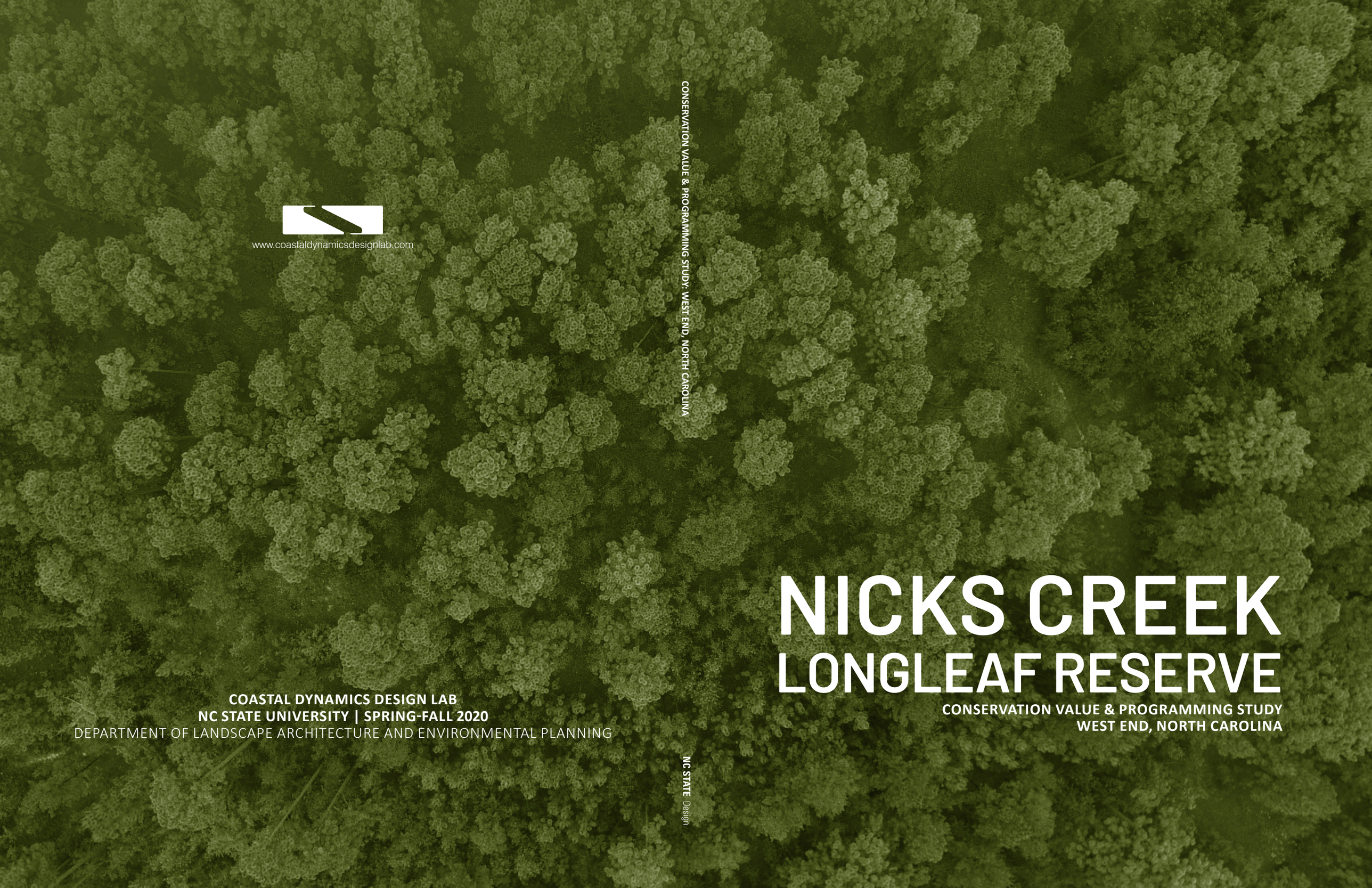

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CONSERVATION VALUE & PROGRAMMING STUDY: WEST END, NORTH CAROLINA

NICKS CREEK
LONGLEAF RESERVE

CONSERVATION VALUE & PROGRAMMING STUDY
WEST END, NORTH CAROLINA

COASTAL DYNAMICS DESIGN LAB
NC STATE UNIVERSITY | SPRING-FALL 2020
DEPARTMENT OF LANDSCAPE ARCHITECTURE AND ENVIRONMENTAL PLANNING

NC STATE Design

www.coastaldynamicsdesignlab.com

COASTAL DYNAMICS DESIGN LAB

CONSERVATION VALUE & PROGRAMMING STUDY: WEST END, NORTH CAROLINA

This study was funded by Pineforest Management, LLC and was completed in cooperation with Southern Conservation Trust and in collaboration with faculty and students from NC State's Department of Landscape Architecture and Environmental Planning.

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Unless stated otherwise, all photographs are by the publication team.

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NC STATE College of Design

COLLEGE OF DESIGN

NC State University's College of Design teaches design thinking in an interdisciplinary environment that makes sense of the world for the benefit of the public. The college integrates practical, ethical, and aesthetic thought and action to enhance the meaning and quality of life through the creation of knowledge informing the critical study of artifacts and places.

The college gathers creative minds from around the world whose interests and expertise span a variety of disciplines. This inspiring and elite group of faculty prepare designers to go out and shape the world.

Now more than ever, design plays a major role in the development of everything from branding to product development and even business practices and procedures. Good design is necessary. The size and shape of mobile devices; the animation we see on the big screen; the materials used in the buildings we enter—design touches everything around us.

In response to an ever-expanding global interest in all disciplines of design, the college's curriculum is customized to incorporate relevant practices that prepare students for a career in design. Effective design requires attention and sensitivity to the social, economic, political, cultural, and behavioral understanding of the environment and people. Each program within the College of Design is intended to develop the designer's perception, knowledge, skills, and problem-solving abilities to develop design solutions for public interest and to serve the needs of users.

The College of Design offers comprehensive undergraduate and graduate degrees in architecture, art + design, graphic design, industrial design, and a graduate degree in landscape architecture. In addition, the College offers a Ph.D. in Design. A selective admissions process ensures a highly motivated and diverse design community. This unique interdisciplinary learning environment ensures that students learn to collaborate with others and see things from new and diverse perspectives.

COASTAL DYNAMICS DESIGN LAB

The mission of the Coastal Dynamics Design Lab (CDDL) is to organize and lead transdisciplinary research and design teams to address critical ecological and community development challenges in vulnerable coastal regions, with a concentrated focus on the Mid-Atlantic seaboard.

Too often, research and design are fragmented into discrete scientific, academic, and professional disciplines. The CDDL seeks to transform this compartmentalized approach by coupling designers—architects, landscape architects, graphic designers, and engineers—with scientists and local stakeholders, to create innovative, sustainable, adaptable, and resilient design solutions that address the environmental and human needs of communities.

The CDDL operates within the NC State University College of Design and has formed strategic partnerships with experts in the College of Engineering, the College of Natural Resources, and the UNC Coastal Studies Institute. Additional collaborators include planning experts from the East Carolina University Department of Geography, Planning, and Environment, the University of North Carolina Coastal Hazards Center, and numerous professional design firms.

In addition to the staff members pictured below, the following students aided in the completion of this report:

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Many thanks to Julie Moore (retired US Fish & Wildlife), Jeff Marcus (The Nature Conservancy), Scott Pohlman (NC Natural Heritage Program), and the Sandhills Conservation Partnership for contributing time and expertise in the development of this report. Additional thanks to Melvin Ezzell, Jesse Woodsmith, and Katie Pace for their input and guidance.

PURPOSE OF THE REPORT

INTRODUCTION

The purpose of this report is to assess and document the conservation values of the approximately 1600-acre tract located between Highway 211 and Highway 73 in West End, North Carolina (Moore County). The information herein describes the approaches to conservation planning and programming that support the responsible and sustainable stewardship of this property's unique and high-value land and water assets.

Landscape planning approaches that align conservation policies with management best practices guided the process. The project team considered environmental, social, and economic factors within the surrounding region, including ecosystem services, transportation, infrastructure, population trends and development patterns, and recreation. The resulting analyses investigated existing site conditions; city, state and federal codes and standards; spatial and temporal socio-ecological scales; and conservation-based programmatic uses. Project objectives included:

+ Employ expertise in land and water resource management to advance conservation and sustainable design best practices.

+ Use best available research to protect natural resources and promote them as civic infrastructure assets.

+ Explore planning, design, and management strategies to identify natural areas whose highest and best use is publicly accessible open space.

+ Evaluate the importance of environmental conservation in protecting the health, safety, and well-being of the environment and society.

+ Develop assessments related to responsible and resilient land management tools and techniques to sensitively protect, restore, and encourage public access to high-value natural systems and features.

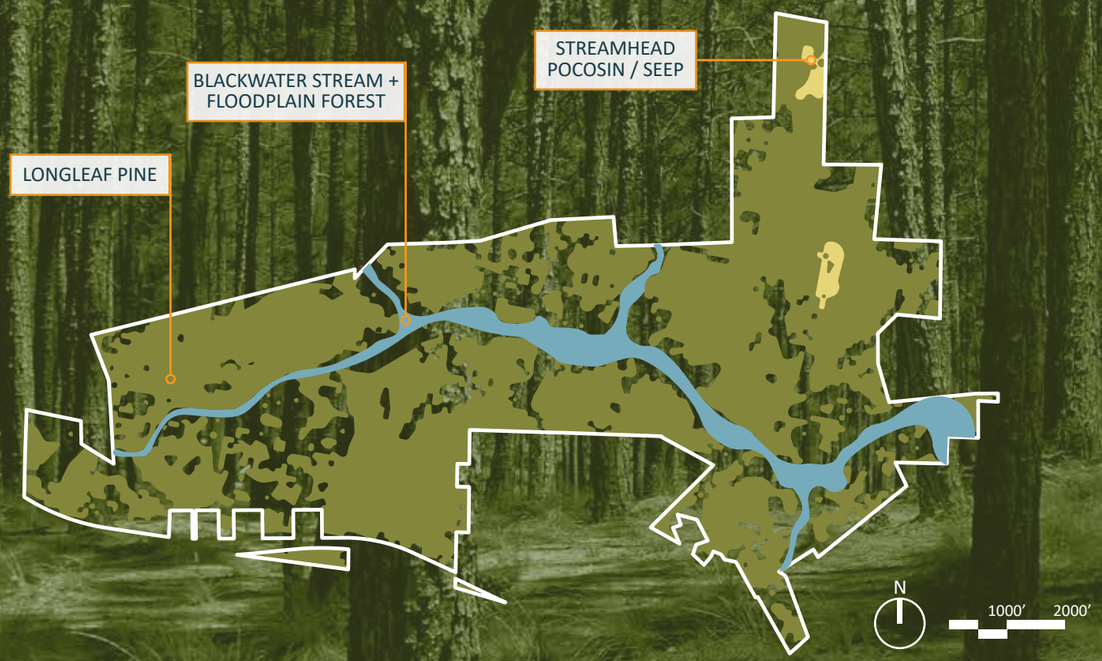
CONSERVATION VALUES

INTENT & ALIGNMENT

The following exhibits describe and illustrate the unique ecological and cultural context of the study area and highlight the elements of the site that support some of the conservation priorities of the Southern Conservation Trust: high-priority and relatively natural habitats, endangered and protected species, and high-priority watersheds. The donation of this property to the Southern Conservation Trust (SCT) offers unique opportunities and alignments with the SCT's mission, values, and conservation goals. The following analysis is intended to inform future decision-making about the conservation, programming, and public access of the study area.

RELATIVELY NATURAL

HIGH PRIORITY HABITATS



MULTIPLE SANDHILLS CONSERVATION TARGETS

The Sandhills are a physiographic region in the southeastern United States that support a range of unique species and ecological communities. Because of limited range and pressures from development, Sandhills habitats and many of the region’s endemic species are threatened or endangered. In 2004, the North Carolina Sandhills Conservation Partnership (NCSCP) authored the Site Conservation Plan for the North Carolina Sandhills and identified several conservation targets which included one species and four ecological communities. Together, these conservation targets account for about 95% of the region’s biodiversity (TNC, 2004). The goal of the Site Conservation Plan is to unify conservation objectives across the multiple NCSCP members and guide ongoing conservation efforts.

Of the four ecological communities identified as conservation targets, the study area was identified as having three, based on GAP Landfire Landcover GIS data (USGS, 2011) and on-the-ground verification. The conservation targets present on the site include Longleaf Pine Mosaic, Streamhead Pocosin/ Seep, and Blackwater Stream. Additionally, there are several historic and one current Red Cockaded Woodpecker (RCW) cluster located on the site as identified by the Natural Heritage Program. The RCW is a federally endangered, keystone species of Longleaf Pine forests that has also been identified as a conservation target by the Site Conservation Plan (TNC, 2004).

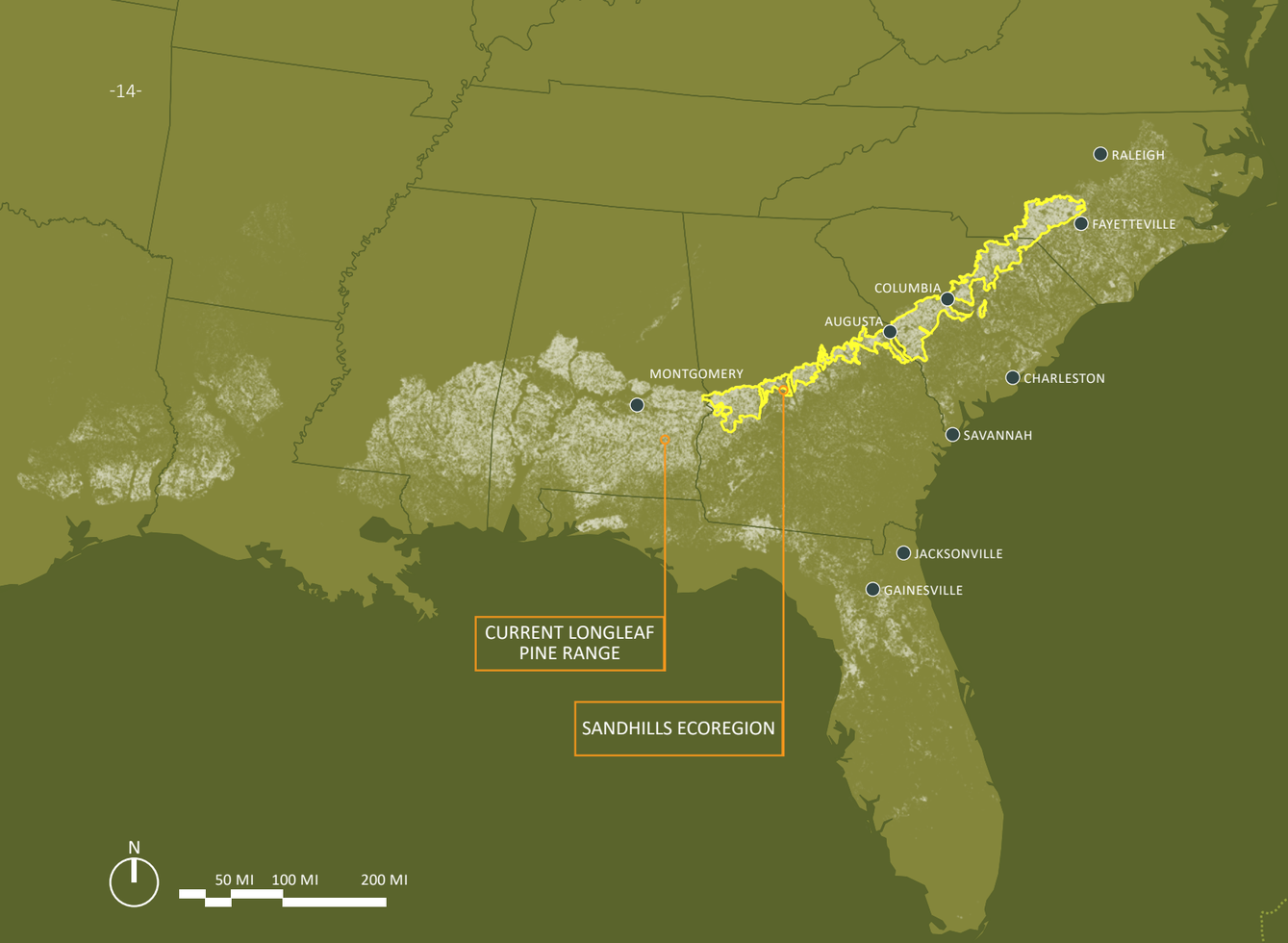
Longleaf Pine ecosystems are rated as the third most endangered ecosystem in the Southeast, and have been identified as a conservation priority by the NC Wildlife Resources Commission: “Because so few examples remain, protecting and expanding remaining examples is crucial... because these systems are likely to withstand the stresses of changing climate well, restoring more of them in the near future would produce more resilient natural landscapes” (NCWRC, 2015).

STREAMHEAD POCOSIN / SEEP

This conservation target consists of four nested communities: Canebrakes; Sandhills Seeps; Streamhead Atlantic White Cedar; and Streamhead Pocosins. They frequently occur at or near streamheads on wet soils dependent on seepage, and are susceptible to hydrologic disturbance and habitat destruction. Streamhead pocosins and seeps can provide habitat to many rare and/or endangered species including Pine Barrens Tree Frog, Eastern Arogos Skipper, Bog Spicebush, Rough-leaved Loosestrife, Sandhills Lily, Sun-Facing Sunflower, and many others (TNC, 2004).

BLACKWATER STREAM + FLOODPLAIN FOREST

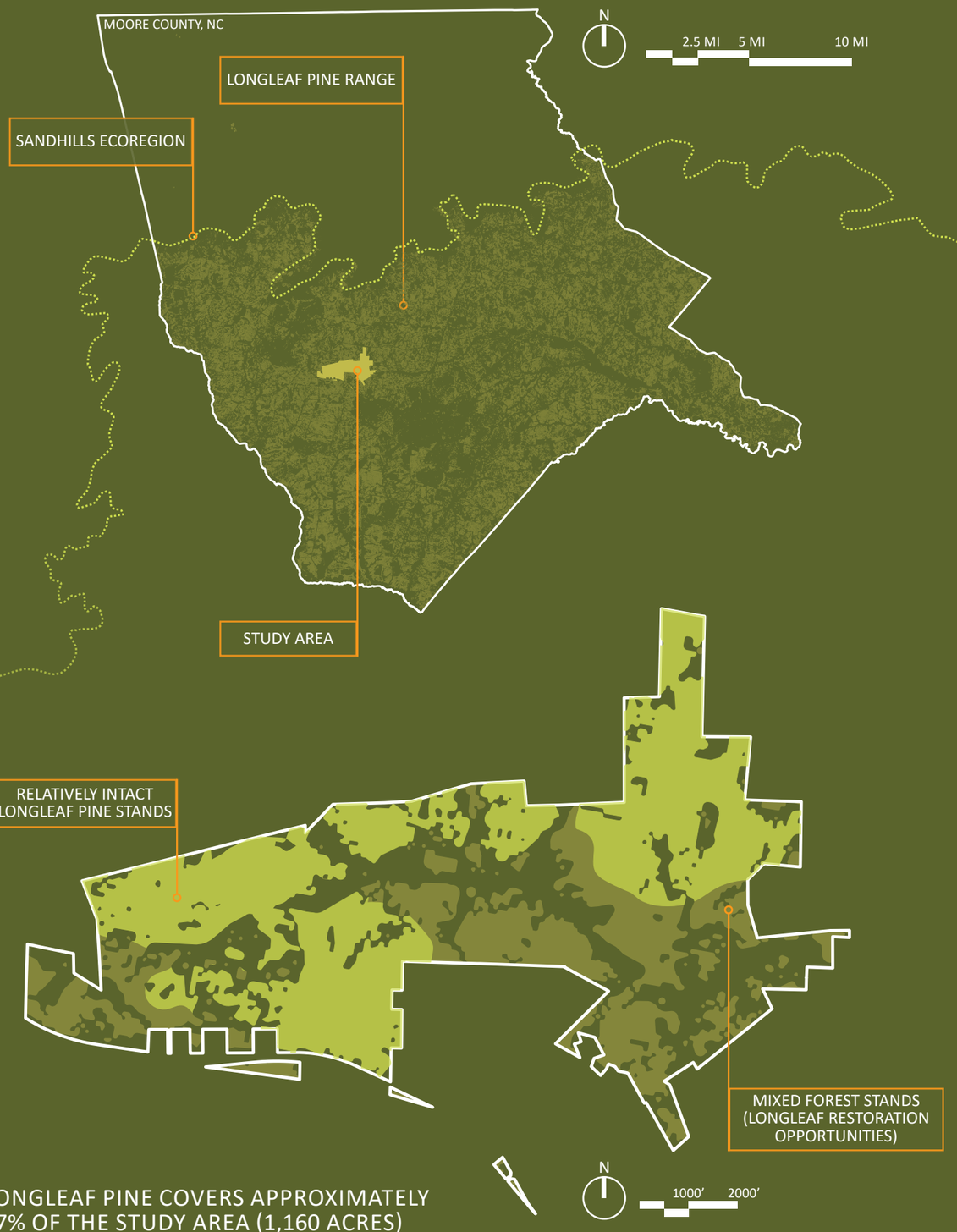
This conservation target consists of three nested communities: Beaver Ponds (and successional Sedge Meadows); Floodplain Forests; and Aquatic Communities. General characteristics of blackwater streams are sandy bottoms, slow to moderate flow rates, clear acidic water stained by tannins, and low turbidity. These areas can support wading bird rookeries, Rafinique’s big-eared bat, and various warblers, as well as myriad rare and endangered species (TNC, 2004).



