The northern long-eared bat's range includes much of the eastern and north central United States, and all Canadian provinces from the Atlantic Ocean west to the southern Yukon Territory and eastern British Columbia. Maximum lifespan for the northern long-eared bat is estimated to be up to 18.5 years (USFWS 2015). No northern long-eared bats are known to exist on the Property, but habitat does exist in the form of cavity trees and snags.

8.6 Pondberry

Pondberry (*Lindera melissifolia*) is a deciduous, aromatic shrub growing 0.5 to 1.8 meters in height with thin, drooping glabrous or pubescent leaves that smell like sassafras when crushed. Pale yellow flowers appear in the spring before the leaves. The bright red 12-millimeter long oval-shaped fruits mature in the fall.

Pondberry is primarily found in association with wetland habitats (USFWS 1992). In South Carolina, pondberry is associated with the margins of seasonally flooded sinks, ponds, and depression in pinelands (USFWS 1993). The depressional wetlands present in many of the pine dominated stands on the property could serve as suitable habitat for pondberry. No pondberry was observed on the Property.

8.7 Red-cockaded Woodpecker

The red-cockaded woodpecker (RCW) (*Picoides borealis*) was once a common bird in the mature pine forests of the Southeast. It lived from east Texas to Florida and north to Missouri, Kentucky and Maryland. Today, its range and population have been reduced through loss of habitat. Under the current management regime on the Property suitable habitat for RCWs does not exist. If the current, short rotation loblolly pine management continues it is very unlikely RCWs will ever be present on the property. However, RCWs are prevalent in the Francis Marion National Forest, and could easily find their way to the Property if habitat conditions were suitable. In order for this to occur the management regime would have to switch to long rotation, old growth loblolly pine management. This old growth management coupled with prescribed fire would create suitable habitat for RCWs. If future forest conditions become favorable for RCWs (ex. mature stands in forest demonstration area), it is recommended that the CCPRC work with SCDNR to enroll the Property in a safe harbor agreement.

Unlike other woodpeckers, the red-cockaded woodpecker roosts in cavities in live southern pines. It needs older pine trees for its cavities, and extensive pine and pine-hardwood forests to meet its foraging requirements. Much of the South has been cleared for agriculture or other incompatible uses. Much of the remaining pine forests are not suitable for the RCW. Each year, more areas become unsuitable. Because of the drastic loss and continued decline of habitat, the bird is considered in danger of extinction.

The RCW has an advanced social system, living in groups that share, and jointly defend, all-purpose territories throughout the year (USFWS 2000). A group typically consists of one breeding pair and additional individuals referred to as helpers. Most helpers are males that remain and assist the breeders, who are typically their parents or other close relatives, on their natal territory. Helpers do not breed, but assist with incubation, feeding and brooding of nestlings, feeding of fledglings, territory and nest defense, and cavity excavation. Groups may contain as many as four helpers, but most groups consist of only a breeding pair with no helpers, or a breeding pair plus one helper (USFWS 2000).

A group nests and breeds in a collection of cavity trees called a cluster. A cluster may have one or two cavity trees to more than twelve, but is used by only one clan. Typically, within a cluster, some cavities are under construction, some are finished and some are abandoned. In most clusters, all the cavity trees are within a circle about 1500 feet (457m) in diameter. It takes months, even years, for a RCW to excavate a cavity. Once completed, a cavity is used for several years.

A RCW group defends, year round, a territory surrounding the colony. Territories range from less than 100 acres to more than 250 acres. The total area used by a group may be as large as 1000 acres. The group spends much of its time foraging for food as it travels about its territory. The birds search for food on the upper trunks and limbs of living pine trees. They scale the bark and dig into dead limbs for spiders, ants, cockroaches, centipedes and larvae of various insects. On occasion, they will eat fruits such as blueberries, sweetbay magnolia, wild cherry, poison ivy and wax myrtle (Hooper et al. 1980).

The USFWS has prepared guidelines for private landowners who wish to harvest timber and successfully manage for RCW's. Activities that are completely prohibited within an active cluster site are as follows:

1. The removal of an active cavity tree.

2. Damaging an active cavity tree which results in the death of that tree; damage may include injury to the hole or root system, exposure to herbicides and fire scorch to the crown due to negligence or inadequate protective measures during prescribed burning.

3. Removing or damaging any pine trees greater than 10 inches dbH, without assessing the cluster's existing stocking rate and potential cavity tree situation. Removal of pine trees within a cluster is permitted. However, all potential (older relict and residual trees) cavity trees must be retained. If stocking is greater than 50 BA (square feet of basal area per acre) the cluster can be thinned down to 50 BA, while favoring sawtimber sized (12+dbh) stems as leave trees. If stocking is below 50 BA (in 10: and large stems) no thinning is permitted.

4. Using pesticides (insecticides) on standing trees. Controlling disease and insect infestations is permitted. However, if such control will result in significant losses of trees, then the USFWS must be contacted.

5. Constructing roads and utility right of ways within a cluster. If no reasonable alternative exists, the USFWS must be contacted before construction or clearing activities are approved.

6. Construction of facilities, including buildings, campgrounds, recreational developments, residential dwellings, business complexes, etc. If in the landowner's opinion, extenuating circumstances require a facility to be constructed in an active cluster, the service must be contacted during the planning phase and prior to any construction activity.

7. Planting of shrubs and/or ornamental plants that will exceed five feet in height within 50 feet from a cavity tree. If cavities are five feet or less in height, planting shrubs within 50 feet of the tree is not permitted. Landscaping within clusters will be accomplished with hand tools or light weight power equipment rather than tractor-mounted equipment.

8. Any activity that will result in artificially induced stress or harassment, such as increased competition and/or predation pressures or disturbance during the breeding season, for instance, installation of bird or other (squirrel) feeders, use of bird and some mammal nest structures, and installation of picnic areas or playgrounds.

Foraging habitat is defined as pine and pine-hardwood stands containing ten-inch DBH or larger pine trees. Generally, depending on site, species and management intensity pines can reach ten-inch DBH in 25-30+ years. Because tree height is also a factor in foraging suitability (female RCWs forage primarily on the bole and not on the crown or in the limbs), trees less than 25 years old, regardless of DBH, will not be considered suitable forage. Foraging habitat must be contiguous to and within one-fourth to one-half mile of the cluster. Areas within the cluster are included as foraging habitat. The one-half mile radius from the cluster represents the average foraging range of RCWs and may encompass areas outside of the lands included in the landowners proposed action. If available foraging habitat within the one-half mile radius of clusters overlaps, then the overlapping area must be divided by the number of groups using the area to determine the amount of foraging available to each group. However, the habitat within the overlap area can be apportioned among groups in any ratio, as long as resulting foraging habitat is sufficient for all groups.

Landowners are not responsible for protecting or maintaining inactive or abandoned RCW clusters. However, declaring a RCW cluster inactive or abandoned can be a difficult "call"; as such, determining the cluster's status requires the expertise of a knowledgeable biologist, forester, or other individual familiar with RCW (and other woodpeckers) identification, life history and ecology and hence the "signs" associated with RCW and other woodpecker's activities. The individual must have ample on-the-ground experience with RCWs to recognize, and be able to interpret, the sometimes confusing and subtle differences between RCW and other bird (particularly woodpeckers) sign (USFWS 1992).

8.8 Wood Stork

The wood stork (*Mycteria americana*) is a large wading bird approximately 127 centimeters tall, with a wingspan of 1 to 1.5 meters. This species is highly colonial, usually nesting in large rookeries and feeding in flocks. The plumage is generally white, with black primary and secondary wing feathers and a short black tail. The head displays a prominent bill that is slightly decurved, thick at the base and black.

Wood storks are typically associated with freshwater and brackish wetlands. The pond/impoundment on the Property serves as suitable habitat for wood storks. No wood storks were observed on the Property, but suitable habitat exists. Most nesting colonies in the Southeast are located in woody vegetation, such as bald cypress, over standing water, or on islands surrounded by open water. Foraging habitat may include freshwater marshes, flooded pastures and flooded ditches (USFWS 1992). Foraging sites are often in areas of fish concentrations due to either local reproduction or drying.

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Chapter Nine: Water Impoundment Management

The Property also consists of managed tidal impoundment (MTI) that will be managed for varying species of waterfowl, including ducks and wading birds. CCPRC, partnering with Ducks Unlimited (DU), has repaired a water control structure in the dike to regain the ability to control water levels in the pond. CCPRC should monitor the water levels in the pond to allow for the growth of beneficial aquatic vegetation that provides food to wading birds and ducks as well as fish. The pond is bisected by an interior road, and the north end of the pond is smaller and shallower than the south end. The pond is composed of freshwater and is fed primarily by the main wetland system through the Property. The water level in the pond fluctuates with rain events, but will be easier to control once the new water control structure is installed.

