Site Conservation Plan for the NC Sandhills

Written by Lindy Nelson

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On behalf of the members of the North Carolina Sandhills Conservation Partnership (NCSCP), the U.S. Fish and Wildlife Service would like to thank the Department of Defense Legacy Program for its 2002 funding to the Army Environmental Center. DoD Legacy Resource Management Program funded several important projects that generated critical data used to formulate a Conservation Reserve Design for the North Carolina Sandhills.   In particular, we acknowledge the DoD Legacy Program's contribution to the completion of two Natural Community Inventories for Hoke and Scotland Counties, the construction of a region-wide GIS database housing over 300 data layers, the first comprehensive red-cockaded woodpecker regional database for the Sandhills, research to determine habitat requirements for two federal species of concern and, the development of a 2000 land cover dataset for the Sandhills. All the information generated from these projects is now available to our partners and other stakeholders in the NCSCP which include the Army Environmental Center and Fort Bragg. Without the support of the DoD Legacy Program, these projects and the invaluable information they provided would not have been possible.

Respectfully,

Peter V. Campbell
NC Sandhills RCW Recovery Coordinator
U.S. Fish and Wildlife Service

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Citation

The Nature Conservancy. 2004. *The Sandhills Conservation Plan.* The Nature Conservancy and US Fish and Wildlife Service. Southern Pines, NC. 83 pp., plus appendices.

EXECUTIVE SUMMARY

Introduction
The *Site Conservation Plan for the NC Sandhills* (*Conservation Plan*) has been written to fulfill dual objectives. One objective is to create an ecologically based directive for the conservation of biodiversity within The Nature Conservancy's Sandhills Project. The other objective is to develop a unifying conservation plan within the NC Sandhills Conservation Partnership that will coordinate the multiple tasks of and share information between the member organizations to produce more efficient conservation work. The NC Sandhills Conservation Partnership (Partnership) is composed of seven organizations and an edict to develop and implement conservation strategies to protect the biodiversity of the Sandhills. To perform this function, the Partnership is further organized into six working groups that focus on different roles of the partnership. These working groups include the Red Cockaded Woodpecker Recovery Working Group, the Communications Working Group, the Natural Resource Working Group, the Land Protection Working Group, the GIS Working Group and the Reserve Design Working Group. Seeking joint opportunities with other existing partnerships has been identified as another means to expand the capacities of the NC Sandhills Conservation Partnership in this mission. With consideration to the diverse functions and perspectives of multiple organizations, the *Conservation Plan* will act as a resource and guide to Partnership members. Future drafts of the document will assimilate updated data relevant to conservation work in the Sandhills and incorporate more detailed ecological and spatial models.

Planning Process
Development of the *Site Conservation Plan for the NC Sandhills* was based on the 5-S process, which was developed by The Nature Conservancy to focus conservation efforts on important elements of biodiversity at each of the organization's project sites. The premise for this process is an integrative, adaptive system of setting priorities, developing strategies, taking action and measuring success. This system is based on the "5-S Framework", which seeks to identify systems, stresses, sources of stress, strategies and (measures of) success for the delineated site boundary of the Sandhills. This process was initially begun in the summer of 2000 by a Nature Conservancy planning team, and the first draft of the *Site Conservation Plan for the NC Sandhills* is expected to be completed and adopted by the NC Sandhills Conservation Partnership by winter, 2005. The *Site Conservation Plan for the NC Sandhills* seeks to take this process a step further by incorporating spatial analysis of threats, targets and strategies through Geographic Information Systems (GIS). The development of this spatial analysis project will be an ongoing aspect of the Conservation Plan.

Sandhills Landscape Description
The boundary of the Sandhills conservation area is defined by the North Carolina portion of the Sandhills Fall-line, a series of highly diverse sandhills habitats formed by Pleistocene wind deposits. Sandhills biodiversity depends on a combination of relatively high rainfall, very porous, sandy soils and an active cycle of wildfires that creates a mosaic of longleaf pine community types. Longleaf pine forests, though once covering

over 90 million acres of the Southeastern US, are now greatly diminished and fragmented by human development. The history and current status of human activities in the Sandhills has greatly reduced the intact longleaf pine habitat in the Sandhills with much of this remnant within the boundaries of the Fort Bragg military installation. Fort Bragg, government agencies and other organizations are seeking to manage and protect this habitat not only for the endangered Red Cockaded Woodpecker and native biota, but also for military training purposes. However, the Sandhills is currently experiencing a surge in population growth, a trend that is expected to continue in the near future.

Conservation Targets
The 5-S Framework calls for the selection of conservation targets, which are species, community types or spatial arrangements of communities that, together, account for over 95% of the biodiversity of the Sandhills. Participants of the *Site Conservation Plan for the NC Sandhills* workshop series identified five conservation targets:
- Red Cockaded Woodpecker – a federally endangered, keystone species of longleaf pine forests.
- Longleaf Pine Mosaic – a greatly diminished forest type that consists of eight community type sub-targets, called "nested" targets, which are: xeric sandhill scrub, sand barren, pine/scrub oak sandhill, mesic transition, mesic pine flatwoods, wet pine flatwoods, river terraces and pine savanna.
- Streamhead Pocosins/Seep – a composite of three mesic to wet soil community types: canebrakes, Sandhills seep, streamhead Atlantic white cedar and streamhead pocosins.
- Blackwater Streams – a composite of aquatic and riparian stream communities: beaver ponds and successional meadows, floodplain forests and blackwater stream aquatic communities.
- Upland Depressional Wetlands – a composite of wetland communities that includes: vernal pools, small depressional ponds and small depressional pocosins.

Biodiversity Health Assessment
The Site Conservation Plan for the NC Sandhills seeks to establish baselines for the current health status of the selected targets in the areas of size, condition and landscape context. Size refers to the abundance or measure of area (i.e., acreage) of a target's occurrence. A target's condition is measured by the composition, structure, and biotic interactions that characterize the occurrence. Landscape Context is an integrated measure of both the dominant environmental regimes and processes that establish and maintain the target occurrence as well as connectivity. The Biodiversity Health Assessment is a valuable measure of current target health not only for the purposes of assessing threats and developing conservation strategies but for adapting, refining and measuring the success of NC Conservation Partnership activities in the Sandhills. Detailed health assessments for each target can be found on pages V-3 through V-16.

Threats Analysis
Threats to conservation targets are divided in two aspects: 1 – stresses to the targets biodiversity health, described as impaired biological attributes, and 2 – sources of stress, described as human activities that are known causes of a stress. By separating these two aspects of threat, the strategies selected for the Site Conservation Plan for the NC Sandhills will be focused on alleviating the stresses to conservation targets, while accommodating the necessary functions of human activity in the Sandhills. There are ten stresses that are recognized to affect the health of Sandhills targets: altered target composition/structure, altered hydrologic regime, altered natural fire regime, altered predator/prey relationships, habitat destruction or conversion, habitat fragmentation, destruction of uplands habitat (for wetland targets), nutrient loading, sedimentation and toxins/contaminants. There are also ten sources of these stresses that have been identified: primary home development, fire suppression, forestry practices, second home and resort development, roads, golf course construction and maintenance, pine straw production, livestock production practices, small dams on headwater tributaries and wastewater treatment. Four of these sources have been ranked very high or high: primary and secondary home development, fire suppression and forestry practices. The rankings of these stresses and sources of stress will guide subsequent strategy selections, spatial analysis and the development of the monitoring program.

Stakeholder Analysis
There are currently two reports that have been identified to have direct impacts on addressing stakeholder issues in Sandhills conservation efforts. The *Joint Land Use Study* looks into the issues of urban encroachment, losses of critical endangered species habitat and diminishing rural land uses that have affected and threaten to further limit the training abilities of the US Army and Air Force on Fort Bragg and Pope Air Force Base. *The Red Cockaded Woodpecker as an Asset: Creating Community Benefits from Habitat Restoration* is a study that focuses on the concerns and opportunities of residents of Hoke County and eastern Moore County, with specific relation to the recovery of the red-cockaded woodpecker, resource management, land protection and education and public relations. A more comprehensive stakeholder analysis would benefit implementation and selection of conservation strategies for the NC Sandhills Conservation Partnership in the future.

Conservation Strategy Framework
The *Conservation Strategy Framework* (*Framework*) outlines 37 strategic actions that hold the most promise to either directly or indirectly abate the threats that are currently weakening the biodiversity health of Sandhills conservation targets. The *Framework* employs a variety of strategies that will either: (1) – remove active sources of stress to targets, (2) – restore natural functions to targets, or (3) – develop the capacity of the NC Sandhills Conservation Partnership to perform conservation work. These strategies are organized under 10 objectives that were identified in Workshop II as most pertinent for both the protection of biodiversity in the Sandhills and the achievement of the Partnership's mission statement.

Monitoring Program

An effective monitoring program will track, through consistent inventory, the indicators of biodiversity health that are described in the Biodiversity Health Assessment, as well as measure the effects of threats to conservation targets. The development and refinement of this monitoring program will be ongoing. Indicators that are already being monitored by members of the NC Sandhills Conservation Partnership and other organizations must first be identified, with subsequent designation of other necessary indicators to be designated to Partnership members for monitoring in the future.

Current and Future Studies/Analysis

A number of studies, inventories and reports have been issued that have direct bearing on planning for Sandhills conservation targets, many of which have been integrated into the *Site Conservation Plan for the NC Sandhills*. These reports are listed with short descriptions in the full *Current and Future Studies/Analysis* section. Requirements for other data and analysis which will benefit future planning efforts and conservation work for the NC Sandhills Conservation Partnership will be documented for development and integration into future drafts of the *Site Conservation Plan for the NC Sandhills*.

INTRODUCTION

Plan Purpose
The *Site Conservation Plan for the NC Sandhills* (*Conservation Plan*) is written to fulfill two organizational objectives. First, for each project area (*see "conservation area" on map, Appendix A, p.1*), The Nature Conservancy creates a landscape-scale conservation plan based on ecological features that focuses conservation efforts and effectively allocates resources for protecting biodiversity. Second, the North Carolina Sandhills Conservation Partnership (Partnership) seeks to develop a comprehensive conservation plan for the Sandhills that incorporates new and existing cooperative action within its partners, as well develop joint ventures outside the Partnership with community and government organizations.

Because of these two overlapping objectives, the *Conservation Plan* has been jointly funded by The Nature Conservancy and US Fish and Wildlife Service, two representatives of the Partnership. By the adoption and implementation of the *Conservation Plan*, the Partnership strives to further its mission (stated below), strengthen its capacity for applying conservation strategies and broaden the network of cooperation in conservation work in the Sandhills.

The North Carolina Sandhills Conservation Partnership
The mission of the North Carolina Sandhills Conservation Partnership is to "coordinate the development and implementation of conservation strategies for the red-cockaded woodpecker, other native biota, longleaf pine and other ecosystems in the Sandhills of North Carolina compatible with the land use objective of the partners[1]." The Partnership is composed of seven organizations that have signed a cooperative charter: Army Environmental Center, Fort Bragg, Sandhills Ecological Institute, North Carolina Wildlife Resource Commission, The Nature Conservancy, Sandhills Area Land Trust and US Fish and Wildlife Service. For a perspective of lands managed by Partnership organizations, see map, *Appendix A, p.2*.

Other organizations lend input to the Partnership, especially through participation in the six working groups tasked with developing conservation strategies and actions. These six working groups are established for the following purposes:
- The Red Cockaded Woodpecker Working Group identifies key areas of landscape that need protection in order to recover the red-cockaded woodpecker population.
- The Land Protection Working Group identifies sources of funding and strategic properties that will increase the protection for key ecological resources.

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[1] North Carolina Sandhills Conservation Partnership Communications Working Group. 2004. *Draft Communications Plan.* North Carolina Sandhills Conservation Partnership. Unpublished.

- The Reserve Design Working Group develops, maintains and updates a conservation design that accounts for "all existing land use plans, relevant data and applicable land use tools and processes."[2]
- The Natural Resource Working Group identifies issues regarding the longleaf ecosystem management and develops recommendations to resolve the issues.
- The GIS Working Group has developed a central GIS database through the NC Department of Commerce, Division of Community Assistance (DCA) and works to streamline data sharing and resolve data issues.
- The Communications Working Group maintains open lines of communication between partners and develops methods for joint strategies of community relations and educational opportunities.

Other Partnerships of Conservation Significance in the Sandhills
There are a number of valuable partnerships executing conservation strategies outside the Partnership, and in different fields of work. Descriptions of some of these existing partnerships are described below:

Cape Fear River Assembly[3] – The purpose and actions of the Cape Fear River Assembly is to "provide for the highest quality of life possible for the residents of the Cape Fear River Basin, through the proper management of the Cape Fear River, its tributaries, and adjacent land uses." Begun in 1973, the organization is a partnership of a wide assortment of interests, which include representatives from conservation organizations, academic institutions, small businesses and industry, government (local, state and federal), and the residents of the Cape Fear watershed.

Cooperative Agreement: U.S. Department of the Army, Fort Bragg, the Army Environmental Center and The Nature Conservancy[4] – In 1995 TNC established a formal relationship via a Cooperative Agreement with the Army at Fort Bragg and the Army Environmental Center to conserve the longleaf pine ecosystem and RCW habitat on private lands around Fort Bragg. Both TNC and the Army put up money for the Conservancy to work with willing landowners to acquire priority parcels, or easements on parcels, identified by the Partnership.

Fort Bragg/Pope Air Force Base Regional Land Use Advisory Commission – The Regional Land Use Advisory Commission (RLUAC) is a group composed of military representatives and appointed local government officials who have, since 1991, strived to deal with a various issues of incompatible urban encroachment on the Fort Bragg military installation. This commission has spurred compatible land use planning efforts in neighboring counties and municipalities and, in 2003, commissioned a study (see *Joint*

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[2] Sandhills Conservation Partnership. 2004. Notes from the meeting of the Reserve Design Working Group. November 14, 2004. Unpublished.

[3] Cape Fear River Assembly, downloaded 8/4/04 from www.cfra-nc.org/acfra.html.

[4] Olstein, D. 2004. *Calloway Forest Management Plan.* NC Chapter – The Nature Conservancy, Sandhills Project. Unpublished.

Land Use Study, p. VII-1 in *Stakeholder Analysis*) by the NC DCA to recommend changes that could be implemented by Fort Bragg and its neighboring communities.

Safe Harbor Program – A partnership program of the US Fish and Wildlife Service (Fish and Wildlife), the Safe Harbor Program is a voluntary agreement between landowners and Fish and Wildlife to manage a property for the health of an endangered species (i.e., the red-cockaded woodpecker) in order to maintain a set of property rights that may otherwise be limited by the Endangered Species Act of 1973. Common examples of Safe Harbor agreements relating to the red-cockaded woodpecker might be a landowner's voluntary agreement to implement prescribed fire on the individual's property to manage for a certain amount of longleaf pine habitat, or to submit a habitat management plan that the individual agrees to follow. Landowners who join a Safe Harbor agreement consent to maintain the status and health of the current endangered species population and manage for new or increasing populations. Currently, 88 landowners have voluntarily joined the Safe Harbor Program in the Sandhills, providing protection for the red-cockaded woodpecker in areas that would otherwise not be managed or monitored.

Sustainable Sandhills Initiative – A partnership effort begun by the Fort Bragg military instillation, the Sustainable Sandhills Initiative (Initiative) seeks to balance environmental, military economic and social equity issues of the region through the development of a non-profit organization that will organize and facilitate region-wide cooperation and planning. This effort recognizes the Sandhills by the political boundaries of Cumberland, Harnett, Hoke, Moore, Richmond and Scotland counties. The Initiative looks to plan for five "media areas" that impact the region, which consist of water, air, materials use/waste, energy and land use. For each media area, a "media team" develops 25-year goals and 5-year objectives, with strategies carried out by all represented organizations. The Initiative's plans are adopted by its Leadership Council, members whom consist of local and regional governing bodies, state and federal agency representatives, planners, and representatives of business, citizen, education and non-profit communities in the Sandhills.

PLANNING PROCESS

The Nature Conservancy's Mission Statement
The mission of The Nature Conservancy is to preserve the plants, animals, and natural communities that represent the diversity of live on Earth by protecting the lands and waters they need to survive.

The Nature Conservancy's Vision Statement
The Nature Conservancy's vision is to conserve portfolios[1] of functional conservation areas within and across ecoregions. Through this portfolio approach, we will work with partners to conserve a full array of ecological systems and viable native species.

Conservation by Design

In 1997, The Nature Conservancy adopted the conservation approach laid forth in *Conservation by Design: A Framework for Mission Success*[2], by which the organization seeks to fulfill its mission statement and long-term vision. The Conservation by Design approach consists of four interrelated elements, as illustrated in Figure 1. These elements are defined as follows:

Figure 1: **Conservation by Design**
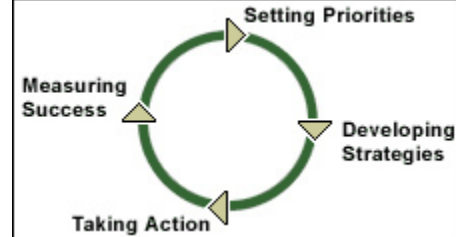
- Setting Priorities – Based on the distribution of species, communities and ecological systems that are found in a given ecoregion (in this case, the Mid Atlantic Coastal Plain), a network of prospective conservation areas are defined and prioritized for conservation action.
- Developing Strategies – Conservation areas that are selected for action undergo the 5-S Framework (a.k.a. Effroymsen Process) of site conservation planning. The Sandhills is an example of such a conservation area.
- Taking Action – The Conservancy employs a mix of strategies that include: implementing land and water conservation measures through acquisition or adaptive management, affecting the implementation of good public policy, and promoting or implementing development alternatives that are compatible with the conservation of biodiversity and achievement of neighboring communities' goals.
- Measuring Success – Based on the elements of biodiversity identified in the planning process, The Nature Conservancy measures the impact of its action strategies by monitoring the health of the species, natural communities and ecological systems that it seeks to protect and enhance.

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[1] For term definitions, please refer to the Glossary, p. IX-1 through IX-3.
[2] The Nature Conservancy. 2001. *Conservation by Design: A Framework for Mission Success*. The Nature Conservancy, Arlington, VA.

The *Conservation Plan* employs these fundamentals into a planning document that will guide the practices of the Partnership in the Sandhills. Furthermore, it is our hope that this plan for the conservation of Sandhills' biodiversity will be expanded and combined with ongoing planning efforts of the Partnership to develop a comprehensive conservation plan in the near future.

5-S Framework[3]

The 5-S Framework approach to site conservation is the organizational structure for The Nature Conservancy's conservation process. This framework incorporates the use of a computerized Microsoft Excel based workbook for entering, ordering and ranking data such as biological information and conservation action strategies. This framework is the basis for the selection of targets, threats and strategies for the *Conservation Plan*, and the tables generated from the use of this program have been collected for reference in *Appendix B*.

The process is identified by its five basic steps:
1. **S**ystems – Define the conservation targets occurring at a site and the natural processes that maintain them. These targets and processes will be the focus of the plan.
2. **S**tresses – Identify the types of degradation and impairment that affect the health and viability of the systems, or conservation targets.
3. **S**ources – Identify the human caused agents that generate stresses to the systems. The combination of stresses and sources composes the overall threat to a given target.
4. **S**trategies – Determine and select conservation activities that will abate the sources of stress (also, threat abatement) and persistent stresses (i.e., restoration).
5. **S**uccess – Select certain measures of biodiversity health and threat abatement to monitor the success of strategies and actions.

The 5-S process is designed to be adaptive and iterative, thereby allowing new or changing information to be incorporated into the ongoing planning process. Figure 2 illustrates the relationship between these planning steps as well as the types of strategies and data that influence the various steps.

Figure 2: 5-S Process

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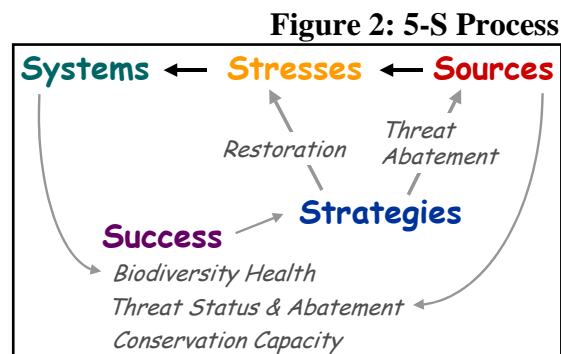
[3] For greater detail on The Nature Conservancy's 5-S framework, see *The Five-S Framework of Site Conservation: A Practitioner's Handbook for Site Conservation Planning and Measuring Conservation Success.* The Nature Conservancy. Arlington, VA. Third Edition: 2003.

Mapping and Spatial Analysis[4]
Early in the process of developing the *Conservation Plan*, it was identified that the 5-S
Framework does not include an extensive spatial element for use in identifying or
analyzing threats, targets or strategies. A number of planning projects have already
identified important aspects of the conservation picture for the Sandhills. An ongoing
intension of the *Conservation Plan* is to better integrate these projects into future drafts of
the document through spatial analysis and projection modeling[5]. Furthermore, gaps that
are discovered in existing biological or spatial data relating to selected targets, threats
and/or strategies will be the focus of future studies undertaken or commissioned by either
The Nature Conservancy, US Fish and Wildlife Service or other partners.

Maps and analysis for the *Conservation Plan* have been produced either through the
ArcGIS 3.2 or ArcInfo 8.3 software package and are assembled in *Appendix A*.

Process Timeline
November, 2004 – Completion of the final draft *Conservation Plan*.

August, 2004 –*Conservation Plan* – Peer Review: Submission of early Draft
Conservation Plan to contributors for review and comment.

July, 2004 –*Conservation Plan* – Internal Review: Submission of early Draft of
Conservation Plan to Rick Studenmund, The Nature Conservancy, and Pete Campbell,
US Fish and Wildlife Service.

June and July, 2004 – Specialists[6] referred to for more detailed target analysis, plan
writing and background research performed.

June 17, 2004 –*Conservation Plan* – Workshop II: Threats review and strategy
formulation were completed for the current *Sandhills Conservation Plan*.

June 10, 2004 –*Conservation Plan* – Workshop I: Targets, target viability and threats
analysis were completed for the current *Sandhills Conservation Plan*.

2000 – Sandhills conservation workshop series: first internal 5-S process for the Sandhills
completed by Nature Conservancy staff.

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[4] Maps and analysis for the *Conservation Plan* have been produced either through the ArcGIS 3.2 or
ArcInfo 8.3 software package.
[5] See *Section X: Future Studies and Analysis.*
[6] See Acknowledgments in *Table of Contents* for list of planning participants and specialists.