REGIONAL LONGLEAF PINE DISTRIBUTION

Longleaf Pine (*Pinus palustris*) occurs only in the southeastern United States, with a historic range extending from East Texas to Maryland. Longleaf Pine were once the most abundant communities in the Coastal Plain, but the range has been significantly reduced due to encroaching development and habitat fragmentation, and ecosystem degradation from fire suppression (NCWRC, 2015). Much of the original range consisted of uninterrupted, contiguous Longleaf stands, but today only patches remain. Longleaf is especially prevalent in the Sandhills ecoregion, with higher densities of Longleaf stands occurring here as illustrated in the graphic above. In Moore County, North Carolina, the boundary of the Sandhills physiographic region aligns almost identically with the extent of Longleaf Pine stands (based on 2011 landcover data).

Longleaf composes much of the study area, totaling about 67% of the site's acreage (1,160 acres). Some of the Longleaf stands are relatively intact, with a canopy dominated by Longleaf, while other areas have mixed canopies of Longleaf, loblolly, and mixed hardwoods. These areas are good candidates for selective thinning of loblolly and hardwood species to support Longleaf restoration.



LONGLEAF PINE COVERS APPROXIMATELY 67% OF THE STUDY AREA (1,160 ACRES)

FIRE-ADAPTED ECOSYSTEMS

Longleaf Pines have developed a suite of adaptations to frequent fire which not only help them survive these conditions, but are also critical to the health of the ecosystem. These adaptations include thicker bark, large seeds/cones, timing of seed dispersal, inconsistent seeding, and slow seedling growth. Typically, these fires would have been ignited by lightning strikes, and the fallen pine needles and flammable wiregrass (*Aristida stricta*) understory would help the fire spread across large swaths of the landscape. These fires help eliminate competition from faster-growing, shrubby species and other trees, keeping the understory and midstory layers relatively open and allowing light to penetrate to the forest floor. The open understory is critical to the success and growth of wiregrass and other understory species. Longleaf Pine landscapes are so open, that botanist and explorer William Bartram noted in his 1791 book, Bartram's Travels, "the country is so good, that one may ride full gallop 20 or 30 miles on end...there being no underwood to prevent a horse from galloping freely in every direction" (Earley, 2004).

Fire suppression strategies began being implemented in Longleaf ecosystems as settlers established towns. Roads and expanding developments act as fire breaks, fragmenting large areas of forests and preventing fire started in one area from traveling across large areas of forest: "the Longleaf Pine environments were so interconnected that a large fire that ignited in Albany, Georgia, might sweep through Tallahassee, Florida four weeks later" (Earley, 2004). In fire suppressed forests, fast-growing shrubs and trees like turkey oak begin to easily out-compete Longleaf. Eventually a dense mid-story layer and closed canopy of hardwoods replaces the open Longleaf canopy, and the understory becomes shady, limiting the growth of wiregrass and other groundcovers with high light requirements. This change in plant species composition also affects vertebrate and invertebrate species that rely on the open landscape of Longleaf Pine forests.

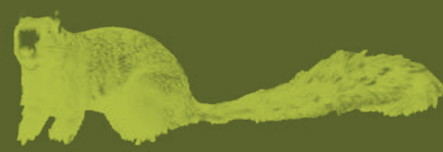
FIRE-DEPENDENT FAUNA

RED COCKADED WOODPECKER
Picoides borealis

RCWs occupy mature Longleaf Pine forests, excavating cavities in living trees. This species requires a very open understory maintained by frequent fires. Fire suppression has created unfavorable understory conditions through most of its range (Audubon, 2020).

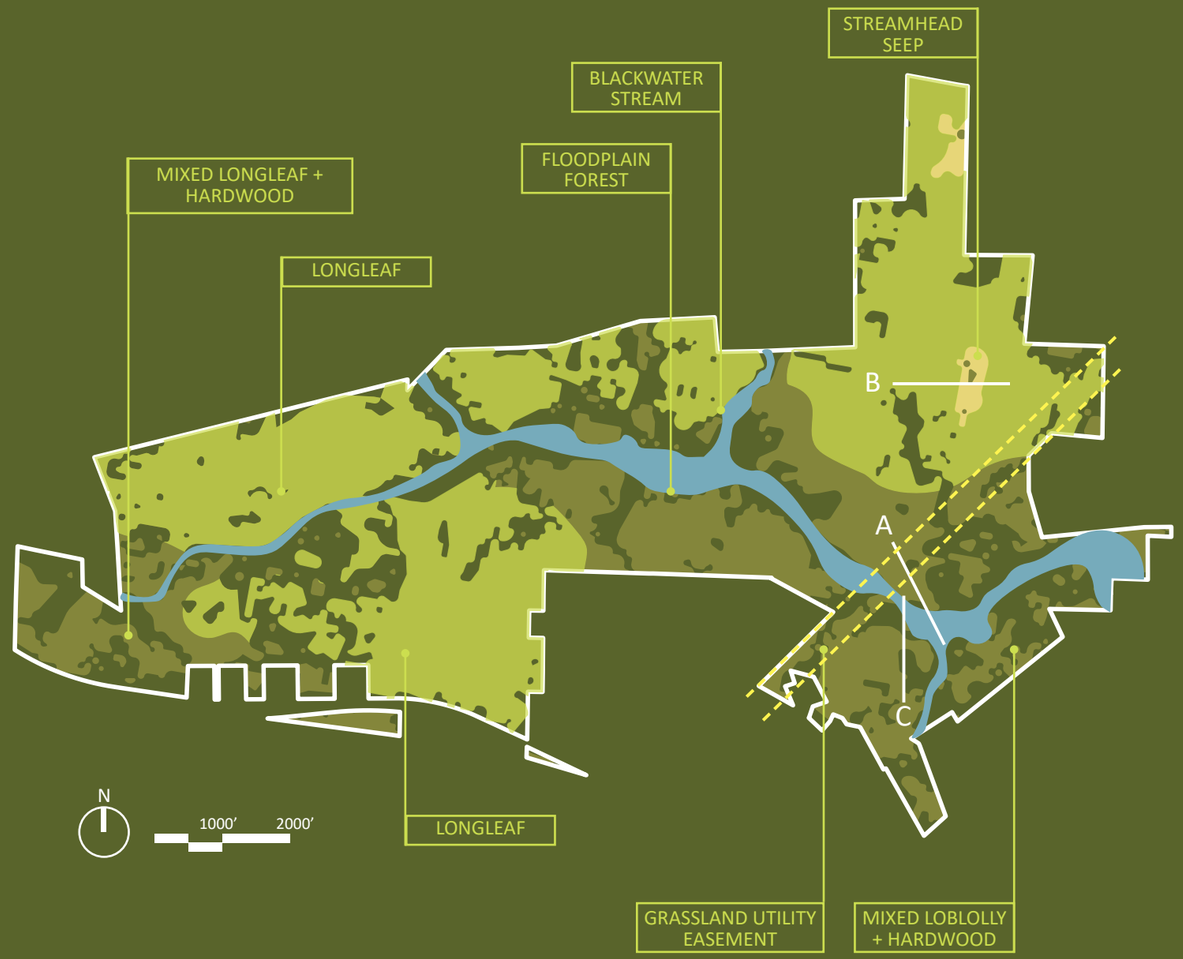
CAROLINA GOPHER FROG
Rana capito

Gopher frogs typically shelter in small, existing burrows or in stump or root tunnels. The mammals that create the burrows depend on fire to maintain an open landscape, and suppression of the natural fire cycle is the primary threat to this species (Roznik, 2017).



SOUTHERN FOX SQUIRREL
Sciurus niger

Fox squirrels prefer mature Longleaf Pine and open Pine-Oak forests. Fire suppression, along with the transition from natural Longleaf stands to Loblolly plantations has fragmented their preferred habitat and made it difficult to recolonize restored or preserved Longleaf forests (NCWRC, 2017).

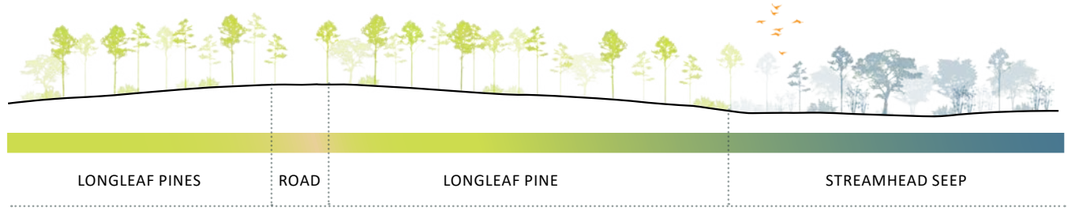


DIVERSITY OF LANDSCAPE + HABITAT TYPOLOGIES

Combined with the rolling topography typical of the Sandhills, the varying ages and compositions of the Longleaf Pine and other forest stands across the study area create unique habitat conditions and landscape typologies. Pines dominate the dry upland areas, while hardwoods are numerous in the wetter lowland areas and around drainages with a dense understory of Sweet Pepperbush (*Clethra alnifolia*) and Cane thickets. The various plant communities and land-cover types, combined with the variation in historical management strategies across the site create habitat niches that support a diverse range of wildlife.

In addition to habitat diversity, contrast in visual qualities can afford unique recreational and educational experiences across the site. If walking a North-South transect across the site, visitors could experience the full range of these unique landscape typologies in about 20 minutes.

SECTION A



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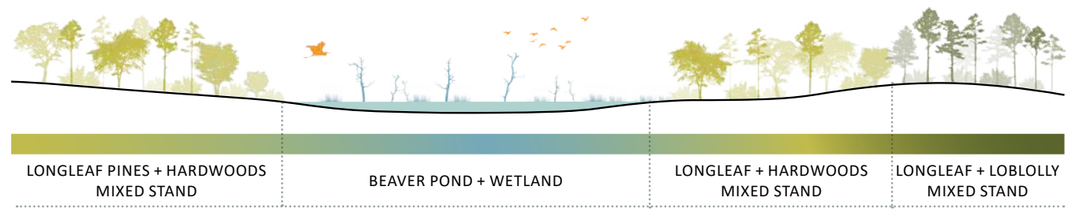
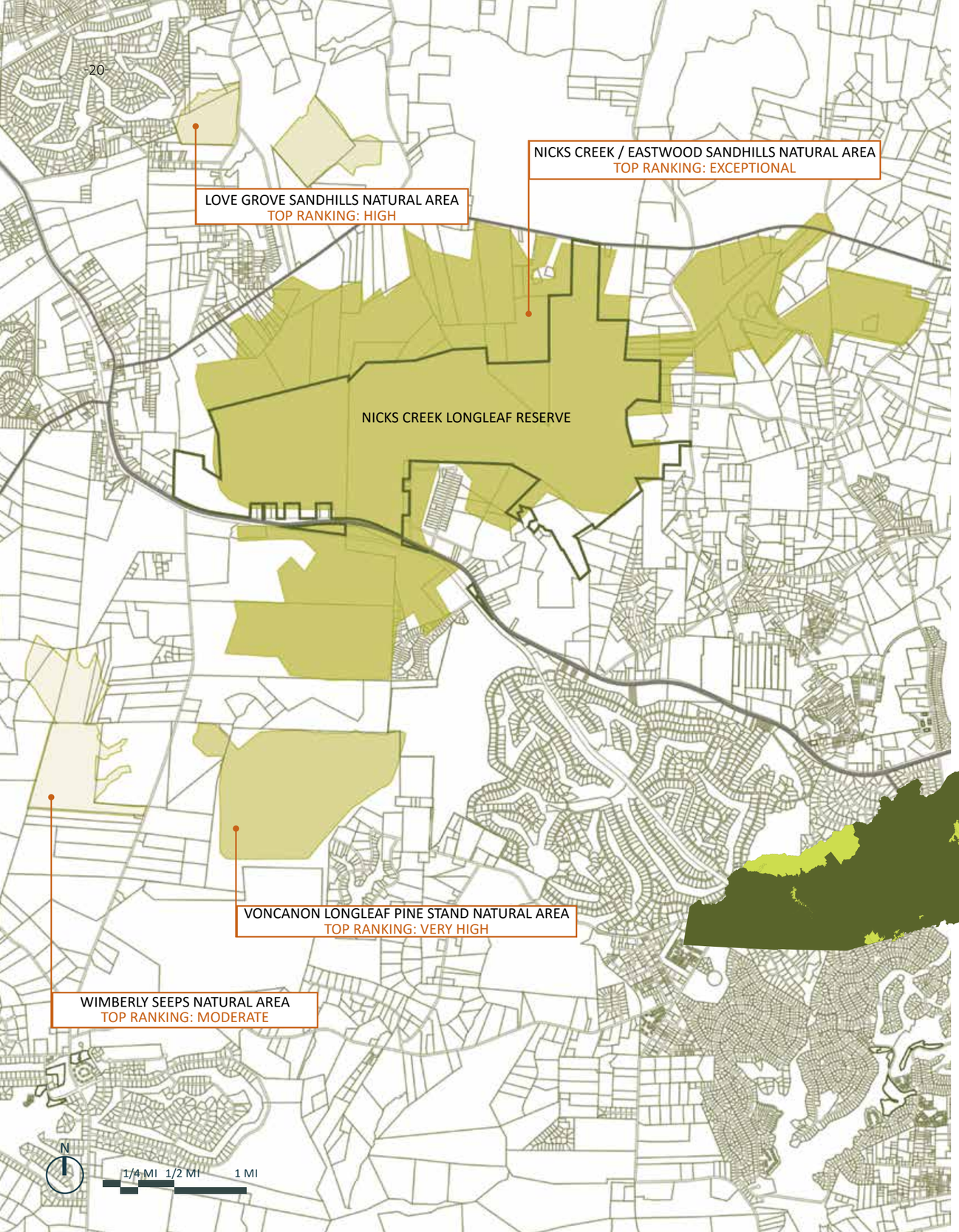


SECTION C

PHOTOS ILLUSTRATING THE RANGE OF SPECIES, TEXTURES, AND DETAILS ACROSS THE STUDY AREA

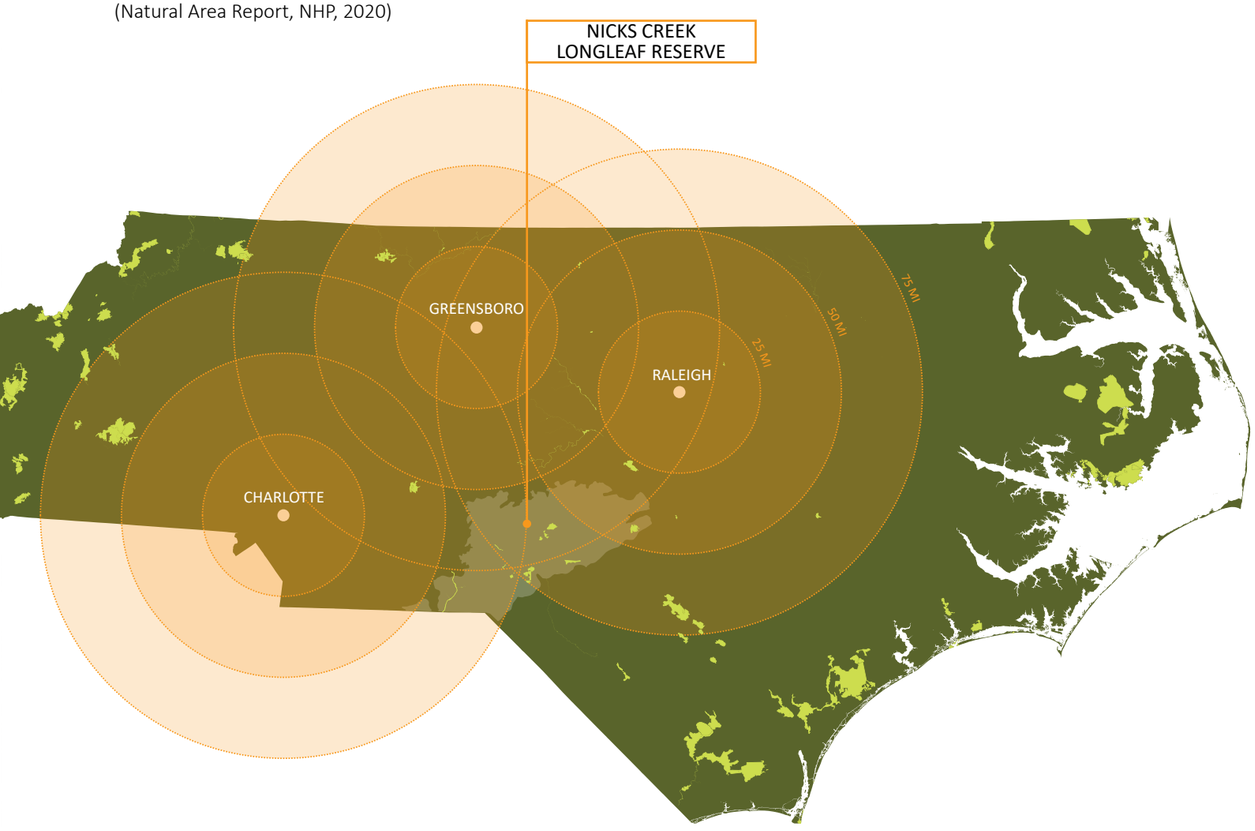


NC NATURAL HERITAGE PROGRAM NATURAL AREA: EXCEPTIONAL RANKING

Much of the study area (approximately 1500 acres) falls within the Nicks Creek / Eastwood Sandhills Natural Area, a Registered Natural Area designated by the North Carolina Natural Heritage Program with a top ranking of 'Exceptional'. Out of almost 2,500 Natural Areas in the state, only 17% achieve the highest ranking. These areas are critically important for the conservation of North Carolina's natural biodiversity and contain some of the best populations of rare species, their habitats, and natural communities in the state. Part of this Natural Area is already protected as the Eastwood Preserve, but the remaining area, much of which is within the boundaries of the study area, has been identified as a conservation priority: "Protection of this large and more-or-less contiguous habitat—which extends all the way to Eastwood—will ensure survival of the best remaining Longleaf in the Sandhills region. Moreover, protection will help to ensure that water quality in Nicks Creek and Little River (drinking water for several villages) remains high." (Natural Area Report, NHP, 2020)

Currently, only about one-third of the exceptionally ranked designated natural areas in North Carolina are publicly accessible. Programming the study area for public access will provide a unique opportunity for the public to experience and learn about stewardship of such a high-quality and important natural resource.

This designated natural area is also one of only a few with the exceptional ranking within a 75-mile driving radius of North Carolina's largest metropolitan areas, including Charlotte, the Research Triangle, and the Triad. In addition to increasing local open-space access, public access to the study area can serve a much broader populous including much of North Carolina, as well as parts of South Carolina and Virginia.



STUDY AREA

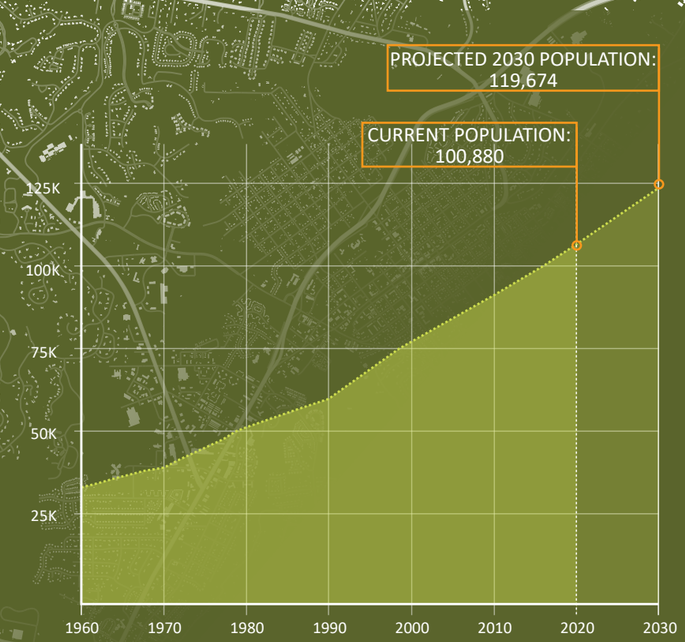
N

1/4 MI 1/2 MI 1 MI

ENCROACHING DEVELOPMENT AND RURAL SPRAWL

In conflict with the need for conservation, Moore County is growing rapidly with the population projected to grow by over 16% between 2020 and 2030. Much of this growth is occurring in formerly rural areas and creating a predominant development pattern of rural-sprawl across the county (Land Use Plan, 2020). In this graphic, the development patterns of Pinehurst and Seven Lakes are illustrated to the northwest and southeast of the study area, with the denser development concentrated within town limits and rural sprawl increasing along transportation corridors. Situated between these two growing towns, the unique habitat occupying the study area is both at risk from encroaching development and in the position to provide a unique recreational and educational opportunity to both nearby communities and regional metropolitan areas.