9.1 Site Conditions

Vegetation

MTI 1 is an estuarine emergent managed wetland. Narrowleaf cattail (*Typha angustifolia*), giant foxtail grass (*Setaria faberi*), and giant reed (*Phragmities australis)* line the banks. Wigeon grass (*Ruppia maritima) &* alligatorweed (*Alternanthera philoxeroides)* occurs throughout the impoundment. Eastern red-cedar (*Juniperous virginiana*), loblolly pine (*Pinus taeda*), chinese tallow (*Sapium sebiferum*), winged sumac (*Rhus copallinum*), live oak (*Quercus virginiana*), water oak (*Quercus nigra*), wax myrtle (*Morella cerifera)* and groundsel bush (*Baccharis halimifolia*) dominate the woody species in and surrounding the impoundment.

Water Regimen

The impoundment at the Property is approximately 11.5 acres in size and has one water control structure, a concrete flashboard riser, connecting the managed impoundment to Horlbeck Creek and eventually the Wando River. The managed impoundment is relatively shallow (2-8 feet) with a large freshwater component draining into the impoundment. The impoundment is open water with an unconsolidated bottom.

Current Management

Management of the impoundment at the Property includes maintaining the impoundment at full pool in order to maintain fish populations as well as emergent and submersed aquatic vegetation for waterfowl. In its current state, the impoundment provides habitat for a variety of game and non-game species and at the time of the site visit, was hosting six pairs of breeding wood ducks (*Aix sponsa*) and their young.

Both impoundments provide year-round foraging for bald eagles, osprey (*Pandion haliaetus*), american alligators *(Alligator mississippiensis)*, and various other carnivorous, omnivorous, and vegetarian species.

Future Management

The goal is to diversify management for waterfowl, fish, and desirable aquatic vegetation. Management recommendations for the impoundment include the treatment of invasive species and introduction of beneficial aquatic vegetation to provide a diversity of beneficial habitat.

Maintenance of the impoundment at full pool with minor fluctuations in water levels during certain times of the year caters to the seasonal needs of the target species. Spring drawdowns can allow for wading bird and shorebird foraging. Water levels should be increased to allow for deeper flooding in the summer and fall when water temperatures are highest, followed by a moderate drawdown in winter for waterfowl use.

Treatment of invasive species including phragmities and alligatorweed should be a priority. These species can quickly take over an aquatic ecosystem and push out native, beneficial habitat. Treatment with aquatic-approved herbicides is the only way to control these species. Specific treatment recommendations for each of these species are outlined in the invasive species section. Once these species are controlled, we recommend planting of banana water lily (*Nymphaea mexicana*) and watershield (*Brasenia schreberi)*. These species host a number of invertebrates that waterfowl feed on and will regenerate year after year on their own, while not taking over a pond. They both can be easily controlled with herbicides if needed, and are two of the most sought after aquatic plants for waterfowl enthusiasts. Both are native to the southeast, and can be purchased commercially. These species not only provide food, but also cover for young fish species and amphibians.

A stock assessment of fish populations should take place to determine fish density and health. Ponds where the fish population is not managed correctly often tend to result in an overpopulation of small, stunted bass and low populations of prey fish. Upon the results of a population study, stocking and harvest recommendations can be determined to sustain a healthy fishery within the impoundment.

These relatively shallow impoundments can experience low dissolved oxygen levels during the summertime as aquatic vegetation dies off. This can often result in fish mortality as water temperatures rise and oxygen availability drops. If this occurs within the impoundment at Laurel Hill, a diffuser or series of diffusers should be installed within the impoundment. These are shore mounted motors that push air through a hose in the impoundment to a stone mounted on the bottom of the pond and forces the air through a diffuser stone. This creates an upwelling, helping to circulate the water and keep dissolved oxygen levels high enough to maintain aquatic species.

Some impoundments and ponds respond to fertilization and/or liming of the water to alter the nutrient load and pH. Due to the amount of runoff from adjacent neighborhoods and development

and vegetation present within the impoundment, we would not recommend any additional input of nitrogen into the system for risk of eutrophication (algae bloom).

As always, maintenance of the water control structures, dikes, and field drains are essential for the continued management of the impoundment. Impoundments are dynamic ecosystems that require constant maintenance and management to maintain productivity and ensure the impoundments will withstand future storm events. The maintenance and management of the impoundments will enhance foraging, breeding, overwintering and migratory habitat for a multitude of avian, reptile, aquatic, and mammalian species.

The pond also contains suitable habitat for wood ducks, whose nesting can be encouraged by providing nesting boxes, to supplement the boxes currently on the impoundment. A full description of wood duck habitat requirements and instructions for building wood duck boxes is located in *Chapter Seven: Wildlife Management*.

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Chapter Ten: Wetlands

The United States Congress passed the Federal Water Pollution Control Act (FWPCA) in 1972. In 1982 a number of rules and changes to the FWPCA were issued. One of these changed the name to the Clean Water Act (CWA). The CWA deals with a multitude of regulations designed to protect the nation's waters. These include cleaning of rivers, ensuring clean drinking water, estuarine protection and ways to prevent the loss of freshwater wetlands. Each one of the areas is addressed in the CWA document under a heading designated as a "section". These sections are numbered and usually referred to by that numerical designation.

Section 404 of the CWA is the section that requires a fill permit from the US Army Corps of Engineers (COE) for the discharge of fill material into "waters of the United States, including wetlands." Activities in wetlands for which permits may be required include:

- Placement of fill material
- Ditching activities when the excavated material is sidecast
- Levee and dike construction
- Mechanized land clearing
- Land leveling
- Most road construction
- Dam construction

10.1 Wetland Definition

The COE and the Environmental Protection Agency (EPA) define wetlands as:

> *Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas.*

The COE investigates three characteristics of the area when making wetland determinations: vegetation, soils and hydrology. Unless the area has been altered or is a rare natural situation, wetland indicators of all three characteristics must be present during some portion of the growing season for an area to be classified as a wetland.

Nearly 5,000 plant types may occur in wetlands in the United States. These plants are known as hydrophytic vegetation. Some common examples are cattails, bulrushes, cordgrass, sphagnum moss, bald cypress, willows, mangroves, sedges, rushes and arrowheads. Other vegetation indicators of wetland include shallow root systems, swollen trunks or roots growing from the stem or trunk above the soil surface.

The second consideration in determining wetlands is the investigation of the soils. Soils with characteristics that indicate they developed in conditions where soil oxygen was limited due to saturation for long periods during the growing season are called hydric soils. There are over 2,000 hydric soils in the United States. The US Soil Conservation Service, now the Natural Resource Conservation Service (NRCS) maintains a list of hydric soils. This list can be used to give an indication as to whether wetlands may be present or not. If the soil type is not known there are a number of indicators that can be used as clues:

- Soil consists of predominately decomposed plant material.
- Soil has bluish or gray color below the surface, or the major color of the soil is dark and dull.
- Soil has the odor of rotten eggs.
- Soil is sandy and has dark stains of organic material in the upper layer of the soil. These streaks are decomposed plant material attached to soil particles. When soil from these streaks is rubbed between the fingers, a dark stain is left on the fingers.

Wetland hydrology refers to the presence of water at or above the soil surface for a sufficient period of the year to significantly influence the plant types and soils. The following indicators provide evidence that flooding or soil saturation is occurring:

- Standing or flowing water is observed during growing season.
- Soil is waterlogged during the growing season.
- Watermarks are present on trees.
- Drift lines, which are small piles of debris oriented in the direction of water movement, are present.
- Thin layers of sediments are deposited on leaves or other objects.

10.2 Wetland Impacts

If wetlands will be impacted in the course of a project, then a permit may be required before the activity begins. There are two basic types of permits. The individual permit is generally used for large projects and impacts of significant importance. A very thorough accounting of the impacts and benefits of the proposed project must be reviewed by the state and federal agencies and public meetings must be held for additional input before the COE can issue the permit. The applicant is usually responsible for providing all the supporting information, tests and studies to prove that the fill permit is necessary. Also, they must compensate for the impacts by providing mitigation. The COE is required to get comments from a wide variety of sources when considering the issuance of a permit. These include US Fish and Wildlife Service (USFWS) National Marine Fisheries (NMF), US Environmental Protection Agency (EPA), South Carolina Department of Health and Environmental Control (DHEC), South Carolina Department of Natural Resources (DNR) and the SC State Historical Preservation Office (SHPO), as well as the public. The permit process can be very daunting.

An individual permit can typically take six months to a year to process. Since this process is so involved and time consuming, a system of Nationwide Permits (NWPs) was instituted with changes to the CWA in 1982. The NWPs are designed to provide a fair and flexible framework that will reduce the regulatory burdens of the individual permit and still meet water quality objectives. The NWPs include specific project limitations, which ensure that impacts will be no more than minimal and the aquatic environment will be protected. The applicant is rewarded for meeting these limitations with a much shortened permit process, saving time and money.

10.3 Permit Exemptions

The CWA contains one other mechanism for impacting wetlands. Some activities are set aside and exempt from the restrictions of the CWA. Certain agricultural and forestry operations were granted these exemptions in Section 404(f) of the CWA. The forestry activities exempt from Section 404 regulation include normal silvicultural activities such as plowing, seeding or planting, cultivating, minor drainage and harvesting for the production of forest products. To be considered as exempt, the activities specified above must be part of an established silviculture operation.