Figure 3: Conservation Plan – Conceptual Model
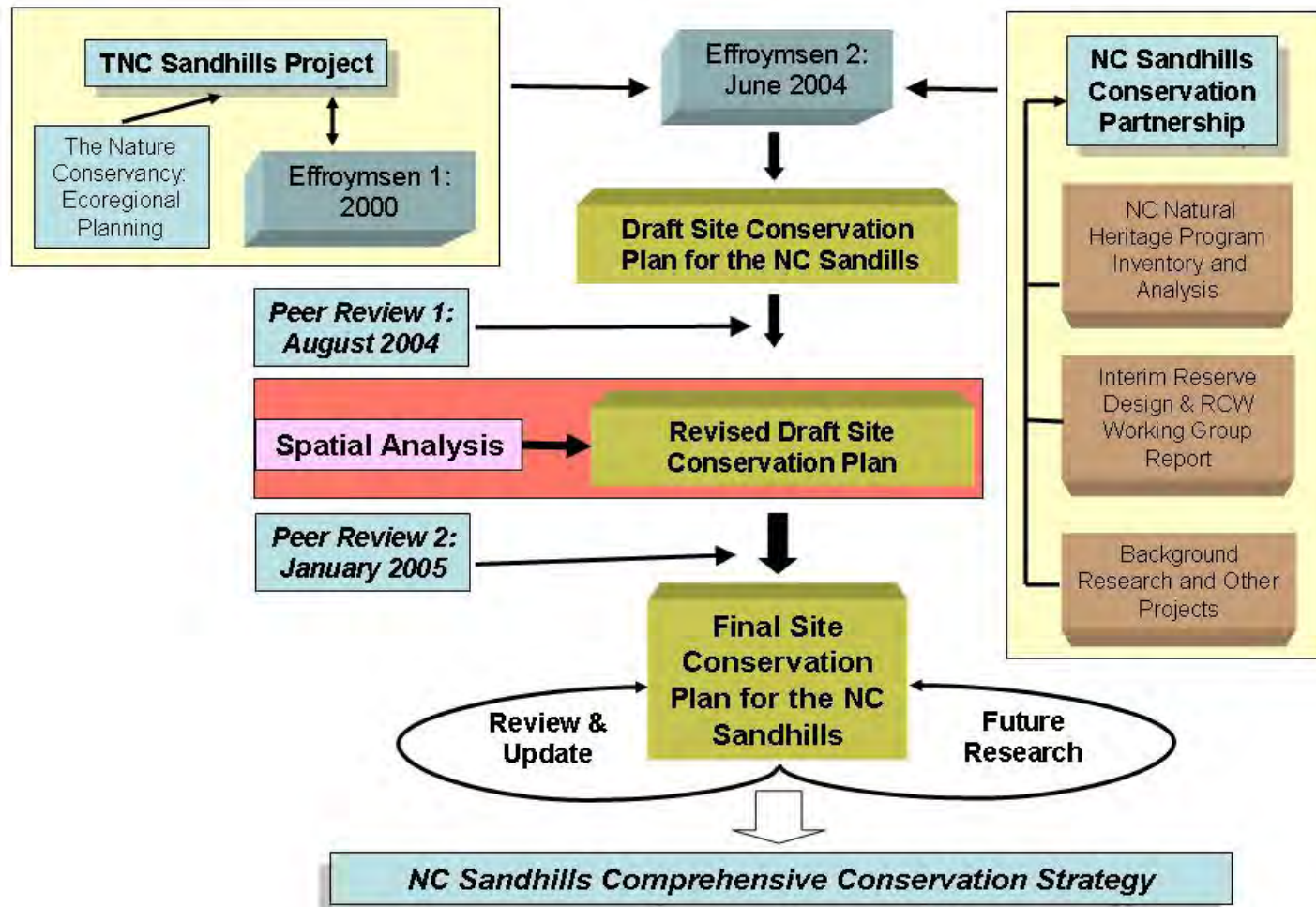
SANDHILLS LANDSCAPE DESCRIPTION

Introduction

The Nature Conservancy's 5-S planning process calls for the delineation of a conservation site or area, where the priorities and strategies for conservation will be identified and directed. The *Conservation Plan* is organized to address the Sandhills at a landscape scale, with the ultimate goal of maintaining the functionality of the landscape. Planning for a functional landscape requires focusing conservation efforts around a group of targets that represent biodiversity at various scales, which represent species, communities and ecological systems that are both known and unknown, and which will retain most or all of the key ecological components, patterns and processes of the area. The Sandhills conservation area does, in fact, still have most of the components, patterns and processes that are necessary for a functional landscape, but issues such as fire suppression, road, resort and residential development, and silvicultural and agricultural practices threaten to undermine many of these ecological elements. This section describes the general geographic, climactic, geomorphologic, ecological and human characteristics of the Sandhills conservation area.

Boundary and Size

The North Carolina Sandhills conservation area (Area) boundary is part of the Sandhills region, also known as the Fall-line Sandhills, formed first by deposition of marine clays and sands in the Upper Cretaceous Period, followed by an influx of material carried by rivers from the Piedmont, and subsequently reworked by wind, weathering and erosion[1] (*see map, Appendix A, p.1* for boundary delineation). This system supports up to 40% of the biodiversity of the North Carolina in just over 1 million acres, due to the diversity of topography, wetlands and drainages that result from these sandhill formations and clay based soils. The Fall-line Sandhills extends north from Georgia to South Carolina into southern North Carolina, including northern Hoke, eastern Richmond, northern Scotland, western Cumberland, Harnett, southern Moore and southern Lee counties of North Carolina.

Climate

Despite the extensive xeric communities that compose much of the Area, the Sandhills has a humid subtropical climate and experiences relatively high levels of precipitation. On average, the Area receives from 46-49 inches of annual precipitation evenly distributed throughout the year, with summer high temperatures averaging from ~83-92°F and winter high temperatures averaging ~52-64°F[2]. Natural disturbance is an important element of the Sandhills ecosystem. Rapid drainage of precipitation supports an active fire regime. Wildfires are ignited an average 45 days each year by thunderstorms and human activities (both pre and post European colonization). Furthermore, tropical storms

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[1] p.17, Hall and Schafale, 1991. *Conservation Assessment of the Southeast Coastal Plain of North Carolina, Using Site-Oriented and Landscape-Oriented Analyses.* North Carolina Natural Heritage Program. Raleigh, NC. pp. 250 and B. Sorrie, personal communication, 8/15/04.
[2] Figures averaged from historic climate summaries from the Southeast Regional Climate Center, found at http://www.dnr.state.sc.us/climate/sercc/climateinfo/historical/historical_nc.html.

and hurricanes have important roles in the system through blowdown events that create gaps in pine and hardwood stands.

Fire Ecology

The vital importance of fire's dominance in the Sandhills' longleaf pine ecosystem has not diminished despite vast changes in fire frequency due to suppression and habitat conversion[3] over the past 200 years. Two of the most dominant species, longleaf pine and wiregrass, are specifically adapted for active fire regimes and thrive in frequent burn cycles. Some plants are specifically adapted to survive fire events; others tend to colonize newly burned patches. Many of the vegetative species in the Sandhills ecosystem have low reproductive rates or require fire occurrence to release seed or stimulate seed production. Furthermore, the habitat structure and species composition of Sandhills natural communities is determined by fire frequency – for some, fire suppression leads to hardwood overgrowth and decreasing levels of species richness. The ability for this natural fire regime to exist on the scale it once did is no longer possible due to the complexity of human development in the Area. Now, fire must be prescribed, ignited and managed according to standards that protect human communities while perpetuating natural communities.

Regional Ecology

More than 150,000 acres of intact natural longleaf pine community are estimated to remain in the Area, and great biodiversity results from the combination of topographical relief, higher elevation than other coastal plain sites, coarse textured soil layers alternating with fine-textured clays, and distinct landscape features such as cemented stone outcrops, river terraces and innumerable streamheads and seepage slopes. This diversity includes rare species, rivaling the southeast coastal plain to the east for the greatest number of rare species and exceeding it for greatest amount of rare populations in the state[4]. The *Conservation Plan* identifies 18 distinct community types. Each type differs in hydrology, soils, species composition, dynamics, fire regime, and biological associations. The ability for these communities to persist and support the numerous rare species of the Sandhills will depend on effective conservation efforts amidst changing land uses and further habitat fragmentation.

Rare and Endangered Species of the Sandhills[5]

- Birds – red cockaded woodpecker (*Picoides borealis*) (RCW), Bachman's Sparrow (*Aimophila aestivalis*)

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[3] Thus, reducing fire's ability to spread across roads and increasing the tendency for human suppression near homes and agricultural sites.

[4] Schafale, M. 1994. *Inventory of Longleaf Pine Natural Communities in North Carolina.* North Carolina Natural Heritage Program. Raleigh, NC. pp. 230 and B. Sorrie, personal communication, 8/15/04

[5] Russo, M. 2000. *Threatened and Endangered Species in Forests of North Carolina: A Guide to Assist with Forestry Activities.* International Paper Company. Raleigh, NC, and *Threatened and Endangered Species of North Carolina*, http://nc-es.fws.gov/es/countyfr.html - 8/4/04. This list includes a sample of rare or threatened species, but is not a comprehensive list.

- Mammals – fox squirrel (*Sciurus niger*), Rafinesque's big-eared bat (*Corynorhinus rafinesquii*)
- Herps – Carolina gopher frog (*Rana capito capito*), eastern tiger salamander (*Ambystoma tigrinum tigrinum*), Northern pine snake (*Pituophis melanoleucus melanoleucus),* Southern hognose snake *(Heterodon simus)*
- Fish – "Broadtail" madtom (*Noturus* sp. 1), cape fear shiner (*Notropis mekistocholas*), Sandhills chub (*Semotilus lumbee*), shortnose sturgeon (*Acipenser brevirostrum)*
- Mussels – atlantic pigtoe (*Fusconaia masoni*), brook floater (*Alasmidonta varicose*), cape fear spike (*Elliptio marsupiobesa*), Roanoke slabshell (*Elliptio roanokensis),* savannah lilliput (*Toxolasma pullus*), squawfoot (*Strophitus undulates),* triangle floater (*Alasmidonta undulata*), yellow lampmussel (*Lampsilis cariosa*)
- Lepidopterae – St. Francis satyr (*Neonympha mitchellii francisci*)
- Plants –bog spicebush (*Lindera subcoriacea),* Carolina grass-of-Parnassus (*Parnassia caroliniana*), chaffseed (*Schwalbea americana*), Georgia indigobush (*Amorpha georgiana* var. *Georgiana*), michaux's sumac (*Rhus michauxii*), roughleaved loostrife (*Lysimachia asperulifolia*), Sandhills bog lily (*Lilium pyrophilum*), Sandhills pixie-moss (Pyxidanthera barbulata var. brevifolia), spiked medusa (*Pteroglossaspis eristata*)

Human Context
The Sandhills area was one of the last places to be settled on the North Carolina coastal plain, largely due to the dry acidic soils that limited agricultural conversion during colonial times. In the early 1800s, the naval stores industry became the first serious human venture for the extraction of rosin, tar, pitch and turpentine from the longleaf pine. This practice peaked in the 1850s around the time when logging of vast stands of virgin longleaf picked up. Logging pace increased as railroads were built into the region in the latter 1800s, and by 1920 most of the virgin longleaf had been cut throughout the Southeast. Free-range cattle and hogs were also an important industry throughout this time, and by 1850 the coastal plain and parts of the Sandhills had reached saturation density for these animals. Though stock laws were passed in the early 1900s, this type of hog and cattle grazing had great affects on the Sandhills vegetative structure.

Fire frequency likely increased for a time, when white settlers adopted local Native American practices of burning open longleaf stands. However, as roads, fields and houses became more numerous, landscape fragmentation and suppression eliminated the ability for natural wildfire to occur. Now, an increased fuel accumulation due to this lack of fire tends to cause more intense fires over much longer time intervals. The closest resemblance to a natural fire regime can currently be found on Fort Bragg's impact areas, where bombing practices lead to frequent fire ignitions and prescribed burns allow for more natural fuel loads.

The Fort Bragg Military Reservation, a training facility for US Army and Air Force personnel, is centrally located in the Area. The installation is a major stronghold for

remaining endangered red cockaded woodpecker (RCW) populations, largely due to its management and support of healthy longleaf pine forest communities. The preservation of natural habitat not only provides the military with quality sites for infantry and light armored training practices, but it also aids the Army's compliance with federally mandated management for the RCW, set into law by the Endangered Species Act of 1973. Currently, the Army manages for these endangered species populations through prescribed fire, stringent training rules, and habitat development (i.e., drilling nesting cavities) for the RCW. RCW populations are monitored by the US Fish and Wildlife Service for the purposes of tracking the success of these measures.

Over the past 15 years, residential development around Fort Bragg has fragmented habitat corridors as well as created encroachment issues that have reduced the military's capabilities to train effectively. In 1991, the Regional Land Use Advisory Committee was formed to generate discussion and coordinate planning efforts of Fort Bragg, Pope Air Force Base and neighboring counties and municipalities to address issues pertaining to encroachment and training[6]. In 2003, these efforts were continued with the issuance of the *Joint Land Use Study*, which recommended the protection of certain land parcels within a one-mile study area surrounding the base by designation of important and critical sites. The recommendations from this study received mixed reception from neighboring counties and municipalities.

The Area has experienced substantial residential growth over the past 15 years in areas surrounding Fort Bragg. Furthermore, the expansion of state highways servicing the Sandhills from the Triangle cities of Raleigh, Durham and Chapel Hill will likely further stimulate this type of growth. Other significant elements of land use include the increased development of small horse farms and large-scale golf course resorts. Agricultural uses have traditionally been timber, tobacco and stock farming, but more recently pine straw raking has become predominant on private and some public forests, while tobacco has become less so. The combination of historic and current land uses, fragmented critical habitat, and trends of significant future population growth and urbanization reemphasizes the importance of identifying the conservation needs of the Area and mobilizing effective action by the partners of the *Conservation Plan*.

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[6] For details on the Regional Land Use Advisory Committee, see *Introduction*, p.I-2.

CONSERVATION TARGETS

> *Identification of focal conservation targets is the basis for all subsequent steps in site planning, including identifying threats, developing strategies, measuring success and delineating the site boundary – a different set of targets is likely to result in different threats, strategies, measures of success, and site boundaries.[1]*

Introduction

Conservation targets (targets), as defined by The Nature Conservancy, may include ecological systems, ecological communities, or species[2]. These targets are defined as follows:

- Ecological systems are spatial assemblages of ecological communities, either occurring together on a given landscape or linked by ecological processes.
- Ecological communities are groupings of co-occurring species.
- Species are chosen as targets when a species is: 1 – imperiled or endangered, 2 – ranked of special concern due to recent trends, 3 – a focal (i.e., keystone) species, 4 – of similar habitat or requirements as major groupings of species, or 5 – an aggregation of global significance.

The purpose for selecting targets is to focus the planning effort and guide conservation strategies in a defined area – in this case, the Sandhills conservation area described in *Section III*. Threats and stresses to the area's biodiversity are identified based on the selected targets, and the resulting strategies focus on methods of alleviating the stresses or mitigating the threats that may potentially destroy elements of biodiversity in the Sandhills area. This section describes the planning process used to select targets for the *Conservation Plan* and describes the ecological components that make up each of the selected targets.

Target Selection Process

For the Sandhills Conservation Plan, targets were selected in Workshop I after discussion of representative species, community types and ecosystems, with an ultimate goal of 95% representation for biodiversity in the Sandhills by eight or fewer targets. The selection of the targets originated from the six targets previously chosen by the first Nature Conservancy Sandhills planning team in 2000 (see Appendix C-1 for original target listing). One aspect of the conversation was focused around the concept of dividing a target by public and private areas due to the diverse threats and strategies that would be applied to each type of ownership. However, it was decided that such a separation could be considered arbitrary and that the related concerns would be addressed in future steps of the planning process. Further discourse lead to the ultimate selection of targets and justifications listed in Table 1.

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[1] The Nature Conservancy. 2003. *The Five-S Framework for Site Conservation: A Practitioner's Handbook for Site Conservation Planning and Measuring Conservation Success.* P. IV-1. The Nature Conservancy, Arlington Virginia.

[2] For details, see p. IV-2, *The Five-S Framework for Site Conservation Planning.*

Target Summary Description

Table 1 lists the selected targets, related target justification and nested targets. Nested Targets represent important natural communities or species that perform critical roles in the ecology of the selected target, but do not warrant individual listing as a conservation target for planning purposes. These nested targets are listed to illustrate important aspects of biodiversity and to guide subsequent steps of the planning process. Detailed target descriptions follow on page IV-3.

Table 1: Target Biodiversity Summary

Target	Target Selection Justification	Nested Targets
Red Cockaded Woodpecker*	Federally endangered species, "keystone" species	None identified
Longleaf Pine Mosaic**	Longleaf community types encompass the primary source of biodiversity in the Sandhills and have experienced great losses in original habitat extent	Small patch communities, rare plants, rare animals, matrix community types (see p.IV-5)
Streamhead Pocosins/Seeps**	Habitat for rare plants and animals, sensitive to diverse sets of environmental factors	Canebrakes, Sandhills seeps, Streamhead Atlantic white cedar, Streamhead pocosins, rare plants, rare animals, lepidoptera (see p.IV-8)
Blackwater Streams**	Healthy aquatic systems that are newly threatened by increasing development	Beaver pond communities, Floodplain forests and rare species, Aquatic communities and rare species (see p.IV-10)
Upland Depressional Wetlands**	Habitat for rare plants and animals, sensitive to diverse sets of environmental factors	Small depressional ponds, vernal pools, rare herps, rare plants, small depressional pocosins and swamps (see p.IV-12)

* The red cockaded woodpecker is a species target.

**All other selected targets are ecological systems targets. The ecological communities that make up these systems are explained in the detailed target descriptions, beginning on page IV-3.

RED COCKADED WOODPECKER[3]
Description
The Red Cockaded Woodpeckers (RCW) is a small species of woodpecker, visually
distinguishable from similar species, such as Hairy and Downy woodpeckers, by a white
barred back, white cheek patch and a small, red patch of feathers (the "cockade")
between the cheek patch and black crown. The RCW is non-migratory and live in
"groups" consisting of one breeding pair and as many as four or more offspring, known
as "helpers", who assist in providing food for nestlings and incubating eggs. The RCW
diet consists of a wide variety of insects at egg, larvae and adult stages, and foraging is
therefore generally preferred on older, more insect ridden trees.

The RCW is a species whose historical distribution is an estimated 1-1.6 million family
groups ranging across the Southeastern US from New Jersey, Maryland and Virginia to
Florida, west to Texas and north to portions of Oklahoma, Missouri, Tennessee and
Kentucky. The decline of the RCW is linked directly to a loss of habitat, which ideally
consists of open pine forests, especially those dominated by longleaf pine. The longleaf
pine ecosystem[4] is also greatly reduced from its estimated pre-settlement extent of over
90 million acres to less than 3 million acres, which lead to the now 99% decline in the
RCW population. RCW populations, federally listed as an endangered in 1970, are
currently estimated at 5,600 groups, or 14,000 individuals

The preference for longleaf pine in RCW habitat relates to the tree species' high tolerance
to fire in ecosystems of frequent fire occurrence, as well as its ability to accommodate the
RCW nesting behavior of excavating and roosting in living pine trees. In fact, the
preference for developing cavities in live trees likely stems from the existence of few
standing dead pines that are often eliminated in fires. RCW cavities are recognizable by
the candle-like appearance of the surrounding trunk area, where the bird will chip "resin
wells" to encourage the flow of pine resin to create a physical barrier for tree climbing
predators, such as rat snakes. The cavities that are constructed by the RCW are used by at
least 27 other species of vertebrates for roosting or nesting, thus the justification for
labeling of the RCW as a keystone species and selection as conservation target for the
Sandhills Conservation Plan.

The RCW requires two different, but vital aspects of habitat – sufficient foraging habitat
and sufficient nesting habitat. Depending on habitat quality and RCW population density,
the species requires at least 75, and up to 300, acres of older (~100 year) pine forest with
little or no mid-story for its' foraging requirements. Nesting habitat requirements
generally include ~ 20 acres of pine trees having reached a mature enough stage to have
sufficient sap-free heartwood to provide a quality sized cavity to lay eggs and raise
nestlings. Each member of a group resides individually in a cavity, therefore a group of a

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[3] Adapted from US Fish and Wildlife Service. 2002. *Red Cockaded Woodpecker*. US Fish and Wildlife
Service, Clemson Field Office, South Carolina.
[4] See *Longleaf Pine Mosaic*, next page.

breeding pair and three helpers will require five cavities. Without sufficient habitat for nesting and foraging, RCW groups will disburse to look for more viable habitat areas.

In the case of the Sandhills RCW population, two demographically independent subpopulations have been identified. These subpopulations, Sandhills East and Sandhills West, are separated by a 5-10km wide gap of insufficient foraging or nesting habitat (*see map, p.3, Appendix A*). As a federally endangered species, conservation efforts seek to restore the RCW population to "recovery" status, or an independently viable population. Recovery efforts for the Sandhills RCW are focused on increasing the number of active clusters in a primary core population (in this case, the Sandhills East population) to a recovery level of at least 440, the minimum number for recovery status. To be counted towards recovery, these clusters are required to have sufficient protection, management and monitoring. Furthermore, the placement of these clusters must improve the demographic viability of the Sandhills population. To do so will require either bridging the current gap between subpopulations, or maintaining Sandhills East and West as independently viable subpopulations. For the time being, the latter strategy has been selected as the preferable, more realistic option.[5]

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[5] NC Conservation Partnership. No date. *Report from the RCW Recovery Working Group.* NC Conservation Partnership. Unpublished.

LONGLEAF PINE MOSAIC[6]
Description
The longleaf pine mosaic is the dominant ecological system of the Sandhills and includes a matrix of community types that form a complex web of relationships. The range-wide reduction of longleaf pine from its estimated extent of over 90 million acres to less than 3 million has highly fragmented the habitat and impacted important natural elements of the system, especially the suppression of an active fire regime. Yet, when compared to other longleaf pine areas, the Sandhills still has a high amount of intact longleaf community types and retains great biological diversity. The area is also globally distinct amongst temperate systems. Sandhills longleaf pine communities have been rated as retaining some of "the highest species richness values reported anywhere in the world."[7] The eight community types that form the ecological system best represent the longleaf pine mosaic in the Sandhills and are described below. These community types are listed as nested targets, since the preservation of the longleaf pine mosaic requires the protection and management of each community type to retain a functioning ecosystem. A few characteristics shared by all Sandhills longleaf pine communities are: a canopy dominated by longleaf pine (*Pinus palustris*), a scrub hardwood layer of varying characteristics, groundcover dominated by wiregrass (*Aristida stricta*) and/or macrolichens (*Cladonia spp.*), and a high dependence on an active fire regime. See *Map 4, p.4, Appendix A* to view selection of longleaf pine community occurrences.

Nested Targets
- Xeric Sandhill Scrub – A community dominated by longleaf pine canopy, a well-developed scrub hardwood layer of mainly turkey oak (*Quercus laevis*), patches of low schrubs such as dwarf huckleberry (*Gaylussacia dumosa*) and small black blueberry (*Vaccinium tenellum*), and sparse to moderately dense wiregrass and/or macrolichens. Of the longleaf pine mosaic communities, Xeric Sandhills scrub communities are best distinguished by the strong dominance of turkey oak over other scrub hardwoods in the scrub layer and the presence of the endangered Sandhills pixie-moss (*Pyxidanthera barbulata var. brevifolia*). This community type is very abundant.

- Sand Barren – A subtype community of Xeric Sandhills Scrub, Sand Barren is distinguishable by its occurrence on the most excessively drained, infertile sands with sparse wiregrass cover, much bare sand exposure, and a dominance of macrolichens. Longleaf pine is slow to regenerate on these sites and fire is likely infrequent due to light fuel accumulations. Sites that have soil disturbance and vegetation removed may superficially resemble Sand Barren. This community type is rare in the Sandhills.

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[6] Content adapted from Schafale, M. 1994. *Inventory of Longleaf Pine Natural Communities*. DENR, North Carolina Natural Heritage Program and B. Sorrie, personal communication, 8/15/04.
[7] Schafale, p.4. These species richness values refer to the number of species in patches ranging in size from 1m^2-1000m^2.

- Pine/Scrub Oak Sandhill – A community with less porous soil and scrub less
  excessively drained than Xeric Sandhill Scrub or Sand Barren. Vegetation of
  Pine/Scrub Oak Sandhill includes an open longleaf canopy, scrub hardwood layer
  and fairly dense herb layer, with a wide variety of grasses and flowering plants.
  The main distinguishing feature of this community is the scrub hardwood layer,
  which includes greater diversity than Xeric Sandhill Scrub, including blackjack
  oak (*Quercus marilandica*), bluejack oak (*Q. incana*), dwarf post oak (*Q.
  margarettae*), sassafras (*Sassafras albidum*) and persimmon (*Diospyros
  virginiana*). Wiregrass dominates the ground cover, and bracken fern (*Pteridium
  aquilinum*) occasionally codominates the herb layer with other species, including
  pyxie moss (*Pyxidanthera barbulata*). This community type is very abundant in
  the Sandhills, but scarce in throughout the rest of North Carolina.

- Mesic Transition – Classified as a Pine/Scrub Oak Sandhill sub-type, Mesic
  Transition is a distinct community that is transitional into Mesic Pine Flatwoods.
  The community type is distinguishable by its occurrence on upland slopes, flats or
  shallow swales with moister, more fertile soils than most sandhills, often on
  loamy soils. The longleaf canopy is of moderate to fairly dense cover, with
  ground cover consisting of dense wiregrass, legumes and a higher diversity of
  other herbs than in other Sandhill communities. Sites rapidly deteriorate when fire
  is absent, being invaded by various dry-mesic species. This community type is
  uncommon.

- Mesic Pine Flatwoods – A community characterized by a substantial absence of
  scrub oaks but small numbers to an absence of wetland plants. Mesic Pine
  Flatwoods (a.k.a., Little River Flatwoods in Schafale, 1994) occur on sites with
  intermediate moisture levels and have diverse, dense groundcover of wiregrass,
  bracken fern, dwarf huckleberry, small black blueberry, inkberry (*Ilex glabra*) or
  other low shrubs. If fire is suppressed for long periods, hardwood invasion can
  lead to a dense understory, which eventually reaches the canopy. This community
  type is uncommon.