"Longleaf Pine stands are very desirable areas for housing developments and golf courses. Development within this habitat can lead to fragmentation that disrupts connectivity between patches for most wildlife except birds. Road crossings can lead to mortalities, especially for reptiles and amphibians" (NCWRC, 2015). In the 2004 Site Conservation Plan, The Sandhills Conservation Partnership identified the top ten threats to sensitive Sandhills ecological communities. Of the ten, four of the top threats were related to development and included primary home construction, second home and resort development, construction of roads, and golf course construction and maintenance (TNC, 2004). All of these development-related threats are present immediately surrounding the study area. In fact, a planned community including each of these elements was planned for this site.



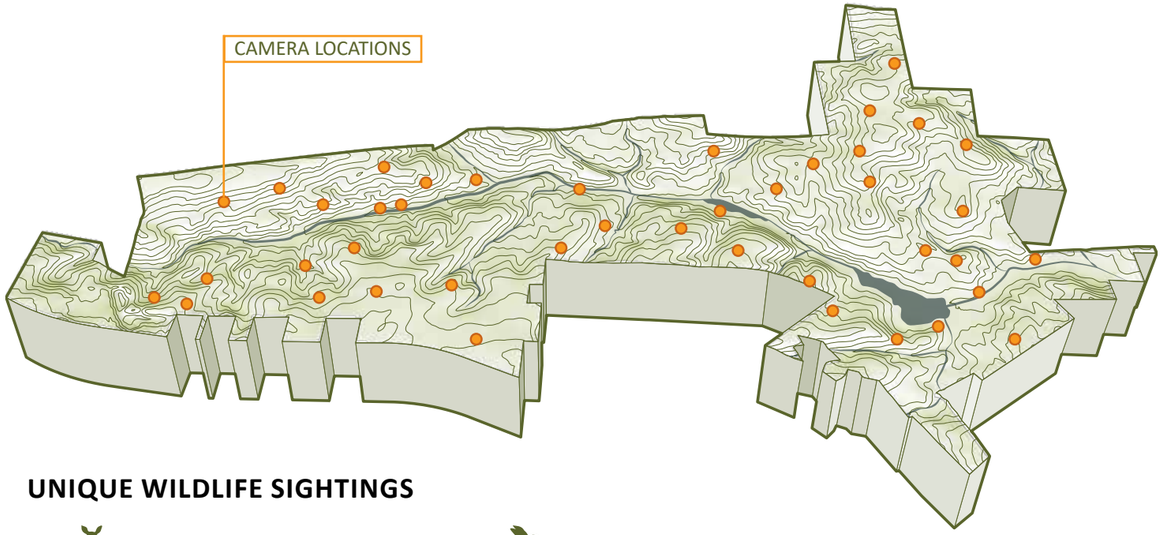
MOORE COUNTY, NC POPULATION TREND

HIGH-QUALITY TERRESTRIAL HABITAT

The combination of upland pine and bottomland hardwood communities provide a range of habitat types across the site. Blackwater streams, associated wetlands, and the beaver pond provide important aquatic habitat, and the variety of canopy and understory conditions also support species diversity. Active management of the existing Longleaf stands and restoration of degraded and mixed stands will greatly elevate the habitat value of the site, but even in its current condition, the site supports a wide range and large number of species.

In order to capture patterns of wildlife present at Nicks Creek, the project team deployed 14 motion-triggered wildlife cameras that were periodically moved to new locations (interval ranged from 4-6 weeks). Cameras were on the site from early May to late August and recorded wildlife activity at 42 unique locations. This process was intended to help identify the types of terrestrial communities that exist on the site, and where within the site they occur in the highest densities. Substantial quantities of white-tailed deer, coyote, and wild turkey were observed, along with bobcats, gray squirrels, and Southern Fox Squirrels.

LOCATIONS OF WILDLIFE CAMERAS ON SITE



UNIQUE WILDLIFE SIGHTINGS

928	WHITE TAILED DEER	38	COTTONTAIL RABBIT
173	COYOTE	19	OPOSSUM
168	RACCOON	12	INSECTS
146	GRAY SQUIRREL	8	BOBCAT
51	WILD TURKEY	8	BIRDS OF PREY
47	SOUTHERN FOX SQUIRREL	4	WATERFOWL
47	SONGBIRDS	1	GRAY FOX

UNIQUE WILDLIFE SIGHTINGS

1,652

TOTAL

COYOTE PUPS
JUNE 15, 2020 (9:55 AM)

WILD TURKEY
MAY 8, 2020 (10:49 AM)

WHITE TAILED DEER FAWN
JUNE 11, 2020 (11:14 AM)

BOBCAT
MAY 13, 2020 (8:32 AM)

SANDHILLS LILY (LILIUM PYROPHILUM) PHOTOGRAPHED AT THE EASTWOOD PLANT CONSERVATION PRESERVE: AUGUST 1, 2020

CONSERVATION VALUES

ENDANGERED & PROTECTED SPECIES

RARE SPECIES OF THE SANDHILLS

The subtle changes in topography, soil moisture, and soil type found in Sandhills Longleaf Pine forests support a diverse range of unique plant and animal species. This abundance makes this ecosystem one of the most biologically diverse of any terrestrial habitat on earth (Earley, 2004). Longleaf Pine forests support many endangered and protected species of plants, birds, mammals, insects, reptiles, and amphibians. The NC Natural Heritage Program has identified occurrences of at least ten species of rare or endangered plants and animals within the study area and greater designated Natural Area (see table below). In addition to endangered species, several unique plant communities and habitat specialists, such as Pitcher Plants and Sundews, have been identified.

Given the increased development pressure, maintaining the site for wildlife habitat is imperative to the survival of these species. While the site currently supports numerous species, much of the on-site habitat conditions can be improved by reintroducing fire and other disturbances and developing management strategies targeting specific species. It has been noted locally that the reintroduction of fire to the Longleaf ecosystem frequently leads to spontaneous reestablishment of Red Cockaded Woodpecker clusters.

NICKS CREEK / EASTWOOD SANDHILLS NATURAL AREA: IDENTIFIED RARE SPECIES

COMMON NAME	SCIENTIFIC NAME	STATE RANK	GLOBAL RANK
Pine Barrens Treefrog	*Hyla andersonii*	**S3** VULNERABLE	**G4** APPARENTLY SECURE
Red Cockaded Woodpecker	*Picoides borealis*	**S2** IMPERILED	**G3** VERY RARE
Northern Pinesnake	*Pituophis melanoleucus melanoleucus*	**S2** IMPERILED	**G4** APPARENTLY SECURE
Drunk Apamea	*Apamea inebriata*	**S1** CRITICALLY IMPERILED	**G3** VERY RARE
Bog Oatgrass	*Danthonia epilis*	**S3** VULNERABLE	**G4** APPARENTLY SECURE
Hidden-flowered Witchgrass	*Dichanthelium cryptanthum*	**S2** IMPERILED	**G3** VERY RARE
Pine Barrens Boneset	*Eupatorium resinosum*	**S3** VULNERABLE	**G3** VERY RARE
Sandhills Lily	*Lilium pyrophilum*	**S2** IMPERILED	**G2** IMPERILED
Chapman's Yellow-eyed Grass	*Xyris chapmanii*	**S3** VULNERABLE	**G3** VERY RARE
Harper's Yellow-eyed Grass	*Xyris scabrifolia*	**S2** IMPERILED	**G3** VERY RARE
Chapman's Redtop	*Tridens chapmanii*	**S1** CRITICALLY IMPERILED	**G5T3** VERY RARE

HIGHLIGHTED ENTRIES INDICATE SPECIES THAT WERE IDENTIFIED ON THE SUBJECT PROPERTY
ALL OTHERS WERE RECORDED ELSEWHERE IN THE GREATER DESIGNATED NATURAL AREA

STUDY AREA

VILLAGE ACRES

PINEHURST RESORT

YADKIN TRAIL

SOUTHERN PINES

THE COUNTRY CLUB OF NORTH CAROLINA

HISTORICAL RCW CLUSTERS

CURRENT RCW CLUSTERS (LAST OBSERVED 2009-2016)

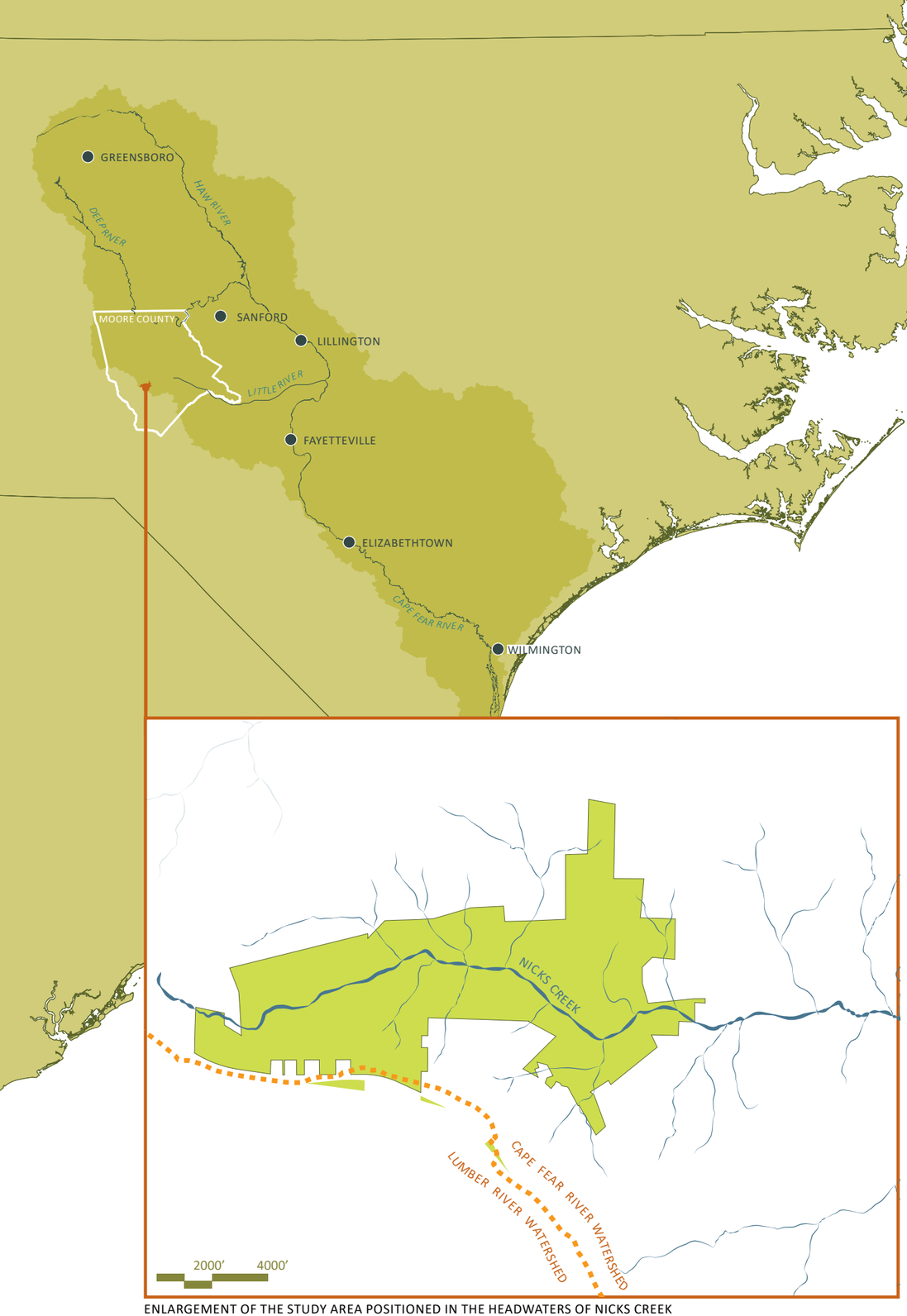
N

1/4 MI 1/2 MI 1 MI

OPPORTUNITY FOR TRANSLOCATION

Red Cockaded Woodpeckers (*Picoides borealis*), a species that depends on Longleaf Pine forests for survival, have experienced profound population declines alongside the decreasing range of Longleaf Pine forests. When the RCW was listed as a federally endangered species in 1970, the population across the Southeast had declined by over 99% (Cornell Lab of Ornithology, 2019). Although the woodpecker is still listed as endangered, populations are recovering, in large part due to extensive conservation efforts that include research, Longleaf restoration, intensive management programs, landowner agreements such as the Safe Harbor Program, and active translocation of woodpeckers.

In the above map, many of the historical RCW clusters (as identified by the NC Natural Heritage Program) follow a spatial pattern that closely mirrors development patterns: where Longleaf habitat has been lost or fragmented due to development, RCW clusters are abandoned. This map also illustrates some of the success of active RCW translocation and management programs. As a result of participating in the Safe Harbor Program, golf courses owned and operated by the Pinehurst Resort and Country Club and other area clubs are now home to many active clusters. With multiple nearby active clusters, the study area, with proper management, has the potential to support additional RCW populations through translocation efforts or through the natural migration of woodpeckers from established clusters.



ENLARGEMENT OF THE STUDY AREA POSITIONED IN THE HEADWATERS OF NICKS CREEK

CONSERVATION VALUES

HIGH-PRIORITY WATERSHEDS

The vitality of headwater habitats is crucial to the integrity of the downstream ecosystems into which they flow. Scientific evidence clearly shows that healthy headwater streams are essential for the health of stream and river ecosystems and their destruction would pose a serious threat to water resources.

-Strowd Water Research Center, 2008

HEADWATERS OF NICKS CREEK AND THE CAPE FEAR RIVER

The health of headwaters and streamhead seeps is critical to overall watershed health. As seen in the graphic below, the study area is within the headwaters of Nicks Creek, a tributary of the Little River and the upper reaches of the Cape Fear River watershed. Undeveloped and protected headwaters, like the tributaries originating in the forested study area, provide critical aquatic ecosystem services and improve water quality in the lower reaches of the watershed by cooling the waters in forested areas; preventing sedimentation, nutrient runoff, and pollution from entering water bodies; helping to improve the health of sensitive aquatic communities; protecting the quality of groundwater and surface water for human consumption; and providing healthy natural resources for recreation and fishing. Because headwaters are small and tightly integrated into their surrounding landscape, they are extremely vulnerable to land use changes (Strowd, 2008).

According to the 2017 National Water Quality Inventory, 46 percent of surveyed U.S. rivers and streams were listed as having poor conditions (US EPA, 2017). Stormwater runoff is one of the leading causes of water quality degradation within these waters, and is host to a suite of pollutants and contaminants that pose substantial threats to water quality. Protection of Nicks Creek headwaters is not only important for maintaining the high-quality habitat on the site, but the quality of these waters also impacts water quality downstream in the Little River and Cape Fear River Basins.

PROPOSED DEVELOPMENT

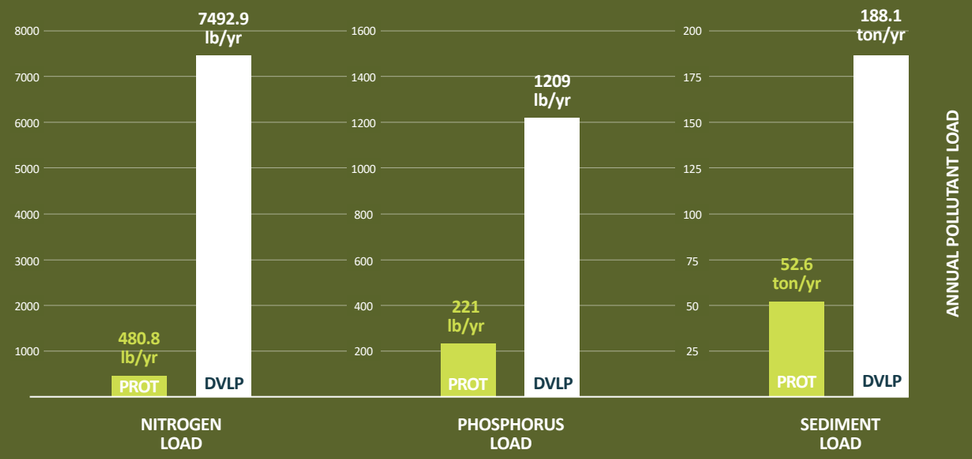
PINE FOREST PLANNED COMMUNITY

IMPACT OF PROPOSED DEVELOPMENT

The impacts and implications of the originally proposed development, Pine Forest Planned Community, would have been extensive. As seen in the graphic at right, the proposed development would have removed or significantly degraded much of the upland Longleaf communities. Development in these areas would have diminished the quantity and quality of habitat and impacted the survival of many of the rare and endangered species currently on the site.

Development would have profoundly affected the on-site aquatic and wetland communities as well as the overall health of the downstream reaches and watershed. As proposed, the development would have caused significant land-cover disturbance on over 1,000 acres (62% of the study area) with 191 acres of impervious surfaces including roads, buildings, and parking areas. Based on runoff calculations for a one-inch rainfall event (NCDEQ: Simple Method, 2009), the fully developed site would generate over 6.6 million gallons of stormwater runoff, or ten olympic swimming pools.

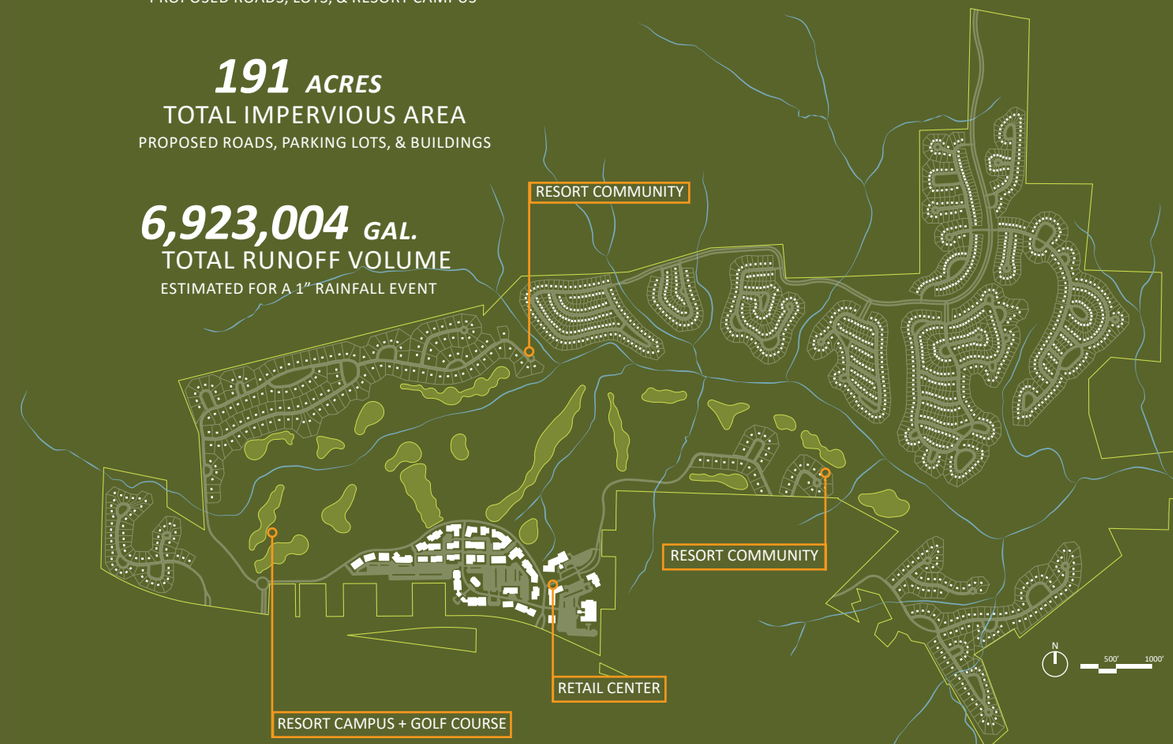
Development at this scale would also contribute significantly to nutrient and sediment runoff to Nicks Creek, with estimates indicating annual contributions of 7,493 pounds of nitrogen, 1,209 pounds of phosphorus, and 188 tons of sediment (US EPA: STEPL, 2020).