Section 404(f) reads as follows:

1. Except as provided in paragraph (2) of this subsection, the discharge of dredge or fill material:
    a. from normal farming, silviculture, and ranching activities such as plowing, seeding, cultivating, minor drainage, harvesting for the production of food, fiber and forest products, or upland soil and water conservation practices;
    b. for the purpose of maintenance, including emergency reconstruction of recently damaged parts of currently serviceable structures such as dikes, dams, levees, groins, riprap, breakwaters, causeways, and bridge abutments or approaches, and transportation structures;
    c. for the purpose of construction or maintenance of farm or stock ponds or irrigation ditches, or the maintenance of drainage ditches;
    d. for the purpose of construction of temporary sedimentation basins on a construction site which does not include placement of fill material into the navigable waters;
    e. for the purpose of construction or maintenance of farm roads or forest roads, or temporary roads for moving mining equipment, where such roads are constructed and maintained, in accordance with best management practices, to assure that flow and circulation patterns and chemical and biological characteristics of the navigable waters are not impaired, that the reach of the navigable waters is not reduced, and that any adverse effect on the aquatic environment will be otherwise minimized;
    f. resulting from any activity with respect to which a State has an approved program, under section 208(b)(4) which meets the requirements of subparagraphs (B) and (C) of such section, is not prohibited by or otherwise subject to regulation under this section or section 301(a) or 402 of the Act (except for effluent standards or prohibitions under section 307).

2. Any discharge of dredged or fill material into the navigable waters incidental to any activity having as its purpose to bring an area of the navigable waters into a use to which it was not previously subject, where the flow or circulation of navigable waters may be impaired or the reach of such waters be reduced, shall be required to have a permit under this section.

Because of the vague language in the CWA defining the conditions under which the exemptions were valid, the EPA in conjunction with state forestry commissions and forestry associations began the process of developing Best Management Practices (BMPs). South Carolina played an important role in being one of the lead states to develop these guidelines.

10.4 South Carolina's Best Management Practices for Forestry

Best Management Practices (BMPs) were developed and published by the South Carolina Forestry Commission in 1994. Most of the BMPs in the manual deal with protection of water quality. Compliance with these is required in order to qualify for the silvicultural exemption of Section 404(f) in the CWA. Additional BMPs are also included to give landowners and foresters guidelines to "conserve site productivity."

Some of the water quality protection practices detailed in the BMP guide include the following:

Streamside Management Zones (SMZ). SMZs are the areas of land adjacent to streams. They act as filters for land manipulation activities uphill of the stream, as well as providing shade for water temperature control. There are specific guidelines for how wide these areas should be and what kind of activities can occur within them. These guidelines are based on the type of stream and the slope of the land adjacent to the stream.

Stream Crossings. These guidelines discuss the engineering of roads that must cross streams.

Forest Road Construction. This section deals with good engineering principles in forest road construction that will reduce erosion and impacts to sensitive areas as well as help protect the investment in the road itself. There is a special section on Forested Wetland Road Construction that lists the Federally Mandated BMPs:

1. Permanent roads, temporary access roads, and skid trails in waters of the United States shall be held to the minimum feasible number, width, and total length consistent with the purpose of silvicultural operations and local topographic and climatic conditions.
2. All roads, temporary or permanent, shall be located sufficiently far from streams or other water bodies (except for portions of such roads which must cross water bodies) to minimize discharges of dredged or fill material into waters of the United States.
3. The road fill shall be bridged, culverted, or otherwise designed to prevent the restriction of expected flood flows.
4. The fill shall be properly stabilized and maintained to prevent erosion during and following construction.

5. Discharges of dredged or fill material into waters of the United States to construct a road shall be made in a manner that minimizes the encroachment of trucks, tractors, or other heavy equipment within the waters of the United States (including adjacent wetlands) that lie outside the lateral boundaries of the fill itself.
6. In designing, constructing, and maintaining roads, vegetative disturbance in the waters of the United States shall be kept to a minimum.
7. The design, construction, and maintenance of the road crossings shall not disrupt the migration or other movement of those species of aquatic life inhabiting the water body.
8. Borrow material shall be taken from upland sources whenever feasible.
9. The discharge shall not take, or jeopardize, the continued existence of a threatened or endangered species as defined under the Endangered Species Act, or adversely modify or destroy the critical habitat of such species.
10. Discharges into breeding and nesting areas for migratory waterfowl, spawning areas, and wetlands shall be avoided if practical alternatives exist.
11. The discharge shall not be located in the proximity of a public water supply intake.
12. The discharge shall not occur in areas of concentrated shellfish production.
13. The discharge shall not occur in a component of the National Wild and Scenic River System.
14. The discharge material shall consist of suitable material free from toxic pollutants in toxic amounts.
15. All temporary fills shall be removed in the entirety and the area restored to its original elevation.

There are several important considerations to keep in mind as they relate to forest roads in wetlands. The purpose of the road has to be for timber harvest or silvicultural operations. Access for wildlife management or hunting is not a qualification for the exemption. If the purpose of the road changes after it is constructed from silviculture to another use like hunting, development, or recreation, the COE can require that the owner get a permit for the existing road. If the permit is denied the road would have to be removed.

The other important guideline is the requirement that the roads be kept to a minimum in regard to the number and width. Single lane roads with an occasional pull over are allowed under the silvicultural exemption. Roads wider than 15’ to 20’ on the top generally will not qualify for the 404 (f) exemption. These larger roads can be built, only with a certification or permit from the COE.

10.5 Timber Harvesting, Site Preparation & Minor Drainage

Impacts to the water quality of wetlands that are harvested result from increased sediment loads and temperature fluctuations. The BMP guidelines include minimizing the number of stream crossings, stabilizing runoff from log decks and proper siting of decks to reduce problems.

Any time the soil is disturbed in the vicinity of wetlands there is a potential for degradation of water quality. Site preparation in forestry operations is divided into three categories: mechanical site preparation, chemical site preparation and prescribed fire. Mechanical site preparation has been, in particular, a very difficult issue with some of the regulatory agencies who are charged with protection of our wetland resource. The BMPs give advice to avoid adversely impacting wet areas, but there have been additional restrictions implemented recently that should be kept in mind.

One of the key tests of an exempt activity is that it must adhere to Section 404 (f)(2). This says that in order for an activity to qualify for the exemption, the circulation and reach of the wetland must not be impaired or decreased. In other words the wetland cannot be converted to upland. Recent court cases have imposed additional restrictions on conversion of habitat. Therefore, mechanical site preparation is, for the most part, restricted in wetland areas that are dominated by hardwoods. This effectively prevents a hardwood area from being changed to a pine habitat. Wetlands that have a predominance of pines can be site prepared according to the guidelines in the BMP manual.

The site preparation methods used must not only conform to the Best Management Practices but must also be of the type and intensity that are "normal" silviculture practices. An example of mechanical site preparation practices that are not considered normal is the practice of pushing up and removing all stumps from a wetland area. Since most site preparation practices leave the majority of the stumps in the ground and trees are planted around them, any activity that is significantly more intense may jeopardize the 404 exemption.

Minor Drainage- the purpose of minor drainage is to remove excess water from a site, especially during harvest and regeneration activities. This is another area of the silvicultural exemption that is still being refined within the regulatory agencies. Minor drainage must only remove surface water temporarily. It cannot violate the 404 (f)(2) test by causing the size of the wetland to be reduced. Any drainage work that does not qualify as being minor will require a permit from the COE.

Another related issue is the maintenance of existing ditches. If a ditch is entirely in upland there are no restrictions as to what you can do with it. But, if that ditch connects two wetlands, all portions of the ditch fall under the jurisdiction of the COE. Existing ditches can be maintained to their original depth as long as the maintenance on them has been periodic and regular. If the drainage function of the jurisdictional ditch has been lost due to a lack of maintenance, the ditch cannot be maintained without a permit from the COE.

Recent studies conducted by the SC Commission of Forestry indicate that 89% of the forestry operations examined were in compliance with the BMPs. The forestry community is trying to increase adherence to the BMP guidelines through logger certification courses offered by the SC Forestry Association as well as timber product company sanctions against habitual BMP violators.

Chapter Eleven: Invasive Plant Species Management

Some plants have escaped cultivation and disrupted native ecosystems. They are referred to as "invasive" plants. Invasive plants all share several common characteristics: they grow quickly, propagate easily, resist native pests, grow in a wide range of soils, can invade undisturbed habitats, and have traits considered attractive enough to encourage the further distribution by people (Jubinsky 2002).

The control of invasive vegetation can be accomplished by utilizing biological control agents (insects and pathogens), herbicides, mechanical manipulation, or combinations of these methods (Jubinsky 2002). Herbicides referenced in the following discussion are currently recognized as being effective for a particular species.

The following invasive species were observed on the property: common reed, Japanese climbing fern (*Lygodium japonicum*), alligator weed, Chinese tallow tree, and cattail. These and other species that are likely to occur on the property are included in this section as well as management recommendations for each species.