- River Terraces – A community originally classified as a sub-type of Mesic Pine
  Flatwoods, it is characterized by its occurrence on relict terraces along deeply
  entrenched rivers in the Sandhills. Species inhabiting this community share a wide
  range of moisture preferences and may be subject to occasional flooding. River
  terrace canopy is often dominated by longleaf pine, or mixed with loblolly. Low
  shrubs may be dense and diverse, and the herb layer, dominated by wiregrass, is
  generally very diverse. Fire suppression may lead to a sub-canopy of sweetgum
  (*Liquidambar styraciflua*), red maple (*Acer rubrum*), black oak (*Quercus nigra*)
  and scrub oaks. This community type is rare, known only from the Sandhills.

- Wet Pine Flatwoods – A community characterized by the lack of scrub oaks and
  low diversity shrub-herb ground cover. Wet Pine Flatwoods occur on soils with
  wetter sites and have sparse to dense canopy often including pond pine (*Pinus*

serotina). Ground cover is dominated by wiregrass, bracken fern or creeping blueberry and consists of a mix of dangleberry (*Gaylussacia frondosa*), dwarf huckleberry, gallberry (*Ilex coriacea)*, sheepkill (*Kalmia carolina*) and dwarf azalea (*Rhododendron atlanticum*). Forest hardwoods are slow to invade with fire suppression, but will lead to an obscured boundary with other community types and a dense shrub layer, which results in the deterioration of the herb layer. This community type is uncommon in the Sandhills, more common elsewhere.

- Pine Savanna – A community that occurs on low, flat, wet sites with a canopy open to sparse, possibly dominated by pond pine instead of longleaf or a combination of longleaf and pond pine. Hardwoods are generally not present in the scrub layer, and the ground cover is characterized by its diversity and density. The herb layer may be dominated by a variety of grasses and sedges, along with a diverse assortment of forbs including orchids and insectivorous plants. When fire is suppressed, the boundaries of Pine savanna become blurred with those of wet pine flatwoods or pocosins and leads to a decline in the diversity of the herb layer. In the Sandhills, this community most often occurs in broad ecotones of streamhead pocosins.

Rare or Endangered Species[8]
Red-Cockaded Woodpecker (*Picoides borealis*), Fox Squirrel (*Sciurus niger*), Eastern Tiger Salamander (*Ambystoma tigrinum tigrinum*), Canby's Cowbane (*Oxypolis canbyi*), Carolina Grass-of-Parnassus (*Parnassia caroliniana*), Chaffseed (*Schwalbea americana*), Georgia Indigo-bush (*Amorpha georgiana* var. *georgiana*), Michaux's Sumac (*Rhus michauxii*), Rough-leaved loosestrife (*Lysimachia asperulifolia*) and rare lepidoptera.

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[8] Russo, 2000.

STREAMHEAD POCOSINS/SEEPS[9]
Target Description
The conservation target of Streamhead Pocosins and Seeps is an aggregate of three distinct natural community types (*see map, p.5, Appendix A*) with diverse characteristics and species composition. However, these four community types share certain traits and are susceptible to similar threats and the focus of the same mitigation strategies, thereby lending to their consolidation into one target. These traits are: an occurrence on wet soils dependent on seepage, site location near streamheads or slopes, ranges in fire frequency, and a dependence and susceptibility to hydrologic disturbance and habitat destruction.

Nested Targets
- Canebrake – A community that, once widespread, has greatly diminished despite the common occurrence of cane, the dominant plant species. Canebrakes serve as important habitat for certain lepidopterae that have been found to feed exclusively on cane. These habitat patches are dependent on high fire return rates and are distinguishable by the dominance of cane, low wet and mesic soils, and near absence of herbs and can widely range in size.

- Sandhill Seeps – A community that occurs on sloping sandy soils, it is subtended by a clay layer that forces water to the surface, which leads to seasonally to permanently saturated soils. Sandhill seep is best distinguished by the occurrence of wetland vegetation on seepage slopes and a sparse canopy cover consisting of longleaf or pond pine and varying hardwoods. Vegetation varies from shrubby to herbaceous, depending on the frequency of fire occurrence and consists of sedges, insectivorous plants and other boggy vegetation.

- Streamhead Atlantic White Cedar – A community found along small headwater streams in sandhill areas, on flat bottoms or extending up adjacent seepage slopes and occurring in similar sites to Streamhead Pocosins and Blackwater Small Stream Swamps. Unlikely to burn frequently but dependent on occasional fire, these communities are dominated by Atlantic White Cedar canopies of varying mix with hardwood species.

- Streamhead Pocosins – A community found at the headwaters of small streams in sandhills, flat bottoms and sometimes fire suppressed seepage slopes. Pocosins tend to be long and narrow of shape, leading to active fire regime disturbance along edges with important nutrient cycle effects. This community's notably open to sparse tree canopy consists of pond pine, magnolia and tulip tree.

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[9] Adapted from Schafale, M. and Weakley, A. 1990. *Classification of the Natural Communities of North Carolina: Third Approximation.* DEHNR, North Carolina Natural Heritage Program. Raleigh, NC. Also, Hall, S. and Schafale, M. 1999. *Conservation Assessment of the Southeast Coastal Plain of North Carolina, Using Site-Oriented and Landscape-Oriented Analysis.* DEHNR, North Carolina Natural Heritage Program. Raleigh, NC.

Rare or Endangered Species[10]

Pine Barrens Tree Frog (*Hyla andersonii*), Eastern arogos skipper (*Atrytone arogos arogos*), Bog Spicebush (*Lindera subcoriacea*), Rough-leaved Loosestrife (*Lysimachia asperulifolia*), Sandhills Bog Lily (*Lilium pyrophilum*), Sun-facing Sunflower (*Rudbeckia heliopsidis*), and many other rare or significant plant species.

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[10] Russo, 2000.

BLACKWATER STREAMS[11]
Description
The conservation target of blackwater streams is an aggregate of three distinct natural
community types (*see map, Appendix A, p.7*)with diverse characteristics and species
composition. However, each community type is directly associated with or dependent on
the natural and hydrologic systems of blackwater streams. Thus, each is susceptible to
similar threats and mitigation strategies, thereby lending to their consolidation into one
target. General characteristics of blackwater streams are sandy bottoms, slow to moderate
flow rates, clear acidic water stained by tannins, and low turbidity. Sandhills blackwater
streams also experience less variable flow rates than other blackwater streams due to the
seepage soils of the area, which results in steadier stream inputs.

Nested Targets
- Beaver Ponds[12] (and successional Sedge Meadows) – This community has been
  found to be of great importance to rare species associated with successional
  habitats and may serve as refuges for species that were once widespread. This
  habitat is restricted to stream valleys and consists of primarily bottomland
  hardwoods. Aquatic communities consist of species present before damming and,
  subsequently, those who can quickly colonize a new pond. These communities are
  subject to high levels of disturbance due to flooding. The successional phases of
  the resulting meadows may become more widespread with the successful return
  of beaver to Sandhills blackwater streams.

- Floodplain Forests – A target consisting of Blackwater Cypress-Gum Swamp,
  Coastal Plain Small Stream Swamp and Coastal Plain Bottomland Hardwood
  community types. Distinguishing characteristics of the community type include
  wet, infertile acidic soils (often standing water), seasonal to intermittent flooding,
  fairly low levels of plant species richness, but often rich in animal species. These
  communities may be of importance for organisms generally associated with the
  river channel, either aquatic or other. Coastal Plain Bottomland Hardwoods are
  dominated by oaks and may have Loblolly pine. Blackwater Cypress-Gum
  Swamps are dominated by swamp black gum. Coastal Plain Small Stream Swamp
  canopies can be dominated by combinations of hardwoods, cypress and gum
  trees, distinguished mainly by a lack of alluvial landforms along stream corridors.
  These communities are home to wading bird rookeries, Rafinesque's big-eared
  bat, Myotis austroriparius, barred owls, red-shouldered hawks and various
  warblers.

- Aquatic Communities – Aquatic blackwater stream communities of the Sandhills
  include sections of three major watersheds: the Lumber, Yadkin and Cape Fear.
  The tributaries that drain the Sandhills contain excellent water quality in areas

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[11] Adapted from Schafale and Weakley, 1990. Also,
Adapted from Hall and Schafale, 1999.
[12] Schafale and Weakley, p.159

surrounded by protected habitat. This allows for the relative abundance and even dominance of fish, plant and insect species that are otherwise intolerant to changing temperature and water quality. Examples present in the area are the piedmont and pinewoods darter, the Sandhills chub, Dusky shiners and *Chimarra* (caddisfly). Though the composition of these communities can vary widely in the Sandhills, blackwater stream aquatic communities are distinguishable by their characteristic water quality (*above*), low levels of aquatic plants and small sized fish.

Rare or Endangered Species[13]
Atlantic Pigtoe (*Fusconaia masoni*), Brook Floater (*Alasmidonta varicose*), Cape Fear Spike (*Elliptio marsupiobesa*), Savannah Lilliput (*Toxolasma pullus*), Squawfoot (a.k.a. Creeper) (*Strophitus undulates*), Triangle Floater (*Alasmidonta undulata*), Yellow Lampmussel (*Lampsilis cariosa*), Saint Francis satyr (*Neonympha mitchellii francisci*), sarvis holly (*Ilex amelanchier*), Two-spotted skipper (*Euphyes bimacula*), Broad-winged sedge grasshopper (*Stethophyma celata*)

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[13] Russo, 2000.

UPLAND DEPRESSIONAL WETLANDS[14]
Description
The conservation target of upland depressional wetlands is an aggregate of three distinct natural community types (*see map, Appendix A, p.7*) with certain distinguishing characteristics and species composition. However, each community type of the nested targets shown below shares landscape features and are often located in near proximity and highly associated with other communities listed below. Thus, these communities are susceptible to similar threats and mitigation (protection/abatement) strategies, thereby lending to their consolidation into one target. General characteristics of upland depressional wetlands are areas with standing water occurring in standing water seasonal to year round, shrubby border, high herbaceous diversity, subject to seasonal fire. An active fire regime is assumed to be important for nutrient cycling and woody vegetation control. These areas are relatively unstudied with much yet to be learned of their ecological importance and roles.

Nested Targets
- Vernal Pools – A community type occurring in complexes of small, seasonally flooded depressions fed by rainfall. Vernal pools are subject to occasional fire and are assumed to be dependent on occasional fire for nutrient cycling and for the prevention of the spread of woody plants. These communities are distinguished from small depressional pocosins by herbaceous rather than shrub or tree dominance and distinguished from small depressional ponds by drying most or all years. These communities can be important breeding sites for amphibians, due to the lack of predatory fish. The rarity of these communities is not well known, but they appear to uncommon to rare.

- Small Depressional Ponds – A community type distinguished from similar communities by permanent or nearly permanent water and with floating aquatic vegetation. Depressional ponds are acidic and nutrient poor, fed by rainfall and groundwater. This community is distinguished from aquatic lake communities by size less than 20 acres. Though widely ranging, small depressional ponds are considered rare due to the limited acreage and great diversity within known examples. These ponds are very rare in the Sandhills.

- Small Depressional Pocosins – A community type distinguished from comparative communities (*above*) by the dominance of dense tall shrubby vegetation. These communities are classified based on size less than 10 acres. Due to this small size, these communities are affected to a greater extent by fire occurrence surrounding the target and are subject to burning either partially or wholly given the level of seasonal wetness, and are affected by nutrients released from fire, which leads to greater diversity in shrubby vegetation than other

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[14] Adapted from Schafale and Weakley, 1990. Also,
Adapted from Hall and Schafale, 1999.

pocosin communities, such as streamhead pocosins. Thus, these communities are also subject to greater disturbance by fire suppression.

Rare or Endangered Species[15]
Eastern Tiger Salamander (*Ambystoma tigrinum tigrinum*), Awned Meadow-beauty (*Rhexia aristosa*), Boykin's lobelia (*Lobelia boykinii*), Herps, insects, plants

[15] Russo, 2000.

BIODIVERSITY HEALTH ASSESSMENT

Introduction
The *Biodiversity Health Assessment* is a valuable step for understanding the critical functions of the selected conservation targets and, subsequently, how the targets are affected by human actions. The goal of performing a biodiversity health assessment on the Sandhills conservation targets is to come to an understanding of the current overall status for each target. By doing so, conservation planners can identify the steps, if any, that must be taken to manage for or restore the natural processes that each target depends on to thrive in its undisturbed state. The current assessment also serves as a point of reference for future assessments in order to measure the amount of progress that has been made through the chosen strategies of the *Conservation Plan*.

The description of biodiversity health for each target is based on three factors:
- Size – the measure of area or abundance of the conservation target's occurrence. For ecological systems and communities, size may simply be a measure of the occurrence's patch size or geographic coverage. For animal and plant species, size takes into account the area of occupancy and number of individuals. Minimum dynamic area, or the area needed to ensure survival or re-establishment of a target after disturbance, is another aspect of size.
- Condition – an integrated measure of the composition, structure, and biotic interactions that characterize the occurrence. Examples include: reproduction, age structure, biological composition, physical and spatial structure, and biotic interactions that directly involve the target.
- Landscape Context – an integrated measure of both the dominant environmental regimes and processes that establish and maintain the target occurrence as well as connectivity.

By first determining how to measure the biodiversity health of the Sandhills, the *Conservation Plan* participants of Workshop II were then able to base subsequent steps of identifying threats to the selected conservation targets, determining strategies to abate those threats and, finally, monitoring the health of Sandhills biodiversity and success of the chosen strategies. It must be noted that gaining an understanding of the complex interactions of Sandhills ecological communities is an iterative process and the *Conservation Plan* will require consistent refining as these systems are better understood. An example of future refinements to the document would be that, for two of the Sandhills conservation targets, factors of *Size* have not been identified. Future drafts of the *Conservation Plan* will undoubtedly work to fill in gaps of understanding such as these.

Format

For each target, sets of key attributes, indicators and indicator ratings (defined below) are arranged by the three factors of biodiversity health (Size, Condition, Landscape Context). The *Biodiversity Health Assessment* for each target, beginning on page V-3, will be arranged in the following format:

<u>TARGET NAME (i.e., RED COCKADED WOODPECKER)</u>
VIABILITY FACTOR CATEGORY (SIZE, CONDITION, LANDSCAPE CONTEXT)
Key Attribute: structure, composition, interactions and abiotic and biotic processes that enable the target to persist through influence on the target's size, condition and landscape context.
Key attribute comment: individual or group responsible for naming key attribute, as well as questions or comments that may remain.
Indicator: measurable entity that is used to assess the status and trend of a key ecological attribute.
Indicator comment: individual or group responsible for naming the indicator, as well as questions or comments that may remain.
Indicator Ratings:
> **Poor:** Allowing the indicator to remain in this condition for an extended period will make restoration or prevention of extirpation of the target practically impossible (e.g., too complicated, costly, and/or uncertain to reverse the alteration).
> **Fair:** The indicator lies outside of its range of acceptable variation and requires human intervention for maintenance. If unchecked, the target will be vulnerable to serious degradation.
> **Good:** The indicator is functioning within its range of acceptable variation, although it may require some human intervention for maintenance.
> **Very Good:** The indicator is functioning within an ecologically desirable status, requiring little human intervention for maintenance within the natural range of variation (i.e., is as close to "natural" as possible and has little chance of being degraded by some random event).

Current Rating: current status of the selected target as determined by the best professional judgment of an experienced professional or group of professionals.
Date of Current Rating: date of decision for above rating.
Desired Rating: status of the selected target that the conservation efforts of The Nature Conservancy and partnered organizations strive to reach.
Date for Desired Rating: date by which the desired rating will be reached.
Desired rating comment: individual or group responsible for determining the current and desired ratings, as well as further comments.
Other comments: comments, questions, or discussion topics that remain for a particular set of key attributes, indicators and indicator ratings.

RED COCKADED WOODPECKER
LANDSCAPE CONTEXT
1. Key Attribute: Application of prescribed fire to mimic natural fire regime on conservation lands
Key attribute comment: Pete Campbell, 7/1/04
Indicator: % acres of conservation land burned per season per annum
Indicator comment: conservation lands = public lands, private conservation lands (easements or ownership by TNC, SALT), and Safe Harbor properties
Pete Campbell, 7/1/04
Indicator Ratings:
        Poor: TBD
        Fair: TBD
        Good: TBD
        Very Good: TBD
Current Rating:
Date of Current Rating:
Desired Rating:
Date for Desired Rating:
Desired rating comment: 33% conservation lands burned - Pete Campbell, 7/1/04

2. Key Attribute: Demographic connectivity between Sandhills East and West populations
Key attribute comment: Pete Campbell, 7/1/04
Indicator: # individuals filling vacancies between populations (East/West)
Indicator comment: Pete Campbell - 7/1/04
Indicator Ratings:
        Poor: TBD
        Fair: TBD
        Good: TBD
        Very Good: TBD
Current Rating: Fair
Date of Current Rating: 7/15/04
Current rating comment: Pete Campbell - 7/1/04
Desired Rating: Very Good
Date for Desired Rating: 7/15/11

Key Attribute: Extent of mature pine habitat
Key attribute comment: Pete Campbell, 7/1/04
Indicator: # acres of mature pine forest on conservation lands
Indicator comment: Pete Campbell, 7/1/04
Indicator Ratings:
>   **Poor:** TBD
>   **Fair:** TBD
>   **Good:** TBD
>   **Very Good:** TBD

Current Rating:
Date of Current Rating:
Desired Rating:
Date for Desired Rating:

CONDITION
Key Attribute: Active clusters in the primary recovery population that have suitable habitat
Key attribute comment: Pete Campbell, 7/1/04
Indicator: % active clusters with suitable pine habitat
Indicator comment: Suitable habitat = suitable foraging habitat + suitable cavity habitat
Pete Campbell, 7/1/04
Indicator Ratings:
>   **Poor:** TBD
>   **Fair:** TBD
>   **Good:** TBD
>   **Very Good:** TBD

Current Rating:
Date of Current Rating:
Desired Rating:
Date for Desired Rating:

Key Attribute: Population structure - group composition
Key attribute comment: Pete Campbell - 7/1/04
Indicator: # adults per cluster
Indicator comment: Pete Campbell - 7/1/04
Indicator Ratings:
>   **Poor:** 1 (solitary male)
>   **Fair:** 2 (potential breeding pair)
>   **Good:** 3 (potential breeding pair + helper)
>   **Very Good:** 4+ (potential breeding pair+ 1/more helpers)

Current Rating:
Date of Current Rating:
Desired Rating:
Date for Desired Rating:
Other comments:

SIZE
Key Attribute: Population size & dynamics
Key attribute comment: current indicator ratings are DRAFT
Indicator: # potential breeding groups
Indicator comment: Pete Campbell - 6-28-04
Indicator Ratings:
>   **Poor:** <75
>   **Fair:** 75-100
>   **Good:** 100-120
>   **Very Good:** >120

Current Rating: Good
Date of Current Rating: 6/15/04
Current rating comment: best professional judgment – Workshop I
Desired Rating: Very Good
Date for Desired Rating: 7/15/14
Desired rating comment: best professional judgment – Workshop I

LONGLEAF PINE MOSAIC
LANDSCAPE CONTEXT
Key Attribute: Connectivity among communities & ecosystems
Key attribute comment: Workshop I
Indicator: connectivity between protected areas and primary areas
Indicator comment: Nelson - edited by Schafale 7/3/04
Indicator Ratings:
> **Poor:** few primary and protected areas connected
> **Fair:** some primary and protected areas connected
> **Good:** most primary and protected areas connected
> **Very Good:** all primary areas permanently connected

Current Rating: Fair
Date of Current Rating: 6/15/04
Current rating comment: best professional judgment – Workshop I
Desired Rating: Very Good
Date for Desired Rating: 6/15/14
Desired rating comment: best professional judgment – Workshop I
Other comments: * Need metrics for connectivity $\rightarrow$ This could be measured by map inspection. Achieving very good rating will require restoration of habitat suitable for connection where it has been lost, as well as placing appropriate levels of protection on existing connections. Some combination of preservation of intact areas and compatible use of semi-natural areas is needed. (Schafale, 7/3/04)
* Relates back to both acres on protected lands and connectivity acres (Campbell, 8/4/04)

CONDITION
Key Attribute: Fire regime - (timing, frequency, intensity, extent)
Key attribute comment: Workshop I
Indicator: # acres burned as compared to natural fire regime
Indicator comment: Workshop I. The # of managed acres burned refers to the scale of the Sandhills landscape, Nelson, 9/6/04.
Indicator Ratings:
> **Poor:** <50k managed acres/year
> **Fair:** 50-75k managed acres/year
> **Good:** 75-100k managed acres/year, including most primary areas
> **Very Good:** > 100k managed acres/year, including all primary areas

Current Rating: Fair
Date of Current Rating: 6/15/04
Current rating comment: best professional judgment – Workshop I
Desired Rating: Good
Date for Desired Rating: 6/15/14
Desired rating comment: best professional judgment – Workshop I
Other comments: Verify metrics? There is more complexity to this that needs to be considered at some point. Seasonality and fire intensity matter, but probably are too complex to address at this scale. Which acres get burned matters though. If you don't

burn your prime remnants, they will quickly cease to be prime, and the mediocre areas will be no substitute for them. - Mike Schafale 7/3/04

Key Attribute: Population size & dynamics
Key attribute comment: Workshop I
Indicator: Rare plant population size
Indicator comment: *Nelson - indicator ratings
Edited by Schafale 7/3/04
Indicator Ratings:
> **Poor:** Few populations or sub-populations, and these small
> **Fair:** Sustainable rare plant population size with at least some populations of each species of sustainable size.
> **Good:** Status quo (?)
> **Very Good:** Populations and sub-populations of sustainable size distributed over their native range within the area, in well-managed natural habitat

Current Rating: Good
Date of Current Rating: 7/3/04
Current rating comment: By definition, if we define "Status quo" as good. - Schafale 7/3/04
Desired Rating: Very Good
Date for Desired Rating:

Key Attribute: Presence of key communities or seral stages
Key attribute comment: capture whole biodiversity - Workshop I
Indicator: abundance of all community types
Indicator comment: See nested targets for community types.
*Nelson - indicator ratings
Schafale edited 7/3/04
Indicator Ratings:
> **Poor:** Few examples of rarer community types represented, with some only occurring in poor condition, and some types extirpated from the region. Rarer communities confined to few portions of the region.
> **Fair:** Some examples of each community type represented
> **Good:** all existing examples remain extant and in at least current condition.
> **Very Good:** All common community types abundant, with numerous examples in good condition, with sufficient good examples of rare types to ensure representation of diversity and sustainability.

Current Rating: Good
Date of Current Rating: 6/15/04
Current rating comment: best professional judgment – Workshop I
good by definition – but is it correct?
Desired Rating: Very Good
Date for Desired Rating: 6/15/14
Desired rating comment: best estimate.