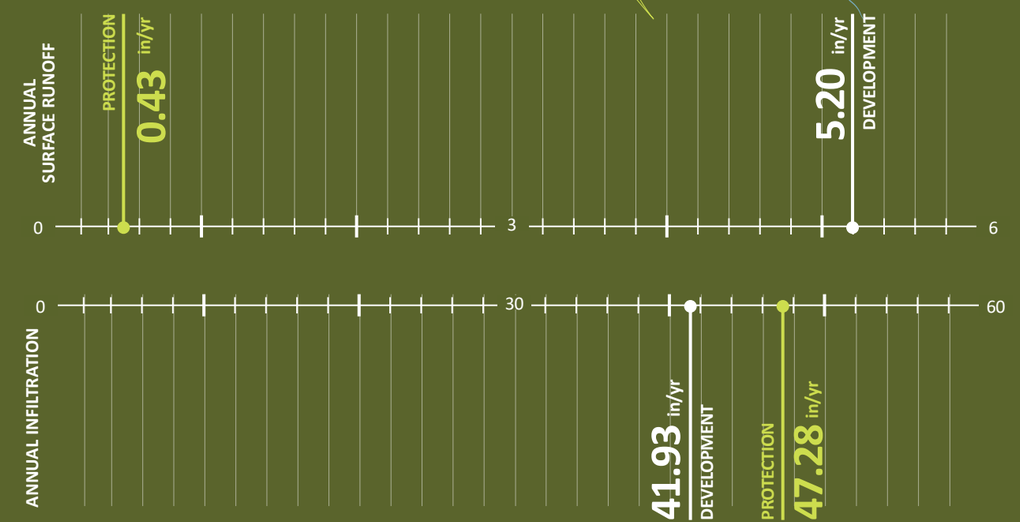


1,027 ***ACRES***
TOTAL SITE DISTURBANCE
PROPOSED ROADS, LOTS, & RESORT CAMPUS

191 ***ACRES***
TOTAL IMPERVIOUS AREA
PROPOSED ROADS, PARKING LOTS, & BUILDINGS

6,923,004 ***GAL.***
TOTAL RUNOFF VOLUME
ESTIMATED FOR A 1" RAINFALL EVENT





METRICS & EQUIVALENCIES

QUANTITATIVE ANALYSIS OF PUBLIC BENEFIT

The conservation of open space can provide significant returns on investment through the provision of ecosystem services, local economic impacts, improved public health, and avoided infrastructure costs. Recent research and reporting suggests that conservation actions may deliver returns on investment of 4 to 1 nationally (Morris, 2018).

The following section provides quantitative equivalencies to suggest how the conservation of the study area can translate to cost savings for Moore County and/or local taxpayers while also providing meaningful environmental and social experiences to the general public.

D AVERAGE DISTANCE OF SOCIAL & RECREATIONAL TRIPS (NHTS, 2017) = SUM TOTAL DISTANCE BY VEHICLE TO ALL STUDIED COMPARABLE RESOURCES / # OF COMPARABLE RESOURCES STUDIED

C AVERAGE COST PER VEHICLE TRIP = 2 [**D**] x REIMBURSABLE RATE PER MILE OF TRAVEL (IRS, 2019)

V ASSUMED NUMBER OF VEHICLE TRIPS FOR ONE YEAR = REPORTED 2017 VISITATION AT NEARBY COMPARABLE RESOURCE (WEYMOUTH WOODS) / AVERAGE OCCUPANCY PER VEHICLE FOR SOCIAL & RECREATIONAL TRIPS (NHTS, 2017)

T ESTIMATED COST OF COMPARABLE TRAVEL = [**C** x **V**]

EQUIVALENCIES: TRAVEL-COST METHOD

The calculations above evaluate the estimated travel costs (in 2020 dollars) of the subject property. The calculations are based on the following assumptions:

+ The conservation and programming scenarios, assuming open access to the general public, will provide to the community recreational and educational amenities of equal or greater value than the six comparable park and recreation facilities identified in this section of the report.

+ The availability of other comparable open space resources in closer proximity to the project site than the average 12-mile, one-way travel distance is minimal.

+ As a nature reserve allowing open access to the general public, this property will see comparable levels of visitors (and vehicle trips) as the average annual visitation rate observed at Weymouth Woods Sandhills Nature Preserve. This site was chosen because it is a comparable recreational resource nearby with similar ecological conditions, size, and educational and recreational programming. Collectively, this study assumes the average vehicle count for proposed recreational and educational programming at Nicks Creek Longleaf Reserve to be approximately 90 vehicle visits per day.

+ The current inflation rate of 1.3% (US Bureau of Labor Statistics, 2020) was applied to these calculations. It is also assumed that the Travel Reimbursement Rate (IRS, 2019) will remain constant for the time frames identified below.

When these assumptions are combined with the data analysis and formulas provided, the result is a maximum travel cost savings of **$459,888.96** per year.

$459,888.96 PER YEAR
POTENTIAL COST SAVINGS IN COMPARABLE TRAVEL EXPENDITURES
CONSERVATION & HYBRID SCENARIOS (PER YEAR, NON-ADJUSTED)

10 YEAR	50 YEAR	100 YEAR
$4,877,466.71	**$32,104,986.76**	**$93,346,337.82**
ASSUMING 1.3% RATE OF INFLATION COMPOUNDING ANNUALLY	ASSUMING 1.3% RATE OF INFLATION COMPOUNDING ANNUALLY	ASSUMING 1.3% RATE OF INFLATION COMPOUNDING ANNUALLY

D AVERAGE DISTANCE TO COMPARABLE RESOURCE

24.5 MILES
UWHARRIE NATIONAL FOREST

+ 789 NC-24 (Troy, NC)
+ 50,645 acre National Forest
+ 90.8 miles hiking and running trails
+ 62 miles of mountain bike trails
+ 40 miles of equestrian trails

12.6 MILES
WALTHOUR-MOSS FOUNDATION

+ 7226 Equestrian Rd (Southern Pines, NC)
+ 4000 acres of Longleaf Pine ecosystem
+ Public walking and equestrian trails
+ Active Longleaf Pine management

12.5 MILES
WEYMOUTH WOODS

+ 1024 Fort Bragg Rd (Southern Pines, NC)
+ Over 900 acres of Longleaf Pine ecosystem
+ 8 miles of trails
+ Ranger-led educational programs

10.3 MILES
RESERVOIR PARK

+ 300 Reservoir Park Rd (Southern Pines, NC)
+ 165 acre park with 95 acre lake
+ Access to 12 miles of greenway trails
+ Natural disc-golf course

7.5 MILES
WEST PINEHURST COMMUNITY PARK

+ 861 Chicken Plant Rd (Aberdeen, NC)
+ 66 acres
+ Athletic fields
+ 18-hole disc-golf course

4.7 MILES
RASSIE WICKER PARK

+ 10 Rassie Wicker Dr (Pinehurst, NC)
+ 103 acre park
+ 33 acre arboretum
+ 3 miles of walking trails
+ Assorted athletic fields and facilities

C AVERAGE COST PER VEHICLE TRIP = 2 [12 MILES x $0.58 IRS, 2020]

V ASSUMED NUMBER OF VEHICLE TRIPS FOR ONE YEAR = 69,380 ANNUAL VISITORS (WEYMOUTH WOODS) / 2.1 PEOPLE PER VEHICLE (NHTS, 2017)

T ESTIMATED COST OF COMPARABLE TRAVEL = [$13.92 AVG COST PER VEHICLE TRIP x 33,038 ASSUMED # VEHICLE TRIPS]

CURRENT CONDITIONS:
1662 FORESTED ACRES

753 METRIC TONS C PER YEAR

POTENTIAL CARBON SEQUESTRATION ESTIMATE BASED ON DATA DEVELOPED BY DUKE UNIVERSITY'S NATURAL & WORKING LANDS ECOSYSTEM SERVICES MAPPING

C VALUE OF ESTIMATED ANNUAL CARBON SEQUESTRATION = CALIFORNIA CAP-AND-TRADE PROGRAM CURRENT (AUGUST 2020) AUCTION SETTLEMENT PRICE PER METRIC TON x ESTIMATED CARBON SEQUESTRATION RATE

C VALUE OF ESTIMATED ANNUAL CARBON SEQUESTRATION = **$16.68 / METRIC TON** x **753 METRIC TONS C PER YEAR**

$12,560.04 PER YEAR

ESTIMATED VALUE OF CARBON SEQUESTRATION BASED ON CALIFORNIA CAP-AND-TRADE AUCTION SETTLEMENT PRICE AS OF AUGUST 2020

10 YEAR
$125,600.40
USING AUGUST 2020 MARKET RATE ONLY; INFLATION NOT INCLUDED

50 YEAR
$628,002.00
USING AUGUST 2020 MARKET RATE ONLY; INFLATION NOT INCLUDED

100 YEAR
$1,256,004.00
USING AUGUST 2020 MARKET RATE ONLY; INFLATION NOT INCLUDED

PLANNED DEVELOPMENT:
564 FORESTED ACRES

258 METRIC TONS C PER YEAR

POTENTIAL CARBON SEQUESTRATION ESTIMATE BASED ON DATA DEVELOPED BY DUKE UNIVERSITY'S NATURAL & WORKING LANDS ECOSYSTEM SERVICES MAPPING

The calculations above and at left evaluate the estimated highest rates of carbon sequestration provided by existing forest on the site in a pre- and post-development scenario. The rate of carbon sequestration is a raster dataset developed by the Nicholas School of the Environment at Duke University Working Lands Action Plan (2020). Calculations are based on the following assumptions:

+ The forest conditions have not changed since the mapping of the input data sources (forest age, landcover, forest type).
+ Management strategies are not accounted for in this dataset, and can have a significant impact on rates of carbon sequestration.
+ According to the methodology report published along with the datasets, "There is no consideration of social or economic constraints. Therefore, all quantitative estimates (of geographic area, carbon storage and sequestration, etc.) are expected to be significantly higher than what will be observed. This assessment provides potential scale, not realistic estimates" (Warnell, 2020).
+ The estimated value of carbon sequestration on the site was calculated using the auction settlement price ($16.68/metric ton C) reported by the California Cap-and-Trade Program in August 2020. Because of recent and historic fluctuations in the settlement price, projections of future price forecasts cannot be assumed as fact for the purposes of this report.

EQUIVALENCIES

2,457 ROAD TRIPS
NEW YORK - LOS ANGELES

319 HOMES
ENERGY USE FOR ONE YEAR

19 ROUND-TRIP FLIGHTS
NEW YORK - LOS ANGELES

C — ESTIMATED COST TO TREAT ONE GALLON OF WATER = ANNUAL OPERATING EXPENDITURES FOR MOORE CO. WATER TREATMENT / [# OF GALLONS TREATED PER DAY x # OF DAYS IN ONE YEAR]

N_R — ESTIMATED NUMBER OF GALLONS TO BE TREATED = # OF DWELLING UNITS IN THE PROPOSED DESIGN SCHEME x [# OF GALLONS PER UNIT/ DAY x # OF DAYS IN ONE YEAR]

N_H — ESTIMATED NUMBER OF GALLONS TO BE TREATED = # OF HOTEL ROOMS IN THE PROPOSED DESIGN SCHEME x [# OF GALLONS PER UNIT/ DAY x # OF DAYS IN ONE YEAR]

T — TOTAL ESTIMATED COST OF WATER TREATMENT & CONTROL = C x [N_R + N_H]

EQUIVALENCIES: WATER TREATMENT & CONTROL

The calculations above and at right evaluate the estimated water treatment and control costs (in 2020 dollars) of the proposed development land-use scenario. The calculations are based on the following assumptions:

+ The development scenario is assumed to include 1,504 single family residential units, 18 cottages, and 14 individual retail units, represented by N(R); and one 200-room hotel, represented by N(H). This is based on the 2017 Market Support Analysis of Pine Forest Planned Community, prepared by Norton Consulting, Inc.

+ The number of gallons of wastewater per day per household is based on the Water Footprint Calculator reporting on indoor water usage and includes toilet, shower, faucet, washing machine, leaks, bath, dishwasher, and other uses. This does not include any outdoor water use which would likely infiltrate or run off the site into Nicks Creek.

+ Hotel water use averages 102 gallons per day as reported by the US EPA and EnergyStar.

+ Estimated cost to treat a gallon of water at the Moore County Pollution Control Plant is based on the budget outlined in the 2019 Moore County Comprehensive Financial Report and the total gallons treated annually.

When these assumptions are combined with the data analysis and formulas provided, the result is an annual water treatment and control cost of **$118,330.47**.

DEVELOPMENT SCENARIO

C — ESTIMATED COST TO TREAT ONE GALLON OF WATER = $2,390,852 (MOORE COUNTY, 2019) / [4,691,000 (MOORE COUNTY, 2020) x 365]

N_R — ESTIMATED NUMBER OF GALLONS TO BE TREATED = 1535 (# OF DWELLING UNITS) x [138 (EST. GAL./ DAY) x 365]

N_H — ESTIMATED NUMBER OF GALLONS TO BE TREATED = 200 (# OF HOTEL ROOMS) x [102 (EST. GAL./ DAY) x 365]

T — TOTAL ESTIMATED COST OF WATER TREATMENT & CONTROL = $0.001396 (EST. COST TO TREAT ONE GAL.) x [77,317,950 + 7,446,000]

$118,330.47

ANNUAL COST SAVINGS IN WATER TREATMENT & CONTROL (EST.)

COST SAVINGS AFTER 10 YEARS
$1,254,982.90
ASSUMING 1.3% RATE OF INFLATION COMPOUNDING ANNUALLY

COST SAVINGS AFTER 50 YEARS
$8,260,683.64
ASSUMING 1.3% RATE OF INFLATION COMPOUNDING ANNUALLY

COST SAVINGS AFTER 100 YEARS
$24,018,217.85
ASSUMING 1.3% RATE OF INFLATION COMPOUNDING ANNUALLY

EXISTING CONDITIONS

SITE ANALYSIS

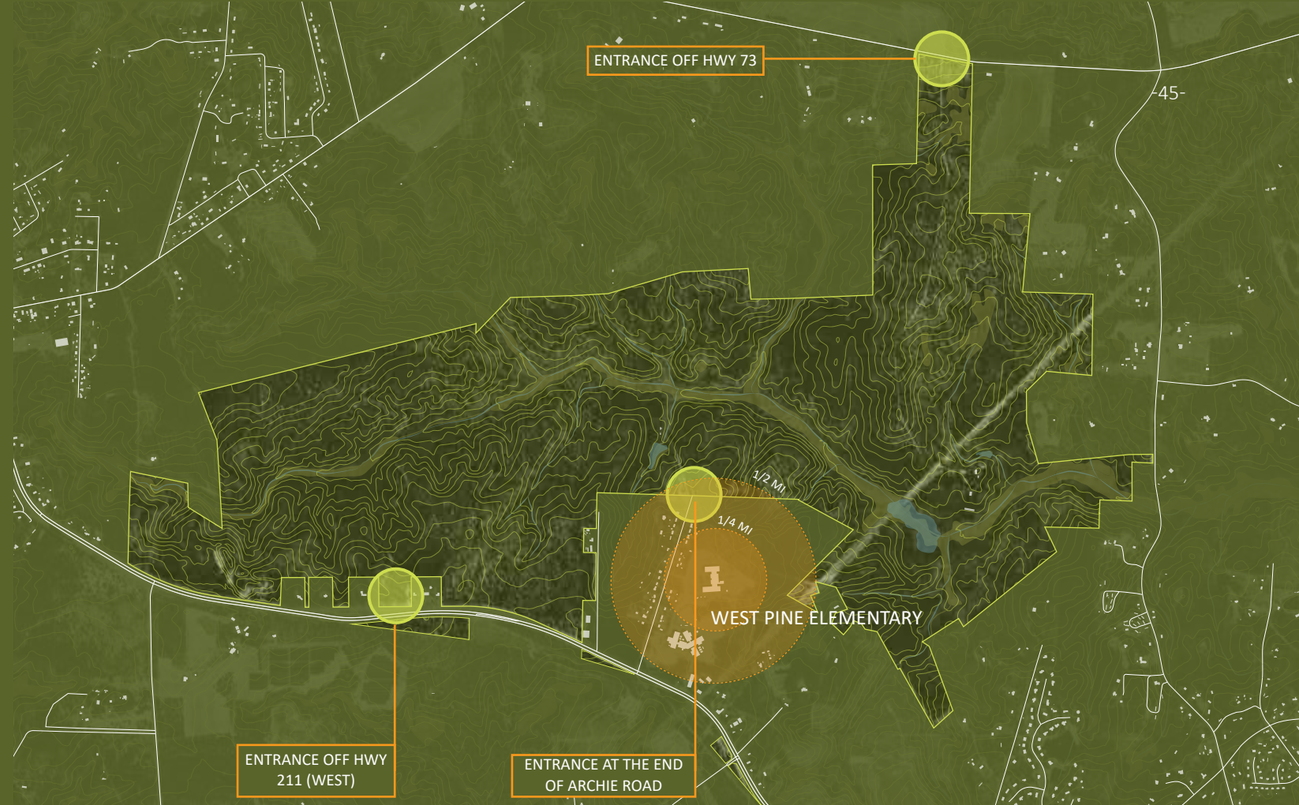
The following spreads and exhibits highlight the existing conditions of the study area based on geospatial analysis and on-site data collection and inventory of features and conditions. The maps in this section include identification of existing site entrances, trails and roads, recent management activity, prior parcel division, rare and sensitive species, and potential usage conflicts. The information included is meant to inform decisions about future programming and public access.

EXISTING SITE ACCESS

There are currently three main points of vehicular access into the site. An entrance at the end of Archie Road, near West Pine Elementary School, provides access to the southern part of the utility corridor (also currently used as a residential driveway). This entrance also provides access to two unoccupied structures and a constructed pond, with connections to trails and roads on the western portion of the site.

Another entrance off of Hwy 211 provides access to the area with a recent history of pine straw raking. This entrance is located in a small residential cluster, which requires additional study and consideration for future public access.

The third site entrance is off of Hwy 73 in the northeastern part of the study area. This entrance provides access to an unpaved arterial road and the utility corridor, and is a good area for future public access. There are other roads leading into the site through adjacent private property, and are currently used by neighbors. Restriction of access is likely needed in these situations.

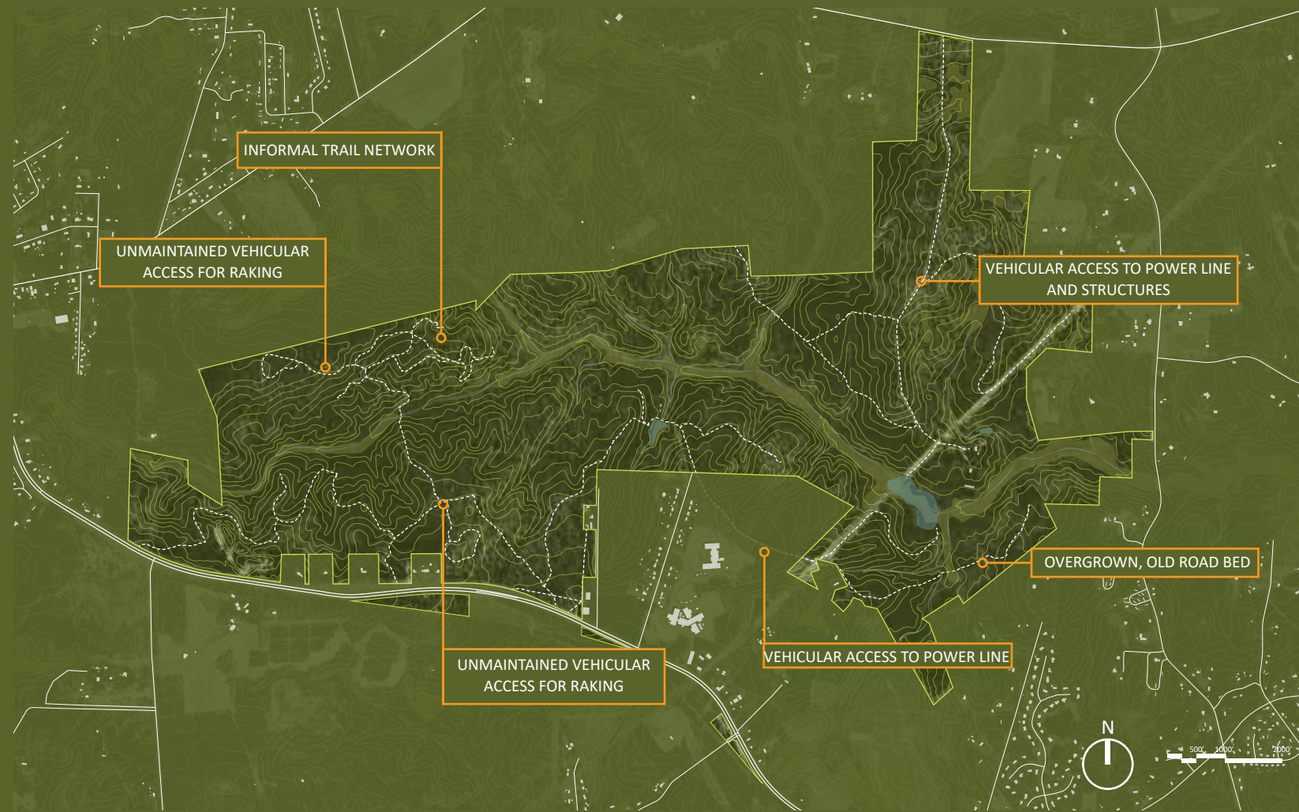


EXISTING TRAILS & ROADS

There are numerous trails and roads on the site in various conditions. Much of the western portion of the site has been raked for pine straw production with unpaved roads supporting this use. This area is the most actively used, and there is little overgrowth on the existing trails. There are several areas where roads located on slopes in the western portion of the site are experiencing severe erosion requiring maintenance.

In a few areas, existing trails form very informal, redundant networks with no clear destination and in several cases trails abruptly end in open woods, making navigation difficult. This condition is most frequently seen in the northwestern part of the site. If used for recreation, trails here would need to be formalized and marked.

In the eastern part of the site, there is one unpaved arterial road that provides access to the utility corridor and the unoccupied structures. The condition is generally good, but some places have deep sand that limits access and there are several eroded areas that require maintenance. There are many older roadbeds on this side of the study area, several of which are overgrown and need clearing and marking for public access, or access will need to be restricted.