11.1 Chinese Tallow Tree

Chinese Tallow tree (Source:tcuinvasives.org)

Chinese tallow tree or popcorn tree was introduced in the late 1700's for vegetable tallow production from the waxy seed coating, possibly as an alternative to expensive whale blubber for lamp fuel and candle tallow. In the early 1900's, extensive plantations were established along the Gulf Coastal Plain in support of a soap-making industry based on the vegetable tallow derived from the tallow tree. The kernels also produce a drying oil, Stillingia oil, which can be used in machine oils, lighting fuels, and varnishes and paints. The oil is considered poisonous and has been proven toxic to cattle. The tree produces heavy seed crops, and oil in the seed averages 20% by weight. The species later became popular for its brilliant fall foliage and quick shade, and was planted extensively across the Gulf coastal plain in suburban housing developments (Louisiana Invasive Plant Species: *Tridica sebifera*: (L.) Small).

Mechanical Control
Cutting of horizontal shoots result in the immediate production of small independent plants, making this method impractical unless combined with herbicide use (see below).

Fire can hold the tallow at bay when tree density is low, but since tallow can suppress fuel species, fire can burn up to a stand but then go out from lack of fuel, leaving the tallow relatively unharmed. Fire control is still under research.

Biological Control
The plant apparently lacks serious biocontrols or pathogens in the United States, although a bagworm, *Eumeta* sp., from Japan appears to be a pest.

Chemical Control
Attempts at managing Chinese tallow suggest that herbicidal methods are the most effective option for control at this time.

> Basal Bark Application – Basal bark applications are made by applying herbicide directly to the bark around the circumference of the tree from ground level up to 15 inches above the ground. Hand-held equipment (paintbrush) or backpack sprayer is usually used for this application. For trees that have stems less than 6 inches in basal diameter, apply up to a 5% Triclopyr (Garlon 4) solution mixed with spray adjuvant oil. Trees exceeding 6 inches in basal diameter can be successfully controlled with a 15-20% Triclopyr/oil solution. Old or rough bark requires more spray than smooth young bark (Jubinsky 2002).
>
> Cut Stump Treatment – To control resprouting of freshly cut stumps, a 20% solution of Triclopyr will provide control. Spray the root collar area, sides of the stump, and the outer portion of the cut surface including the cambium until thoroughly wet. No more than ½ hour should elapse between cutting and applying herbicide (Jubinsky 2002).

The best time to initiate herbicidal control measures on Chinese tallow is during the spring months. During this time, either the cut stump or basal bark treatment is effective. During a normal weather year, trees begin producing seed in late August or early September. Use of the cut stump treatment during periods of the year when seeds are present is not recommended. During autumn months, restrict control measures to the Basil Bark method only (Jubinsky 2002).

11.2 Japanese Climbing Fern

Japanese Climbing Fern is a vine like plant that grows or “climbs” on to trees, shrubs and structures. The leaves of the fern are triangular in shape and approximately three to six inches long by three inches wide. It was originally introduced into the United States as an ornamental, but has

found its way into forests throughout the Southeast. The fern poses a threat to timber because of its ability to climb up and completely cover the crown of trees. This poses a serious threat to overall tree health, and can sometime kill the tree. The fern's roots system grows approximately an inch underground and forms a rhizome mat in the forest stand. The fern is spread through wind dispersed spores making control especially difficult.

Japanese Climbing Fern (Source:invasives.org)

Management

Control and management of Japanese Climbing Fern is especially difficult because of the wind dispersed spores it uses to spread. Mechanical disturbance can often cause accelerated rate of spread of these spores. Care should be taken when logging stands with high concentrations of this fern to not further spread. Chemical control is also difficult. Since the fern overtops and covers trees and shrubs in many instances it is hard to apply herbicide without also negatively affecting the host tree. For similar reason prescribed fire is also not an effective method of control. The fern will burn hot and act as a ladder fuel allowing fire to reach the forest canopy. Fire in the crowns of trees is detrimental to tree health and often leads to mortality. Hand cutting and pulling is the most effective means of control. After removing large amounts of fern care should be taken to continue to monitor the area for re-sprout and control as needed as soon as possible. The rhizome mat should be removed if possible when hand cutting and pulling to deter re-sprout.

11.3 Cattails

Cattails are prolific plants that play an important role as a source of food and shelter for different marsh-dwelling animals. They can be found in damp soil or shallow water where sufficient nutrients are available. However, they can quickly dominate a wetland plant community. A 50:50 ratio of open water and vegetation is a frequent objective when managing cattail marshes in North America (Fredrickson & Reid 1987).

Management

Mechanical Control

Water Level Management: The control of cattails by the manipulation of water level must be timed to the annual cycle of carbohydrate storage. Special leaf and stem cells called aerenchyma provide

air passage from both living and dead leaves to the rhizomes. Removing dead leaves and submerging the shoots in early spring will strain the plant and eventually kill it. The depth of water necessary to kill the plants depends on temperature, the quantity of starch the plant stored the previous year, and the general vigor of the plants. Therefore, no minimum water depth can be prescribed, but generally, a water level maintained at 3-4 feet above the tops of existing spring shoots will retard growth. The use of water is most efficient if the water level is raised progressively, so that all plant parts remain submerged by no less than a few inches (Fredrickson & Reid 1987).

Cattails (Source mtpr.org)

Cutting, Crushing, Shearing, and Disking: Cutting, crushing, shearing, and disking during the growing season can be used to impede starch storage. These treatments are effective if done during a 3-week window from 1 week before to 1 week after the pistillate spike is lime green and the staminate spike is dark green. However, the treatments are most effective during the 3-4 days when the spikes are so colored (Fredrickson & Reid 1987).

Deep disking can retard shoot formation and can damage the rhizomes, but the effect on plant survival is variable. The overall effect on the entire stand is minimal if water conditions are favorable for cattail survival. Control of water levels and of recruitment from the seed bank is necessary to prevent reestablishment of the cattails. Deep disking combined with continued drying and freezing in fall decreases plant survival. If the wetland can be kept sufficiently dry to repetitively disk in any two to three successive seasons, cattails can be eliminated or their stem densities severely reduced (Fredrickson & Reid 1987).

When the plants are dormant, cutting, crushing, shearing, or disking is extremely effective for severing the aerenchyma link between the rhizomes and the leaves. To reduce plant survival, however, these techniques must be combined with high water levels in spring to induce stress from anaerobic starch conversion (Fredrickson & Reid 1987).

Prescribed Burning: Burning cattails is difficult during the growing season, except during extreme low-water conditions. Dry residual cattail litter provides enough fuel to carry a fire through growing plants. The fire usually does not kill the plants but can reduce starch storage. Fires in cattail marshes rarely are hot enough at ground level for heat penetration to impede rhizome function or shoot viability (Fredrickson & Reid 1987).

Most cattail marshes must be burned in winter or before significant growth has occurred in spring when fuels are dry enough to carry a fire. However, frozen or saturated soils can hamper the progress of the fire through cattail duff. When combined with high water levels in spring to smother the residual stalks, fire can be used to control cattails (Fredrickson & Reid 1987).

In wetlands with well-developed peat soils, fires during drought conditions can destroy the entire cattail plant including the rhizomes. Such fires actually burn the peat, and the ability to smother the fire by reflooding the marsh must exist before prescribing such fires. Peat fires can also eliminate the existing seed bank and, if sufficiently severe, lower the relative bottom of a marsh. Local concern with the effects of peat fires on air quality can be substantial (Fredrickson & Reid

Chinese Tallow tree (Source:tcuinvasives.org)

1987).

Biological Control

There is currently no good choice to achieve biological control of cattails. Grass carp are often mentioned as a potential control method, but in reality, they prefer not to eat cattails (Lynch Jr. 2002).

Chemical Control

Herbicides, especially glyphosate, interrupt metabolic pathways and have been used successfully to kill cattails. Herbicides that are translocated to the rhizomes are most effective for cattail control. Application in mid to late summer when carbohydrates are stored enhances the effectiveness of translocated herbicides. Therefore, herbicides have little effect on seed production during the year of application. As with other techniques, the duration of the effect of herbicides depends on subsequent water-level control and recruitment from the seed bank (Fredrickson & Reid 1987).

11.4 Sesbania

Sesbania (*Sesbania exaltata*) is an erect annual herb of the legume family, which typically grows to a height of 3-10 feet. Sesbania prefers wet, highly disturbed habitats and sandy sites. It occurs in low sandy fields, sandbars of streams, alluvial ground along sloughs and borders of oxbow lakes, and along roadsides, railroads, in disturbed urban sites and agricultural areas. It may become a troublesome exotic species in wetland communities that are managed for waterfowl (Vegetation Management Guideline Sesbania 2001).

Management

Control of sesbania is best accomplished by creating conditions favorable for the germination of beneficial plants early in the growing season. Once established, beneficial plants can outcompete newly germinated sesbania. Therefore, control strategies should be performed early in the growing season. If early control is not possible, late disk-flood often prevents reestablishment of sesbania

and creates conditions favorable for fall migrating shorebirds. This can be followed by an early drawdown during the subsequent growing season (Vegetation Management Guideline Sesbania 2001).