One of the aspects of this that is hard to capture is the need to not have all the eggs in one basket. Some community types currently exist in good condition, or at all, only on the big public lands, some only on Fort Bragg. -Schafale, 7/3/04

Key Attribute: Vegetation structure (age class)
Key attribute comment: Workshop I
Indicator: representation of all age classes in natural spatial distribution
Indicator comment: Schafale (7/3/04):
- canopy tree age distribution
- canopy tree spatial structure
Indicator Ratings:
> **Poor:** Most longleaf pine communities even-aged and/or young, with homogenized patch structure
> **Fair:** most acres with some other older trees present but at less than natural abundances, patch structure homogenized over large areas
> **Good:** substantial acreage with patchy, uneven age distribution and many older trees present - All acres currently in good condition remaining in good condition.
> **Very Good:** Most acres with patchy, uneven age distribution and with many older trees present
Current Rating: Fair
Date of Current Rating: 7/15/04
Desired Rating: Good
Date for Desired Rating: 7/15/14
Desired rating comment: Schafale, 7/3/04. trees take time to grow
Other comments: *original indicator = all age classes represented

SIZE
Key Attribute: Size / extent of characteristic communities / ecosystems
Key attribute comment: Workshop I comment: based on the minimum dynamic area of matrix forest
Schafale, 7/3/04: Minimum dynamic area is a poor basis for size rating in this system. Natural disturbances (fires, hurricanes) cover large areas but relevant processes (mortality) occur on a fine scale. Large area of matrix is needed because many species (even non-rare ones) exist as very sparse populations, because fire-sensitive animals need numerous potential fire-free patches to survive, and because (probable) area-sensitive species such as fox squirrels and pine snakes are part of the system. Large area of matrix improves the probability of capturing sufficient acreage of most rare communities to have viable populations of specialized species in them, but targeted protection of rare communities is likely needed.
Indicator: # acres of pine forest
Indicator comment: Insufficient evidence exists to determine specific acreage for poor/fair indicators of Longleaf Pine Mosaic forest. - Nelson
*Nelson - Poor and Fair indicator ratings
Indicator Ratings:
> **Poor:** Unsustainable # acres

       Fair: Sustainable # acres
       Good: status quo (250-300k acres)
       Very Good: > 300k acres
Current Rating: Good
Date of Current Rating: 6/15/04
Current rating comment: best professional judgment – Workshop I
Desired Rating: Very Good
Date for Desired Rating: 6/15/14
Desired rating comment: best professional judgment – Workshop I
Good is probably all we can aspire to in this time frame. Keeping what we have will be
hard enough) -Schafale, 7/3/04

STREAMHEAD POCOSINS/SEEPS
LANDSCAPE CONTEXT
Key Attribute: Landscape pattern (mosaic) & structure
Key attribute comment: * landscape pattern = context of occurrence with sufficient buffer
Workshop I
Indicator: adequate buffer around occurrences
Indicator comment: *Nelson - indicator ratings
Indicator Ratings:
>   **Poor:** adequate buffer around few/no occurrences
>   **Fair:** adequate buffer around some occurrences
>   **Good:** adequate buffer around many occurrences
>   **Very Good:** adequate buffer around all occurrences

Current Rating: Good
Date of Current Rating: 7/15/04
Current rating comment: Schafale, 7/3/04
Desired Rating: Very Good
Date for Desired Rating:
Desired rating comment: Schafale, 7/3/04

CONDITION
Key Attribute: Fire regime - (timing, frequency, intensity, extent)
Key attribute comment: Workshop I
Indicator: % occurances with appropriate fire regimes
Indicator comment: Workshop I
*Nelson - indicator rating
Indicator Ratings:
>   **Poor:** No/few occurances with appropriate fire regimes
>   **Fair:** Some occurances with appropriate fire regimes
>   **Good:** Many occurances with appropriate fire regimes
>   **Very Good:** 100% occurances with appropriate fire regimes

Current Rating: Fair
Date of Current Rating:
Current rating comment: (to poor) - Schafale, 7/3/04
Desired Rating: Very Good
Date for Desired Rating:

Key Attribute: Presence of key communities or seral stages
Key attribute comment: Workshop I
Indicator: representation of all community types
Indicator comment: See nested targets for community types.
Workshop I - indicator
*Nelson - indicator ratings, edited by Schafale 7/3/04
Indicator Ratings:

> **Poor:** Few or no examples of some community types represented, many in poor condition
> **Fair:** Some examples of all community types each community type represented, some in poor condition
> **Good:** Many examples of all community types represented, many in good condition.
> **Very Good:** Examples of all community types in good condition occurring at natural level. Common community types abundant; rare types with numerous examples well distributed over their native range.

Current Rating: Good
Date of Current Rating: 7/15/04
Current rating comment: trending towards fair, as some are not in good condition - Schafale, 7/3/04
Desired Rating: Very Good
Date for Desired Rating:
Desired rating comment: Schafale, 7/3/04

CONDITION
Key Attribute: Species composition / dominance
Key attribute comment: Mike Schafale
Indicator: Size and number of rare species populations
Indicator comment: Mike Schafale, interpreted by Nelson
Indicator Ratings:

> **Poor:** Low size and number of rare species populations
> **Fair:** Fair size and number of rare species populations
> **Good:** Good size and number of rare species populations – all existing populations extant.
> **Very Good:** Very good size and number of rare species populations – all existing populations at sustainable (or natural) size, well distributed over their native range, with additional populations established in historic sites for the rarest species.

Current Rating: Good
Date of Current Rating: 7/15/04
Current rating comment: Schafale, 7/3/04
Desired Rating: Very Good
Date for Desired Rating:
Desired rating comment: Schafale, 7/3/04

BLACKWATER STREAMS
LANDSCAPE CONTEXT
Key Attribute: Connectivity among communities & ecosystems
Key attribute comment: Workshop I
Indicator: adequate buffer around occurrences
Indicator comment: (?) adequate buffers around floodplain headwater swamps -
Schafale, 7/3/04
Indicator Ratings:
      Poor: Poor quality buffer around floodplain headwater swamps
      Fair: Fair quality buffer around floodplain headwater swamps
      Good: High quality buffer around floodplain headwater swamps
      Very Good: Very high quality buffer around floodplain headwater swamps
Current Rating:
Date of Current Rating:
Desired Rating:
Date for Desired Rating:
Other comments: ? impoundments - presence, function - Schafale

Key Attribute: Hydrologic regime - (timing, duration, frequency, extent)
Key attribute comment: Workshop I
Indicator: intactness of hydrologic regime
Indicator comment: Workshop I – indicator. Hydrologic regime is affected by dams,
channelization, potentially windthrows and discharges, Schafale – 8/31/04.
*Nelson - indicator rating edited by Schafale, 7/3/04. Nelson – edit 9/6/04, changed
obstructions to human interferences.
Indicator Ratings:
      Poor: Much human interference along stream corridor
      Fair: Some human interference along stream corridor - some streams with
      severely altered hydrologic regimes.
      Good: Little human interference along stream corridor - status quo
      Very Good: Hydrologic regimes on all stream under only natural influences, or
      managed to mimic natural influences.
Current Rating: Good (?)
Date of Current Rating: 7/15/04
Current rating comment: close to very good. (?)
* Bruce Sorrie, 8/04, there have been hundreds, perhaps thousands [of dams] built
throughout the Sandhills.
Desired Rating:
Date for Desired Rating:

CONDITION
Key Attribute: Nutrient concentrations & dynamics
Key attribute comment: Workshop I
Indicator: key nutrient levels
Indicator comment: *Nelson - indicator rating.
Healthy stream range = range of naturally occurring levels of key nutrients
Occurrences = along the entirety of the stream
Need to define healthy levels in reference to natural blackwater systems, which may have
lower nutrient levels but higher organic matter and lower dissolved oxygen than is
considered healthy elsewhere. -Schafale, 7/3/04
Indicator Ratings:
> **Poor:** Many occurrences of key nutrient levels outside healthy blackwater stream
> range
> **Fair:** Some occurrences of key nutrient levels outside healthy blackwater stream
> range
> **Good:** Few occurrences of key nutrient levels outside healthy blackwater stream
> range
> **Very Good:** No occurrences of key nutrient levels outside healthy blackwater
> stream range

Current Rating:
Date of Current Rating:
Desired Rating:
Date for Desired Rating:

Key Attribute: Presence of key communities or seral stages
Key attribute comment: Workshop I
Indicator: sufficient representation of all community types
Indicator comment: See nested targets for community types.
[Maybe this comment is need for all groups. This should probably have wording similar
to the others, about levels of representation of all community types. You should perhaps
specifically mention terrestrial (floodplain) and aquatic communities. Or maybe not
aquatic, since there is no classification of aquatic community types. This needs
something about maturity of the terrestrial communities too. There is also a need to
address the role of beavers in this system. The swamp forests naturally exist as almost all
old-growth forest, except that beaver ponds would create a successional mosaic. So, we
need an appropriate number of beaver ponds (which nobody knows what is) and an
appropriate amount of post-beaver pond successional stages, a lot of old growth, and not
really any recently logged forest. -Schafale, 7/3/04
Indicator Ratings:
> **Poor:** Few examples of rare community types represented, with some only
> occurring in poor condition, and some types extirpated from the region. Rare
> communities confined to few portions of the region.
> **Fair:** Some examples of each community type represented

Good: status quo, or, all existing examples remain extant and in at least current condition.
Very Good: All common community types abundant, with numerous examples in good condition, with sufficient good examples of rare types to ensure representation of diversity and sustainability.
Current Rating:
Date of Current Rating:
Desired Rating:
Date for Desired Rating:

Key Attribute: Species composition / dominance
Key attribute comment: Workshop I
Indicator: representation of all rare species
Indicator comment: Schafale, 7/3/04
Indicator Ratings:
    Poor: Few examples of rare species populations represented, with some only occurring in poor condition, and some populations extirpated from the region. Rare species populations confined to few portions of the region.
    Fair: Some examples of each rare species population represented
    Good: All existing examples remain extant and in at least current condition.
    Very Good: All rare species population types with sufficient good examples to ensure representation of diversity and sustainability
Current Rating:
Date of Current Rating:
Desired Rating:
Date for Desired Rating:

UPLAND DEPRESSIONAL WETLANDS
LANDSCAPE CONTEXT
Key Attribute: Landscape pattern (mosaic) & structure
Key attribute comment: *landscape pattern = context buffer, condition and size of surrounding natural landscape (see size needed for adult amphibian life cycle)
Indicator: # occurrences with adequate buffer for indigenous amphibian life cycle
Indicator comment: *Nelson - indicator ratings, indicator specifics (amphibian life cycle)
Indicator Ratings:
> **Poor:** No/very few occurrences with adequate buffer for indigenous amphibian life cycle
> **Fair:** Some occurrences with adequate buffer for indigenous amphibian life cycle
> **Good:** Most occurrences with adequate buffer for indigenous amphibian life cycle
> **Very Good:** All occurrences with adequate buffer for indigenous amphibian life cycle

Current Rating: Fair to good.
Date of Current Rating:
Desired Rating:
Date for Desired Rating:

CONDITION
Key Attribute: Hydrologic regime - (timing, duration, frequency, extent)
Key attribute comment: Workshop I
Indicator: intactness of hydrologic regime
Indicator comment: Workshop I
*Nelson - indicator ratings edited by Schafale, 7/3/04
Indicator Ratings:
> **Poor:** Few examples with natural hydrologic regime
> **Fair:** Some examples with natural hydrologic regime
> **Good:** More examples with natural hydrologic regime
> **Very Good:** All examples with natural hydrologic regime

Current Rating:
Date of Current Rating:
Desired Rating:
Date for Desired Rating:

Key Attribute: Presence of key communities or seral stages
Key attribute comment: Mike Schafale
Indicator: representation of rare species populations
Indicator comment: Schafale - interp. by Nelson, edited 7/12/04
Indicator Ratings:

> **Poor:** Few examples of rare species populations represented, with some only occurring in poor condition, and some populations extirpated from the region. Rare species populations confined to few portions of the region.
> **Fair:** Some examples of each rare species population represented
> **Good:** All existing examples remain extant and in at least current condition.
> **Very Good:** All rare species population types with sufficient good examples to ensure representation of diversity and sustainability

Current Rating:
Date of Current Rating:
Desired Rating:
Date for Desired Rating:
Other comments: Schafale- interp by Nelson

Key Attribute: Presence of key communities or seral stages
Key attribute comment: suggested by Schafale, 8/31/04
Indicator: sufficient representation of all community types
Indicator comment: See nested targets for community types.
Indicator Ratings:

> **Poor:** Few examples of rare community types represented, with some only occurring in poor condition, and some types extirpated from the region. Rare communities confined to few portions of the region.
> **Fair:** Some examples of each community type represented
> **Good: A**ll existing examples remain extant and in at least current condition.
> **Very Good:** All common community types abundant, with numerous examples in good condition, with sufficient good examples of rare types to ensure representation of diversity and sustainability.

Current Rating:
Date of Current Rating:
Desired Rating:
Date for Desired Rating:

THREATS ANALYSIS

Introduction

The *Threats Analysis* investigates the elements of biological impairment that result from human processes and activities. There are two basic aspects of the threats analysis: stresses and sources of stress. Stresses are defined as an "impairment or degradation of the size, condition, and landscape context of a conservation target, and results in reduced viability of the target." Sources of stress are defined as "an extraneous factor, either human [i.e., policies, land uses] or biological [e.g., non-native species], that infringes upon a conservation target in a way that results in a stress."[1]

The difference between these two topics is important. The *Strategy Framework* (see section *VIII*) is based on the stresses identified, with consideration to the human caused sources of stress. For example, the development of a road could impair the surface hydrology of a nearby wetland. The stress to the impaired wetland would be the impaired surface hydrology, whereas the source of the stress would be the development of the new road. Were a planning team to focus mitigation strategies on the source, the strategy would focus on relocating the road, or preventing it from being built. However, by focusing on the stress of impaired surface hydrology, a planning team could possibly accommodate both the human requirements of a road and the natural processes of surface hydrology by implementing best management practices such as culverts, French drains, or riparian buffers. The *Conservation Plan* has been designed to focus on reducing stresses in this manner. Therefore, strategies that aim to reduce the overall threats to the selected conservation targets are maximized for efficiency, as well as ability for implementation.

The Threats Analysis has been organized in two sections. The first section identifies the stresses to conservation targets in the Sandhills and explains the roles of each stress in the current impairment of biodiversity health. The second section identifies the sources of stress and a ranked assessment of threat to each target.

Threats Analysis Process

The stresses, sources of stress, and threats analysis were gathered and performed by the participants of Workshop I in June, 2004. During this workshop, ten stresses and ten sources of stress were identified through group discussion and entered into the Excel based *Conservation Project Management Workbook v.4.0a* tool. Participants then ranked these threat elements in an Excel based matrix for each target, where stresses were cross referenced with sources and ranked according to the respective contribution and irreversibility that each source lends to a particular stress. This set of stresses and sources, along with the ranking scheme, were then sent out to the participants of the Peer Review in August, 2004. From the critique generated by this review, the final list of stresses and sources were integrated into the final *Threats Analysis*, which begins on the next page.

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[1] p.V-1, The Nature Conservancy, 2003. *The 5-S Framework for Site Conservation.*

Stresses
The stresses identified for the *Sandhills Conservation Plan* are based on The Nature
Conservancy's definition as human caused destruction, degradation or impairment of
focal conservation targets. Although natural processes such as wildfires, beaver dams and
hurricanes also cause changes to conservation targets, these processes are considered to
be disturbances that enhance the ecology of a region by creating a mosaic of compatible,
biodiversity rich ecosystems and communities. Human actions that lead to impairments,
however, cause changes to the key attributes (such as the attributes identified in
Biodiversity Health) of a given conservation target that reduce its ability to function in
the natural system. Therefore, the *Conservation Plan* identifies stresses as altered key
attributes. The altered key attributes listed below in the *Stress Matrix Summary Table* are
simplified adaptations of the key attributes that were defined in the *Biodiversity Health
Assessment*. This table lists the ranked contribution of each stress to a given target. The
detailed stresses matrix for each target can be found in Tables 5-9 on pp. B-14 through B-
16, *Appendix B*.

Table 2: Stress Matrix Summary Table

Stresses (Altered Key Ecological Attributes) Across Systems		Red Cockaded Woodpecker	Longleaf Pine Mosaic	Streamhead Pocosins/Seeps	Blackwater Streams	Upland Depressional Wetlands
1	Altered composition/structure	Medium	Very High	Low	High	-
2	Altered hydrologic regime	-	-	-	Medium	-
3	Altered natural fire regime	Very High	High	High	-	Medium
4	Altered predator/prey relationships	-	Medium	Low	Low	-
5	Habitat destruction or conversion	High	Medium	Medium	-	Medium
6	Habitat fragmentation	High	Medium	-	-	-
7	Loss of landscape context (destruction of uplands habitat)	-	-	-	-	High
8	Nutrient loading	-	-	-	High	-
9	Sedimentation	-	-	Medium	Medium	Medium
10	Toxins/contaminants	-	-	-	Low	-

Stresses Definitions[2]

1. <u>Altered composition/structure</u> – This stress refers to fundamental changes in the ecological processes and key habitats of species in a given target. For the RCW, this stress refers to foraging and nesting habitat, group composition and interrelationships between groups. For the longleaf pine mosaic, this stress refers to longleaf pine age distribution within stands, quality and diversity of groundcover and the amount of scrub oak mid-story. For blackwater streams, this stress refers to a combination of water quality, species diversity and population size amongst rare and endangered species.

2. <u>Altered hydrologic regime</u> – This stress refers to changes in the ability, direction or quality of water flow as compared to a given blackwater stream's natural run.

3. <u>Altered natural fire regime</u> – This stress refers to changes to the frequency, intensity and/or ability of fire to spread across a landscape with respect to the naturally occurring elements of a fire regime (i.e., soil, vegetation, topography characteristics). Though the affects are many, alterations to a natural fire regime generally influence all targets similarly by reducing the abilities of indigenous species, which are adapted to a natural fire regime, to grow and reproduce due to the influx of invasive species and unchecked growth of mid-story plants, such as scrub oak.

4. <u>Altered predator/prey relationships</u> – This stress refers to changes in the balance in proximity and population size of the longleaf pine mosaic's key predators and prey.

5. <u>Habitat destruction or conversion</u> – This stress refers to the destruction of or changes to habitat that no longer allow for a target to survive in its natural location or state. Habitat destruction and conversion affects all targets similarly by disallowing a given target to persist in a location due to the removal of its' key elements of survival.

6. <u>Habitat fragmentation</u> – This stress refers to the isolation of habitat patches through the destruction or conversion of habitat that would otherwise allow a target to interact with like species or communities. For the RCW, habitat fragmentation leads to interbreeding and loss of genetic viability. For the longleaf pine mosaic, habitat fragmentation reduces the ability for fire to spread in a natural mosaic, increases scrub oak populations, benefits invasive species, reduces the ability of component species to exchange genetic material and increases the susceptibility for patches to experience local extinctions.

7. <u>Loss of landscape context (destruction of uplands habitat)</u> – This stress refers to the destruction of uplands habitat per upland depressional wetlands, usually to

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[2] These definitions were written and refined in Peer Review 1 in August, 2004.

residential development. The presence of this stress alters surface water flow and fire behavior which are key elements to maintaining diversity in wetlands, as well as water quality.

8. <u>Nutrient loading</u> – This stress refers to excess nutrients, such as nitrogen and oxygen, which negatively impacts fish, mussel and vegetation species of blackwater streams. Nutrient loading can lead to algal bloom, changes in invertebrate populations, raising water temperatures and subsequent fish kills.

9. <u>Sedimentation</u> – This stress refers to increased particulate level (i.e., mud, sand or organic matter) in water bodies. Sedimentation affects all targets both by reducing light transmission and increasing the temperature of a water body and thus altering the natural conditions for native species of a given aquatic target.

10. <u>Toxins/contaminants</u> – This stress refers to the presence of polluting toxins or contaminants in a blackwater stream. These pollutants can directly lead to fish kills or "dead zones", as well as indirectly lead to lowered reproductive rates and "bioamplification", or the accumulation of toxins in species further up a food chain.

Threats Analysis
The sources of stress, or threats, to the health and vitality of Sandhills conservation targets were identified in Workshop I according to an emphasis on current and proximate human causes. A threat is current if the action is not only presently active but expected to deliver additional stresses to a target over the next ten years. A threat is considered historic if the current stresses will likely persist over the next ten years, but the source of the stress is no longer active.

Furthermore, the threats identified in this analysis are proximate to definitive activities (i.e., primary home development), as opposed to general or indirect actions (i.e., population growth). To increase the precision of these threats, definitions have been created to further specify what human activities the *Conservation Plan* addresses, and to which targets these activities affect.

Ultimately, the threats and stresses analyzed in this section lead to the conservation strategies that are selected to focus the efforts of the Partnership. These strategies focus on threat abatement, considering both the stress and its source. By doing so, two types of threats lead to different kinds of strategies. Abatement strategies focus on highly ranked threats with active sources of stress. Restoration strategies focus on highly ranked threats with persistent or historic sources of stress. A third type of strategy is to build capacity through means of improving policy, building organizational strength or recruiting additional partners. A summary of these threats and the threat rankings per each target can be found in Table 3 on the following page. For detailed rankings of sources of stress, please see Tables 10-14, pp. B-17 through B-22 in Appendix B.

Table 3: Threats Summary Table

	Threats Across Systems	Red Cockaded Woodpecker	Longleaf Pine Mosaic	Streamhead Pocosins/Seeps	Blackwater Streams	Upland Depressional Wetlands	Overall Threat Rank
1	Primary home development	Very High	High	High	Low	High	Very High
2	Fire suppression/ inhibitions to the use of prescribed fire	Very High	High	High	-	Medium	High
3	Forestry practices	Very High	High	-	High	-	High
4	Second home/resort development	Very High	High	High	-	-	High
5	Pine Straw Production	High	Medium	-	-	-	Medium
6	Roads	-	-	Medium	-	High	Medium
7	Small dams on headwater tributaries	-	-	High	Low	-	Medium
8	Golf course construction and maintenance	-	-	-	Low	High	Medium
9	Livestock production practices	-	-	-	Medium	-	Low
10	Wastewater treatment	-	-	-	Low	-	Low
	Threat Status for Targets and Site	Very High	High	High	Medium	High	Very High

Threats Descriptions
1. <u>Primary home development</u> – Primary home development refers to the construction of residential properties on formerly undeveloped sites. This is the highest ranking threat to Sandhills biodiversity and significantly affects each of the selected targets through habitat loss, degradation and fragmentation as well as alterations to the fire regime and target composition. Current highway projects and population projections indicate that primary home development will continue at an increasing pace in upcoming years.

2. <u>Fire suppression and inhibitions to the use of prescribed fire</u> – Fire suppression refers to the containment of naturally ignited wildfires through firefighting. Inhibitions to prescribed fire refers to policies, political issues and landowner concerns that limit the ability of conservation parties to implement prescribed fire in lieu of a natural fire regime. This threat affects all targets, with the exception of blackwater streams, by altering the natural fire regime, structure and composition of a target's habitat.[3]

3. <u>Forestry practices</u> – Forestry practices refers to the activities of timber harvesting. Though to-date a less predominant activity, timber cutting affects the longleaf pine mosaic and RCW directly through the loss of longleaf pine trees and affects blackwater streams through degraded riparian buffers and increased levels of sedimentation.

4. <u>Second home and resort development</u> – Second home and resort development refers to the construction of golf communities, horse farms and vacation homes. The development of these homes, farms and condominiums leads to habitat loss and further stresses caused by requirements for road development and water/sewerage infrastructure. Differences in human use and activity warrant the separation of this threat from primary home development (Threat 1), but the targets affected are similar.

5. <u>Roads</u> – This threat refers to the development of new roads, as well as the widening or rerouting of existing roads. Not only does the development of roads directly impact the hydrology and connectivity of aquatic targets (streamhead pocosins/seeps and upland depressional wetlands) and fragment upland habitats, but it also facilitates the occurrence of all other threats (i.e., primary, secondary home and golf course development, timber harvesting, etc.) mentioned in the *Conservation Plan*.

6. <u>Golf course construction and maintenance</u> – This threat refers to the development of new golf courses, as well as the routine maintenance of existing and new golf courses. The development of new golf courses directly alters the composition of habitat that is converted to greens and fairways. Due to the use of chemical

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[3] Though, the affects of fire on blackwater streams is not well understood and may be more significant.

fertilizers and pesticides, routine maintenance of golf courses leads to significant nutrient and toxin runoff into blackwater streams and upland depressional wetlands

7. <u>Pine straw production</u> – Pine straw production refers to the raking of longleaf pine needles for use as landscape bedding. Pine straw raking leads to deteriorated groundcover conditions and biodiversity, which not only affects the long-term structure of pine stands in the longleaf pine mosaic, but also the foraging habitat and food supply of the RCW.

8. <u>Livestock production practices</u> – This threat refers to chicken farms in the Sandhills area. Chicken farms, though generally small in footprint size, tend to be a source of significant levels of pollutants (toxin and nutrient loading) to blackwater streams.

9. <u>Small dams on headwater tributaries</u> – This threat refers to headwater tributaries, where small-scale dams are put in place for private landowner use. This practice severs the connectivity of blackwater streams in sensitive aquatic habitat areas.

10. <u>Wastewater treatment</u> – This threat refers to the piping of gray water and (illegally) brown water into blackwater streams. This practice degrades stream water quality by adding stresses of nutrient loading and toxins (from household cleaning chemicals, automobile fluids, etc.).

STAKEHOLDER ANALYSIS

Introduction

An important element of the *Conservation Plan* should include a stakeholder analysis that identifies the individuals, groups and organizations that affect, or are affected by, biodiversity conservation efforts. These stakeholders may consist of various interests, from government agencies or non-government organizations to local communities, landowners or corporate groups. An effective stakeholder analysis identifies the stakeholders that hold the most critical or urgent stakes in the conservation area, then defines the stakeholders' interests with respect to the selected conservation targets as well as the group's leverage held in associated strategies and relationship(s) to other stakeholders[1]. A comprehensive stakeholder analysis is yet to be completed for the *Conservation Plan*. However, examples of completed studies that can lend input to this process exist and are described below.

Current Applications

The Red Cockaded Woodpecker as an Asset: Creating Community Benefits from Habitat Restoration[2] – This study was commissioned by the Sandhills Conservation Partnership to "engage in a process of community contact so that the broader interests of the community would be served by its partnership effort." The study focuses on the concerns and opportunities of residents of Hoke County and eastern Moore County, with specific relation to the recovery of the red-cockaded woodpecker, resource management, land protection and education and public relations. This document captures the results of interviews with at least 212 people and looks for means to balance physical and social environments in ecosystem management. Examples of these ways include strengthening community relations, broadening partnership opportunities and making local communities the beneficiaries of conservation activities.