RECENT MANAGEMENT

The study area shows evidence of several different, recent forest management strategies. As mentioned earlier, a large area, approximately 248 acres, of the western portion of the site has been raked for pine straw production. In this area, the understory is almost entirely open with some wiregrass and other herbs. In an adjacent portion of the study area, there has been extensive thinning of pines within the last 10-15 years. In this area, significant regrowth of oaks has resulted in a dense, woody understory and midstory condition. Midstory management with mechanical thinning, chipping, and/or burning is recommended for restoration of Longleaf stands in this part of the study area.

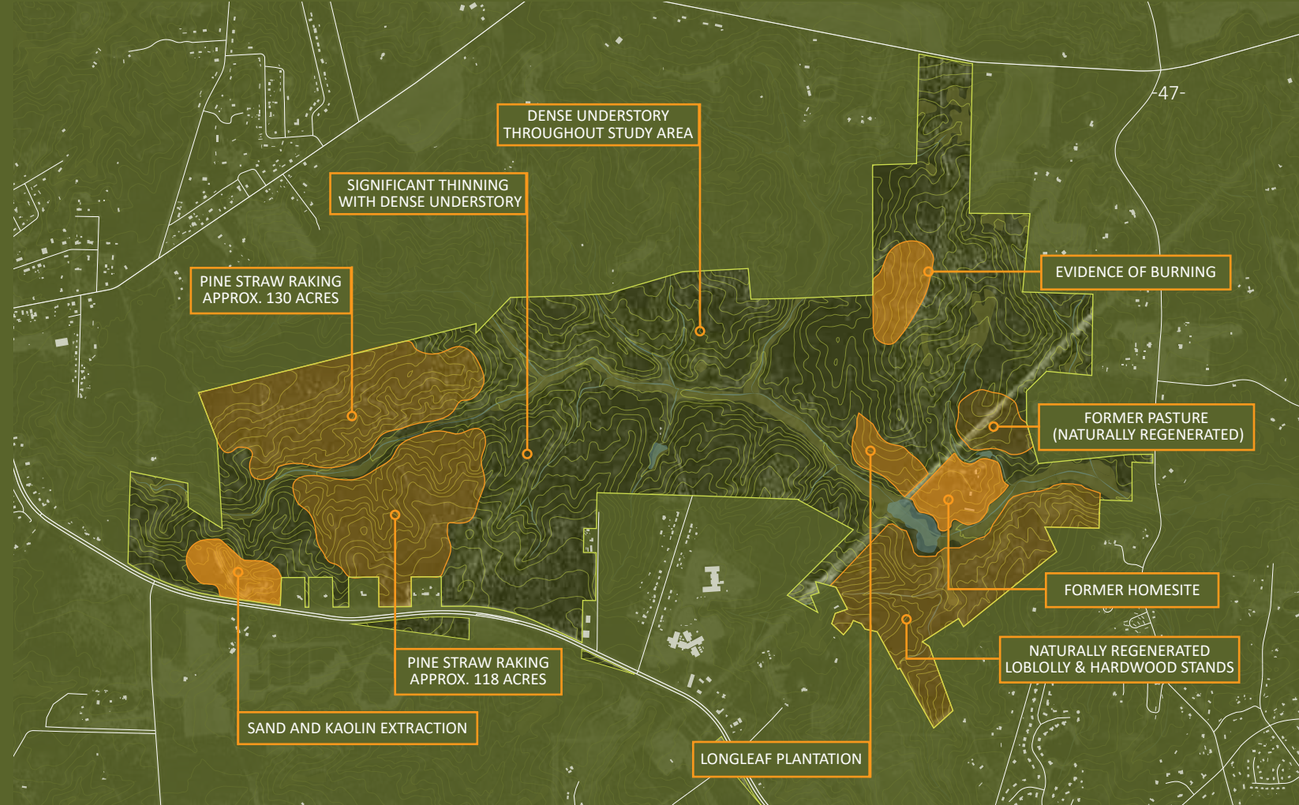
There is one Longleaf Pine plantation in the eastern part of the study area that underwent one thinning approximately 10-15 years ago. The pines in this area are densely spaced with a significant woody understory layer and require a second thinning and understory management (mechanical or burning) as soon as possible. This plantation could be included in a sustainable pine straw production plan in the future. Also on the eastern part of the study area is a Longleaf stand with evidence of past burning. Burn scars are visible on the bark, but there is a buildup of pine straw and a shrubby understory layer indicating that it has been many years since it was last burned.

A former home site with multiple buildings is located to the southeast of the utility corridor (north of the beaver pond and forested wetland). As seen in historic aerial photographs, a large area surrounding the buildings was cleared as pasture as far back as 1950 (oldest available aerial photograph) with natural regeneration of forest starting in the 1980s.

Much of the area to the southeast of the utility corridor is composed of naturally regenerated loblolly pine and hardwood stands. This area is a good candidate for selective timbering, with the long-term goal of Longleaf reestablishment.

PARCEL DIVISION

The study area is made up of several individual tracts. Previous individual management strategies are reflected in this division. Understanding management history can inform ongoing and future management plans tailored to site conditions.

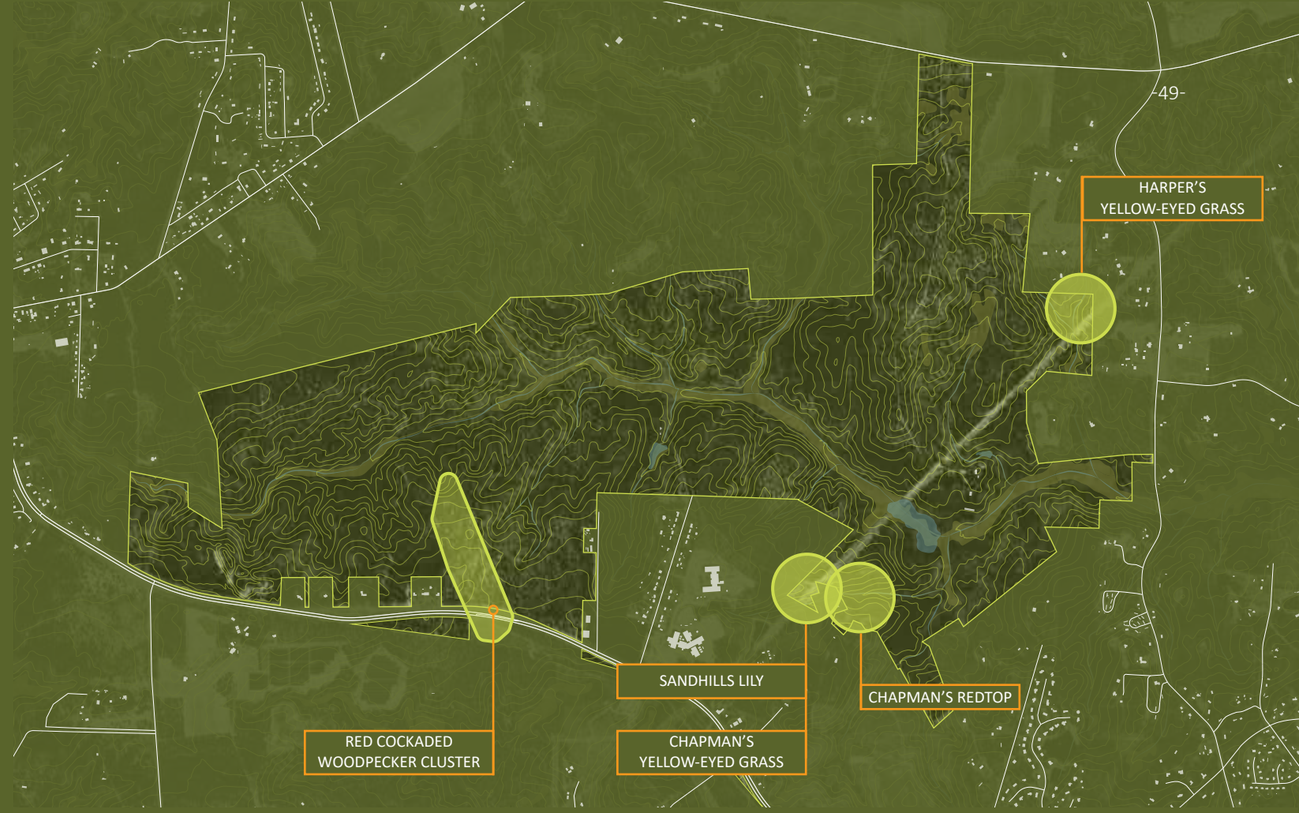


RARE & SENSITIVE SPECIES

The study area provides important habitat for multiple endangered species and, with proper management, additional habitat can be restored or created. Data from the North Carolina Natural Heritage Program identifies five rare species located on the study area: Red Cockaded Woodpecker (*Picoides borealis*); Sandhills Lily (*Lilium pyrophilum*); Chapman's Yellow-Eyed Grass (*Xyris chapmanii*); Chapman's Redtop (*Tridens chapmanii*); Harper's Yellow-Eyed Grass (*Xyris scabrifolia*). Many of these identified species are located within the Duke Energy utility easement and will require special management practices to ensure the survival of existing populations. In order to further protect these populations, public access in these areas should be limited or restricted.

The site contains one RWC cluster that is labeled 'active' and several additional historic clusters. At least one cavity has been positively identified within the study area during the course of this analysis, although it was not in use by an RCW. These clusters, and nearby clusters, indicate that this site has potential for successful RCW translocation if properly managed. In planning for future programming, disturbance should be limited near RCW clusters.

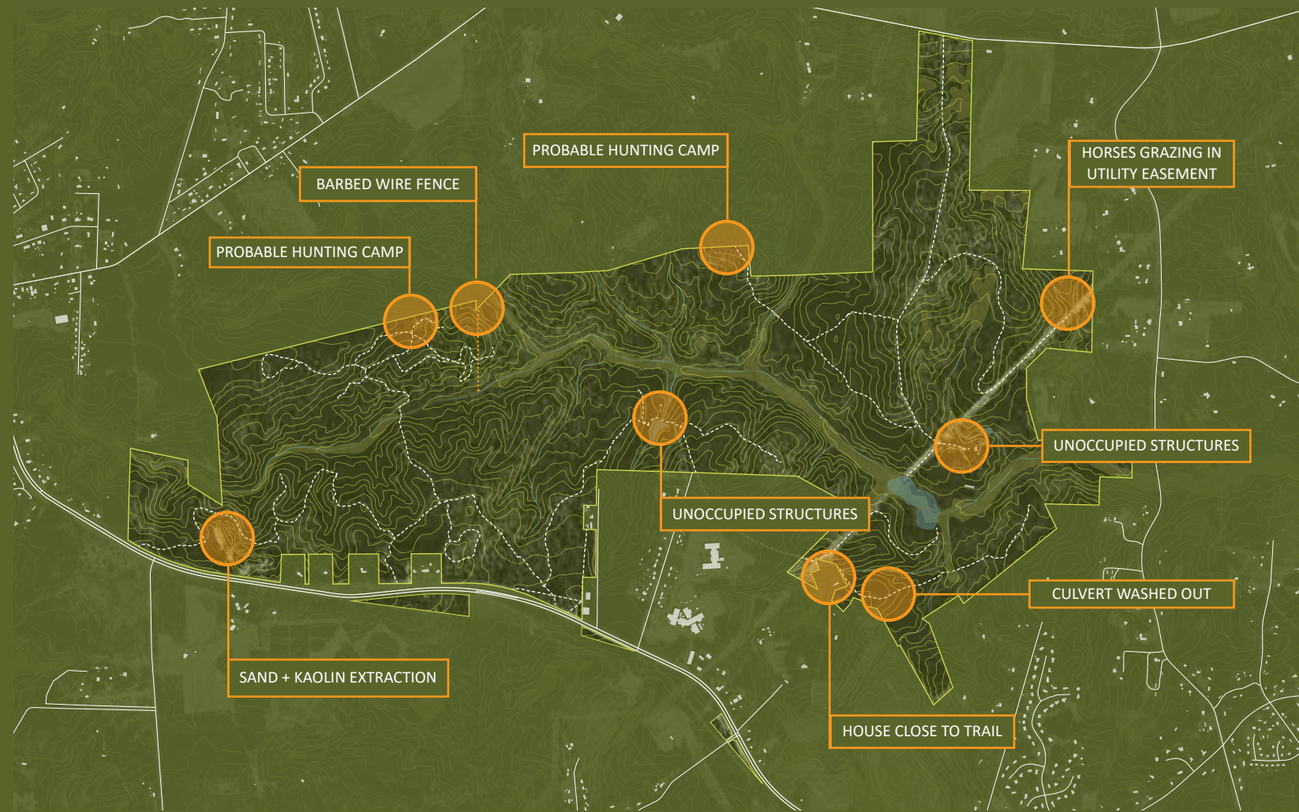
In addition to the species identified within the study area, the following species have been identified in the greater Nicks Creek / Eastwood Sandhills Natural Area: Pine Barrens Treefrog (*Hyla andersonii*), Northern Pinesnake (*Pituophis melanoleucus melanoleucus*), Drunk Apamea (*Apamea inebriata*), Bog Oatgrass (*Danthonia epilis*), Hidden-flowered Witchgrass (*Dichanthelium cryptanthum*), and Pine Barrens Boneset (*Eupatorium resinosum*).



POTENTIAL USAGE CONFLICTS

Several areas were identified as having potential conflicts with future public access and recreation programming. There are many areas around the perimeter of the study area where the site boundary is unclear, including the presence of structures and tents along certain boundaries that are likely used as hunting camps. On several occasions, people were seen on ATVs or on foot using the site without authorization. Access to areas with unclear boundaries or via trails from adjacent private property should be restricted.

There are several unoccupied buildings on the site that currently pose a safety hazard. There are a few buildings near the utility corridor that can be retrofitted and used for recreational or management infrastructure, but there are several other buildings that need to be demolished or have access restricted.



PROGRAMMATIC OPPORTUNITIES

SITE ACCESS & MANAGEMENT

The uniqueness and ecological value of this site can support a range or combination of programs. The broad programmatic categories to consider in future plans include management, research, recreation, and education. There are myriad local and regional organizations and institutions focused on Longleaf ecosystems that offer programs related to the above categories. The chart (right) outlines many of these organizations and identifies which programmatic categories they participate in or support. In some cases, the organizations listed may be interested in direct partnerships involving program development of the study area, while others may be good candidates as precedent examples and continued case study investigation.

The following pages explore various programming scenarios and outline necessary considerations for development of site program and management plans.

MANAGEMENT
- ECOLOGICAL RESTORATION
- FOREST PRODUCTS

RESEARCH
- RARE SPECIES MONITORING
- HIGHER EDUCATION
- LOCAL / REGIONAL NON-PROFITS
- GOVERNMENTAL AGENCIES

RECREATION
- FULL PUBLIC ACCESS
- LIMITED PUBLIC ACCESS
- CLOSED TO THE PUBLIC

EDUCATION
- SITE INTERPRETATION
- CURRICULUM ALIGNMENT
- OUTREACH / DEMONSTRATIONS

	EDUCATION + OUTREACH	RESEARCH	RECREATION	MANAGEMENT
LONGLEAF ALLIANCE				
AMERICA'S LONGLEAF RESTORATION INITIATIVE				
LONGLEAF PARTNERSHIP COUNCIL				
NC PLANT CONSERVATION PROGRAM				
THE NATURE CONSERVANCY				
SANDHILLS GAME LAND				
SANDHILLS PRESCRIBED BURN ASSOCIATION				
NATIONAL WILDLIFE FEDERATION SOUTHEAST FORESTRY PROGRAM				
SANDHILLS ECOLOGICAL INSTITUTE				
THREE RIVERS LAND TRUST				
US FISH & WILDLIFE				
WEYMOUTH WOODS SANDHILLS NATURE PRESERVE				
WALTHOUR-MOSS FOUNDATION				
NC STATE PARKS				
MOORE COUNTY PARKS + REC				
NC BOTANICAL GARDEN				
NATIONAL WILD TURKEY FEDERATION				
NORTH CAROLINA STATE UNIVERSITY				
HERITAGE PRESERVATION TRUST				

PROGRAMMATIC ALTERNATIVES

FULL PUBLIC ACCESS

In this scenario, the extensive existing trail and road network is developed and maintained for full public access throughout the site. This scenario requires extensive maintenance to clean up overgrown trails and install wayfinding and signage throughout the site. The three existing access points require improvement with parking lots, access gates, kiosks and signage, and other trailhead amenities such as shelters, restrooms, etc.

In addition to recreation, programmatic and partnership opportunities include research, management, and education.

8.9 MILES TRAILS
EXISTING + PROPOSED

ENTRANCE OFF HWY 73

VEHICULAR AND/OR PEDESTRIAN ROUTE

BLACKWATER STREAM + FLOODPLAIN FOREST

MATURE LONGLEAF PINE FOREST

MATURE LONGLEAF PINE FOREST

STREAMHEAD SEEP

REPURPOSE VACANT STRUCTURES FOR RECREATIONAL OR MANAGEMENT INFRASTRUCTURE

POND ACCESS

ENTRANCE AT THE END OF ARCHIE ROAD

ENTRANCE OFF HWY 211 (WEST)

MATURE LONGLEAF PINE FOREST

PARTNERSHIP OPPORTUNITIES

RESEARCH *MANAGEMENT* *EDUCATION* *RECREATION*

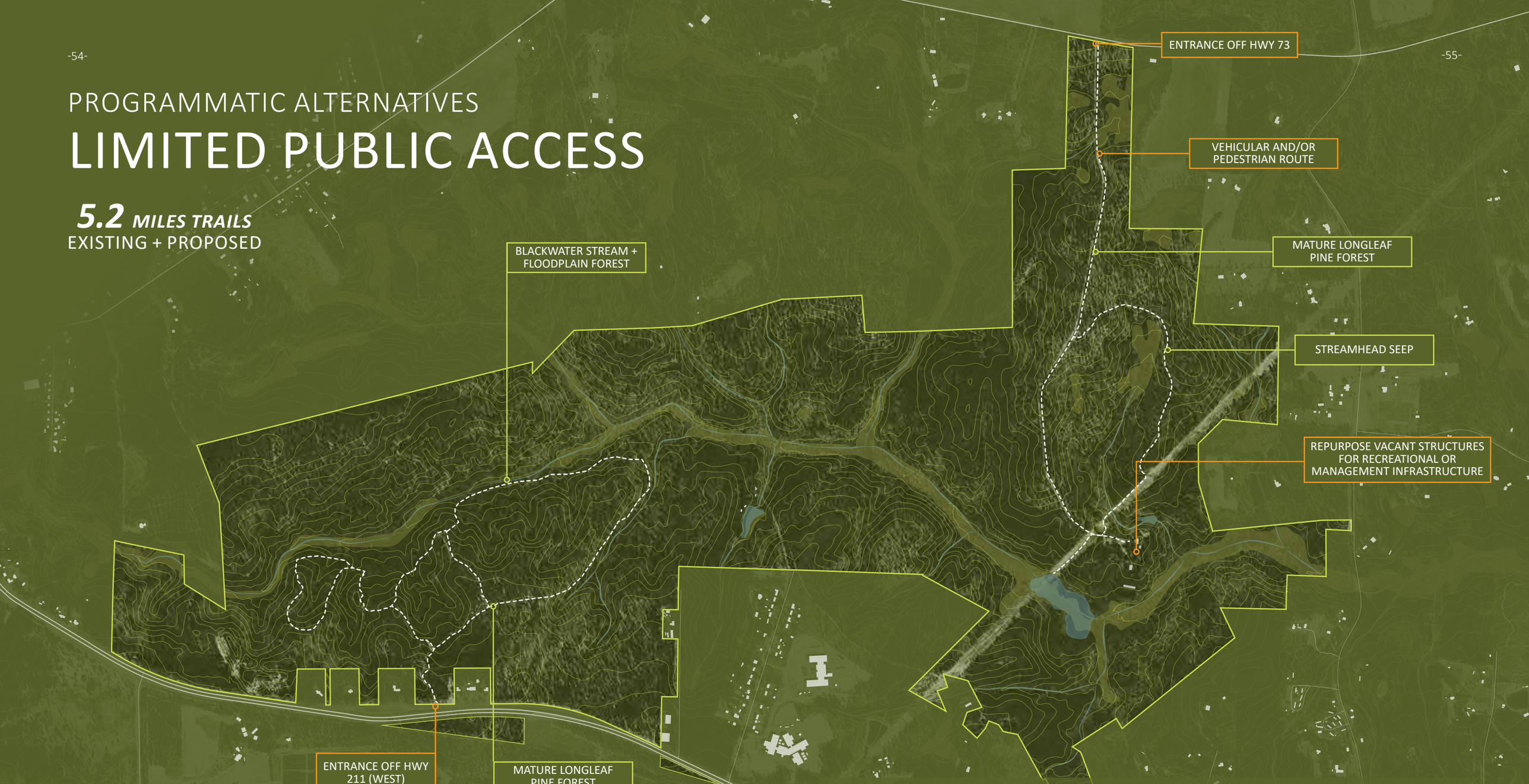
N

500′ 1000′ 2000′

PROGRAMMATIC ALTERNATIVES

LIMITED PUBLIC ACCESS

5.2 ***MILES TRAILS***
EXISTING + PROPOSED



This scenario illustrates similar recreational opportunities as the full access alternative, but with pared-down facilities and infrastructure. Instead of a fully connected trail system based on existing roads, the site offers two isolated trail networks, each accessible from separate entrances. This scenario also requires: maintenance to clean up select portions of overgrown trails; installation of wayfinding and signage throughout the site; and either restoration (to facilitate access) or abandonment (to restrict access) of unused trail segments. In this option, the three existing access points require improvement with parking lots, access gates, kiosks and signage, and other trailhead amenities such as shelters, restrooms, and etcetera.