Mechanical Control:
Spot treatment can best be accomplished by removal of the stems prior to the production of fruits. Follow-up will probably be necessary for several additional growing seasons if a seed bank is present or if reinfestation occurs (Vegetation Management Guideline Sesbania 2001).

Mowing should occur prior to seed set if possible. Mow as high as possible to preserve and promote growth of desirable plants in the understory.

Burning appears to stimulate germination.


Sesbania (Source:alabamaplants.org)

Biological Control
An isolate of the fungal pathogen *Colletotrichum truncatum* was discovered on the Southern Weed Science Laboratory Experimental Research Farm and has been evaluated over the past several years for use as a bioherbicide against this weed. Various invert and vegetable oil emulsion formulations developed in this laboratory eliminated or greatly reduced free moisture requirements, and have consistently provided 85-95% control of weeds in field trials (Biological Control of the Weed Sesbania with Colletotrichum Truncatum 2002).

Chemical Control
Various herbicides have proved to be effective in controlling sesbania. One such method includes spraying 2,4-D with a boom sprayer at the rate of three/quarter pint per acre. The plants can also be wicked with Roundup or Rodeo (Vegetation Management Guideline Sesbania 2001).

Another chemical that has had success is propanil or Stam. The Stam 3+3 method (Stam is used twice at 3 quarts per acre) seems to work best. Blazer is another herbicide that works well against sesbania. Grandstand is a good, low-cost broad-leaf herbicide. It works best tank mixed with about a quart of Stam (Kendig 2003).

Two herbicides registered for use will help manage broadleaf weeds and sedges. Research indicates that Permit has the potential to injure rice when applied pre-emergence. Therefore, Permit applications should be limited to post-emergence. The control of sesbania taller than 8 inches or after permanent flood has been inconsistent. (Williams et al 2001).

Regiment belongs to the sulfonylurea herbicide family, which includes Londax. Regiment is slow-acting and usually takes two to three weeks to kill weeds. However, Regiment stops weed growth within a few hours of application. Because of injury potential, Regiment application to rice before the three-leaf stage is not recommended. Another strength is its ability to control alligatorweed when tank-mixed with Aim. (Williams et al 2001).

11.5 Chinese Privet

Chinese Privet (Source:invasives.org)

Chinese Privet (*Ligustrum sinense*) was introduced from China in the 1800s. It is a semi-evergreen shrub growing to 30 feet in height. Leaves are opposite in two rows and at right angles to the stem. Panicles of white flowers open from April through June followed by ovoid drupes formed as pale green and ripening to dark purple, almost black in late fall. The trunks of these shrubs usually branches near the ground and has a smooth gray appearance. Privet is shade tolerant and forms dense thickets in bottomlands and along boundary lines. Reproduction is by root sprouts as well as seed which are spread abundantly by birds and other animals. Very few plants can grow under the dense vegetation of these shrubs. (Cook 2005)

Management

The most important aspect of controlling privet is managing sprouting that often occurs subsequent to initial control. Control methods that remove or damage aboveground stems, such as mechanical cutting or prescribed burning, will likely cause sprouting. Subsequent monitoring and repeated treatments may be necessary to eliminate sprouting stems.

Mechanical Control

Seedlings can be removed by hand-pulling. When hand-pulling seedlings, the entire root system must be extracted to prevent sprouting. Established seedlings become increasingly difficult to hand-pull because of a strong root system. Mowing or cutting can reduce the spread of privet by preventing seed production. Repeated cutting may eventually eradicate privet. Cutting close to ground level and applying herbicides to the cut stumps may control larger stems (see below). Cutting stems without accompanying herbicide treatment will likely promote growth from sprouting. Even with repeated follow-up cutting, mechanical control alone may be difficult.

Effectiveness of prescribed fire to control privet may vary. Fire can kill aboveground portions of Chinese privet. Due to the ability of privet to sprout following damage from fire, persistent annual burning will likely be required for local eradication. (Miller 2005)

Biological Control:
There are currently no biological controls for Chinese privet.

Chemical Control:
Painting cut stumps with herbicides can often effectively control invasive privet. Areas where this method may be particularly desirable include sparse infestations of large stems, places where stems are concentrated, such as fence lines, or habitats where the presence of desirable native species precludes foliar application. Foliar spraying can also be effective, particularly for dense populations. Apply a glyphosate herbicide solution or Arsenal AC solution in water with a surfactant to thoroughly wet all leaves in August to December. For stems too tall for foliar sprays, apply Garlon 4 as a solution in commercially available basal oil, diesel fuel, or kerosene with a penetrant (check with herbicide distributor) to young bark as a basal spray. Alternatively, cut large stems and immediately treat stumps with Arsenal AC, or Velpar L as solutions in water with a surfactant. When safety to surrounding vegetation is a concern, immediately treat stumps and cut stems with a glyphosate herbicide or Garlon 3A as solutions in water with a surfactant. (Miller 2005)

11.6 Autumn Olive

Autumn olive (*Eleagnus umbellata*) was introduced from China and Japan in 1830 and was widely planted for wildlife habitat improvement. This deciduous bush grows up to 20 feet in height, has silver undersides and produces red berries in the fall. Autumn olive prefers dryer sites and is a shade tolerant species that forms dense stands that grow at the expense of other species. (Miller 2004).


Autumn Olive (Source:wikipedia.org)

Management
The most effective control against autumn olive is early detection and detection by annually monitoring for small plants and hand pulling to prevent seed production. Cutting and burning stimulate sprouting. Repeated cutting over several consecutive years will reduce plant vigor and

may prevent spread. The combination of cutting and the use of herbicide are the most effect means of control.

Mechanical Control:
Seedlings and small plants should be hand pulled when the soil is moist. Be sure to remove the entire plant including the roots since new plants can sprout from the root fragments. It is difficult to pull the entire root system. Larger plants should be cut off from the main stem and treated with herbicide.

Biological Control:
Currently, there are no known biological control methods. (Invasive Plant Information Sheet - Autumn Olive)

Chemical Control:
Apply Arsenal AC or Vanquish as solutions in water with a surfactant to thoroughly wet all leaves in April to October (can damage trees with roots in area). For stems too tall for foliar sprays, apply a solution of Garlon 4 in commercially available basal oil, diesel fuel, or kerosene with a penetrant (check with herbicide distributor) to young bark completely around the trunk up to 16 inches above the ground. Or, cut large stems and immediately treat stumps with a solution of a glyphosate herbicide (safe to surrounding trees) or Arsenal AC or Chopper (both will damage trees with roots in treated zone) in water with a surfactant. (Miller 2002)

11. 7 Multiflora Rose


Multi-flora Rose (Source:UNH.edu)

Multiflora rose (*Rosa multiflora*) was introduced from Asia and planted as an ornamental, as living fences for livestock containment, and for wildlife habitat. Multiflora rose is a deciduous climbing, arching, and or trailing shrub that grows 10 feet tall. Distinguishing features are the clustered white flowers with yellow anthers, pinnately compound leaves, sharp thorns and red rose hips in the fall. This species spreads by root stems, sprouts and seed dispersal by animals. Thickets of multiflora rose forms small and large infestations that often climb trees and exclude other desired plants and hinder site management. (Miller 2004)

Management

Young plants may be pulled by hand. Mature plants can be controlled through frequent, repeated cutting or mowing. Several contact and systemic herbicides are also effective in controlling multiflora rose. Follow-up treatments are likely to be needed. Two naturally occurring biological controls affect multiflora rose to some extent: a native fungal pathogen (rose-rosette disease) that is spread by a tiny native mite and a non-native seed-infesting wasp, the European rose chalcid. Native alternatives to Multiflora rose include common blackberry (*Rubus allegheniensis*), swamp rose (*Rosa palustris*), flowering raspberry (*Rubus odoratus*), and pasture rose (*Rosa carolina*). (Multiflora Rose - Plant Invaders of Mid-Atlantic Natural Areas, 2002)

Mechanical Control:

Mechanical and chemical methods are currently the most widely used methods for managing multiflora rose. Frequent, repeated cutting or mowing at the rate of three to six times a year per growing season, for two to four years has proven effective at achieving mortality of multiflora rose. In high quantity natural communities, cutting of individual stems plants is preferred to mowing to minimize site disturbance.

Biological Control:

Biological control is not yet available for the management of multiflora rose. However, researchers are investigating several options, including a native viral pathogen (rose-rosette disease), which is spread by a very tiny mite and a seed-infesting wasp, the European rose chalcid. An important drawback to the rose-rosette fungus and the European rose chalcid is their potential impact to other rose species and cultivators.