Joint Land Use Study: Living in Harmony with Fort Bragg and Pope AFB[3] - This study looks into the issues of urban encroachment, losses of critical endangered species habitat and diminishing rural land uses that are currently limiting the training abilities of the US Army and Air Force on Fort Bragg and Pope Air Force Base. The study was Commissioned by the Fort Bragg/Pope Air Force Base Regional Land Use Commission, the study generates recommendations to neighboring counties and municipalities that will generate a compatible land use buffer around Fort Bragg. Currently, 5 of 6 counties and 12 of 13 municipalities have adopted these recommendations, which include changes to zoning, infrastructure and transportation policies along with revisions to real estate disclosures and building codes. The cooperative planning efforts that have resulted from this study lend valuable insight to understanding opportunities that might be capitalized

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[1] Parrish, J. 2001. *Recommended Template for Written Site Conservation Plans: Version 1.0.* The Nature Conservancy – International Site Conservation Program. Arlington, Virginia.

[2] Kent, J.A., et al. 2000. *The Red-Cockaded Woodpecker as an Asset: Creating Community Benefits from Habitat Restoration.* James Kent Associates. Aspen, Colorado.

[3] Dougherty, J. et al. 2003. *Joint Land Use Study: Living in Harmony with Fort Bragg/Pope AFB.* NC Department of Commerce, Division of Community Assistance. Fayetteville, North Carolina.

on by The Nature Conservancy and partnered organizations in Sandhills conservation efforts.

Future Requirements for Stakeholder Analysis
Any future stakeholder analysis for the *Sandhills Conservation Plan* should include elements that strengthen the Partnership's ability to implement conservation strategies and restoration efforts. Examples of these elements include:
- The identification of all critical stakeholders in the Sandhills landscape.
- A matrix that identifies the interests of a given stakeholder group with relation to a conservation target.
- The leverage and sources of power of a given stakeholder group with relation to a conservation target or strategy.
- Key assessments of a stakeholder group's bargaining strength's and limits.
- A stakeholder's contribution or ability to lessen the affects of a stress, or its relationship to the identified threats.

By understanding the various aspects of Sandhills stakeholders in conservation activities, The Nature Conservancy can increase the effectiveness of its partnerships and identify opportunities for outreach and education.

CONSERVATION STRATEGY FRAMEWORK

Introduction

The *Conservation Strategy Framework* outlines the strategies that could be undertaken to ensure the long-term success of the selected conservation targets. These strategies are the actions that, given this planning effort's rigorous selection process[1], hold the most promise to either directly or indirectly abate the threats that are currently weakening the biodiversity health of Sandhills conservation targets.

The following *Conservation Strategy Framework* includes strategies of three distinguishing categories:

- *Threat abatement strategies* remove or reduce active sources of stress to a conservation target (i.e., purchasing conservation easements to prevent residential development).
- *Restoration strategies* directly work to reduce human caused stresses or restore natural functions to a conservation target (i.e., restoring riparian buffers so as to reduce stream sedimentation).
- *Capacity building strategies* work to engage stakeholders, promote priority policies, offer compatible development alternatives, or otherwise develop the capabilities of the Partnership to engage in conservation work in the Sandhills.

In the *Conservation Strategy Framework*, sets of these strategies are organized under conservation objectives. Objectives are defined as "specific statements detailing the desired accomplishments or outcomes of a particular set of activities within a project."[2] These objectives aim to ultimately achieve the Partnership's mission, which is stated on page VII-2.

Strategy Selection Process

The strategies and objectives for the *Conservation Plan* were generated in Workshop II in June, 2004. Thirteen objectives and sixty five strategies were identified in brainstorming sessions through group discussion and entered into the Excel based *Conservation Project Management Workbook v.4.0a* tool. Later, the strategies were ranked by overall benefit to the selected conservation targets, overall feasibility and overall cost. This set of strategies and objectives, along with the ranking scheme, were then sent out to the participants of Peer Review. From the critique generated by this review, a list of 37 strategies and 10 objectives were selected for the final *Conservation Strategy Framework* (following page).

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[1] For a comprehensive list of strategies generated in Workshop II, as well as rankings per the selection process, see Table 21 on p. B-24, Appendix B
[2] 2003. The Nature Conservancy. *The Enhanced 5-S Project Management Process*. The Nature Conservancy.

Mission Statement
The North Carolina Sandhills Conservation Partnership was established to coordinate the development and implementation of conservation strategies for the red-cockaded woodpecker, other native biota, longleaf pine and other ecosystems in the Sandhills of North Carolina compatible with the land use objective of the partners.

STRATEGY FRAMEWORK

Objective 1 – To protect critical conservation lands
- Strategy 1.1 – Purchase lands or easements that protect unique natural values and/or connect, buffer or expand existing conservation lands
- Strategy 1.2 – Encourage and provide incentives to restore degraded natural communities through cost share and other incentive programs, such as Safeharbor

Objective 2 – To eliminate legal obstructions to prescribed fire
- Strategy 2.1 – Affect North Carolina Department of Environment and Natural Resources rules on air quality regulation interpretation

Objective 3 – To educate the public and decision makers about the benefits of prescribed fire
- Strategy 3.1 – Implement fire outreach and awareness programs, such as demonstrations of professional fire management

Objective 4 – To increase resources (personnel, training, equipment, funding, etc.) to private and public land managers for prescribed fire
- Strategy 4.1 – Establish a "North Carolina Fire Council"
- Strategy 4.2 – Identify outside sources of funding for prescribed fire on Partnership lands
- Strategy 4.3 – Increase the ability of fire management entities to collaborate and cross boundaries through formal agreements
- Strategy 4.4 – Seek additional State and/or Federal funding for the application of prescribed fire on private lands
- Strategy 4.5 – Increase the number of private qualified landowners and contractors to burn on private lands
- Strategy 4.6 – Make available and promote training opportunities to private landowners and contractors in government and non-profit fire courses
- Strategy 4.7 – Work with North Carolina Forest Service to increase internal funding for prescribed fire on private lands
- Strategy 4.8 – Work with the North Carolina Forest Service to implement the Fire Wise program in the Sandhills

Objective 5 – To encourage forestry practices that maintains and/or restores longleaf pine communities
- Strategy 5.1 – Bolster existing and create new incentive programs for natural forest stewardship
- Strategy 5.2 – Educate the public and foresters about the economic benefits of longleaf pine and importance of healthy groundcover
- Strategy 5.3 – Encourage reforestation practices that don't diminish the wiregrass groundcover
- Strategy 5.4 – Review Best Management Practices and propose changes based on the most recent sustainable forestry research
- Strategy 5.5 – Promote prescribed fire as an alternative to herbicide use for hardwood control in existing forest stands
- Strategy 5.6 – Promote the use of prescribed fire to minimize ground disturbance for site preparation of new forest stands

Objective 6 – To lessen the impacts of pinestraw raking on forest health, including groundcover
- Strategy 6.1 – Review literature and impacts of pinestraw raking and fertilizer application in longleaf pine
- Strategy 6.2 – Encourage pinestraw harvesting on plantations instead of natural forests
- Strategy 6.3 – Working with pinestraw producers, create Best Management Practices in natural forests (i.e., hand raking versus mechanical raking, fire rotation, etc.)

Objective 7 – To improve the design, construction and maintenance of roads for environmental compatibility
- Strategy 7.1 – Establish working relationships with North Carolina Department of Transportation (DOT) district engineers
- Strategy 7.2 – Encourage the DOT to use existing right-of-ways over new routes
- Strategy 7.3 – Provide DOT with information about sensitive natural resources in time to influence planning and siting of roads and road expansions
- Strategy 7.4 – Prevent the planting of invasive species by DOT along roadsides and expand the use of native species, where appropriate
- Strategy 7.5 – Improve the implementation of roadside management for rare species

Objective 8 – To implement land use controls that are environmentally sustainable
- Strategy 8.1 – Educate decision makers and the public about the value of open space and incentives that exist to maintain it
- Strategy 8.2 – Encourage local strategies to preserve open space through tools such as tax abatement, local trust funds, etc.
- Strategy 8.3 – Encourage the adoption of sustainable county or local land use plans

- Strategy 8.4 – Encourage the preservation of new and existing natural riparian buffers
- Strategy 8.5 – Develop relationships with equestrian community to encourage the design and management of horse farms compatible with Red Cockaded Woodpeckers and adjacent natural areas
- Strategy 8.6 – Encourage the incorporation of Smart Growth principles and practices in local and county land use planning

Objective 9 – To minimize the impacts of golf course development and management
- Strategy 9.1 – Ensure the application of new Red Cockaded Woodpecker guidelines and encourage clustered design in the development of golf courses
- Strategy 9.2 – Establish relationships with golf course managers to affect changes I management, such as water use, herbicides, etc.

Objective 10 – To build a stronger, more effective partnership through communication, coordination and sharing of resources
- Strategy 10.1 – Build the capacity of individual partners and their commitment to the mission of the NC Sandhills Conservation Partnership
- Strategy 10.2 – Attract additional partners to the NC Sandhills Conservation Partnership with common interests and available resources
- Strategy 10.3 – Train and coordinate the use of volunteers between agencies and non-profits

MONITORING PROGRAM

Introduction

The *Conservation Plan* is designed to be an adaptive, iterative document that continually addresses the dynamic ecological processes and status of Sandhills biodiversity. As such, it is necessary to measure the progress and success of strategies and actions that the Partnership takes. To do so requires an active monitoring program that measures the very elements of biological health that have been selected to develop the *Strategy Framework*. These elements are the same measurable indicators of status or trend that were selected to determine the *Biodiversity Health Assessment* (section *V*) of Sandhills targets.

Indicators are measurable factors of conservation targets that can be quantitatively and qualitatively monitored to test the success the three types of strategy described in the *Strategy Framework*: threat abatement, restoration of biodiversity health and capacity building. Indicators for biodiversity health measure threat abatement and restoration strategies, whereas indicators of capacity building will be based on the achievement of increasing organizational strength with relation to the chosen capacity building strategies. These measures will be collected and reviewed on a semi-annual basis, with full plan review performed on a five-year basis.

The monitoring program will be a cooperative venture, whereby the full measure of Sandhills biodiversity is measured by the agreed upon indicators listed in section *V* of the *Conservation Plan*. These indicators should be divided effectively amongst partners and field personnel, with a strategy for communication and centralized data management to process and update current understanding of conservation target health.

#	Conservation Targets	Category	Key Ecological Attribute	Indicator	Threat References
1	Red Cockaded Woodpecker	Landscape Context	Application of prescribed fire to mimic natural fire regime on conservation lands	% acres of conservation land burned per season per annum	-Forestry practices -Fire suppression/ inhibitions to the use of prescribed fire -Fire suppression
1	Red Cockaded Woodpecker	Landscape Context	Demographic connectivity between Sandhills East and West populations	# individuals filling vacancies between populations (E/W)	-Forestry practices -Fire suppression/ inhibitions to the use of prescribed fire
1	Red Cockaded Woodpecker	Landscape Context	Extent of mature pine habitat	# acres of mature pine forest on conservation lands	-Forestry practices -Fire suppression/ inhibitions to the use of prescribed fire
1	Red Cockaded Woodpecker	Condition	Active clusters in the primary recovery population that have suitable habitat	% active clusters with suitable pine habitat	-Forestry practices -Fire suppression/ inhibitions to the use of prescribed fire -Pine Straw Production -Livestock production practices
1	Red Cockaded Woodpecker	Condition	Population structure - group composition	# adults per cluster	
1	Red Cockaded Woodpecker	Size	Population size & dynamics	# potential breeding groups	-Forestry practices -Fire suppression/ inhibitions to the use of prescribed fire
1	Red Cockaded Woodpecker	Threat-based monitoring		# of impediments to prescribed fire practices	-Fire suppression/ inhibitions to the use of prescribed fire
1	Red Cockaded Woodpecker	Threat-based monitoring		% occurances with oppropriate fire regimes	-Forestry practices -Fire suppression/ inhibitions to the use of prescribed fire -Fire suppression

1	Red Cockaded Woodpecker	Threat-based monitoring		connectivity between protected areas	-Primary home development -Second home/resort development -Roads -Golf course construction and maintenance
1	Red Cockaded Woodpecker	Threat-based monitoring		connectivity between protected areas and primary areas	-Primary home development -Second home/resort development -Roads -Golf course construction and maintenance
1	Red Cockaded Woodpecker	Threat-based monitoring		level of influence in DOT's siting and road expansion process	-Primary home development -Second home/resort development -Roads -Golf course construction and maintenance
1	Red Cockaded Woodpecker	Threat-based monitoring		level of public awareness of benefits of prescribed fire	-Forestry practices -Fire suppression/ inhibitions to the use of prescribed fire -Fire suppression
1	Red Cockaded Woodpecker	Threat-based monitoring		level of public awareness of Sandhills natural fire regime	-Forestry practices -Fire suppression/ inhibitions to the use of prescribed fire -Fire suppression
1	Red Cockaded Woodpecker	Threat-based monitoring		representation of all rare species	-Primary home development -Forestry practices -Fire suppression/ inhibitions to the use of prescribed fire -Golf course construction and maintenance

1	Red Cockaded Woodpecker	Threat-based monitoring		representation of rare species populations	-Primary home development -Forestry practices -Fire suppression/ inhibitions to the use of prescribed fire -Golf course construction and maintenance
2	Longleaf Pine Mosaic	Landscape Context	Connectivity among communities & ecosystems	connectivity between protected areas and primary areas	-Primary home development -Second home/resort development -Roads -Golf course construction and maintenance
2	Longleaf Pine Mosaic	Condition	Fire regime - (timing, frequency, intensity, extent)	# acres burned as compared to natural fire regime	-Forestry practices -Fire suppression/ inhibitions to the use of prescribed fire -Fire suppression
2	Longleaf Pine Mosaic	Condition	Population size & dynamics	rare plant population size	-Primary home development -Forestry practices -Fire suppression/ inhibitions to the use of prescribed fire -Fire suppression
2	Longleaf Pine Mosaic	Condition	Presence of key communities or seral stages	representation of all community types	-Primary home development -Forestry practices -Fire suppression/ inhibitions to the use of prescribed fire -Fire suppression
2	Longleaf Pine Mosaic	Condition	Vegetation structure (age class)	representation of all age classes in natural spatial distribution	-Forestry practices -Fire suppression/ inhibitions to the use of prescribed fire -Fire suppression -Pine Straw Production

2	Longleaf Pine Mosaic	Size	Size / extent of characteristic communities / ecosystems	# acres of mature pine forest on conservation lands	-Forestry practices -Fire suppression/ inhibitions to the use of prescribed fire
2	Longleaf Pine Mosaic	Threat-based monitoring		# of impediments to prescribed fire practices	-Fire suppression/ inhibitions to the use of prescribed fire
2	Longleaf Pine Mosaic	Threat-based monitoring		% acres of conservation land burned per season per annum	-Forestry practices -Fire suppression/ inhibitions to the use of prescribed fire -Fire suppression
2	Longleaf Pine Mosaic	Threat-based monitoring		% occurances with oppropriate fire regimes	-Forestry practices -Fire suppression/ inhibitions to the use of prescribed fire -Fire suppression
2	Longleaf Pine Mosaic	Threat-based monitoring		abundance of all community types	-Primary home development -Second home/resort development -Forestry practices -Small dams on headwater tributaries
2	Longleaf Pine Mosaic	Threat-based monitoring		adequate buffer around occurances	-Primary home development -Forestry practices -Fire suppression/ inhibitions to the use of prescribed fire -Fire suppression
2	Longleaf Pine Mosaic	Threat-based monitoring		connectivity between protected areas	-Primary home development -Second home/resort development -Roads -Golf course construction and maintenance

2	Longleaf Pine Mosaic	Threat-based monitoring		level of influence in DOT's siting and road expansion process	-Primary home development -Second home/resort development -Roads -Golf course construction and maintenance
2	Longleaf Pine Mosaic	Threat-based monitoring		level of public awareness of benefits of prescribed fire	-Forestry practices -Fire suppression/ inhibitions to the use of prescribed fire -Fire suppression
2	Longleaf Pine Mosaic	Threat-based monitoring		level of public awareness of Sandhills natural fire regime	-Forestry practices -Fire suppression/ inhibitions to the use of prescribed fire -Fire suppression
2	Longleaf Pine Mosaic	Threat-based monitoring		representation of all rare species	-Primary home development -Forestry practices -Fire suppression/ inhibitions to the use of prescribed fire -Golf course construction and maintenance
2	Longleaf Pine Mosaic	Threat-based monitoring		representation of rare species populations	-Primary home development -Forestry practices -Fire suppression/ inhibitions to the use of prescribed fire -Golf course construction and maintenance
3	Streamhead Pocosins/Seeps	Condition	Presence of key communities or seral stages	representation of all community types	-Primary home development -Forestry practices -Fire suppression/ inhibitions to the use of prescribed fire -Fire suppression

3	Streamhead Pocosins/Seeps	Condition	Species composition / dominance	representation of rare species populations	-Primary home development -Forestry practices -Fire suppression/ inhibitions to the use of prescribed fire -Golf course construction and maintenance
3	Streamhead Pocosins/Seeps	Threat-based monitoring		# occurences with adequate buffer	-Forestry practices -Livestock production practices
3	Streamhead Pocosins/Seeps	Threat-based monitoring		# of impediments to prescribed fire practices	-Fire suppression/ inhibitions to the use of prescribed fire
3	Streamhead Pocosins/Seeps	Threat-based monitoring		% acres of conservation land burned per season per annum	-Forestry practices -Fire suppression/ inhibitions to the use of prescribed fire -Fire suppression
3	Streamhead Pocosins/Seeps	Threat-based monitoring		% occurances with oppropriate fire regimes	-Forestry practices -Fire suppression/ inhibitions to the use of prescribed fire -Fire suppression
3	Streamhead Pocosins/Seeps	Threat-based monitoring		abundance of all community types	-Primary home development -Second home/resort development -Forestry practices -Small dams on headwater tributaries
3	Streamhead Pocosins/Seeps	Threat-based monitoring		adequate buffer around occurances	-Primary home development -Forestry practices -Fire suppression/ inhibitions to the use of prescribed fire -Fire suppression

3	Streamhead Pocosins/Seeps	Threat-based monitoring		connectivity between protected areas	-Primary home development -Second home/resort development -Roads -Golf course construction and maintenance
3	Streamhead Pocosins/Seeps	Threat-based monitoring		connectivity between protected areas and primary areas	-Primary home development -Second home/resort development -Roads -Golf course construction and maintenance
3	Streamhead Pocosins/Seeps	Threat-based monitoring		level of influence in DOT's siting and road expansion process	-Primary home development -Second home/resort development -Roads -Golf course construction and maintenance
3	Streamhead Pocosins/Seeps	Threat-based monitoring		level of public awareness of benefits of prescribed fire	-Forestry practices -Fire suppression/ inhibitions to the use of prescribed fire -Fire suppression
3	Streamhead Pocosins/Seeps	Threat-based monitoring		level of public awareness of Sandhills natural fire regime	-Forestry practices -Fire suppression/ inhibitions to the use of prescribed fire -Fire suppression
3	Streamhead Pocosins/Seeps	Threat-based monitoring		rare plant population size	-Primary home development -Forestry practices -Fire suppression/ inhibitions to the use of prescribed fire -Fire suppression

3	Streamhead Pocosins/Seeps	Threat-based monitoring		representation of all rare species	-Primary home development -Forestry practices -Fire suppression/ inhibitions to the use of prescribed fire -Golf course construction and maintenance
4	Blackwater Streams	Landscape Context	Hydrologic regime - (timing, duration, frequency, extent)	intactness of hydrologic regime	-Primary home development -Golf course construction and maintenance -Small dams on headwater tributaries -Wastewater treatment
4	Blackwater Streams	Condition	Nutrient concentrations & dynamics	key nutrient levels	-Primary home development -Livestock production practices -Small dams on headwater tributaries -Wastewater treatment
4	Blackwater Streams	Condition	Presence of key communities or seral stages	representation of all community types	-Primary home development -Forestry practices -Fire suppression/ inhibitions to the use of prescribed fire -Fire suppression
4	Blackwater Streams	Condition	Species composition / dominance	representation of rare species populations	-Primary home development -Forestry practices -Fire suppression/ inhibitions to the use of prescribed fire -Golf course construction and maintenance
4	Blackwater Streams	Threat-based monitoring		# physical barriers (i.e. dams)	-Small dams on headwater tributaries

4	Blackwater Streams	Threat-based monitoring		abundance of all community types	-Primary home development -Second home/resort development -Forestry practices -Small dams on headwater tributaries
4	Blackwater Streams	Threat-based monitoring		adequate buffer around occurances	-Primary home development -Forestry practices -Fire suppression/ inhibitions to the use of prescribed fire -Fire suppression
4	Blackwater Streams	Threat-based monitoring		connectivity between protected areas	-Primary home development -Second home/resort development -Roads -Golf course construction and maintenance
4	Blackwater Streams	Threat-based monitoring		connectivity between protected areas and primary areas	-Primary home development -Second home/resort development -Roads -Golf course construction and maintenance
4	Blackwater Streams	Threat-based monitoring		representation of all rare species	-Primary home development -Forestry practices -Fire suppression/ inhibitions to the use of prescribed fire -Golf course construction and maintenance
5	Upland Depressional Wetlands	Landscape Context	Landscape pattern (mosaic) & structure	# occurrences with adequate buffer for indigenous amphibian life cycle	-Forestry practices -Fire suppression/ inhibitions to the use of prescribed fire -Wastewater treatment

5	Upland Depressional Wetlands	Condition	Hydrologic regime - (timing, duration, frequency, extent)	intactness of hydrologic regime	-Primary home development -Golf course construction and maintenance -Small dams on headwater tributaries -Wastewater treatment
5	Upland Depressional Wetlands	Condition	Presence of key communities or seral stages	representation of rare species populations	-Primary home development -Forestry practices -Fire suppression/ inhibitions to the use of prescribed fire -Golf course construction and maintenance
5	Upland Depressional Wetlands	Threat-based monitoring		# occurences with adequate buffer	-Forestry practices -Livestock production practices
5	Upland Depressional Wetlands	Threat-based monitoring		# of impediments to prescribed fire practices	-Fire suppression/ inhibitions to the use of prescribed fire
5	Upland Depressional Wetlands	Threat-based monitoring		% acres of conservation land burned per season per annum	-Forestry practices -Fire suppression/ inhibitions to the use of prescribed fire -Fire suppression
5	Upland Depressional Wetlands	Threat-based monitoring		% occurances with oppropriate fire regimes	-Forestry practices -Fire suppression/ inhibitions to the use of prescribed fire -Fire suppression
5	Upland Depressional Wetlands	Threat-based monitoring		abundance of all community types	-Primary home development -Second home/resort development -Forestry practices -Small dams on headwater tributaries

5	Upland Depressional Wetlands	Threat-based monitoring		adequate buffer around occurances	-Primary home development -Forestry practices -Fire suppression/ inhibitions to the use of prescribed fire -Fire suppression
5	Upland Depressional Wetlands	Threat-based monitoring		connectivity between protected areas	-Primary home development -Second home/resort development -Roads -Golf course construction and maintenance
5	Upland Depressional Wetlands	Threat-based monitoring		connectivity between protected areas and primary areas	-Primary home development -Second home/resort development -Roads -Golf course construction and maintenance
5	Upland Depressional Wetlands	Threat-based monitoring		key nutrient levels	-Primary home development -Livestock production practices -Small dams on headwater tributaries -Wastewater treatment
5	Upland Depressional Wetlands	Threat-based monitoring		level of influence in DOT's siting and road expansion process	-Primary home development -Second home/resort development -Roads -Golf course construction and maintenance
5	Upland Depressional Wetlands	Threat-based monitoring		level of public awareness of benefits of prescribed fire	-Forestry practices -Fire suppression/ inhibitions to the use of prescribed fire -Fire suppression

5	Upland Depressional Wetlands	Threat-based monitoring		level of public awareness of Sandhills natural fire regime	-Forestry practices -Fire suppression/ inhibitions to the use of prescribed fire -Fire suppression
5	Upland Depressional Wetlands	Threat-based monitoring		rare plant population size	-Primary home development -Forestry practices -Fire suppression/ inhibitions to the use of prescribed fire -Fire suppression
5	Upland Depressional Wetlands	Threat-based monitoring		representation of all rare species	-Primary home development -Forestry practices -Fire suppression/ inhibitions to the use of prescribed fire -Golf course construction and maintenance

CURRENT AND FUTURE STUDIES AND ANALYSIS

Introduction

The Partnership's mission of protecting Sandhills biodiversity has been greatly aided by inventory, research and analysis performed by various organizations. Primary among those is the extensive inventory and classification that has been performed by the North Carolina Natural Heritage Program and the development of a "Reserve Design" for the area (*see map, Appendix A, p.8*), which identifies areas of the greatest overall biological value and diversity. The advent of Geographic Information Systems (GIS) technology allows for a more precise and extensive spatial understanding of an area than has been possible in years prior. The ability to perform further spatial analysis on Sandhills targets with consideration to the identified threats and strategies is a major priority for future drafts of the *Conservation Plan*. The end sought is to develop a spatially accurate, comprehensive, scientifically based protection design for the Sandhills that can be continually updated with the most current data. This design will, like the Reserve Design, maintain an account of the lands with greatest biological value but, unlike the Reserve Design, also take into consideration threats such as changing rates and locations of urbanization and infrastructure development, as well as strategies such as possible biological corridors or compatible land uses.