In addition to recreation, programmatic and partnership opportunities include research, management, and education.

PARTNERSHIP OPPORTUNITIES

RESEARCH *MANAGEMENT* *EDUCATION* *RECREATION*

N

500′ 1000′ 2000′

PROGRAMMATIC ALTERNATIVES

MANAGEMENT DEMONSTRATION SITE

5.2 MILES TRAILS
EXISTING + PROPOSED

This scenario combines the recreational opportunities outlined in the previous two scenarios with a plan for management demonstration plots as research, public education, and outreach tools. Public access can include most of the site, or be limited to the demonstration areas. This alternative requires similar infrastructural improvements as outlined in the previous scenarios. The entire study area affords opportunities for the adoption of innovative and regenerative Longleaf management practices and has the potential to become a regional destination for management education and research. The plan shown on this spread illustrates an example of how public access for recreation can be combined with demonstration of best management practices and indicates areas where such strategies may be implemented.

A more detailed inventory of existing conditions is required to implement the management demonstration areas and test plots for forest management practices, and a forest management plan should be developed to inform the specific management strategies and intervals to be adopted. Several considerations are outlined in the following pages of this report.

ENTRANCE OFF HWY 73

SUSTAINABLE PINE STRAW RAKING DEMONSTRATION

UNDERSTORY & MIDSTORY MANAGEMENT

LEARN & BURN DEMONSTRATIONS

DEMONSTRATION PLOTS FOR VARIOUS MANAGEMENT TECHNIQUES (30-50 ACRES EACH)

DEMONSTRATION OF UTILITY EASEMENT MANAGEMENT FOR RARE SPECIES

REPURPOSE VACANT STRUCTURES FOR RECREATIONAL OR MANAGEMENT INFRASTRUCTURE

RED COCKADED WOODPECKER TRANSLOCATION RESEARCH & MONITORING

ENTRANCE OFF HWY 211 (WEST)

UNDERSTORY & MIDSTORY MANAGEMENT

HARVEST LOBLOLLY & MIXED HARDWOOD AND INITIATE LONGLEAF RESTORATION

SUSTAINABLE PINE STRAW RAKING DEMONSTRATION

PARTNERSHIP OPPORTUNITIES

RESEARCH *MANAGEMENT* *EDUCATION* *RECREATION*

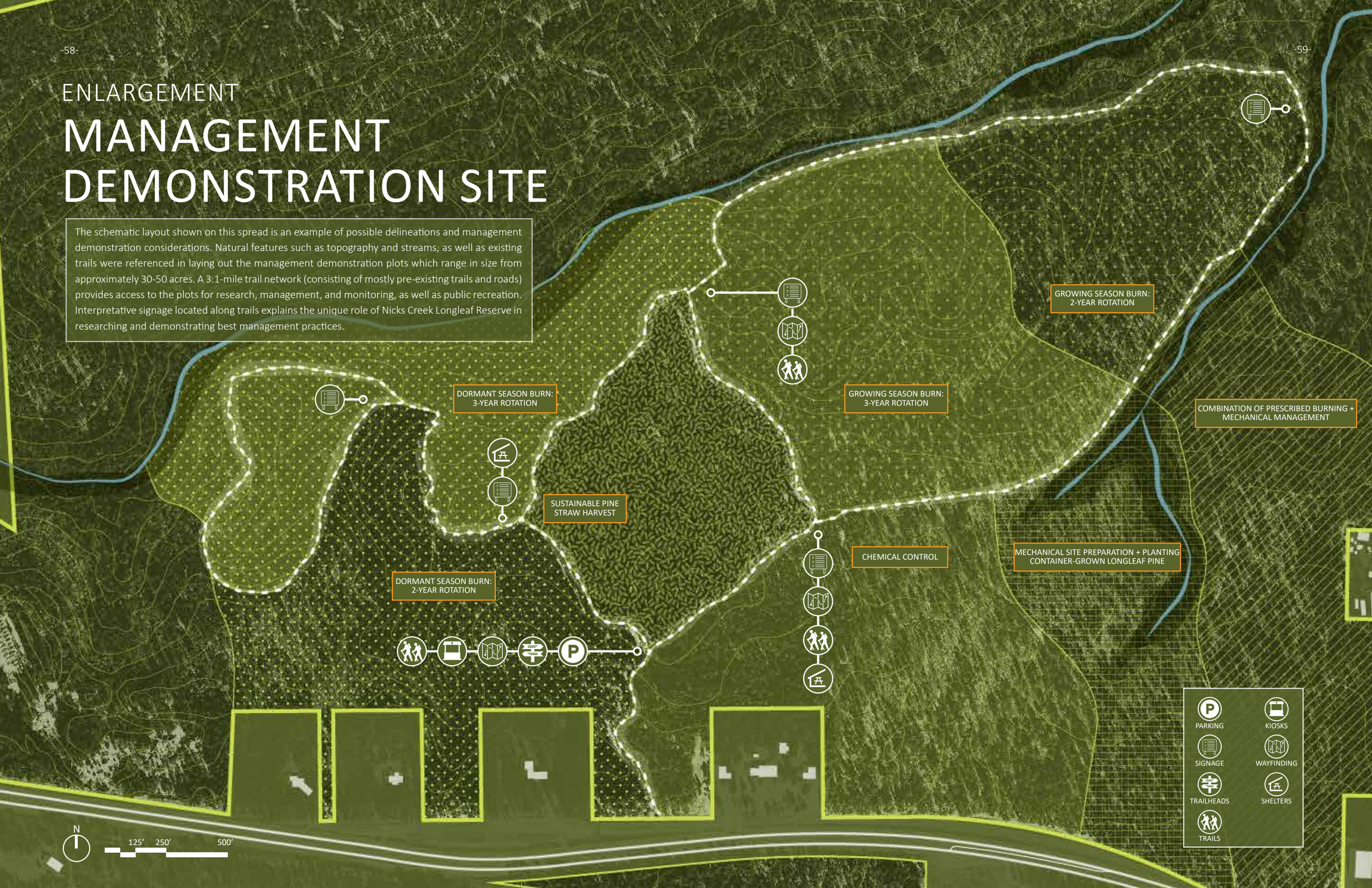
N

500′ 1000′ 2000′

ENLARGEMENT

MANAGEMENT DEMONSTRATION SITE

The schematic layout shown on this spread is an example of possible delineations and management demonstration considerations. Natural features such as topography and streams, as well as existing trails were referenced in laying out the management demonstration plots which range in size from approximately 30-50 acres. A 3.1-mile trail network (consisting of mostly pre-existing trails and roads) provides access to the plots for research, management, and monitoring, as well as public recreation. Interpretative signage located along trails explains the unique role of Nicks Creek Longleaf Reserve in researching and demonstrating best management practices.



FIRE MANAGEMENT

PRESCRIBED BURNING

IMAGE CREDIT: NC WILDLIFE RESOURCES COMMISSION

CRITICAL ECOLOGICAL DISTURBANCES

As a fire-dependent ecosystem, establishing a management plan centered around regular prescribed burning is critical to maintaining and restoring Longleaf Pine stands. Fire has been suppressed in much of the study area for a number of years, so supplemental management techniques and site preparation need to be implemented as a regular fire regime is established. These additional strategies include thinning and mechanical clearing, target application of herbicides, and the planting of Longleaf seedlings in parts of the study area. Reintroducing fire to fire-suppressed forests must be done with caution as there may be areas of significant fuel buildup. Consultation with a professional certified burner is a necessary next step for establishing an appropriate management plan.

Reintroducing fire will support the reestablishment of the suite of native herbaceous understory plants—many of them rare—that depend on the open canopy and midstory to survive. It will also promote Longleaf seedling reestablishment and survival by limiting growth of competitive species. In addition to the ecological value gained by fire management, the open landscape and enhanced wildflower understory provide an aesthetic value that make Longleaf forests popular destinations for recreation. “In essence, well managed Longleaf forests that are carefully burned and managed for wildlife and timber will be aesthetically pleasing. Attention to detail with the timing and scale of land management activities is usually all that is needed” (Longleaf Alliance, 2008).

NC FOREST SERVICE FOREST DEVELOPMENT PROGRAM MANAGEMENT COSTS

PRESCRIBED BURNING

$45.56 / ACRE
SITE PREPARATION

The use of prescribed fire for the purpose of site preparation

$40.00 / ACRE
UNDERSTORY CONTROL

The use of fire in a planned and controlled manner to provide silvicultural benefits from forest fuel reduction or reduced understory competition. Prescribed burning must be conducted under the supervision of a “certified prescribed burner”

HAND-PLANTING LONGLEAF

$196.66 / ACRE
CONTAINER-GROWN SEEDLINGS

The use of planting bars or other hand tools to plant forest tree seedlings

CHEMICAL CONTROL

$167.24 / ACRE

The use of herbicides to reduce competing vegetation for the purpose of site preparation and to control vegetation to develop a stand of trees

MECHANICAL SITE PREPARATION

$164.33 / ACRE

The use of machine-pulled chopper to crush and chop non-merchantable trees, brush, and other debris for the purpose of site preparation

The above figures describe average management costs per acre for different forest management practices in Moore County, North Carolina and were reported in the NC Forest Service Forest Development Program 2019-2020 Payment Report By District. The Forest Development Program is a reforestation, afforestation and forest stand improvement cost-sharing program run by the North Carolina Forest Service. The goals of the program include timber production and the creation of the benefits associated with active forest management (NCFS, 2017). The figures listed above refer to the total cost per acre of different management techniques, and do not include payments received through the cost-share program.

FORESTRY PRACTICE DEMONSTRATION SITE

RESTORATION & MANAGEMENT

2-YEAR BURN INTERVAL (GROWING SEASON)	3-YEAR BURN INTERVAL (DORMANT SEASON)	CHEMICAL UNDERSTORY CONTROL	FIRE & MECHANICAL UNDERSTORY CONTROL
PLOT A	**PLOT B**	**PLOT C**	**PLOT D**

MANAGEMENT EDUCATION AND OUTREACH

Based on conversations with Julie Moore, a botanist and Sandhills ecologist, a need for a Longleaf-specific management demonstration site was identified. While there are many opportunities for public access and recreation throughout Longleaf's range, including areas where research is being conducted on management strategies and ecology, this site offers a unique opportunity to combine management practice research with public education and outreach. These benefits will be further amplified through strategic programming that combines public access and management to enhance understanding of the effectiveness and implications of various strategies. This type of site will draw users interested in recreational opportunities as well as those interested in specific management techniques. Educational signage and interpretive exhibits should be used as a passive way to inform the general public about ongoing research and the role of management within this forest. Additionally, guided tours or training sessions can provide a more in-depth educational experience. The northern area of the site, easily accessible from Highway 211, is composed primarily of a mature Longleaf forest with varying degrees of management needs, which is a condition typical of residential and privately owned Longleaf forests. By demonstrating the impacts and effectiveness of a range of management strategies, local and regional property owners can better understand their options and the required investment for private forest management.

Variables to consider in a management demonstration site plan include: disturbance type (burning, mechanical, chemical, or combination), disturbance frequency (annual, 2-4 year rotation), and disturbance season (dormant vs. growing season). Planting and other vegetation reestablishment techniques can also be demonstrated (i.e., natural regeneration after disturbance, seeding, transplanting plugs vs. containers). This program option will require a significant time commitment because results may not be seen for many seasons, however the long-term research outcomes will provide invaluable insight into local Longleaf management considerations.

FORESTRY PRACTICE DEMONSTRATION SITE

BURN CERTIFICATION SITE

BURN CERTIFICATION SITE

In North Carolina, prescribed fires must be planned and managed by certified burners. Another niche that this site can fill is the local need for burn trainings and certification. Burn certification is administered by the North Carolina Forest Service and requires in-person training, completion of a written test, and the successful planning, implementation, and management of a supervised controlled burn. This involves writing a management plan that includes: a detailed description and maps of the area to be burned: estimated tons per acre of fuel in the burn area; the objectives of the burn; acceptable weather conditions and environmental parameters for initiating the burn; and a summary of the methods to be used to start, control, and extinguish the burn. Using the information in the burn plan, the student must obtain the necessary burn permits and authorization from the NC Forest Service and notify nearby residents and emergency services of the planned burn. The burn must be carried out under the supervision of a certified burner who will provide documentation of the event and a recommendation for certification of the student (NC Forest Service, 2020).

There is no documented minimum size requirement for burns conducted for certification purposes, but based on correspondence with North Carolina Forest Service staff, the general rule of thumb is that the burn should be at least one acre. Unfortunately, some people interested in becoming certified burners don't have access to land to burn. The study area has the unique potential to provide forest land for certification burning at a range of sizes. Burn trainings and certifications could easily fit into the overall management plan and burn intervals for different areas of the site, and participation in trainings could reduce some of the required management costs of contracting burns.

NORTH CAROLINA BURN CERTIFICATION PROCESS

1 STEP — ATTEND TRAININGS
Classes offered by the NC Forest Service are held 2-3 times per year across the state

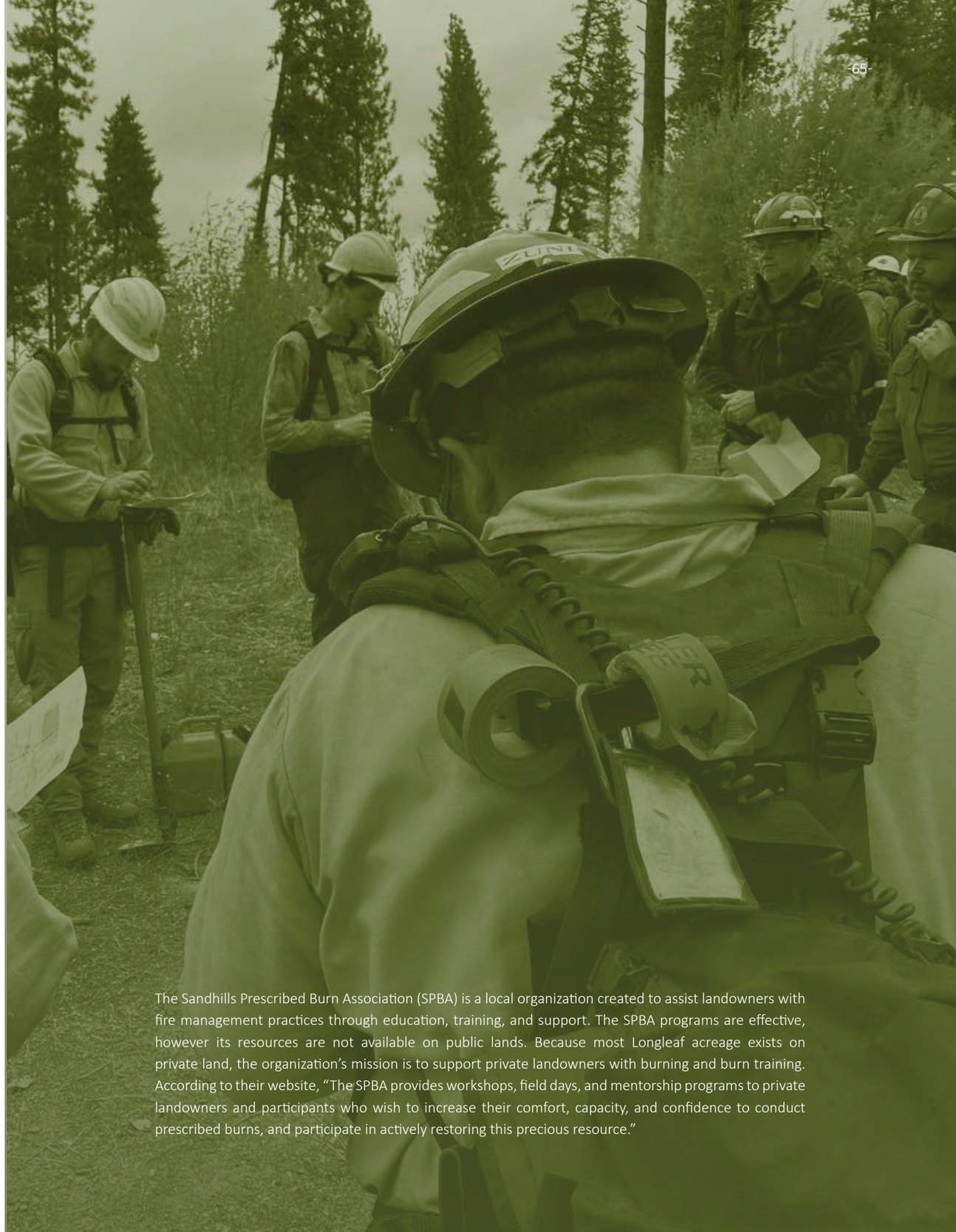
2 STEP — EXAM
After completing the training, students must pass a written exam

3 STEP — PREPARE SITE-SPECIFIC PRESCRIBED BURN PLAN
The plan must include detailed information that describes the area to be burned, objectives, weather conditions, and map

4 STEP — OBTAIN A BURN PERMIT
Apply for a burn permit from the NC Forest Service and submit the prepared burn plan

5 STEP — NOTIFY RESIDENTS & EMERGENCY SERVICES
Nearby residents and emergency response agencies should be notified of any scheduled burns

6 STEP — CONDUCT BURN SUPERVISED BY CERTIFIED BURNER
A certified burner must be present for the planned burn and fill out a burner certification checkoff sheet and recommendation of certification



The Sandhills Prescribed Burn Association (SPBA) is a local organization created to assist landowners with fire management practices through education, training, and support. The SPBA programs are effective, however its resources are not available on public lands. Because most Longleaf acreage exists on private land, the organization's mission is to support private landowners with burning and burn training. According to their website, "The SPBA provides workshops, field days, and mentorship programs to private landowners and participants who wish to increase their comfort, capacity, and confidence to conduct prescribed burns, and participate in actively restoring this precious resource."

FORESTRY PRACTICE DEMONSTRATION SITE

SUSTAINABLE PINE STRAW HARVESTING

DEMONSTRATING BEST MANAGEMENT GUIDELINES

The most common practice for harvesting pine straw is by raking, either mechanically or by hand. Straw can be raked from either natural stands or plantations, with natural stands usually requiring a crew of workers with rakes to harvest between the irregularly spaced trees, and plantations favoring efficient mechanized harvesting. Densely spaced, frequently raked stands with little to no ground cover have very little habitat value for wildlife, although prioritizing habitat health and incorporating sustainable pine straw harvesting techniques can improve the ecological value of harvested stands while remaining profitable.

Pine Straw harvesting has occurred in the western part of the study area for some time. The raking practices that are currently being employed are not sustainable and have resulted in bare areas and areas with little to no diversity in the herbaceous layer. Woody debris has also accumulated in piles to decompose, creating unnaturally high fuel loads in some areas. If pine straw harvesting continues on the site, sustainable harvesting practices should be adopted to improve the ecological value of harvested areas. While pine straw raking can help offset some of the management and maintenance costs in other areas of the site, there is also an opportunity to showcase and demonstrate sustainable practices as public education and outreach.

BEST MANAGEMENT GUIDELINES FOR SUSTAINABLE PINE STRAW HARVESTING

AVOID OR LIMIT MECHANICAL RAKING

Raking by hand is much less damaging to the herbaceous understory layer and limits soil compaction by machinery

STRAW LIFTING vs RAKING

Using pitchforks to lift straw by hand leaves much of the understory intact and improves habitat value

MANAGE WITH FIRE

Regular fires are essential to wildlife management and should be used to maintain the open understory

MAINTAIN OPEN CANOPY

Thin Longleaf stands as needed to maintain an open canopy and encourage a native composition of groundcover

ROTATION OF HARVESTED AREAS

Areas should be left unharvested to maintain habitat value and provide refuge for wildlife

MAINTAIN HABITAT CONNECTIVITY

If harvesting occurs in a large area, leave unharvested corridors to facilitate movement of ground-dwelling species

HARVEST IN EARLY FALL

Complete harvesting operations by late October and allow any late falling needles to accumulate and prevent erosion

AVOID SPREAD OF INVASIVE SPECIES

Avoid harvesting in areas with invasive groundcover. Inspect and sanitize harvesting equipment regularly

IMAGE CREDIT: "THE MERCURY". EXTON, PA

UTILITY EASEMENT MANAGEMENT

PROGRAMMATIC CONSIDERATIONS

MANAGE WITH FIRE
When possible, fire is the preferred management strategy in the right-of-way on a 3-4 year rotation.

SPOT-TREATMENT WITH HERBICIDE
Spot-application of select herbicides should be used to maintain ideal conditions between other management strategies.

WOODY VEGETATION
Leave some patches of woody vegetation intact in the right-of-way to provide shelter after disturbance.

MOWING
Mowing should occur at 3-year intervals or as needed to control woody vegetation. Maintaining a regular disturbance pattern is essential.

MANAGE RARE SPECIES
For areas with known or suspected occurrences of rare or sensitive species (such as Sandhills Lily and Pine Barrens Treefrog), develop individualized management and monitoring plans.