Chemical Control:

Various herbicides have been used successfully in controlling multiflora rose but, because of the long-lived stores of seeds in the soil, follow up treatments are usually necessary. Application of systemic herbicides (e.g. glyphospate) to freshly cut stumps may be the most effective methods, especially if conducted late in the growing season. Plant growth regulators may be been used to control the spread of multiflora rose by preventing fruit set. (PCA Fact Sheet – Multiflora Rose)

11.8 Japanese Honeysuckle

Japanese honeysuckle (*Lonicera japonica*) was introduced from Japan in the 1800's and planted as am ornamental and a deer browse. It is the most commonly occurring invasive plant in the southeastern United States. Japanese honeysuckle is semi-evergreen woody vine with opposite branches and leaves. It is a high climbing vine that can trail up to 80 feet. The fragrant stalked flowers are in bloom from April to August. Fruits and seeds are produced from June to March in the form of nearly spherical green berries, which turn black as they ripen. (Miller 2005)

Management

Japanese honeysuckle produces long vegetative runners that develop roots where stem and leaf junctions come in contact with moist soil. Underground stems help establish and spread the plant locally. Long distance dispersal is by birds and other wildlife that readily consume the fruits. Several effective methods of control are available for Japanese honeysuckle, including chemical and non-chemical, depending on the extent of the infestation and available time and labor.

Japanese Honeysuckle (Source:invasives.org)

Mechanical Control:

Repeated pulling of the entire vine and root system may be effective for small patches. Monitor frequently and remove any new plants. Cut and remove any twining vines to prevent them from girdling and killing shrubs and other plants. Mowing large patches may be useful of repeated regularly but is most effective when combined with herbicide application. Mow at twice a year, first in mid-July and again in mid-September. Burning removes above ground vegetation but does not kill the underground rhizomes, which will continue to sprout.

Biological Control:

No biological control agents are currently available for Japanese honeysuckle.

Chemical Control:

In moderate cold climates, Japanese honeysuckle leaves continue to photosynthesize long after most other plants have lost their leaves. This allows for application of herbicides when many native species are dormant. However, for effective control with herbicides, healthy green leaves must be present at application time and temperatures must be sufficient for plant activity. Several systemic herbicides (e.g., glyphosate and triclopyr) move through the plant to the roots when applied to the leaves or stems and have been used effectively on Japanese honeysuckle. Follow the label guidelines. (PCA Fact Sheet –Japanese honeysuckle)

11.9 Kudzu

Kudzu (*Pueraria montana*) was introduced into the United States in 1876 at the Philadelphia Centennial Exposition where it was promoted as a forage crop and an ornamental plant. It is a deciduous woody leguminous vine that grows 30 to 100 feet long. Distinguishing features include

three-leaflet leaves, yellow-green stems with erect golden hairs, lavender pea-like flowers, and hairy flattened seedpods. Colonizes by vines rooting at nodes and by wind, animal, and water-dispersed seeds. Seed viability is generally low. Kudzu grows rapidly forming dense mats of vegetation that overwhelm all other plant species including tall trees. Kudzu requires direct sunlight for rapid growth.

Management

With a large root system packed with starch and aggressive growth habit, eradication of kudzu requires persistent treatment. Several strategies can be employed to eradicate kudzu, including herbicides, prescribed burning, mowing, and livestock grazing. When selecting control strategy consider restraints, which may prevent broadcast applications of herbicides, use of tractors to spray, or mow, and the presence of desirable vegetation in the patch. Because kudzu can reach depths of four feet or greater, the thick mat of vines and leaves can hide gullies, ditches, logs, wells and other hazards. Carefully check the site after a prescribed burn, or in winter or early spring when the leaves have fallen to determine if obstacles to application exist.

Kudzu (Source:alabamacooperative.com)

Mechanical Control:

Repeated mowing can weaken and ultimately control kudzu. Mowing is generally a good first step towards control, provided it can be done without risk to the tractor operator. Close mowing reduces the tangle of leaves and vines and treatment of re-growth is much easier accomplished. Thick mats of vines are often difficult to mow with light-duty rotary mowers. Flail mowers with horizontal blades cutting in a chopping action may operate more effectively.

Using kudzu as forage for cattle and other livestock was an early promotion with its introduction into the U.S. Kudzu hay has excellent nutritional value and is palatable to livestock. To control kudzu by grazing it is necessary to adequately fence the entire patch and to provide sufficient additional grazing areas on which to rotate livestock as the kudzu is grazed down. Only by repeatedly grazing the re-growth over successive growing seasons will the root reserves of starch be depleted.

Prescribed fire can be used to consume vines and leaves to permit inspection of the site and to determine the size and density of the kudzu root crowns. Burning should be done in the winter or

early spring. Using spring burns limits exposure of bare soil to winter rains minimizing soil erosion on steep slopes. Prescribed burning is useful in promoting seed germination prior to a herbicide treatment. (Moorhead D.J. and Johnson K.D. 2005)

Biological Control:
Efforts are being organized by the U.S. Forest Service to begin a search for biological control agents for kudzu.

Chemical Control:
Apply foliar sprays of Tordon 101 as a solution in water or Tordon K as a solution in water with a surfactant to wet foliage until run-off in July to October for successive years (Tordon herbicides are Restricted Use Pesticides). Spray foliage of climbing vines as high as possible. When using Tordon herbicides, rainfall must occur within 6 days after application for needed soil activation. The soil activity of Tordon herbicides can kill or damage plants having roots within the treated area. Other options provide partial control and may be useful in specific situations. Apply Escort in water to foliage from July to September. For areas where minimal injury to other plants is desired, apply Transline as a solution in water with a surfactant to thoroughly wet all leaves and stems in July to September. A glyphosate herbicide or Garlon 4 as solutions in water with a surfactant can be used during the growing season with repeated applications. Follow product application instructions. (Miller 2002)

11.10 Wisteria (Chinese and Japanese)

Wisteria (*Wisteria sinensis* and *W. floribunda*) were introduced from Asia in the early 1800's as an ornamental. Both varieties of wisteria were used on porches across the south. The climbing woody vines can reach up to 70 feet long. They are deciduous vines with showy fragrant lavender pea-like flowers in the spring. The leaves are alternate, and pinnately compound. Wisteria spreads by rooting at nodes and water-dispersal of seeds that form in large, velvety leguminous pods. Forms dense growth capable of killing trees and excluding other plant species.


Wisteria (Source:wikipedia.org)

Management

The only practical methods currently available for control of exotic wisterias are mechanical and chemical. Cut climbing or trailing vines as close to the root collar as possible. This technique, while labor intensive, is feasible for small populations, as a pretreatment for large impenetrable infestations, or

for areas where herbicide use is not desirable. Wisteria will continue to re-sprout after cutting until its root stores are exhausted. For this reason, cutting should begin early in the growing season and, if possible, sprouts cut every few weeks until autumn. Cutting will stop the growth of existing vines and prevent seed production. However, cut vines left coiled around trunks may eventually girdle trees and shrubs as they continue to grow and increase in girth. For this reason, the vines should be removed entirely or at least cut periodically along their length.

Mechanical Control:
Grubbing, removal of entire plants from the roots up, is appropriate for small initial populations or environmentally sensitive areas where herbicides cannot be used. Using a pulaski, weed wrench or similar digging tool, remove the entire plant, including all roots and runners. Juvenile plants can be hand pulled depending on soil conditions and root development. Any portions of the root system not removed may re-sprout. All plant parts (including mature fruit) should be bagged and disposed of in a trash dumpster to prevent reestablishment. (PCA Fact Sheet – Wisteria)

Biological Control:
No biological control agents are currently available for wisteria.

Chemical Control:
Apply Tordon 101, Tordon K, or Garlon 4 as solutions in water with a surfactant to thoroughly wet foliage until run-off in July to October for successive years (Tordon herbicides are Restricted Use Pesticides). Spray foliage of climbing vines as high as possible. When using Tordon herbicides, rainfall must occur within 6 days after application for needed soil activation. The soil activity of Tordon herbicides can kill or damage plants having roots within the treated area. Other options provide partial control and may be useful in specific situations. For areas where minimal injury to other plants is desired, apply Transline as a solution in water to thoroughly wet all leaves and stems in July to August. Apply a glyphosate herbicide as a solution in water with surfactant to wet all leaves in September to October with repeated applications. (Miller 2002)

11.11 Common Reed

Common reed is a tall grass that inhabits wet areas like brackish and freshwater marshes, riverbanks, lakeshores, ditches and dredge spoil areas. Native and introduced forms of Phragmites occur in the United States. Researchers believe that introduced European forms are the aggressive invasive that have replaced much of our native reed. Common reed threatens by displacing native plants and forming monocultures in otherwise biologically diverse natural wetlands. It spreads by seed and strong vegetative growth and is very difficult to control once established.

Management
Control of Phragmites is difficult, time-consuming, labor intensive and costly. Cutting, burning and chemical herbicides are all used to control it under various circumstances. Researchers have recently begun investigating the potential for biological control of this plant.

Mechanical Control:

This type of control (e.g., repeated mowing) may be effective at slowing the spread of established stands but is unlikely to kill the plant. Excavation of sediments may also be effective at control but if small fragments of root are left in the soil, they may lead to reestablishment.

Common Reed aka Phragmites (Source:alabamaextension.org)

Prescribed burning after the plant has flowered, either alone or in combination with herbicide treatment, may also be effective. Burning after herbicide treatment also reduces standing dead stem and litter biomass, which may help to encourage germination of native plants in the following growing season. Plants should not be burned in the spring or summer before flowering as this may stimulate growth.

Biological Control:

At this time no means of biological control are available in the United States for treating Phragmites infestations.