The *Current and Future Studies and Analysis* section catalogues existing studies and ideas for future studies that will aid Sandhills conservation efforts. The *Current Studies* section lists, by citation, and gives short descriptions of studies that has been performed and are specific and applicable to the Partnership's mission. The *Future Studies* section lists research or analysis that is needed to fulfill purposes of inventory, biodiversity health, threats analysis or protection design.

Current Studies

Carter, J., et. al. *Report from the RCW Recovery Working Group.* Unpublished. North Carolina Sandhills Conservation Partnership – RCW Recovery Working Group. *This report outlines the findings of the RCW Recovery Working Group on an overall recovery plan. The group recommends strengthening the populations of Sandhills East and West RCW populations, as opposed to developing a gap corridor between populations.*

Daly, K.M. 1998. *Assembling a portfolio of priority sites for biodiversity conservation in the North Carolina Sandhills.* Master's Project, Nicholas School of the Environment, Duke University. Durham, North Carolina.

Desmarais, A.E. 2000. *Using Ecological Surrogates for Conservation Planning in the North Carolina Sandhills.* Master's Project, Nicholas School of the Environment, Duke University. Durham, North Carolina. *This project looks at using multivariate statistical analysis with ecological surrogates to predict high quality biological sites for The Nature Conservancy's planning purposes.*

Dougherty, J., J. Epley, K. Rutkofske and R. Stricklin. 2003. *Joint Land Use Study: Living in Harmony with Fort Bragg/Pope AFB.* NC Department of Commerce, Division of Community Assistance. Fayetteville, North Carolina. *This study creates recommendations for neighboring counties and municipalities of Fort Bragg, pertaining to issues of urban encroachment and incompatible land uses.*

Jarvis, B. 1998. *Applications of GIS and Remotely Sensed Data in Ecoregion and Multiple-Site Conservation: Examples from the North Carolina Sandhills.* Master's Project, Nicholas School of the Environment, Duke University. Durham, North Carolina.

Hall, S. Unpublished. *Preliminary Natural Heritage Program Landscape Assessment for the Fall-Line Sandhills Ecoregion.* Department of Environment, Health and Natural Resources, Division of Parks and Recreation, NC Natural Heritage Program. *This assessment develops a preliminary guild-based community classification for fauna of the Sandhills.*

Kent, J.A., et al. 2000. *The Red-Cockaded Woodpecker as an Asset: Creating Community Benefits from Habitat Restoration.* James Kent Associates. Aspen, Colorado. *This report collects stakeholder feedback from Hoke and eastern Moore county residents with regards to RCW recovery and land conservation efforts.*

Schafale, M. and Weakley, A. 1990. *Classification of the Natural Communities of North Carolina: Third Approximation.* Department of Environment, Health and Natural Resources, Division of Parks and Recreation, NC Natural Heritage Program. 325p. *This study follows up on the Second Approximation to create a classification system of North Carolina ecological communities, considering the composition of flora, fauna, soils, hydrology and various other external effects (i.e., fire regime).*

Schafale, M. and Weakley, A. Unpublished. *Classification of the Natural Communities of North Carolina: Fourth Approximation.* Department of Environment, Health and Natural Resources, Division of Parks and Recreation, NC Natural Heritage Program. *This study follows up on the Third Approximation to create a classification system of North Carolina ecological communities, considering the composition of flora, fauna, soils, hydrology and various other external effects (i.e., fire regime).*

Schafale, M. 1994. *Inventory of Longleaf Pine Natural Communities in North Carolina.* Department of Environment, Health and Natural Resources, Division of Parks and Recreation, NC Natural Heritage Program. 230 p. *This study looks at the status, composition and locations of longleaf pine communities in North Carolina, based on extensive Natural Heritage inventories.*

Schafale, M., Hall, S. and Finnegan, J. 1999. *Conservation Assessment of the Southeast Coastal Plain of North Carolina, Using Site-Oriented and Landscape-Oriented Analysis*. Department of Environment, Health and Natural Resources, Division of Parks and Recreation, NC Natural Heritage Program. 249 p. *This study looks into the status, composition and locations of longleaf pine communities in North Carolina, based on extensive Natural Heritage inventories.*

Schafale, M. 2002. *Sandhills Reserve Design Biological Analysis*. Unpublished report. 7p. *This analysis prioritizes sites of the Sandhills for protection, based on biological value assessments that are generated from Natural Heritage inventories and aerial photo analysis.*

Westervelt, J. 2004. *Attraction to Urban Growth Around Fort Bragg*. US Army Corps of Engineers. Washington, DC. Unpublished report. *This analysis creates attractor indexes for urban growth around Fort Bragg to predict future growth areas and test regional planning alternatives.*

Future Studies

- Protection Design – An analysis of the Sandhills landscape that is based on ecological and threat based variables by spatial analysis is needed to determine how to integrate the priority and potential areas defined in Schafale's *Reserve Design* (*above*) with the priorities of addressing current threats.

- Monitoring Program – A rigorous monitoring program will be a forthcoming aspect of the Conservation Plan that measures Sandhills biodiversity by the agreed upon indicators listed in section *V* and coordinates effectively amongst partners and field personnel, with a strategy for communication and centralized data management to process and update current understanding of conservation target health.

GLOSSARY[1]

Alluvial[2]: (Alluvium) deposits resulting directly or indirectly from the sediment transport of streams deposited in riverbeds, flood plains, lakes, fans and estuaries.

Best Management Practices*: effective, practical, structural or nonstructural methods which achieve the ends of a given field of activity (i.e., forestry or stormwater BMPs) while minimizing negative impacts.

Biodiversity: the full range of natural variety and variability within and among living organisms, and the ecological and environmental complexes in which they occur. It encompasses multiple levels of organization, including genes, species, communities, and ecological systems or ecosystems.

Biodiversity health: see *Viability*.

Canopy[2]: overhead or dominant trees in a forest; the overhead branches and leaves of streamside vegetation.

Conservation lands: public lands, private lands under easements or ownership by The Nature Conservancy or SALT, and Safe Harbor properties

Conservation targets: specific components of biodiversity identified by The Nature Conservancy in Ecoregional Planning and used to design ecoregional portfolios and develop and prioritize conservation strategies. Currently, the conservancy's conservation targets consist of ecological systems, natural communities and species.

Ecological systems: dynamic assemblages of native plant and/or animal communities that are (1) occur together on the landscape or in the water, and (2) are tied together by similar ecological processes (e.g., fire, hydrology), underlying environmental features (e.g., soils, geology) or environmental gradients (e.g., elevation).

Ecoregion: relatively large geographic areas of land and water delineated by climate, vegetation, geology and other ecological and environmental patterns.

Encroachment*: in the case of the Fort Bragg military installation, encroachment refers to urban development along military boundaries that is incompatible with military training practices and land requirements.

Fire regime*: the cycle of natural disturbance caused by wildfire in a given ecosystem.

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[1] Glossary definitions taken from *Conservation by Design: A Framework for Mission Success*, and Conservation Project Management Workbook v4.a, unless otherwise noted.
[2] From *Forest Ecology Terminology*, Compiled by the Forest Ecology Working Group of the Society of American Foresters, retrieved on 7/22/04 from http://www.cnr.vt.edu/for3364/ecolterms.htm#D.

Fire Wise*: a public outreach and education program sponsored by a coalition of federal and state agencies to increase fire awareness of homeowners and communities located in and around areas with active natural fire regimes.

Foraging habitat*: sufficient habitat necessary for food collection for a given species.

Functional landscape or ecosystem: a landscape or ecosystem is considered functional if the fundamental ecological patterns and processes that maintain the targeted biodiversity of the given area are within natural (or acceptable) ranges of variation over a timeframe relevant to conservation planning (i.e., 50-500 years).

Groundcover[2]: Herbaceous plants (including grasses and ferns) and the lowest shrubs occupying an area.

Habitat corridors*: linear strips of protected land that connect conservation areas and allow for the movement and dispersal of species.

Keystone species*: a species whose extirpation from a given ecosystem would result in cascading effects of disturbance on other populations or vitality of other species.

Mesic[2]: Of sites or habitats characterized by intermediate moisture conditions, i.e. neither decidedly wet or decidedly dry.

Minimum dynamic area: The area needed to ensure survival or re-establishment of a target after natural disturbance.

Mixed use development*: a type of development that blends residential, commercial, office and other land use by strategic design to reduce auto dependency and create more vital neighborhoods and communities.

Natural communities: Assemblages of species that re-occur under similar habitat conditions and environmental regimes.

Nested targets: individual species, natural communities and species assemblages that are associated with, and represented by, the focal conservation target.

Portfolio: The suite of conservation areas within an ecoregion selected to represent and conserve the conservation targets and their genetic and ecological variation.

Primary recovery population: Sandhills East RCW population located primarily in and around the Fort Bragg military complex and neighboring Safe Harbor Program sites (see RCW in *Conservation Targets*, p. IV-3).

Reserve Design*: a cooperative planning effort of the Sandhills Conservation Partnership to rank and prioritize the Sandhills areas for conservation efforts, based on biodiversity value.

Riparian[2]: Of, pertaining to, situated, or dwelling on the margin of a river or other body of water. Trees forming a strip along a watercourse may be termed gallery forest. Vegetation growing along the seashore or a very large lake is termed littoral.

Saturation Density: the point at which a species population completely utilizes its entire available habitat.

Scrub layer*: woody plants and shrubs less than 6 meters tall occupying an area.

Seral stage[2]: A temporal and intermediate stage in the process of succession.

Species richness*: The number of species present in a community, ecosystem, landscape, region, etc.

Succession[2]: The gradual supplanting of one community of plants by another, the sequence of communities being termed a sere and each stage seral.

S (5-S): Systems, Stresses, Sources, Strategies, Success – see p. II-2 of Planning Process for further explanation.

Turbidity[3]: muddiness created by stirring up sediment or having foreign particles suspended in water.

Viability: Viability indicates the ability of a conservation target to persist for many generations or over long time periods. This term often corresponds with biodiversity health in this document.

Xeric[2]: Of sites or habitats characterized by decidedly dry conditions.

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[3] Webster's Dictionary online: retrieved on 7/22/04 from http://www.webster-dictionary.org/definition.

Sandhills Conservation Area:
Political and Municipal Features

LEE

Sanford

Broadway

US-1

NC-42

US-401

US-421

Lillington

HARNETT

Angier

Coats

Buies Creek

Dunn

NC-27

US-401

Linden

Godwin

Falcon

MONTGOMERY

NC-134

NC-705

NC-22

Robbins

NC-109

NC-731

NC-73

NC-109

NC-73

Cartage

Cameron

MOORE

Whispering Pines

Taylortown

Union

Pinehurst

Southern Pines

Norman

Foxfire Village

Abderen

Pinebluff

Ellerbe

Hoffman

Camp
Mackall

Fort Bragg

Spring Lake

Wade

Fayetteville

CUMBERLAND

Stedman

NC-53

RICHMOND

US-1

Rockingham

Hamlet

US-1

HOKE

Raeford

US-401

Hope Mills

I-95

NC-20

NC-211

US-401

NC-20

NC-210

SCOTLAND

Wagram

Red Springs

Gibson

Laurinburg

Maxton

NC-74

N
W E
S

NORTH CAROLINA

Sandhills Counties

Legend

Sandhill Counties ⬭

Major Roads ─

Urban Areas ⬭

Military Installations ⬭

Conservation Area ⬭

Miles
0   4   8   16   24   32
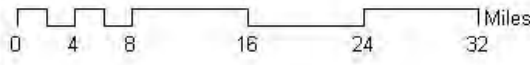
Sandhills Conservation Area: Managed Areas

NORTH CAROLINA

N

Sandhills Counties

Miles

0   3   6   12   18   24

Legend

Managed Area Jurisdictions

FEDERAL

LOCAL

PRIVATE

STATE

UNKNOWN

Safe Harbor Lands

Sandhills Conservation Area
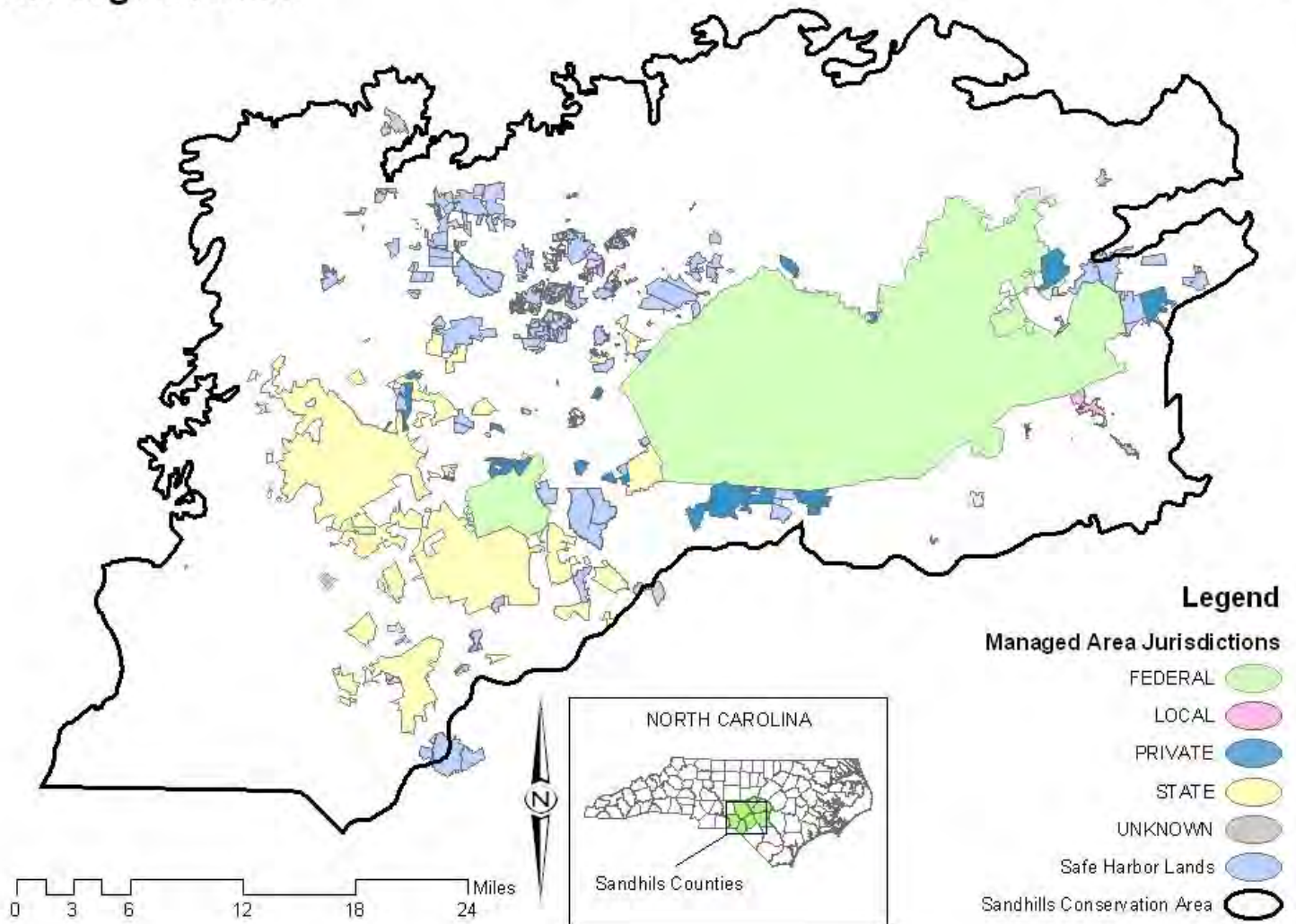
Sandhills Conservation Area:
Red Cockaded Woodpecker Occurrences

Legend

Streams and Rivers
Military Installations
Sandhills Conservation Area

Red Cockaded Woodpecker - 2003 Status

Active Clusters
Inactive Cluster
Historic Clusters

NORTH CAROLINA

N

Sandhills Counties

Miles
0   3   6   12   18   24
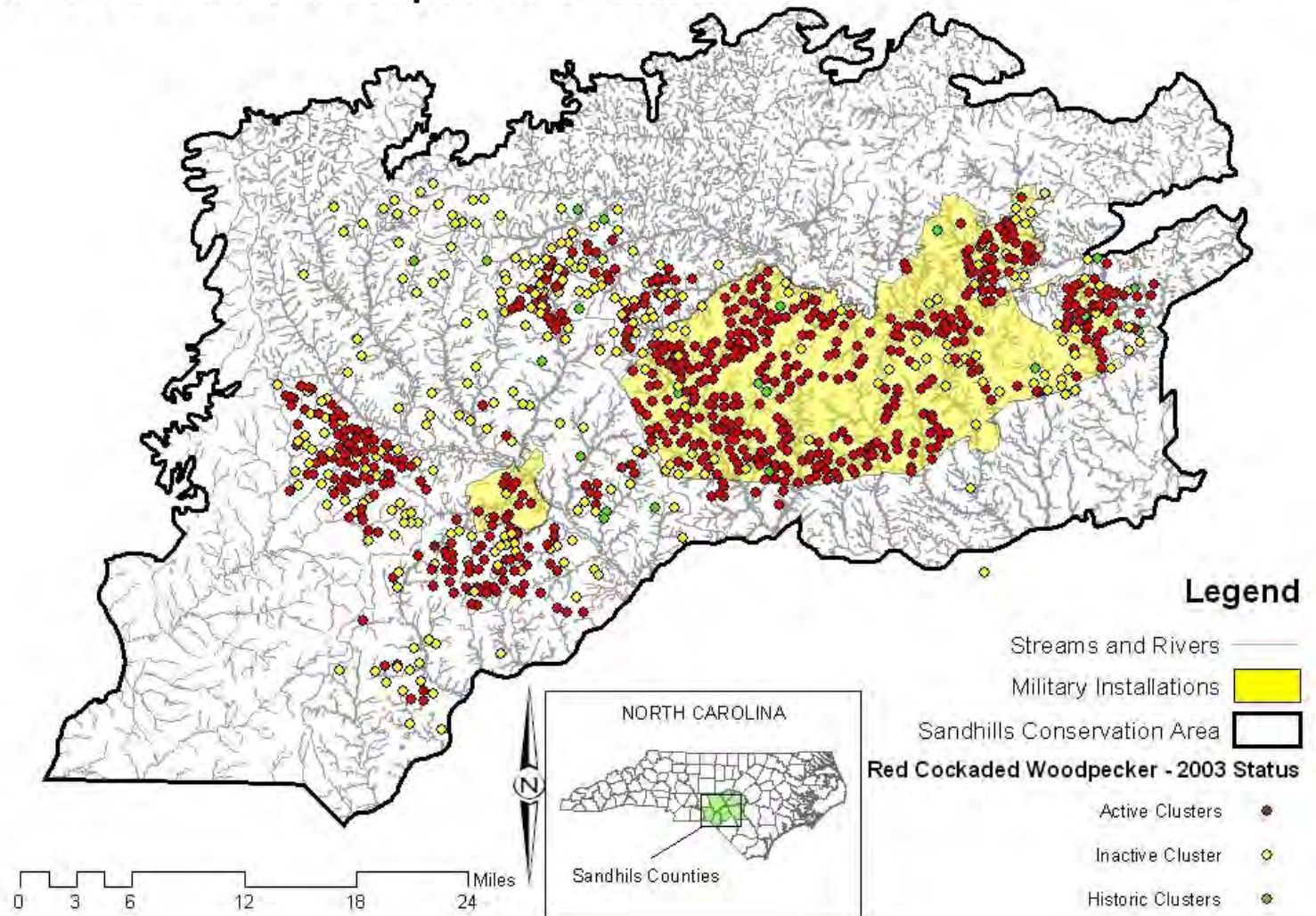
Sandhills Conservation Area:
Longleaf Pine Mosaic Occurrences

NORTH CAROLINA

Sandhills Counties

N

Miles
0   3   6   12   18   24

Legend

Known Target Occurrences •

Streams and Rivers ———

Military Installations 🟡

Sandhills Conservation Area ◯
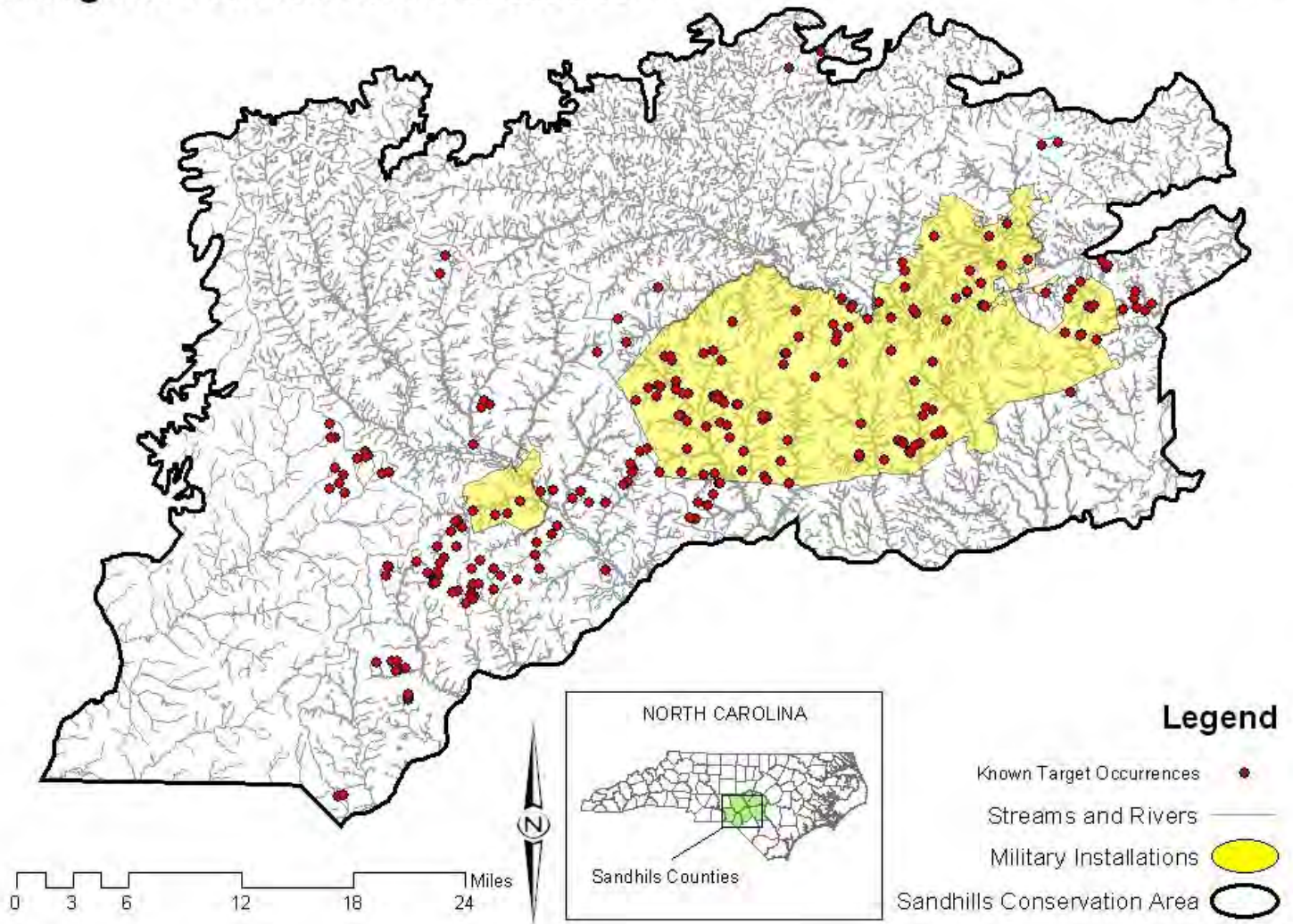
Sandhills Conservation Area:
Streamhead Pocosins/Seeps Occurrences
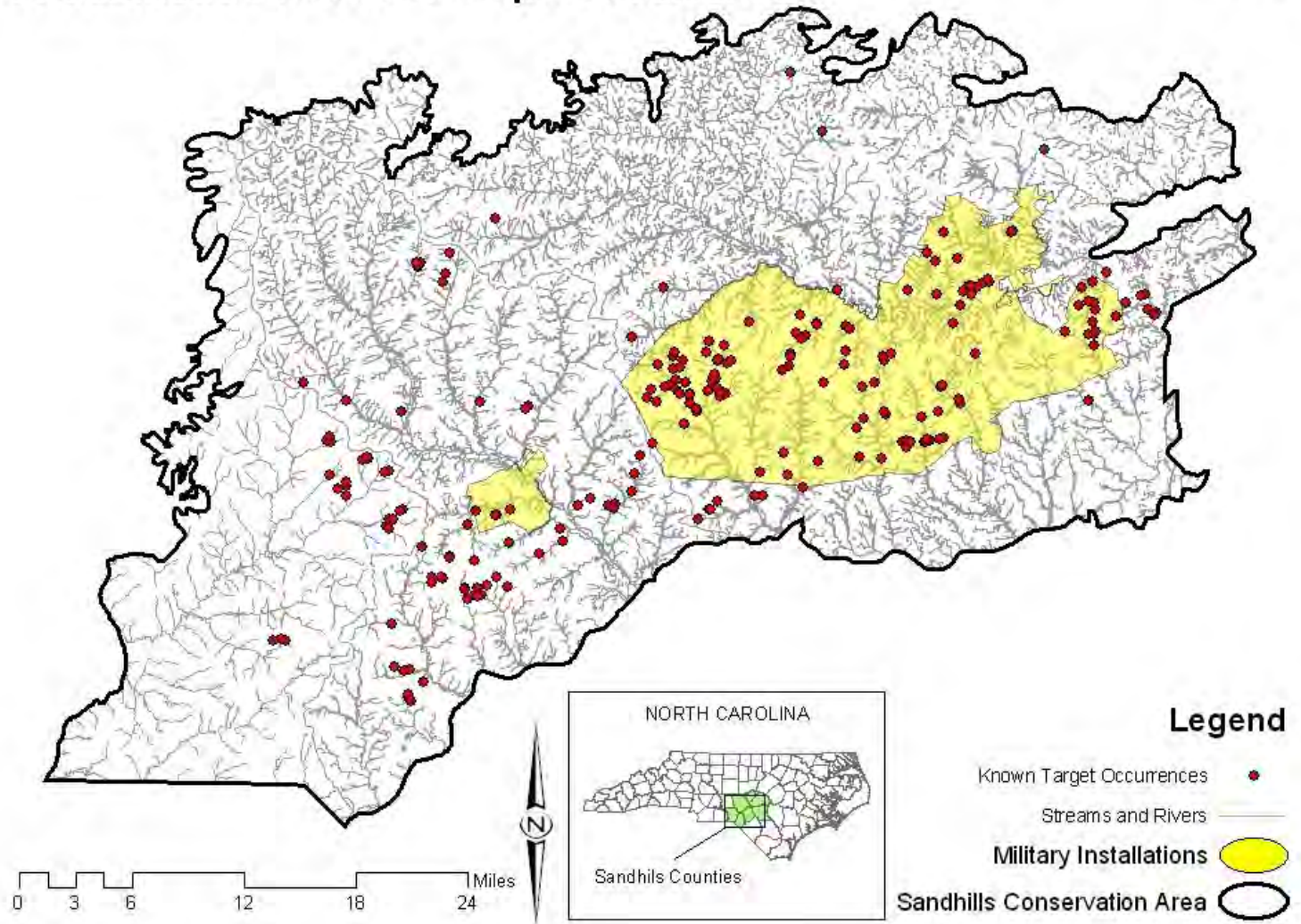
NORTH CAROLINA