REMNANT SANDHILLS MEADOW COMMUNITIES

Utility easements and corridors often provide habitat conditions uniquely suited to rare plant species that have historically relied on fire or other disturbance. The periodic mowing and clearing of brush and other woody vegetation replaces the historic role of natural disturbances and creates refugia for rare and sensitive species in an otherwise disturbance-free landscape (Sheridan, 1997).

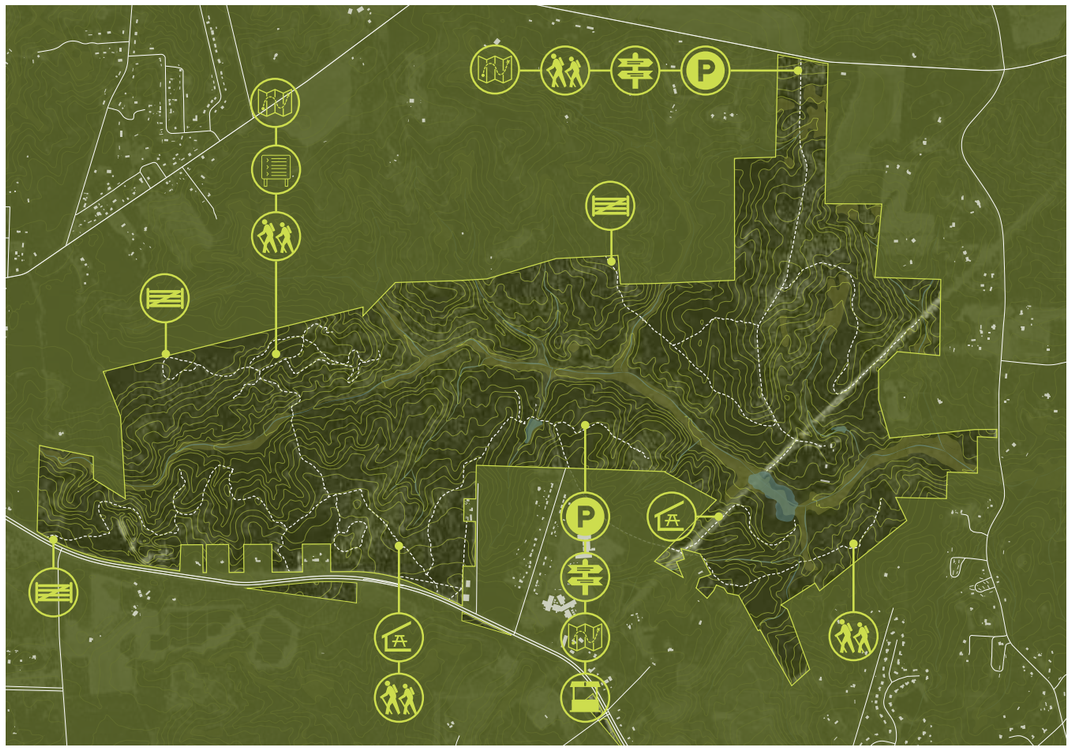
The utility easement that crosses the eastern part of the site (Duke Energy) extends across significant portions of the Sandhills, including Sandhills Game Lands and Voncannon Longleaf Pine Forest to the south, and the Eastwood Plant Conservation Preserve to the north. This right-of-way has many documented occurrences of rare and endangered species including Sandhills Lily, Pine Barrens Treefrog, and Chapman's Yellow eyed grass (among many others), and also supports populations of unique carnivorous plants such as Sundews and Pitcher Plants.

Duke Energy maintains overall management control of this right-of-way, but has expressed cooperation with underlying landowners and managers who are taking the lead on site-specific management plans. The right-of-way located within the study area has three identified rare or endangered plant species as well as rare plant communities that depend on the regular disturbance. This is a truly unique refugia for these natural communities, and a management plan that best supports these species should be developed and implemented. The recommendations above are based on conversations and correspondence with members of the Sandhills Conservation Partnership.

RECREATION + PUBLIC ACCESS

PROGRAMMATIC CONSIDERATIONS

With trails and roads already established, as well as access points in place, the site requires minimal infrastructure improvements for safe public accessibility. The icons below illustrate specific interventions and site elements that need to be addressed before opening to the public, and where they occur on the site. Depending on the preferred level of accessibility, these site improvements can be completed in a short period of time.



TRAILS

Areas where access will be permitted need trail maintenance before public use. In some areas this is as simple as installing maps and markers, but other areas require more extensive improvements and clearing.

MAPS & WAYFINDING

Maps of the site, including designated trail networks and points of interest, should be developed. Trail markers or blazes should be installed along all trails, and trail mileage should be indicated.

KIOSKS

Kiosks located at trailheads, shelters, and other points of interest provide park rules, information about upcoming events, maps, and interpretive elements.

SHELTERS

Picnic shelters and/or shade structures located at points of interest provide resting and gathering areas for recreational users and also support outdoor learning activities of school groups and other educational programs.

TRAILHEADS

Designated trailheads should be identified and all other informal access areas should be gated or restricted. Maps, signage, and park rules should be clearly visible at trailheads.

PARKING AREAS

Establish parking areas at all trailheads with access for emergency vehicles. Required number of spaces depends on number of access areas and anticipated trail use.

SIGNAGE

Develop signage for trail maps, interpretive signs and exhibits, entry signs, and other informational materials to be displayed throughout the site. Exhibits from this document can be used to inform interpretive signs, if desired.

GATES

Install gates to limit off-hours access from trailheads and parking lots, and install gates at all emergency access points and informal trailheads.

EDUCATION & OUTDOOR LEARNING

PROGRAMMATIC CONSIDERATIONS

K-12 CURRICULUM ALIGNMENT

The proximity of the study area to West Pine Middle School and West Pine Elementary School affords unique opportunities for educational programming that aligns with Moore County's STEM and Physical Education programs. These two schools are within walking distance of the site, and can utilize educational site components regularly. The site can also be a draw for groups from other schools in Moore County, as well as some of the nearby metropolitan areas. Field trip programming should align with school group programs already established by the Southern Conservation Trust, or be self-directed by instructors and students utilizing educational signage and materials.

SUMMER CAMP & AFTER-SCHOOL

The size and ecological value of the study area can provide opportunities for extracurricular education through afterschool programming and summer camps. These types of programs are popular at the nearby Weymouth Woods Sandhills Nature Preserve, a State Park with ranger-led educational programs. This type of week-long or afterschool curriculum also aligns with established SCT programs including Camp Wild and Adventure Camp.

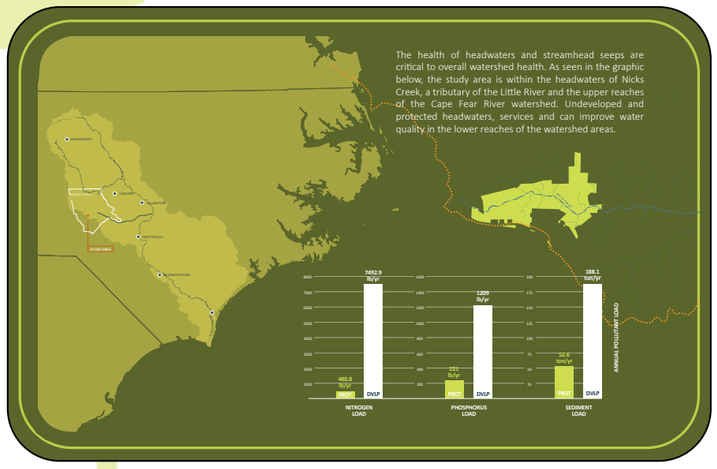
SITE INTERPRETATION

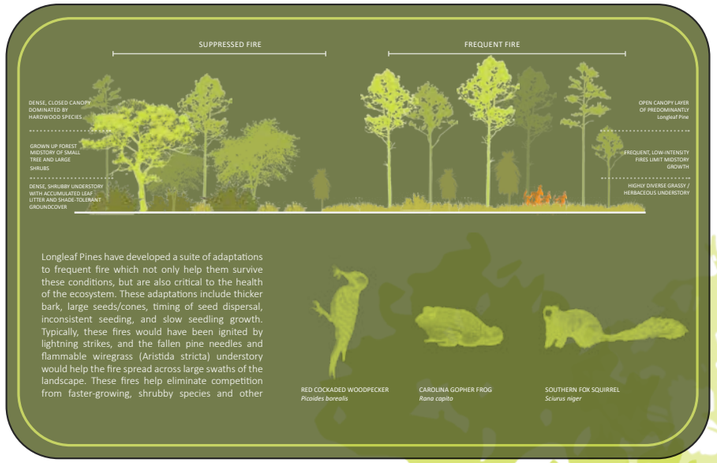
PUBLIC EDUCATION & OUTREACH

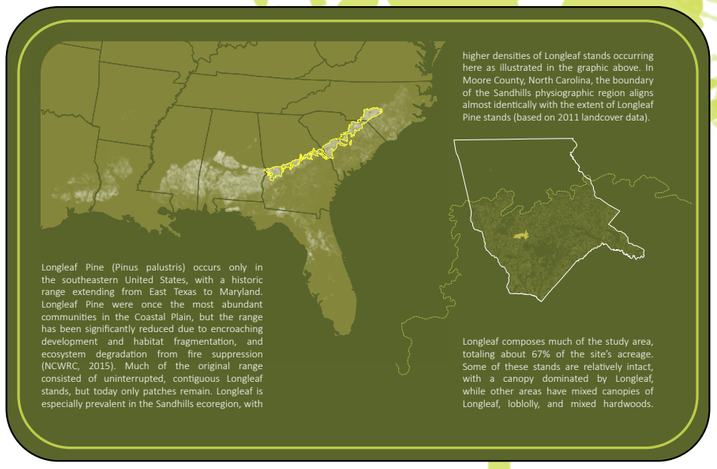
ENVIRONMENTAL EDUCATION & OUTREACH

If public access for recreational and educational purposes is encouraged on the site, educational and interpretive signage should be developed and installed at trailheads, along trails, and near shelters. The unique ecology, cultural history, and conservation value of this site provide ample material to highlight in interpretive signage and displays. Additionally, signage specific to the management strategies and demonstration areas on the site should be developed as educational tools to promote sustainable and innovative Longleaf management.

Exhibits developed for this document make a great starting point for educational and promotional materials and can be adapted to target a range of audiences. Educational signage can be used as a public education tool or incorporated into public school field trip curriculum or naturalist-led events on the site.







EXAMPLE OF ENTRANCE AND INTERPRETIVE SIGNAGE

RESEARCH & MONITORING

PROGRAMMATIC CONSIDERATIONS

OPPORTUNITIES FOR PARTNERSHIP

There is an ongoing need throughout the Sandhills for research and monitoring of Longleaf forests and the associated rare and sensitive species. There are numerous local and regional organizations and educational institutions already conducting similar research or who might be involved in a research and monitoring partnership. Ongoing research can align with broader regional efforts or can be site-specific monitoring of specific stands related to the effectiveness of management. The proximity to nearby RCW clusters, and the historic clusters observed imply that with proper management the site will be suitable for RCW translocation and monitoring.

The North Carolina Wildlife Action Plan (2015) identified the following research areas critical to Longleaf and priority species conservation:

+ Habitat use and preferences
+ Reproductive behavior
+ Population dynamics and genetics
+ Feeding, competition, and food web dynamics
+ Long-term research studies to investigate various methods for restoring and maintaining Longleaf Pine ecosystems including herbicides, fire, clearcutting, site preparation techniques, and management practices

Additionally, the North Carolina Wildlife Resources Commission has identified the following priority research, survey, and monitoring needs (excerpt from NCWRC, 2011):

+ Document the status and distribution of small mammals, bats, and Southern Fox Squirrel
+ Initiate long-term monitoring related to snag ecology and cavity nesting birds during different seasons
+ Initiate long-term monitoring during breeding, winter, and migration periods for all priority landbirds
+ Initiate long-term monitoring for priority reptiles and amphibian species associated with dry longleaf pine systems
+ Explore spatial and temporal distribution patterns of amphibians related to temporary and scattered water sources
+ Study predator and cowbird parasitism effects on bird productivity for canopy- and ground-nesting birds
+ Study the effect of fire ants on ground nesting birds and herpetofauna
+ Examine the effects of red-cockaded woodpecker management on other birds and reptiles, amphibians, and bats
+ Develop strategies for pine straw raking that minimizes impacts to understory habitat structure
+ Examine the effects of intensive fire management on the habitat requirements of the Southern Fox Squirrel
+ Examine the effects of herbicides used to control hardwoods on non-target herbaceous plants; also, study techniques and preferred chemicals for hardwood control that have the least negative impacts on non-target herbaceous plants

IMAGE CREDIT: SANDHILLS ECOLOGICAL INSTITUTE

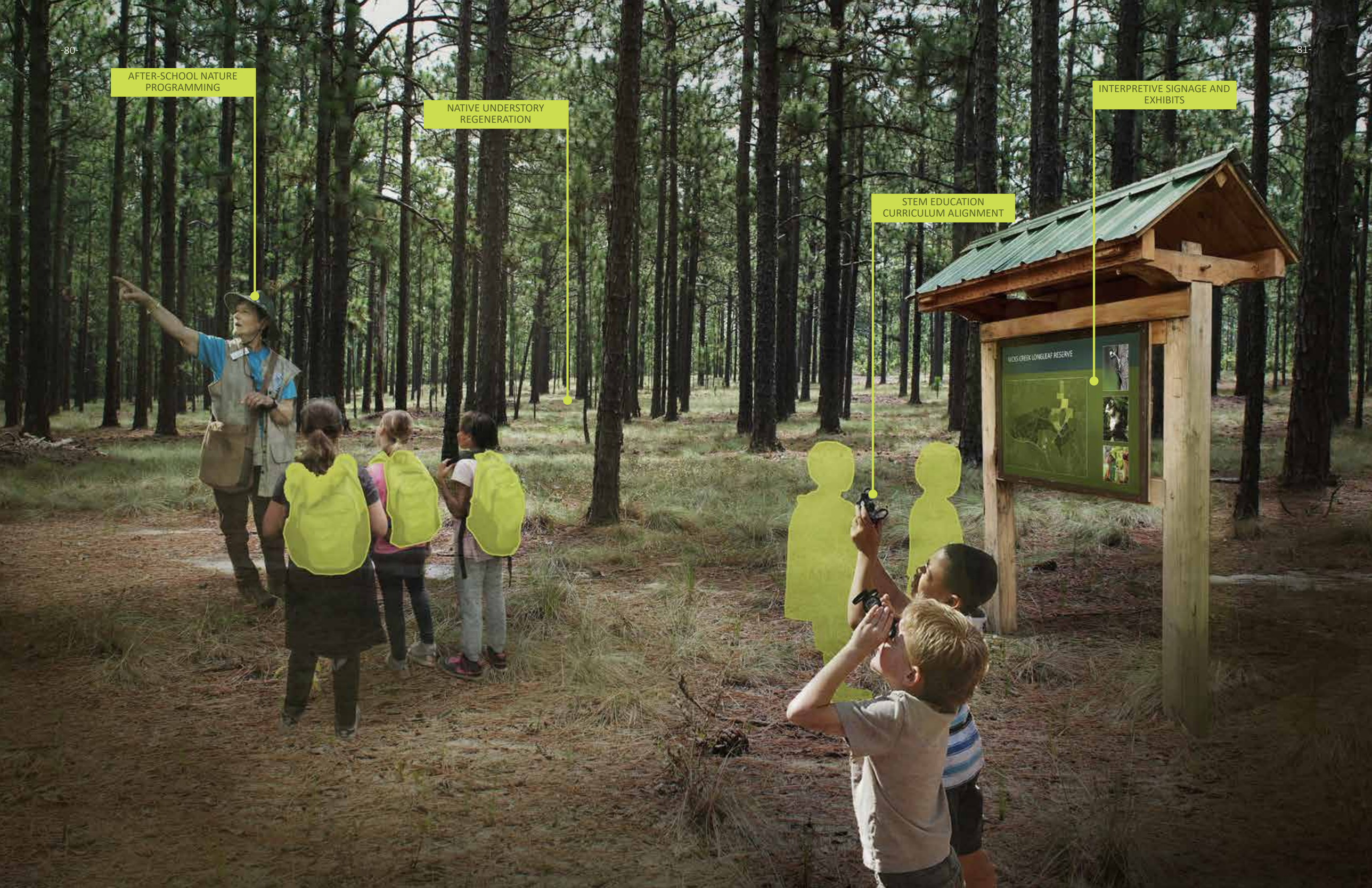
PROGRAMMATIC ILLUSTRATIONS

EXAMPLES OF PUBLIC USE

The findings of this study demonstrate that the subject property has the potential to serve the general public by:

+ Providing recreational opportunities for local residents and visitors across much of North Carolina
+ Implementing and demonstrating best practices for Longleaf management and restoration
+ Providing educational opportunities that highlight the value and uniqueness of Longleaf ecosystems
+ Creating partnership opportunities to advance critical research and monitoring efforts

The following pages illustrate the programs and scenarios identified and discussed in earlier sections of this report and show unique opportunities for the overlapping priorities of research, management, education, and recreation at Nicks Creek Longleaf Reserve.


AFTER-SCHOOL NATURE PROGRAMMING
NATIVE UNDERSTORY REGENERATION
STEM EDUCATION CURRICULUM ALIGNMENT
INTERPRETIVE SIGNAGE AND EXHIBITS
UCKS CREEK LONGLEAF PRESERVE


LONGLEAF RESTORATION SITE
SITE INTERPRETATION AND EDUCATION
8 MILES OF RECREATIONAL TRAILS


SUCCESSFUL ESTABLISHMENT OF RCW CLUSTERS
RESEARCH AND MONITORING BY PARTNERING INSTITUTIONS
RCW TRANSLOCATION AND MONITORING

PRESCRIBED BURNING AT REGULAR INTERVALS

CITIZEN BURN CERTIFICATION IN PROGRESS

IMPROVED DIVERSITY OF HERBACEOUS UNDERSTORY

LEARN + BURN COMMUNITY WORKSHOP

SUMMARY & APPENDICES

REFERENCES

This report, including the maps, photographs, diagrams, and data analysis represents the Nicks Creek Longleaf Reserve property at the time of the study (May - September 2020). The contents represent, to the best of the research team's abilities, the conservation values, potential public benefits, management considerations, and programmatic opportunities of this unique property as they align with the mission and values of the Southern Conservation Trust.

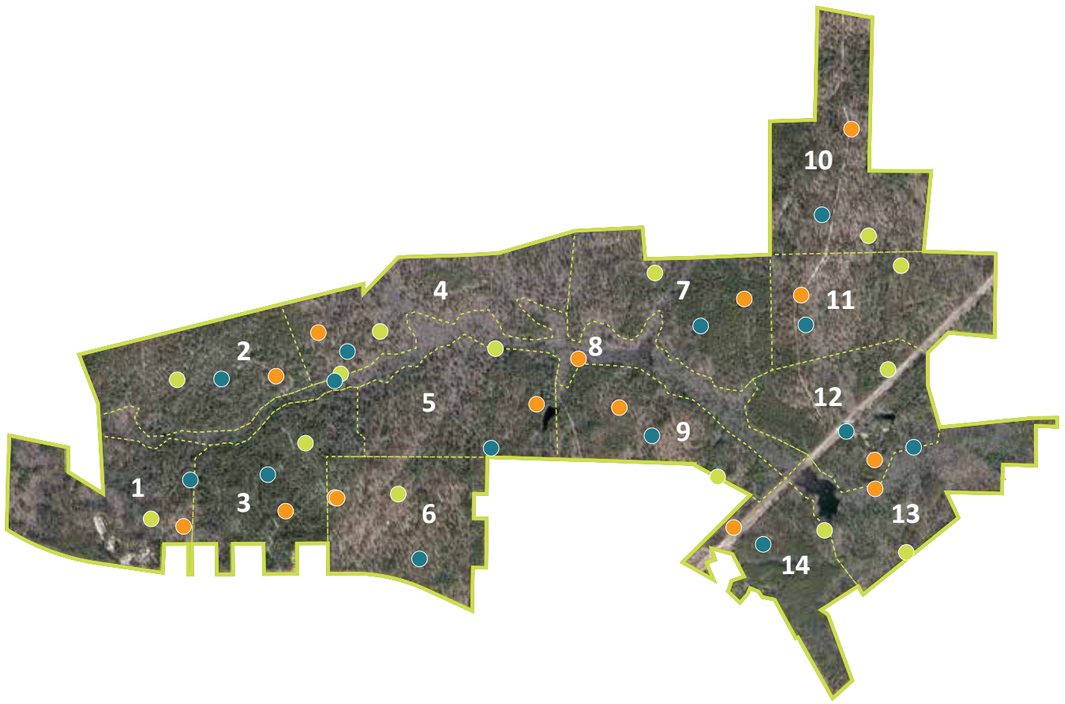
The remaining pages provide additional resources that were either cited in the creation of this report or are believed to be of potential future use to the Southern Conservation Trust in informing management and programming decisions.