Chemical Control:

Glyphosate-based herbicides (e.g., Rodeo®) are the most effective control method for established populations. S. C. Department of Natural Resources has also reported good success with Habitat®. If a population can be controlled soon after it has established chances of success are much higher because the below-ground rhizome network will not be as extensive. Herbicides are best applied in late summer/early fall after the plant has flowered either as a cut stump treatment or as a foliar spray. It is often necessary to do repeated treatments for several years to prevent any surviving rhizomes from re-sprouting. When applying herbicides in or around water or wetlands, be sure to use products labeled for that purpose to avoid harm to aquatic organisms. (PCA Fact Sheet – Common Reed)

11.12 Tree of Heaven

Tree of heaven (*Ailanthus altissima*) was introduced from Europe as an ornamental. It is a rapid growing deciduous tree, which reaches 80 feet tall, and 6 feet in diameter and forms thickets and dense stands. It tolerates dense shade and flooding. Leaves are alternate and pinnately compound.

The tree flowers April to June in long clusters, some measuring 20 inches, of greenish flowers. Persistent clusters of wing-shaped fruit can be seen on the female trees through the winter into February. Ailanthus spreads by root sprouts and wind and water born seed.

Management

Because of the high seed germination rate and the vegetative reproduction, ailanthus is difficult to irradicate and requires persistent monitoring and treatment to control this species. Most effective control is usually accomplished through the use of herbicides.

Tree-of-Heaven (Source:nature.org)

Mechanical Control

Cutting or pulling stem and vegetation will usually respond by resprouting multiple suckers from stumps and broken roots. Entire plants must be removed leaving no parts of the root or root fragments. If mechanical control is attempted targeting female trees decreases the reproduction rate. Choosing to remove the plants when soil is moist and early in the growing season may produce the best mechanical result.

Biological Control

Several fungal pathogens (*Verticillium dahliae* and *Fusarium oxysporum*) have been found in dying ailanthus. These may hold some potential for development of a biological control. (PCA Fact Sheet - Tree Of heaven)

Chemical Control

For larger trees the most effective method of control can be achieved through the careful use the of herbicides Garlon 3A or Arsenal AC with stem injection. Small trees, 6 inches or less can be treated with a basal spray of Garlon 4 or Pathfinder II at recommended dilution in a wide band around the circumference of the tree. For small trees and shrubs foliar spray can be applied July through October using Arsenal AC, Krenite S or Garlon 4 as the chemical company prescribes. Thorough wetting of the foliage is the most effective control in situations were application can be accomplished without unacceptable contact with nearby ornamental shrubs and trees. (PCA Fact Sheet - Tree Of Heaven)

11.13 Alligatorweed


Alligatorweed (Source:weedbusters.org)

Alligatorweed is a perennial herb introduced from South America. It is one of the most difficult aquatic weeds to control. It grows in a wide range of soil and water conditions. It may be found free-floating, loosely attached, rooted, emersed, or in a dry field. It generally grows as a mat of interwoven plants. The leaves are glossy, lance-shaped, 2-5 inches long, and have a distinct midrib. The leaves are opposite and the flowers white.

Management

Mechanical Control:
Successful mechanical/physical removal of this plant is extremely difficult since the plant is able to re-establish from very small pieces.

Biological Control:
Biological control efforts using insect predators brought from the plant's native region have been successful in the south. Two insects that have been established are the flea beetle (*Agasicles hygrophhila*) and the stem-boring moth (*Vogtia malloi*).

Chemical Control:
Alligatorweed grows in different situations, each requiring particular herbicide controls. Various herbicides have proven to be successful. Glyphosate herbicides are recommended because they are biodegradable. However, glyphosate is a nonselective systemic herbicide that affects all green vegetation (Invasive Alien Plant Species of Virginia, Alligatorweed). Brushoff is another herbicide suggested for terrestrial plants only (NRM Facts Pest Series, Alligatorweed 2001).

11.14 Water Hyacinth

Water hyacinth (*Eichhornia crassipes*) is a member of the pickerelweed family (Pontedericeae). The plants vary in size from a few centimeters to over a meter in height. Water hyacinth can form dense mats that interfere with navigation, recreation, irrigation, and power generation. These mats competitively exclude native submersed and floating-leaved plants, create low oxygen conditions

beneath the mats, impede water flow, and create good breeding conditions for mosquitoes (Non-Native Freshwater Plants Water Hyacinth 2002).

Management

Mechanical Control:
Mechanical controls such as harvesting have been used in such states as Florida for many years but are ineffective for large scale control, very expensive, and can't keep pace with the rapid plant growth in large water systems (Non-Native Freshwater Plants Water Hyacinth 2002).

Water Hyacinth (Source:UMNextension.org)

Biological Control:
Scientists believe that the best bet for a long-term solution is to introduce one or more natural enemies as biological controls. In the 1970's, two South American weevils (*Neochetina bruchi* and *N. eichorniae*) and the water-hyacinth borer (*Sameodes albiguttalis*) were released in the United States. These and other organisms are being deployed in more than 20 other countries, including Australia, Cuba, Egypt, Honduras, Indonesia, Malaysia, Mexico, Panama, South Africa, Thailand, Vietnam, and Zimbabwe. There have been many successes, but results have been variable and the weed continues to cause problems (Watch Out Water-hyacinth! New Jungle Enemies Are Coming 2000).

Chemical Control:
The success of herbicidal control measures has varied in effectiveness. This method of control seems to work better in controlling small infestations accessible by land or boat. The herbicides most commonly used have been 2,4-D and Glyphosate.

Many plants, both aquatic and terrestrial, are susceptible to the herbicides registered for water hyacinth control, so care must be taken when applying the chemical. Instructions on application methods should be read and understood before using the chemical (Dyason 1999).

11.15 American Lotus

American Lotus (*Nelumbo lutea*) can be found in muddy, shallow waters such as lake margins or in water as deep as six feet. Its leaves may be emergent above the water or floating on it. The flowers are yellow and extremely large (typically six inches wide). American lotus leaves are circular, and do not have a "cut", as do water lily leaves.

Management

Mechanical Control:
Repeated cutting of leaves has been effective in controlling American lotus. Cutting should begin before the first flower buds open in June. Care should be taken to remove the majority of the cut leaves to avoid depleting the water of oxygen as they decay (Floating Leaf Plant Control in Missouri Lakes and Ponds 1999).

American Lotus (Source:svtweb.org)

Exposing sediments to prolonged freezing and drying during the months of December, January, and February can be effective in controlling certain aquatic plants, if exposure lasts 2-4 weeks. Drain no more water than necessary to expose the unwanted plants and always leave at least eight feet of water in the deepest part of the pond to reduce the chance of a winter fish kill (Floating Leaf Plant Control in Missouri Lakes and Ponds 1999).

Biological Control:
Grass carp do not effectively control American lotus. The waxy coating (cuticle) and thick, fibrous stems of these plants make them difficult for grass carp to eat (Floating Leaf Plant Control in Missouri Lakes and Ponds 1999).

Chemical Control:
RODEO (Glyphosate) is labeled by its manufacturer, Monsanto, for use on American lotus. Refer to the product label for specific instructions. For best results apply herbicides in early spring and early summer, when plants are growing rapidly (Floating Leaf Plant Control in Missouri Lakes and Ponds 1999).

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APPENDIX 1:

Wood Ducks and Artificial Habitat Creation

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Wood Ducks and Artificial Habitat Creation

The wood duck is the only migratory duck to breed in all geographic locations of South Carolina. Wood ducks begin the search for appropriate nesting sites in late winter. Nest initiation typically occurs from late January through July; however, the peak of nesting activity takes place in late March through April. Wood duck hens incubate their eggs for approximately 28 days. Predation by raccoons, largemouth bass and wading birds as well as other species represents a natural aspect of wood duck ecology. Wood duck breeding habitat is characterized by predominantly woody vegetation including shrub and larger trees where there is a ratio of 50 percent open water to 50 percent vegetation. Mature shrubs, rising approximately two feet above the water surface with overhanging branches, provide space beneath the canopy to allow ducks to swim freely, as well as providing optimum escape cover. Important components of the shrub community include buttonbush, willows, and alder. Although natural cavities commonly occur in forested wetlands frequented by wood ducks, the density of cavities providing suitable nesting sites may be limited. Suitable natural cavities include the following general characteristics: a tree with DBH of at least eleven inches, a four to twelve inch horizontal entrance hole located at least six feet above the water or ground surface, a cavity depth of four to 78 inches and a cavity diameter of eight to 15 inches. Suitable natural cavities cannot contain water or be utilized by competing species such as bees, hornets, and squirrels. In large, coastal plain river swamps natural cavities frequently occur in bald cypress; whereas in upland habitat throughout the state cavities often occur in various species of oaks, and hickories as well as other hardwood trees.

In addition to shrubs and a limited number of trees, herbaceous emergent vegetation is a significant component of suitable brood rearing habitat. An approximate ratio of 75 percent cover (40 percent emergents, 30 percent shrubs and 5 percent trees) to 25 percent open water is believed to provide optimum brood rearing conditions.