Sandhils Counties

N

Miles
0   3   6   12   18   24

Legend

Known Target Occurrences •

Streams and Rivers

Military Installations

Sandhills Conservation Area

Sandhills Conservation Area:
Blackwater Stream Occurrences

NORTH CAROLINA

Sandhils Counties

Miles

| 0 | 3 | 6 | 12 | 18 | 24 |

Legend

*Known Target Occurrences

Blackwater Rivers and Streams

Military Installations

Sandhills Conservation Area

*Blackwater stream occurrences represent riparian habitats, not only aquatic factors
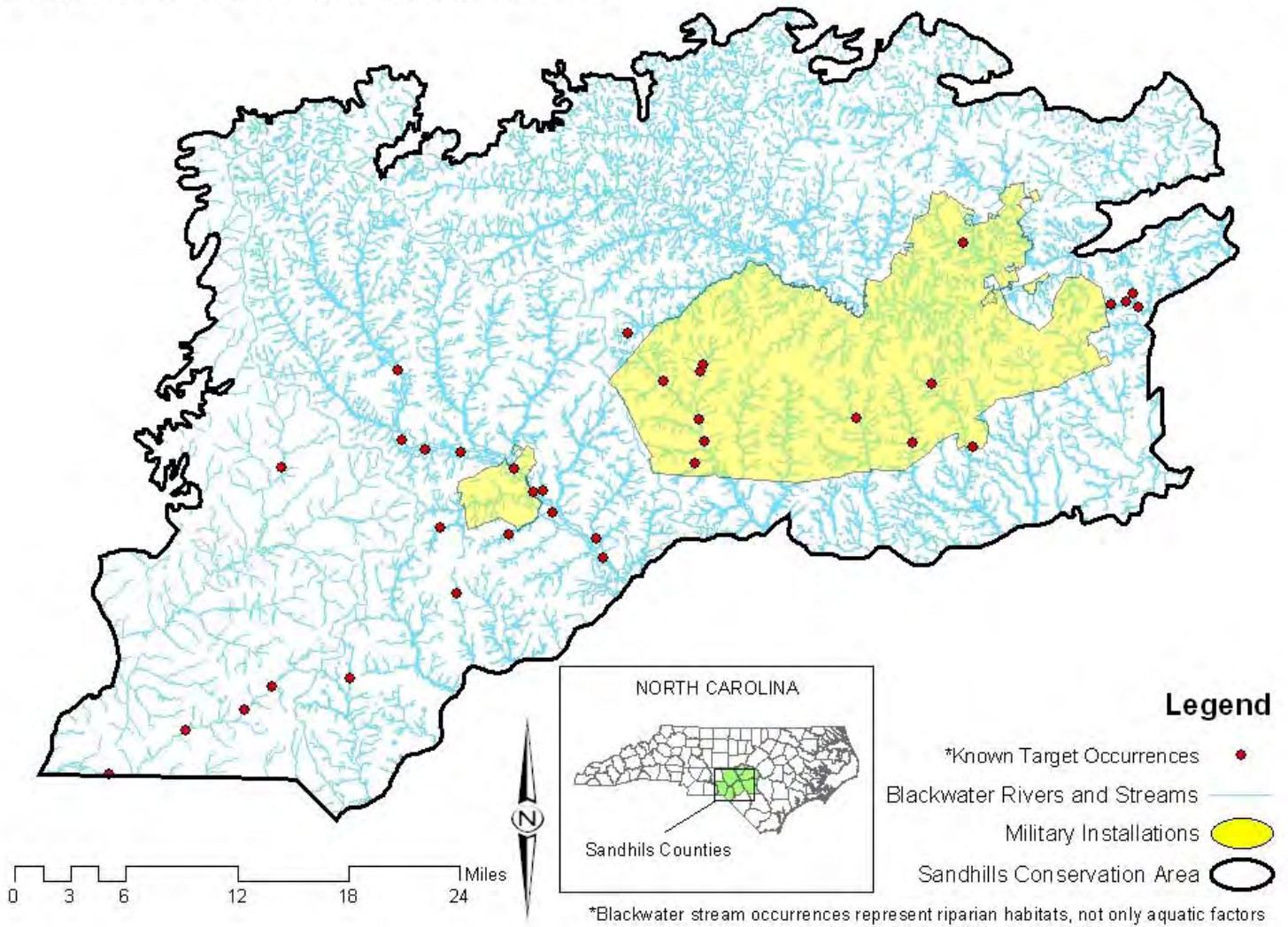
Sandhills Conservation Area:
Upland Depressional Wetland Occurrences

NORTH CAROLINA

Sandhills Counties

Miles
0   3   6   12   18   24

N

Legend

Known Target Occurrences ●

Streams and Rivers ——

Military Installations 🟡

Sandhills Conservation Area ⬭
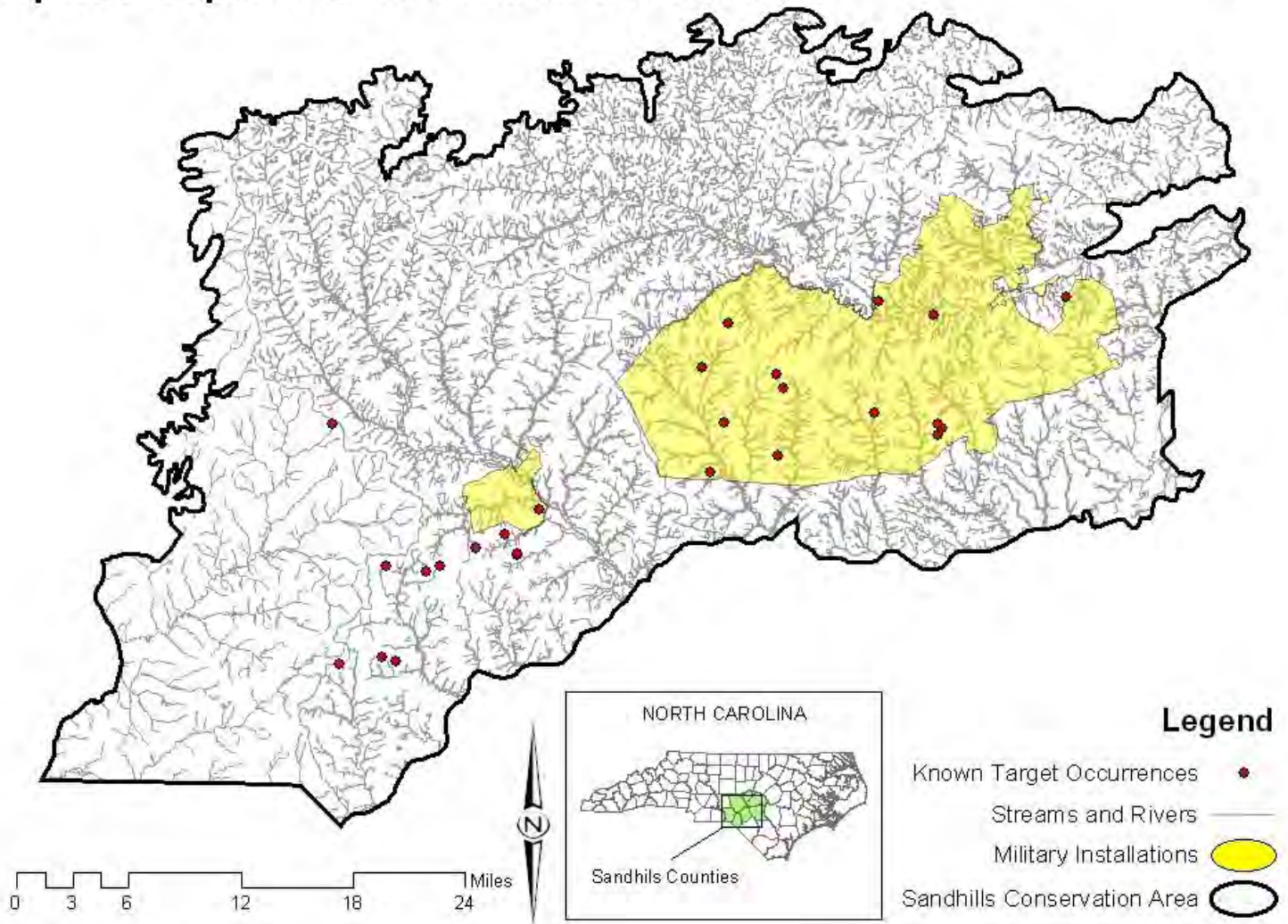
Sandhills Conservation Area: Reserve Design
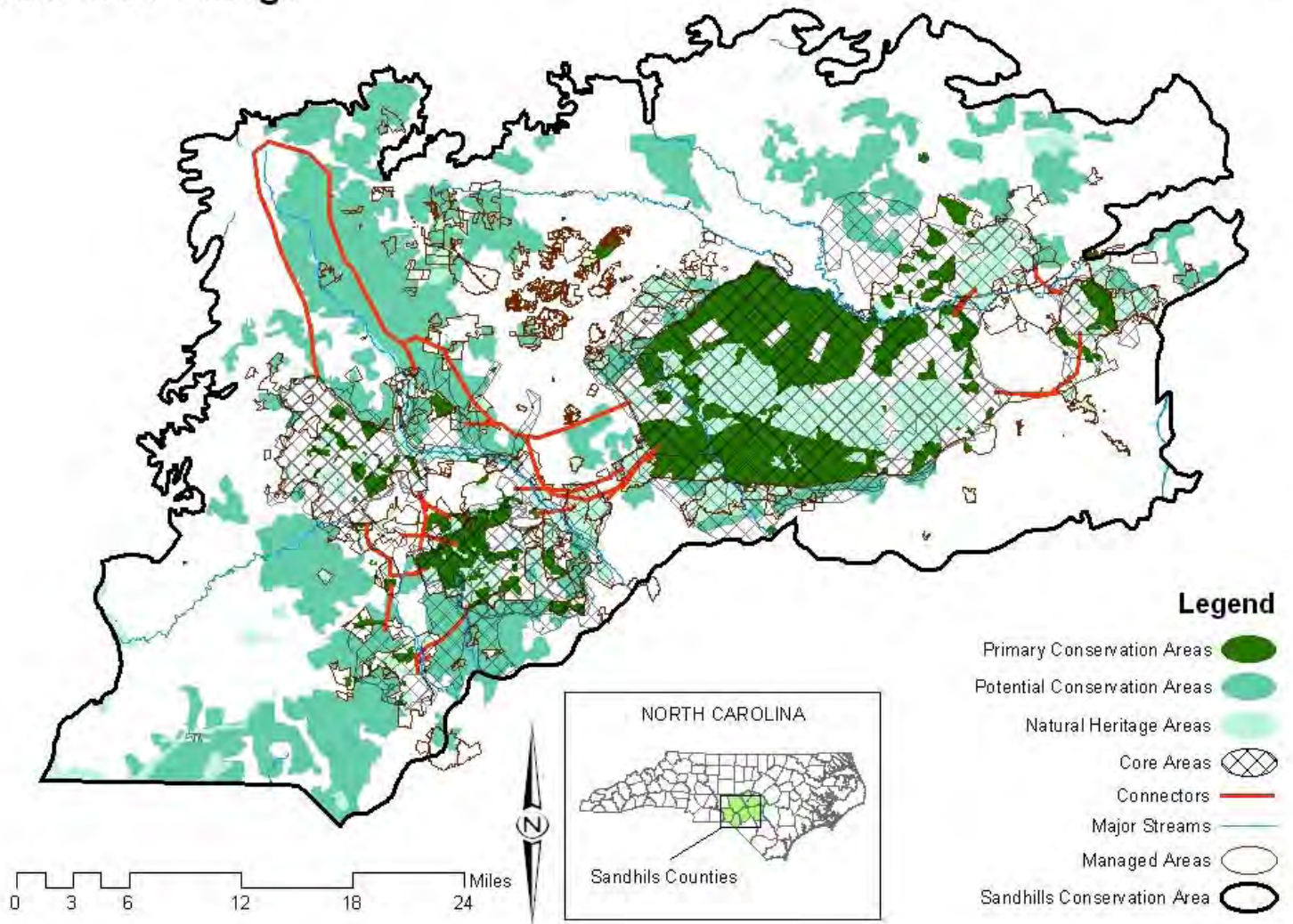
Legend

Primary Conservation Areas
Potential Conservation Areas
Natural Heritage Areas
Core Areas
Connectors
Major Streams
Managed Areas
Sandhills Conservation Area

NORTH CAROLINA

Sandhills Counties

Miles
0   3   6   12   18   24

APPENDIX B: CONSERVATION PROJECT MANAGEMENT WORKBOOK TABLES

Table #: Conservation Project Management Workbook Title Page

Table 1: Nested Targets

	1	2	3	4	5
Conservation Targets	Red Cockaded Woodpecker	Longleaf Pine Mosaic	Streamhead Pocosins/Seeps	Blackwater Streams	Upland Depressional Wetlands
Focal Target Description				Including aquatic and floodplain elements	
Nested Target # 1		Small patch communities (Sand Barren, Mesic Transition, Mesic and Wet Pine Flatwoods, Pine Savanna, River Terraces	Cane breaks	Beaver ponds	Small depressional ponds
Nested Target # 2		Rare plants	Sandhills seeps	Floodplain forests and rare species (Cypress - Gum Swamp	Vernal pools
Nested Target # 3		Rare animals (I.e. fox squirrel, reptiles, lepidoptera)	Streamhead Atlantic White Cedar	Aquatic communities and rare species	Rare herps (insects?)
Nested Target # 4		Matrix community types (Xeric sandhill scrub, Pine scrub oak)	Streamhead pocosins/ small stream swamps		Rare plants
Nested Target # 5			Rare plants and animals		Small depressional pocosins/ Coastal plain small stream swamps
Nested Target # 6			Lepidoptera		

Table 2: Target Viability Health Summary

Conservation Targets		Landscape Context		Condition		Size		Viability Rank
		Grade	Weight	Grade	Weight	Grade	Weight	
1	Red Cockaded Woodpecker	Fair	1	-	1	Good	1	**Good**
2	Longleaf Pine Mosaic	Fair	1	Fair	1	Good	1	**Fair**
3	Streamhead Pocosins/Seeps	Good	1	Fair	1	-	1	**Good**
4	Blackwater Streams	Good	1	-	1	-	1	**Good**
5	Upland Depressional Wetlands	-	1	-	1	-	1	**-**
Site Biodiversity Health Rank								**Good**

Table 3: Detailed Target Viability Health

	Conservation Targets	Key Ecological Attributes				Indicators				Calculated Rank	User Override
		Poor	Fair	Good	Very Good	Poor	Fair	Good	Very Good		
1	**Red Cockaded Woodpecker**									**Good**	
	Landscape Context		1				1			Fair	
	Condition									-	
	Size			1				1		Good	
2	**Longleaf Pine Mosaic**									**Fair**	
	Landscape Context		1				1			Fair	
	Condition		2	2			2	2		Fair	
	Size			1				1		Good	
	Streamhead Pocosins/Seeps									**Good**	
	Landscape Context			1				1		Good	
	Condition		1	2			1	2		Fair	
	Size									-	
4	**Blackwater Streams**									**Good**	
	Landscape Context			1				1		Good	
	Condition									-	
	Size									-	
5	**Upland Depressional Wetlands**									**-**	
	Landscape Context									-	
	Condition									-	
	Size									-	

Appendix B-4

Table 4: Target Key Attributes, Indicators and Indicator Rankings

Conservation Target Enter # of Target	Category	Key Attribute	Indicator	**Bold = Current** Indicator Ratings *Italics = Desired*			
				Poor	Fair	Good	Very Good
1 Red Cockaded Woodpecker	Landscape Context	Application of prescribed fire to mimic natural fire regime on conservation lands	% acres of conservation land burned per season per annum	TBD	TBD	TBD	TBD
1 Red Cockaded Woodpecker	Landscape Context	Demographic connectivity between Sandhills East and West populations	# individuals filling vacancies between populations (East/West)	TBD	**TBD**	TBD	*TBD*
1 Red Cockaded Woodpecker	Landscape Context	Extent of mature pine habitat	# acres of mature pine forest on conservation lands	TBD	TBD	TBD	TBD
1 Red Cockaded Woodpecker	Condition	Active clusters in the primary recovery population that have suitable habitat	% active clusters with suitable pine habitat	TBD	TBD	TBD	TBD

				1 (solitary male)	2 (potential breeding pair)	3 (potential breeding pair + helper)	4+ (potential breeding pair+ 1/more helpers)
1	Red Cockaded Woodpecker	Condition	Population structure - group composition	1 (solitary male)	2 (potential breeding pair)	3 (potential breeding pair + helper)	4+ (potential breeding pair+ 1/more helpers)
1	Red Cockaded Woodpecker	Size	Population size & dynamics	# potential breeding groups	<75	75-100	**100-120**	*>120*
2	Longleaf Pine Mosaic	Landscape Context	Connectivity among communities & ecosystems	connectivity between protected areas and primary areas	few primary and protected areas connected	**some primary and protected areas connected**	most primary and protected areas connected	*all primary areas permanently connected*
2	Longleaf Pine Mosaic	Condition	Fire regime - (timing, frequency, intensity, extent)	# acres burned as compared to natural fire regime	<50k managed acres/year	**50-75k managed acres/year**	*75-100k managed acres/year, including most primary areas*	> 100k managed acres/year, including all primary areas

Appendix B-6

2	Longleaf Pine Mosaic	Condition	Population size & dynamics	rare plant population size	Few populations or sub-populations, and these small	Sustainable rare plant population size with at least some populations of each species of sustainable size	**Status quo (?)**	*Populations and sub-populations of sustainable size distributed over their native range within the area, in well-managed natural habitat*

| 2 | Longleaf Pine Mosaic | Condition | Presence of key communities or seral stages | abundance of all community types | Few examples of rarer community types represented, with some only occurring in poor condition, and some types extirpated from the region. Rarer communities confined to few portions of the region | Some examples of each community type represented | **all existing examples remain extant and in at least current condition** | *All common community types abundant, with numerous examples in good condition, with sufficient good examples of rare types to ensure representation of diversity and sustainability* |

2	Longleaf Pine Mosaic	Condition	Vegetation structure (age class)	representation of all age classes in natural spatial distribution	Most longleaf pine communitiesseven-aged and/or young, with homogenized patch structure	**most acres with some other older trees present but at less than natural abundances, patch structure homogenized over large areas**	*substantial acreage with patchy, uneven age distribution and many older trees present - All acres currently in good condition remaining in good conditon*	Most acres with patchy, uneven age distribution and with many older trees present
2	Longleaf Pine Mosaic	Size	Size / extent of characteristic communities / ecosystems	# acres of pine forest	Unsustainable # acres	Sustainable # acres	**status quo (250-300k acres)**	*> 300k acres*
3	Streamhead Pocosins/Seeps	Landscape Context	Landscape pattern (mosaic) & structure	adequate buffer around occurrences	adequate buffer around few/no occurances	adequate buffer around some occurances	**adequate buffer around many occurances**	*adequate buffer around all occurances*

3	Streamhead Pocosins/Seeps	Condition	Fire regime - (timing, frequency, intensity, extent)	% occurrances with oppropriate fire regime	No/few occurances with oppropriate fire regimes	**Some occurances with oppropriate fire regimes**	Many occurances with oppropriate fire regimes	*100% occurances with oppropriate fire regimes*
3	Streamhead Pocosins/Seeps	Condition	Presence of key communities or seral stages	representation of all community types	Few or no examples of some community types represented, many in poor condition	Some examples of all community types each community type represented, some in poor condition	**Many examples of all community types represented, many in good condition**	*Examples of all community types in good condition occuring at natural level. Common community types abundant; rare types with numerous examples well distributed over their native range*

3	Streamhead Pocosins/Seeps	Condition	Species composition / dominance	representation of rare species populations	Low size and number of rare species populations	Fair size and number of rare species populations	**Good size and number of rare species populations – all existing populations extant**	*Very good size and number of rare species populations – all existing populations at sustainable (or natural) size, well distributed over their native range, with additional populations established in historic sites for the rarest species*
4	Blackwater Streams	Landscape Context	Connectivity among communities & ecosystems	adequate buffers around floodplain headwater swamps	Poor quality buffer around floodplain headwater swamps	Fair quality buffer around floodplain headwater swamps	High quality buffer around floodplain headwater swamps	Very high quality buffer around floodplain headwater swamps