APPENDIX I

METHODOLOGY FOR RECORDING WILDLIFE ACTIVITY

In order to capture patterns of wildlife present at Nicks Creek Longleaf Reserve, motion-triggered wildlife cameras were placed within the study area and periodically moved to new locations. Each camera was assigned to a zone that was delineated in ArcGIS Pro. The 14 zones were roughly the same size (approximately 100 acres) and delineated based on landcover data and high-resolution orthophotographs so that each zone was more or less composed of a single landcover class or habitat type. The zones are roughly the same shape, except Zone 8, which includes the blackwater stream and associated floodplain forest that runs east-west across the entire site. This zone was delineated using the wetland and floodplain boundaries, and is therefore an irregular shape. Each camera was assigned to a zone, and moved three times within that same zone over the course of the study. The three rounds of wildlife activity photography occurred during the following dates:

- Round 1: May 2, 2020- June 17, 2020
- Round 2: June 17, 2020- July 29, 2020
- Round 3: July 29, 2020- August 30, 2020



APPENDIX II

SUPPLEMENTAL WILDLIFE CAMERA PHOTOS

The following images in “Appendix II. Supplemental Wildlife Camera Photos” provide additional photographs of the 42 wildlife camera locations utilized within the duration of the project reporting. These images are representative of the property during a 17-week period spanning from May 2, 2020- August 30, 2020.

SOUTHERN FOX SQUIRREL. ZONE 11: AUGUST, 22 2020 (4:46PM)

WHITE-TAILED DEER. ZONE 7: AUGUST 17, 2020 (1:27 PM)

WILD TURKEYS. ZONE 12: AUGUST 16, 2020 (3:02 PM)

COYOTE. ZONE 7: JUNE 2, 2020 (10:55 AM)

GREAT BLUE HERON. ZONE 13:
MAY 9, 2020 (3:51 PM)

WHITE-TAILED DEER FAWN. ZONE 3: JULY 25, 2020 (8:38 AM)

BOBCAT. ZONE 12: JUNE 18, 2020 (7:13 PM)

WHITE-TAILED DEER AND FAWN. ZONE 1: JULY 21, 2020 (6:46 PM)

BARRED OWL. ZONE 6: AUGUST 14, 2020 (8:33 PM)

COYOTE AND PUPS. ZONE 4: JUNE 15, 2020 (9:55 AM)

WHITE-TAILED DEER. ZONE 4: AUGUST 21, 2020 (7:08 AM)

WILD TURKEY. ZONE 2: JULY 21, 2020 (1:35 PM)

GRAY SQUIRREL. ZONE 1:
JULY 31, 2020 (6:00 PM)

GRAY FOX. ZONE 10: MAY 28, 2020 (3:43 PM)

WHITE-TAILED DEER. ZONE 14: MAY 26, 2020 (7:27 AM)

AMERICAN CROW. ZONE 13: JULY 28, 2020 (12:16 PM)

SOUTHERN FOX SQUIRREL. ZONE 4:
JUNE 21, 2020 (10:43 AM)

RACCOON AND KITS. ZONE 9: AUGUST 21, 2020 (1:02 AM)

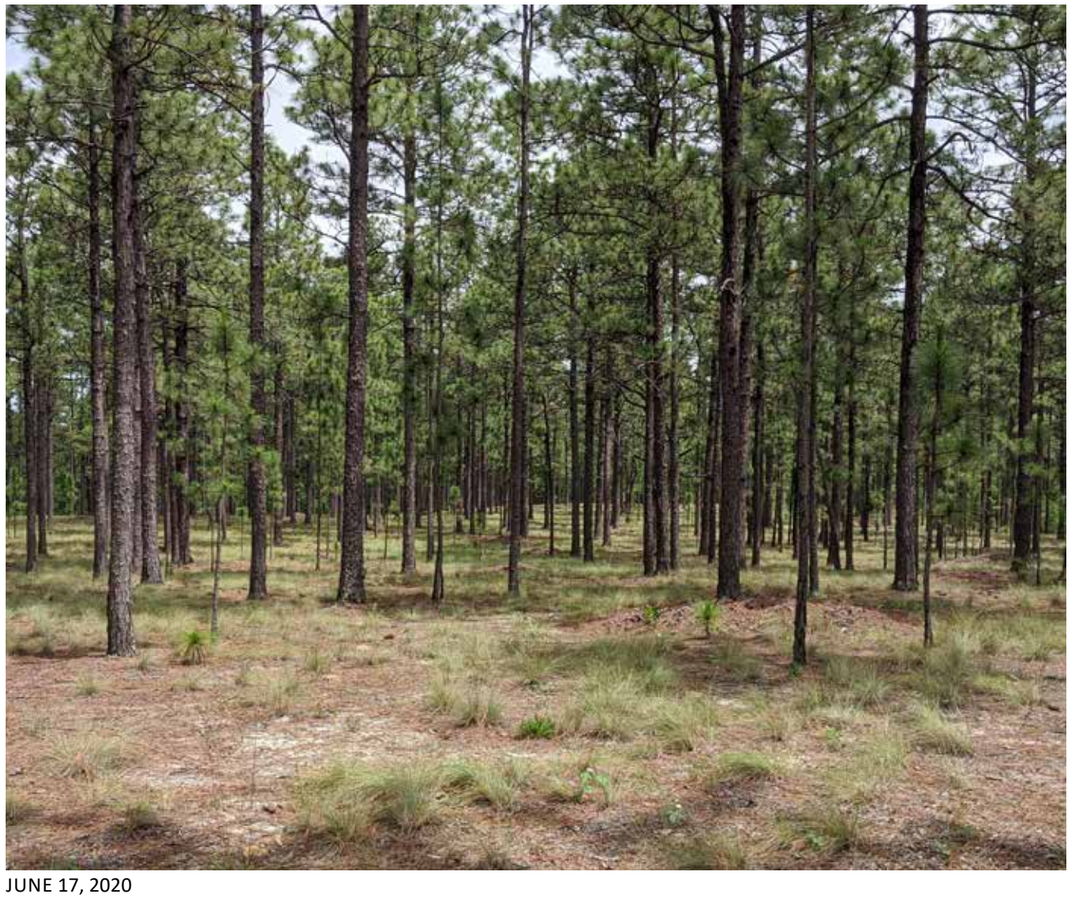
APPENDIX III

SUPPLEMENTAL SITE PHOTOGRAPHY

The following images in “Appendix III. Supplemental Site Photography” provide additional photographs taken across the study area during the duration of project reporting from May 2, 2020- August 20, 2020. All photographs were taken by members of the project team on the ground or with a drone. Subject matter includes site details, native flora and fauna, and broader views of the various landscape and habitat typologies.

JUNE 17, 2020

JUNE 17, 2020



JUNE 17, 2020

JULY 29, 2020

MAY 3, 2020

JULY 29, 2020

JULY 8, 2020

MAY 3, 2020

JULY 8, 2020

MAY 3, 2020

JULY 8, 2020

JULY 29, 2020

MAY 3, 2020

JULY 8, 2020

JULY 29, 2020

MAY 3, 2020

JULY 29, 2020

JULY 8, 2020

MAY 3, 2020

JULY 8, 2020

JULY 8, 2020

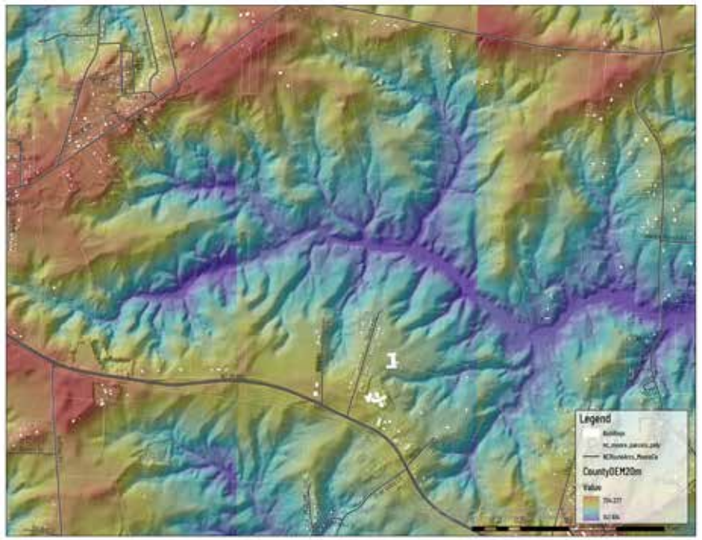
JULY 8, 2020

MAY 3, 2020

APPENDIX IV

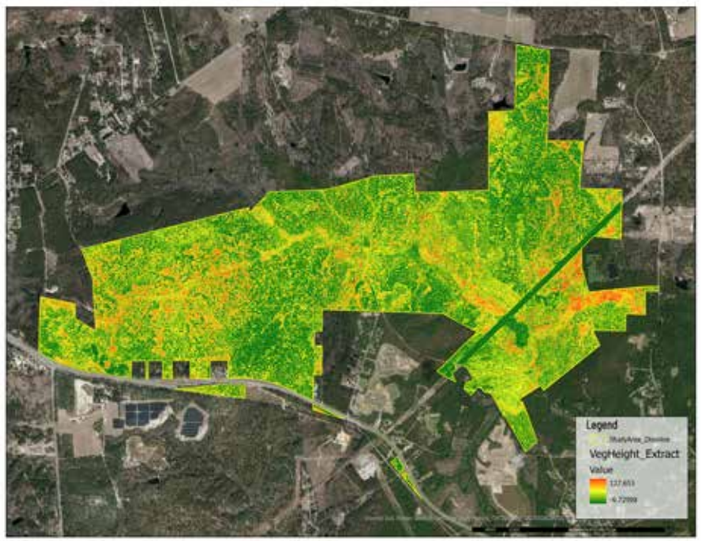
GIS MAP EXPORTS

The following images in “Appendix IV. GIS Map Exports” provide the raw data export graphics from ArcGIS Pro that were produced during the site inventory and site analysis phases of due diligence for this study. These exported images were graphically modified in earlier sections of this report for clarity and legibility purposes.

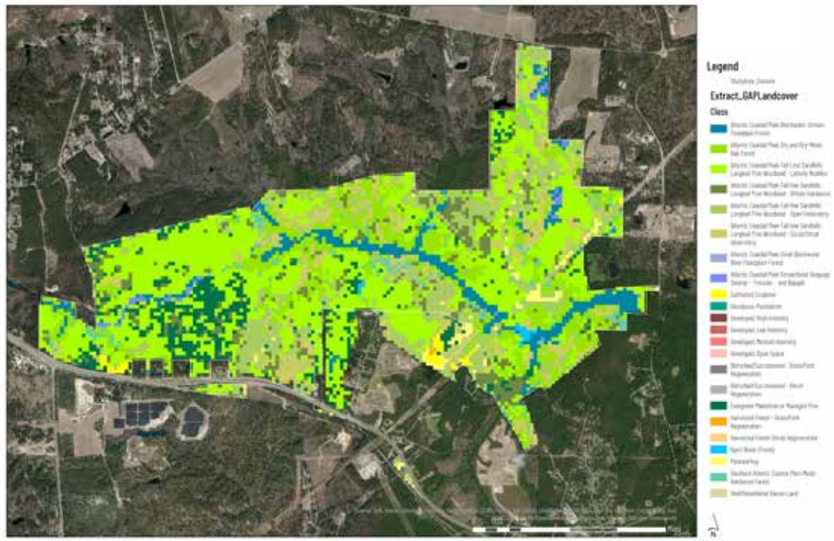


DIGITAL ELEVATION MODEL + HILLSHADE

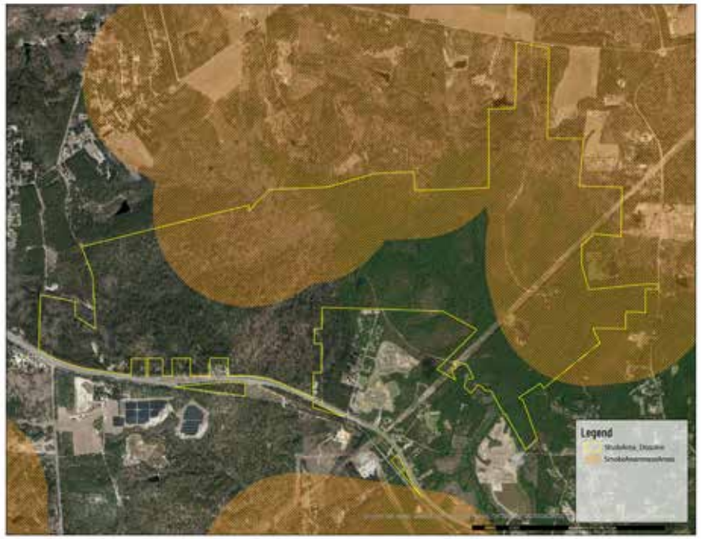
FLOODPLAIN



VEGETATIVE HEIGHT



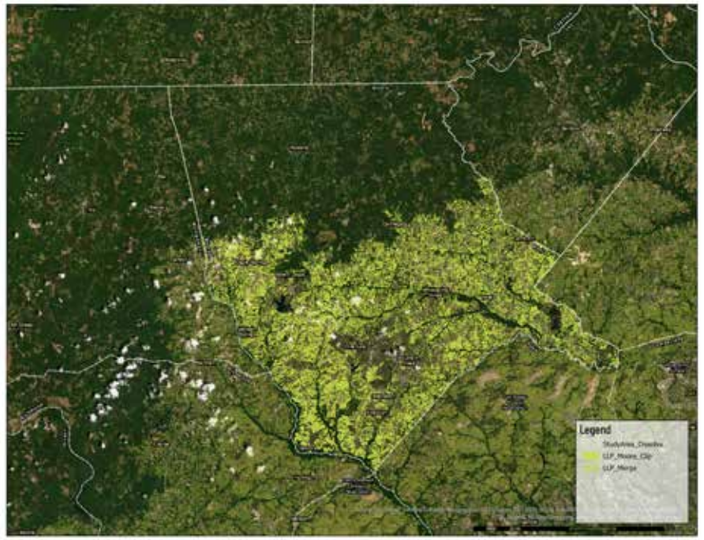
LANDCOVER



DESIGNATED SMOKE AWARENESS ZONES

BLUE-LINE STREAMS AND DESIGNATED WETLANDS

LONGLEAF PINE RANGE



LONGLEAF PINE DISTRIBUTION IN MOORE COUNTY, NC

APPENDIX V

POTENTIAL RESEARCH PARTNERS

The following list identifies educational institutions in the region with colleges and/or departments that could align with research and monitoring initiatives at Nicks Creek Longleaf Reserve. These institutions should be considered as potential programmatic and research partners in addition to the organizations listed on page 51 of the report.

North Carolina State University | Raleigh, NC
College of Natural Resources
Undergraduate programs: Environmental Sciences; Fisheries, Wildlife, and Conservation Biology; Forest Management
Graduate programs: Forestry and Environmental Resources

Duke University | Durham, NC
Nicholas School of the Environment
Undergraduate programs: Environmental Sciences and Policy
Graduate programs: Master of Environmental Management; Master of Forestry

University of North Carolina | Chapel Hill, NC
College of Arts and Sciences
Environment, Ecology and Energy Program
Undergraduate degrees: Environmental Sciences; Environmental Studies
Graduate degrees: Ecology

Montgomery Community College | Troy, NC
Forest Management Technology
Forest Management Technology AAS; Wildlife Certificate; Recreation Certificate

Wayne Community College | Goldsboro, NC
Forest Management Technology
Forest Management Technology AAS; Wildlife Certificate; Natural Resource Certificate

Haywood Community College | Clyde, NC
Natural Resources Management
Forest Management Technology AAS; Fish and Wildlife Management Technology AAS

Western Carolina University | Cullowhee, NC
College of Arts and Sciences; Geosciences and Natural Resources Department
Undergraduate programs: Natural Resource Conservation and Management; Environmental Science

University of Georgia | Athens, GA
Warnell School of Forestry and Natural Resources
Undergraduate programs: Forestry; Natural Resource Management and Sustainability
Graduate degrees: Master of Forest Resources; Master of Natural Resources
Odum School of Ecology
Graduate program: Conservation Ecology and Sustainable Development

Virginia Tech | Blacksburg, VA
College of Natural Resources and Environment
Department of Forest Resources and Environmental Conservation
Undergraduate programs: Environmental Conservation and Society; Environmental Resources Management; Forestry
Graduate programs: Forestry; Master of Natural Resources
Department of Fish and Wildlife Conservation
Undergraduate: Wildlife Conservation
Graduate: Fisheries and Wildlife Sciences

Clemson University | Clemson, SC
College of Agriculture, Forestry and Life Sciences
Department of Forestry and Environmental Conservation
Undergraduate programs: Ecology; Environmental and Natural Resources; Forest Resources Management; Wildlife and Fisheries Biology
Graduate programs: Forest Resources; Wildlife and Fisheries Biology

APPENDIX VI

GIS DATA SOURCES

All layers were projected to the NAD 1983 State Plane North Carolina FIPS 3200 (US Feet) Coordinate System

MOORE COUNTY BOUNDARY
Moore County GIS Portal
https://www.moorecountync.gov/gis

NORTH CAROLINA STATE BOUNDARY
United States Census
https://www.census.gov/cgi-bin/geo/shapefiles/index.php

PARCELS
Moore County GIS Portal
https://www.moorecountync.gov/gis

BUILDING FOOTPRINTS
Moore County GIS Portal
https://www.moorecountync.gov/gis

CARBON SEQUESTRATION OF EXISTING FORESTS RASTER
Duke University- Natural and Working Lands Data
https://research.repository.duke.edu/concern/parent/4m90dw143/datasets/h128nf171

TOPOGRAPHY - 2' CONTOURS
NC One Map GIS Portal
https://www.nconemap.gov/

DIGITAL ELEVATION MODEL
North Carolina Emergency Management Spatial Data Download Portal
https://sdd.nc.gov/DataDownload.aspx

LiDAR
North Carolina Emergency Management Spatial Data Download Portal
https://sdd.nc.gov/DataDownload.aspx

LANDCOVER RASTER
GAP/LANDFIRE National Terrestrial Ecosystems 2011 Raster
https://www.usgs.gov/core-science-systems/science-analytics-and-synthesis/gap/science/land-cover-data-overview?qt-science_center_objects=0#qt-science_center_objects

LANDCOVER RASTER
National Landcover Dataset
https://www.mrlc.gov/

MANAGED AREAS
NC Natural Heritage Program Data Download
https://ncnhde.natureserve.org/content/data-download

NATURAL HERITAGE PROGRAM NATURAL AREAS
NC Natural Heritage Program Data Download
https://ncnhde.natureserve.org/content/data-download

FLOODPLAIN
North Carolina Emergency Management Spatial Data Download Portal
https://sdd.nc.gov/DataDownload.aspx

CAPE FEAR WATERSHED
NC Department of Environmental Quality Online GIS
https://data-ncdenr.opendata.arcgis.com/

WETLANDS
NC Wetlands Geodatabase - National Wetlands Inventory
https://www.fws.gov/wetlands/data/data-download.html

STREAMS + RIVERS
National Hydrography Dataset
https://www.usgs.gov/core-science-systems/ngp/national-hydrography

ORTHO-IMAGERY
NC One Map GIS Portal
https://www.nconemap.gov/

SMOKE AWARENESS AREAS
NC Natural Heritage Program Data Download
https://ncnhde.natureserve.org/content/data-download

STATE-OWNED LANDS
NC One Map GIS Portal
https://www.nconemap.gov/

RARE + ENDANGERED SPECIES ELEMENT OCCURENCES
NC Natural Heritage Program Data Request

PARKS
Moore County GIS Portal
https://www.moorecountync.gov/gis

HIGHWAYS + ROADS
Connect NCDOT GIS Data Layer Download
https://connect.ncdot.gov/resources/gis/Pages/GIS-Data-Layers.aspx

APPENDIX VII

REFERENCES AND ADDITIONAL RESOURCES

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APPENDIX VIII

CITATIONS FOR ICONS INCLUDED IN REPORT

MONTHLY CALENDAR icon by iconsphere from the Noun Project
BULLDOZER icon created by Bayu Ardhy from the Noun Project
PITCHFORK icon by lastspark from the Noun Project
BALES OF HAY icon by chappara from the Noun Project
ROTATE icon by icon 54 from the Noun Project
TREES icon by Made by Made from the Noun Project
CONNECTION icon by Ecem Afacan from the Noun Project
LILY icon by Pham Duy Phuong Hung from the Noun Project
TRACTOR Plowing icon by Symbolon from the Noun Project
SHRUB icon by Laymik from the Noun Project
CAR icon by Lluisa Iborra from the Noun Project
HOUSE icon by Sherrinford from the Noun Project
AIRPLANE icon by Mat fine from the Noun Project
FIRE icon by Aisyah from the Noun Project
HIKER icon from johanna from the Noun Project
RESEARCH icon by Nikita Kozin from the Noun Project
EDUCATION icon by DPIcons from the Noun Project
PLANT icon by Chris Homan from the Noun Project
WATER DROPLETS icon by Adnen Kadri from the Noun Project
HIKERS icon by Ben Alderfer from the Noun Project
TRAILHEAD icon by Nick Kinling from the Noun Project
MAP icon by habione 404 from the Noun Project
KIOSK icon by Vectors Market from the Noun Project
SIGN icon by Made x Made from the Noun Project
SHELTER icon by National Park Service, US from the Noun Project
GATE icon by Martin Turner from the Noun Project
PARKING icon by Melvin Salas from the Noun Project