Wood ducks utilize a variety of habitat types during the fall and winter seasons. One of the most important habitats is semi-permanently flooded bottomland hardwood areas where ducks feed extensively on abundant supplies of acorns and other hard mast crops. In freshwater coastal marshes, wood ducks feed on the seeds of smart weeds, Asiatic dayflower, soft-stem bulrush, arrow-arum, white water-lily and other natural occurring grasses and herbs.

The installation of wood duck nest structures is a principal management technique utilized to enhance local wood duck production (see Wood Duck Box Construction Section). It is important that the existing wood duck boxes are properly maintained. Annual box maintenance including replacement of nesting material is strongly recommended. In order to evaluate the effectiveness of nest box programs, boxes should be checked monthly during the nesting season and maintain detailed records of nesting activities maintained.

Wood ducks utilize many different habitat types throughout the year to meet various biological requirements. For example, ponds with abundant shrubs and persistent herbaceous vegetation

provide excellent brood rearing and roosting habitat but may be utilized only on a limited basis as fall and winter feeding sites. Conversely, shallow ponds with herbaceous seed producing plants and overhanging mast producing trees provide excellent winter feeding habitat but are less valuable as brood area. Managed freshwater impoundments provide for excellent wood duck habitat as well. Wood duck habitat requirements should be considered in timber management plans involving forested wetlands. Adequate densities of species representing important habitat components (bald cypress, oaks and willows) should be maintained throughout stands (Prevost).

Wood Duck Box Management and Construction

The installation of wood duck nest structures is a principal management technique utilized to enhance local wood duck production. Wood ducks are one of the only few resident breeding waterfowl species in South Carolina that prefer to nest in cavities. Wood ducks easily utilize nest boxes where natural cavities may not occur.

Wood duck boxes should be erected immediately adjacent to open water, and in areas that are protected from predators. It is essential that predator shields be installed below the nest box to protect from climbing predators. Preparing for the installation of a nest box requires some site maintenance before and after installation has occurred. Low, overhanging limbs or nearby small trees within 48" of the nest box should be trimmed to prevent the overhead approach of predators.

Nest boxes should be placed in shallow or permanent water at least 48” deep with a good mix of open water and emergent plant cover that will not hinder future maintenance. All nest boxes should be checked each winter prior to the nesting season to replace nesting material, check the tightness of the predator guard and secure the lid and screen door latch.

Be sure to adequately space nest boxes to prevent intraspecific competition. Wood ducks are not a colonial nesting species, and evolved as solitary nesters in forested wetlands where natural cavities were widely dispersed; therefore, nest boxes should attempt to mimic nature.

The optimal time to erect nest boxes is prior to the start of the nesting season, which can vary between December and March. Nest boxes should be constructed on wooden or metal poles. Wood ducks do not carry nesting material into the nest, so be sure to place 3"- 8" of wood shavings in the box to insulate nests when cleaning out boxes prior to the start of nesting season.

Rough sawn, cypress, pine or cedar lumbers are excellent choices as a nest box building material. If smooth or dressed lumber is used, be sure to tack a piece of mesh screening to the inside under the entrance hole. This will enable day-old ducklings to climb up and exit with the brood when the hen calls from the water below.

Specifications for Wood Duck Box Construction
Materials

- Rough cut cedar, yellow pine or cypress boards 1" thick are preferred, but exterior plywood is an acceptable substitute. DO NOT use treated lumber.
- Weather resistant latch on the side flap that opens for maintenance (ex. 2" zinc hook & eye)
- Zinc coated 1 ½" inch wood screws

Sides (10" wide)

- One side with pivoting flap
- Flap beveled for opening 8 ½" above the bottom
- Flap beveled at top
- Pivot screws 16" above the bottom
- Use countersunk wood screws

Bottom

- Recessed at least 1/4" with five holes at least 3/8" diameter for drainage

Top (12" wide)

- Overhang front by 1½"
- Use countersunk wood screws
- Bevel back cut to match back board

Front (12" wide)

- Opening cut 4" diameter circle (allows for use by WODU & BBWD)
- Opening 4" from top of front board
- Use countersunk wood screws
- Bevel top cut to match top board

Back (12" wide)

- Leave 2" above and below for mounting to post with lag bolts

Use countersunk wood screws

Predator Guard

- Use 26-29 gauge aluminum flashing or galvanized metal, 36" wide
- See figure for specifications on inverted cone design

Post

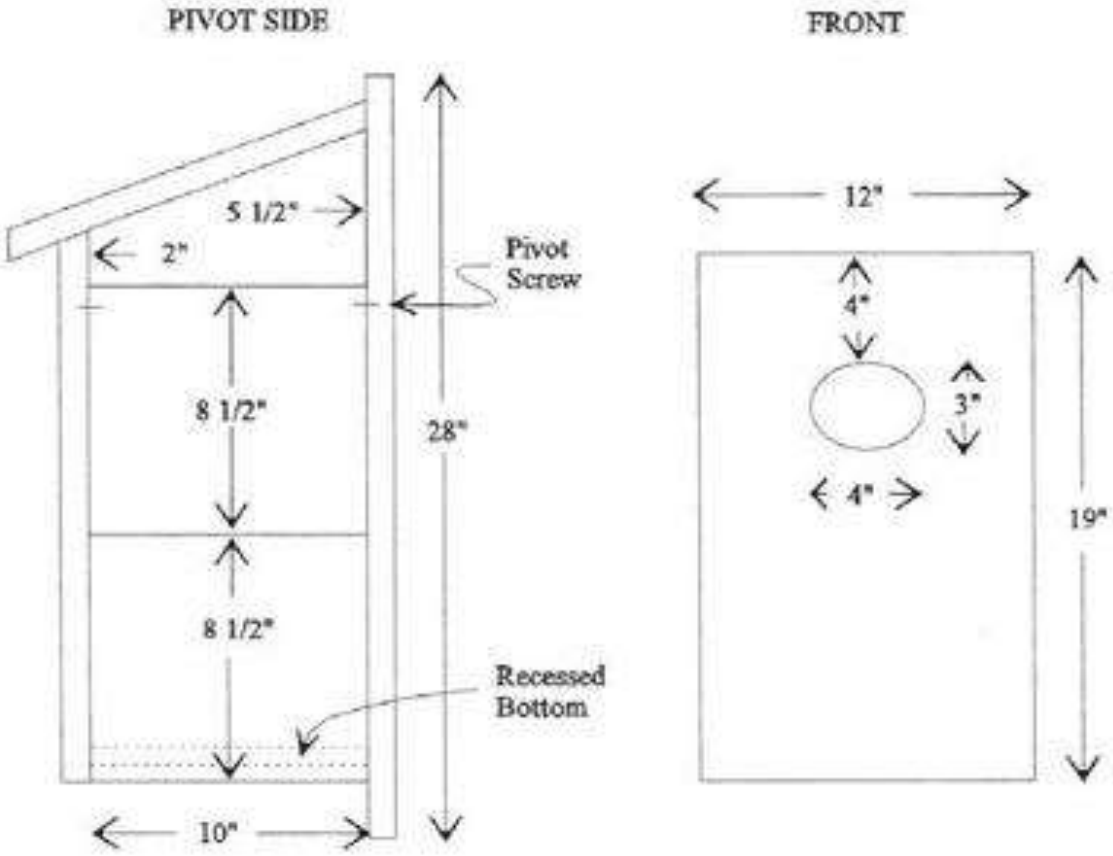
- Pressure treated 4" by 4" wooden post, various lengths depending on water depth

Guidelines for Mounting Wood Duck Nest Boxes

1. Boxes should not be hidden. Boxes should be placed so that there is a 40" flight line in front of the box that is free from obstructions such as tree limbs or bushes.

2. Using a 4"x4"x10' treated wooden post, the post should be buried deep enough (24-36") to support the weight of the box and secure enough to support monitoring activities. If using lag bolts, drill a hole for the lag bolts used to mount the box. Install the post into the ground.
3. Slip the predator guard over the post, but do not nail to post. Mount the box onto the post; then nail the predator guard in place, just below the box.
4. When attaching the box to the post, use 2, 3"- 5" lag bolts or 4, 2"- 3" deck screws instead of nails. Bolts and screws make it easier to remove boxes in the future for replacement or repair as necessary.
5. Attach a 2" hook and eye to the base of the door to ensure box remains shut
6. Position the box as nearly vertical as possible, with a very slight tilt forward. The tilt will enable ducklings to climb out more easily. Add wood shavings to a depth of 4"- 8" in the bottom of the box.
7. Boxes should be placed at the rate of 1 per acre in suitable brood-rearing habitat.
8. Boxes should be placed so that the bottom of the box is at least 4 feet above the high water mark.
9. Do not place more than one box per post, as this may increase the possibility of "dump nesting."
10. No box should be mounted without a predator guard or without the intention of maintenance and monitoring.
11. If multiple boxes are used on a property, livestock ear tags can be purchased from many farm supply stores and used to number the boxes.

WOOD DUCK BOX SPECIFICATIONS



PREDATOR GUARD SPECIFICATIONS