4	Blackwater Streams	Landscape Context	Hydrologic regime - (timing, duration, frequency, extent)	intactness of hydrologic regime	Much human interferance along stream corridor	Some human interference along stream corridor - some streams with severely altered hydrologic regimes	**Little human interference along stream corridor - status quo**	Hydrologic regimes on stream under only natural influences, or managed to mimic natural influences
4	Blackwater Streams	Condition	Nutrient concentrations & dynamics	key nutrient levels	Many occurrances of key nutrient levels outside healthy stream range	Some occurrances of key nutrient levels outside healthy stream range	Few occurrances of key nutrient levels outside healthy stream range	No occurrances of key nutrient levels outside healthy stream range

| 4 | Blackwater Streams | Condition | Presence of key communities or seral stages | representation of all community types | Few examples of rarer community types represented, with some only occurring in poor condition, and some types extirpated from the region. Rarer communities confined to few portions of the region. | Some examples of each community type represented | status quo, or, all existing examples remain extant and in at least current condition | All common community types abundant, with numerous examples in good condition, with sufficient good examples of rare types to ensure representation of diversity and sustainability |
| 4 | Blackwater Streams | Condition | Species composition / dominance | representation of all rare species | Few examples of rare species populations represented, with some only occurring in poor condition, and some populations extirpated from the region. Rare species populations confined to few portions of the region. | Some examples of each rare species population represented | All existing examples remain extant and in at least current condition. | All rare species population types with sufficient good examples to ensure representation of diversity and sustainability |

5	Upland Depressional Wetlands	Landscape Context	Landscape pattern (mosaic) & structure	# occurrances with adequate buffer for indigenous amphibian life cycle	No/very few occurrances with adequate buffer for indigenous amphibian life cycle	Some occurrances with adequate buffer for indigenous amphibian life cycle	More occurrances with adequate buffer for indigenous amphibian life cycle	Many occurrances with adequate buffer for indigenous amphibian life cycle
5	Upland Depressional Wetlands	Condition	Hydrologic regime - (timing, duration, frequency, extent)	intactness of hydrologic regime	Few examples of natural hydrologic regime	Some examples of natural hydrologicregime	More examples of natural hydrologic regime	Many examples of natural hydrologic regime

| 5 | Upland Depressional Wetlands | Condition | Presence of key communities or seral stages | representation of rare species populations | Few examples of rare species populations represented, with some only occurring in poor condition, and some populations extirpated from the region. Rare species populations confined to few portions of the region. | Some examples of each rare species population represented | All existing examples remain extant and in at least current condition. | All rare species population types with sufficient good examples to ensure representation of diversity and sustainability |

| 5 | Upland Depressional Wetlands | Condition | Presence of key communities or seral stages | sufficient representation of all community types | Few examples of rare community types represented, with some only occurring in poor condition, and some types extirpated from the region. Rare communities confined to few portions of the region. | Some examples of each community type represented | All existing examples remain extant and in at least current condition | All common community types abundant, with numerous examples in good condition, with sufficient good examples of rare types to ensure representation of diversity and sustainability. |

Table 5: Red Cockaded Woodpecker Viability Summary and Stresses

1	Red Cockaded Woodpecker			
Viability Summary	Landscape Context	Condition	Size	Viability Rank
	Fair	-	Good	Good

Stresses - Altered Key Ecological Attributes		Severity	Scope	Stress
1	Altered natural fire regime	Very High	Very High	Very High
2	Habitat destruction or conversion	High	High	High
3	Habitat fragmentation	High	High	High
4	Altered composition/structure	High	Medium	Medium

Table 6: Longleaf Pine Mosaic Viability Summary and Stresses

2	Longleaf Pine Mosaic			
Viability Summary	Landscape Context	Condition	Size	Viability Rank
	Fair	Fair	Good	Fair

Stresses - Altered Key Ecological Attributes		Severity	Scope	Stress
1	Habitat destruction or conversion	Very High	Medium	Medium
2	Habitat fragmentation	High	Medium	Medium
3	Altered composition/structure	Very High	Very High	Very High
4	Altered natural fire regime	High	High	High
5	Altered predator/prey relationships	Medium	High	Medium

Table 7: Streamhead Pocosins/Seeps Viability Summary and Stresses

3	Streamhead Pocosins/Seeps			
Viability Summary	Landscape Context	Condition	Size	Viability Rank
	Good	Fair	-	Good

Stresses - Altered Key Ecological Attributes		Severity	Scope	Stress
1	Altered natural fire regime	Very High	High	High
2	Habitat destruction or conversion	Very High	Medium	Medium
3	Sedimentation	High	Medium	Medium
4	Altered composition/structure	Medium	Low	Low
5	Altered predator/prey relationships	Medium	Low	Low

Table 8: Blackwater Streams Viability Summary and Stresses

4	Blackwater Streams			
Viability Summary	Landscape Context	Condition	Size	Viability Rank
	Good	-	-	Good

Stresses - Altered Key Ecological Attributes		Severity	Scope	Stress
1	Nutrient loading	High	High	High
2	Sedimentation	High	Medium	Medium
3	Altered composition/structure	High	High	High
4	Toxins/contaminants	High	Low	Low
5	Altered hydrologic regime	Medium	High	Medium
6	Altered predator/prey relationships	Medium	Low	Low

Table 9: Upland Depressional Wetlands Viability Summary and Stresses

5	Upland Depressional Wetlands			
Viability Summary	Landscape Context	Condition	Size	Viability Rank
	-	-	-	-

Stresses - Altered Key Ecological Attributes	Severity	Scope	Stress
1	Altered natural fire regime	High	Medium	Medium
2	Sedimentation	Medium	Medium	Medium
3	Habitat destruction or conversion	Very High	Medium	Medium
4	Loss of landscape context (destruction of uplands habitat)	Very High	High	High

Table 10: Red Cockaded Woodpecker Threats

Threats - Sources of Stress		Altered natural fire regime	Habitat destruction or conversion	Habitat fragmentation	Altered composition/structure	Threat to System Rank
1	Red Cockaded Woodpecker	*Very High*	*High*	*High*	*Medium*	
1	Fire suppression/ inhibitions to the use of prescribed fire	Contribution: Very High	High		Very High	Very High
		Irreversibility: High	Medium		Medium	
		Override				
		Source: Very High	Medium	-	High	
		Combined Rank: Very High	Medium	-	Medium	
2	Forestry practices	Contribution: Medium	High	High		Very High
		Irreversibility: Medium	High	High		
		Override				
		Source: Medium	High	High	-	
		Combined Rank: High	High	High	-	
3	Primary home development	Contribution: Very High	High	High	High	Very High
		Irreversibility: Very High	High	High	High	
		Override				
		Source: Very High	High	High	High	
		Combined Rank: Very High	High	High	Medium	
4	Second home/resort development	Contribution: Very High	Very High	Medium	High	Very High
		Irreversibility: Very High	Very High	High	High	
		Override				
		Source: Very High	Very High	Medium	High	
		Combined Rank: Very High	High	Medium	Medium	
5	Pine Straw Production	Contribution: High			Very High	High
		Irreversibility: Medium			Medium	
		Override				
		Source: Medium	-	-	High	
		Combined Rank: High	-	-	Medium	

Table 11: Longleaf Pine Mosaic Threats

Threats - Sources of Stress		Habitat destruction or conversion	Habitat fragmentation	Altered composition/structure	Altered natural fire regime	Altered predator/prey relationships	Threat to System Rank
2	Longleaf Pine Mosaic	*Medium*	*Medium*	*Very High*	*High*	*Medium*	
1	Forestry practices						High
	Contribution	High	High	Medium	High	Medium	
	Irreversibility	High	High	High	Medium	Medium	
	Source	High	High	Medium	Medium	Medium	
	Combined Rank	Medium	Medium	High	Medium	Low	
2	Fire suppression/ inhibitions to the use of prescribed fire						High
	Contribution	High			Very High	Medium	
	Irreversibility	Medium			Medium	Medium	
	Source	Medium	-	-	High	Medium	
	Combined Rank	Low	-	-	High	Low	
3	Primary home development						High
	Contribution	High	High		Very High	High	
	Irreversibility	Very High	Very High		Very High	Very High	
	Source	High	High	-	Very High	High	
	Combined Rank	Medium	Medium	-	High	Medium	
4	Second home/resort development						High
	Contribution	Very High	Very High		Very High	High	
	Irreversibility	Very High	High		Very High	High	
	Source	Very High	Very High	-	Very High	High	
	Combined Rank	Medium	Medium	-	High	Medium	
5	Pine Straw Production						Medium
	Contribution	Medium		Medium	Medium	Low	
	Irreversibility	Low		Low	Low	Low	
	Source	Low	-	Low	Low	Low	
	Combined Rank	Low	-	Medium	Low	Low	

Table 12: Streamhead Pocosins/Seeps Threats

Threats - Sources of Stress		Altered natural fire regime	Habitat destruction or conversion	Sedimentation	Altered composition/structure	Altered predator/prey relationships	Threat to System Rank
3	Streamhead Pocosins/Seeps	*High*	*Medium*	*Medium*	*Low*	*Low*	
1	Primary home development — Contribution	Very High	High	Medium	Medium	Medium	High
	Irreversibility	Very High	High	Medium	High	High	
	Source	Very High	High	Medium	Medium	Medium	
	Combined Rank	High	Medium	Low	Low	Low	
2	Second home/resort development — Contribution	Very High	High	Medium	Medium	High	High
	Irreversibility	Very High	High	Medium	High	High	
	Source	Very High	High	Medium	Medium	High	
	Combined Rank	High	Medium	Low	Low	Low	
3	Roads — Contribution			High	High	High	Medium
	Irreversibility			High	Very High	Very High	
	Source	-	-	High	High	High	
	Combined Rank	-	-	Medium	Low	Low	
4	Fire suppression/ inhibitions to the use of prescribed fire — Contribution	Very High	Medium		Very High	Medium	High
	Irreversibility	Medium	Medium		Medium	Medium	
	Source	High	Medium	-	High	Medium	
	Combined Rank	High	Low	-	Low	Low	
5	Small dams on headwater tributaries — Contribution	Very High	Very High	Very High	Very High		High
	Irreversibility	Medium	Medium	Medium	Medium		
	Source	High	High	High	High	-	
	Combined Rank	High	Medium	Medium	Low	-	

Table 13: Blackwater Streams

Threats - Sources of Stress			Nutrient loading	Sedimentation	Altered composition/structure	Toxins/contaminants	Altered hydrologic regime	Altered predator/prey relationships	Threat to System Rank
4	Blackwater Streams		*High*	*Medium*	*High*	*Low*	*Medium*	*Low*	
1	Wastewater treatment	Contribution	Medium			Medium			Low
		Irreversibility	Low			High			
		Override							
		Source	Low	-	-	Medium	-	-	
		Combined Rank	Low	-	-	Low	-	-	
2	Livestock production practices	Contribution	High						Medium
		Irreversibility	Low						
		Override							
		Source	Medium	-	-	-	-	-	
		Combined Rank	Medium	-	-	-	-	-	
3	Forestry practices	Contribution		Medium	High				High
		Irreversibility		Medium	High				
		Override							
		Source	-	Medium	High	-	-	-	
		Combined Rank	-	Low	High	-	-	-	
4	Golf course construction and maintenance	Contribution	Medium	Medium		Medium			Low
		Irreversibility	Low	Medium		High			
		Override							
		Source	Low	Medium	-	Medium	-	-	
		Combined Rank	Low	Low	-	Low	-	-	

#	Activity		C1	C2	C3	C4	C5	C6	Final
5	Primary home development	Contribution	Low	Medium					
		Irreversibility	Medium	Medium					
		Override							Low
		Source	Low	Medium	-	-	-	-	
		Combined Rank	Low	Low	-	-	-	-	
6	Small dams on headwater tributaries	Contribution					Medium		
		Irreversibility					Medium		
		Override							Low
		Source	-	-	-	-	Medium	-	
		Combined Rank	-	-	-	-	Low	-	

Table 14: Upland Depressional Wetlands Threats

Threats - Sources of Stress			Altered natural fire regime	Sedimentation	Habitat destruction or conversion	Loss of landscape context (destruction of uplands habitat)	Threat to System Rank
5	Upland Depressional Wetlands		*Medium*	*Medium*	*Medium*	*High*	
1	Fire suppression/ inhibitions to the use of prescribed fire	Contribution	Very High			Medium	Medium
		Irreversibility	Medium			Medium	
		Override					
		Source	High	-	-	Medium	
		Combined Rank	Medium	-	-	Medium	
2	Primary home development	Contribution		High	High	High	High
		Irreversibility		High	Very High	Very High	
		Override					
		Source	-	High	High	High	
		Combined Rank	-	Medium	Medium	High	
3	Roads	Contribution	Medium	Medium	Low	Medium	High
		Irreversibility	Very High	High	Very High	Very High	
		Override					
		Source	High	Medium	Medium	High	
		Combined Rank	Medium	Low	Low	High	
4	Golf course construction and maintenance	Contribution		High	High	High	High
		Irreversibility		High	Very High	Very High	
		Override					
		Source	-	High	High	High	
		Combined Rank	-	Medium	Medium	High	

Table 15: Threats/Strategies Matrix

	Threats Across Systems	Overall Threat Rank	Strategic Actions Addressing Each Threat First column: Qty Other columns: Strategic Action Index									
1	Primary home development	Very High	10	4	5	6	9	10	13	16	17	21	22
2	Fire suppression/ inhibitions to the use of prescribed fire	High	10	1	3	7	8	12	13	28	32	33	34
3	Forestry practices	High	10	3	7	8	11	12	13	19	26	31	46
4	Second home/resort development	High	10	2	4	5	9	10	13	14	16	17	21
5	Pine Straw Production	Medium	9	3	11	18	52	53	54	56	60	64	
6	Roads	Medium	10	4	6	15	16	20	25	30	36	41	51
7	Small dams on headwater tributaries	Medium	0										
8	Golf course construction and maintenance	Medium	10	4	9	10	13	14	16	21	22	24	25
9	Livestock production practices	Low	9	9	10	23	26	39	49	50	52	53	
10	Wastewater treatment	Low	4	5	16	44	53						
Threat Status for Targets and Site		Very High											

Table 16: Strategic Action List and Ranking

Strategic Actions	Overall Rank	Benefits	Feasibility	Cost
Affect DENR rules on air quality regulation interpretation	Low	High	Low	High
Avoid excessive application of herbicides and select herbicides with low collateral damage	High	High	Low	Low
Bolster existing incentive programs for natural forest stewardship	Medium	Medium	Medium	Medium
Create public and DOT awareness of ecological reprocussions of road building and widening	Medium	High	Low	Medium
Create trust fund to purchase development rights (or "tax abatement strategy")	High	Very High	Medium	Very High
Cultivate DOT as a stakeholder in the Sustainable Sandhills Initiative	Very High	Very High	Medium	Low
Demonstrate professional fire management through PR and field programs	High	High	High	Medium
Develop an educational package describing the benefits of prescribed fire	Very High	Very High	Medium	Medium
Educate decision makers and the public about the value of open space	Very High	Very High	Medium	Low
Educate Sandhills developers and real estate community about the benefits and existing incentives relating to sustainable development	Very High	Very High	Low	Low

Educate the public about the importance of groundcover to healthy longleaf forests	Medium	Medium	Medium	Low
Educate the public and foresters about the economic benefits of longleaf pine	High	High	Medium	Low
Encourage and provide incentives, through cost share programs and Safeharbor, to control hardwoods in pine stands	Very High	Very High	High	High
Encourage clustered design in new golf course developments	Very High	Very High	Medium	Low
Encourage DOT to use existing right-of-ways over new routes	High	High	Low	Low
Encourage local governments to adopt low density zoning in rural areas	Very High	Very High	Low	Low
Encourage mixed use development	High	Very High	Low	Medium
Encourage pinestraw harvesting on plantations instead of natural forests	Medium	Medium	Low	Low
Encourage reforestation practices that don't diminish the wiregrass groundcover	Very High	Very High	High	Low
Encourage sustainable transportation design on roadway and highway improvements	High	High	Low	Low
Encourage the adoption of sustainable county land use plans	High	High	Medium	Low
Encourage the preservation of existing and creation of new (where possible) natural riparian buffers	Very High	Very High	Medium	Low

Encourage the protection of open space lands	High	High	Medium	Low
Encourage the use of environmentally responsible design elements (i.e. gray water recycling, native vegetation, drought tolerant species, etc.)	Very High	Very High	Medium	Low
Encourage the use of runnoff catchments that prevent siltation and the pollution of waterbodies	Very High	Medium	Very High	Low
Encourage tree preservation ordinances at the County or Municipal level (i.e. no clearcutting or sustainable forestry provisions)	High	High	Medium	Low
Ensure the application of new RCW guidelines for the design and development of golf courses	Very High	Very High	Medium	Low
Establish a "North Carolina Fire Council" (see Florida Fire Council)	Very High	Very High	High	Medium
Establish relationships with golf course managers to effect changes in management	Medium	Medium	Medium	Low
Establish working relationships with DOT district engineers	High	Medium	High	Low
Facilitate wider use of sustainable forest management plans	Medium	Medium	Low	Low
Identify and track existing or potential impediments to the use of prescribed fire	High	Medium	High	Low
Identify outside sources of funding for prescribed fire	Very High	Very High	Very High	Low
Implement fire outreach and awareness programs	Low	Medium	Low	Medium

Implement the establishment of urban services boundaries	High	Very High	Low	Medium
Improve the implementation of roadside management for rare species	Medium	Medium	Low	Low
Increase financial incentives for land owners to implement prescribed fire	Very High	Very High	High	High
Increase the ability of fire management entities to collaborate and cross boundaries through formal agreements	High	High	Medium	Low
Investigate growth management tools that pertain to open space protection	Medium	Medium	Medium	Low
Make available and promote training opportunities to private landowners and contractors in government and non-profit fire courses	Very High	Very High	High	Medium
Prevent the planting of invasive species by DOT along roadsides and expand the use of native species, where appropriate	High	High	Medium	Low
Promote a "Right to Burn" law (State or County level)	High	Very High	Low	Medium
Promote and provide input on the establishment of conservation subdivision design	Very High	Very High	Low	Low
Promote green architecture	Medium	Medium	Medium	Low
Promote low impact development site design	Medium	Medium	Low	Low
Promote prescribed fire as an alternative to herbicide use for hardwood control	Medium	Medium	Medium	Medium

Promote responsible water usage (i.e. replacement of current grass species with low water usage types)	Medium	Low	High	Low
Promote revitalization (infill) of urban cores	Very High	Very High	Low	Low
Promote the use of prescribed fire and minimize ground disturbance for site preparation	Medium	Medium	High	Medium
Protect open space lands	High	Very High	Medium	Very High
Provide DOT with information about sensitive natural resources in time to influence planning and siting of roads and road expansions	High	High	Medium	Low
Purchase or create avenues for public purchase of conservation easements	High	Very High	Medium	Very High
Purchase or create avenues for public purchase of open space lands	High	Very High	Medium	Very High
Review and evaluate "chicken litter fertilizer application" study	Very High	Medium	Very High	Low
Review BMPs and propose changes based on most recent sustainable forestry research	Very High	High	High	Low
Review literature on impacts of pinestraw raking	Very High	Medium	Very High	Low
Seek additional funding from the General Assembly for the application of prescribed fire (Forest Stewardship Programs, etc.)	High	Very High	Low	Medium
Train and coordinate the use of volunteers between agencies and non-profits	Very High	Very High	Very High	Low

Work to increase the number of private qualified burners to work on private lands	Very High	High	Very High	Medium
Work with Fort Bragg's resource management staff to restrict pinestraw raking to plantations only	Very High	Medium	Very High	Low
Work with industrial forest landowners to promote sustainable forestry practices and native species	High	High	Medium	Low
Work with NC Forest Service to increase internal funding for prescribed fire on private lands	Medium	Medium	Medium	Low
Work with the Forest Service to implement the Fire Wise program in the Sandhills	Very High	Very High	Medium	Low
Working with pinestraw producers, create BMPs for pinestraw practices in natural forests (i.e. hand raking v. mechanical raking, fire rotation, etc.)	High	Very High	Low	Medium

Table 17: Sandhills Project Resources Assessment

Categories & Measures	Score
People	
Staff Leadership	High
Multidisciplinary Team	High
People Average	**High**
Internal Resources	
Institutional Leadership	High
Funding	High
Internal Resources Average	**High**
External Resources	
Social/Legal Framework for Conservation	High
Community and Constituency Support	High
External Resources Average	**High**
Overall Project Resource Rank	**High**

Table 18: Scoring References for Workbook v4.0a

Viability Ranks in the Assessment of Target Viability Summary Table

Rank	RankValue
Very Good	4
Good	3.5
Fair	2.5
Poor	1
-	0

SiteRank	RankThreshold
Poor	0.95
Fair	1.745
Good	2.995
Very Good	3.745
-	< 1

Stress Ranking

Stress = f (Severity and Scope)

	<----------------- Severity ----------------->				
	Very High	High	Medium	Low	-
Very High	Very High	High	Medium	Low	-
High	High	High	Medium	Low	-
Medium	Medium	Medium	Medium	Low	-
Low	Low	Low	Low	Low	-
-	-	-	-	-	-

< Scope >

Threat (Source-Stress Combination) Ranking

Source = f (Contribution and Irreversibility)

		<---------------- Contribution ---------------->			
		Very High	High	Medium	Low	-
< Irrever-sibility >	Very High	Very High	High	High	Medium	-
	High	Very High	High	Medium	Medium	-
	Medium	High	Medium	Medium	Low	-
	Low	High	Medium	Low	Low	-
	-	-	-	-	-	-

Threat = f (Source and Stress)

		<---------------- Source ---------------->			
		Very High	High	Medium	Low	-
< Stress >	Very High	Very High	Very High	High	Medium	-
	High	High	High	Medium	Low	-
	Medium	Medium	Medium	Low	Low	-
	Low	Low	Low	Low	-	-
	-	-	-	-	-	-

Threat-to-System Ranking - Threat Summary at the Target Level
Overall Threat Ranking - Threat Summary ACROSS ALL TARGETS

# of "High" System Ranks that equal a "Very High"	3
# of "Medium" System Ranks that equal a "High"	5
# of "Low" System Ranks that equal a "Medium"	7

Rules for the Threat Status
for a project

Kick-in percentage for the "majority rank override" rule: over   50%

Majority Rank Override Rule

		Very High	High	Medium	None
<2 Prime>	Very High	Very High	Very High	Very High	Very High
	High	Very High	High	High	High
	Medium	Very High	High	Medium	Medium
	Low	Very High	High	Medium	Low
	-	Very High	High	Medium	-

Strategic Action Ranking

Benefits

Threat Abatement Benefit

	# of "High" System Ranks that equal a "Very High"	3
	# of "Medium" System Ranks that equal a "High"	5
	# of "Low" System Ranks that equal a "Medium"	7

Viability Enhancement Rank

	# of "Fair" System Improvements that equal a "Poor" Improvement	2
	# of "Good" System Improvements that equal a "Fair" Improvement	3
	# of "Very Good" System Improvements that equal a "Good" Improvement	0
	# of "Poor" System Improvements to yield a "Very High" benefit	2
	# of "Poor" System Improvements to yield a "High" benefit	1
	# of "Fair" System Improvements that yield a "Medium" benefit	1
	# of "Good" System Improvements that yield a "Low" benefit	1

Benefits

Initial Benefits Rank = f (Threat Abatement and Viability Enhancement)

<-------- Threat Abatement -------->

< Viability Enhancement >		Very High	High	Medium	Low	-
	Very High	Very High	Very High	Very High	Very High	Very High
	High	Very High	High	High	High	High
	Medium	Very High	High	Medium	Medium	Medium
	Low	Very High	High	Medium	Low	Low
	-	Very High	High	Medium	Low	-

Second Benefits Rank = f (Threat Abatement, Viability Enhancement and

Contribution)

<---- Threat Abatement and Viability Enhancement ---->

< Contribution >		Very High	High	Medium	Low	-
	Very High	Very High	High	Medium	Low	-
	High	Very High	High	Medium	Low	-
	Medium	High	Medium	Low	Low	-
	Low	Medium	Low	Low	Low	-
	-	-	-	-	-	-

Benefits

Third Benefits Rank = f (Threat Abatement, Viability Enhancement, Contribution and Duration)

<---- Threat Ab. x Viability En. x Contribution ---->

< Duration >		Very High	High	Medium	Low	-
	Very High	Very High	Very High	High	Medium	-
	High	Very High	High	Medium	Medium	-
	Medium	High	Medium	Medium	Low	-
	Low	Medium	Medium	Low	Low	-
	-	-	-	-	-	-

Overall Benefits Rank = f (Threat Ab., Viability En., Contribution, Duration and Leverage)

<-Threat Ab. x Viability En. x Contribution x Duration->

<Leverage>		Very High	High	Medium	Low	-
	Very High	Very High	Very High	High	Medium	Medium
	High	Very High	High	Medium	Medium	Low
	Medium	Very High	High	Medium	Low	-
	Low	Very High	High	Medium	Low	-
	-	-	-	-	-	-

Feasibility

Leader = Very
High

		<----Ability to Motivate Key Constituencies--->			
		Very High	High	Medium	Low	-
Very High		Very High	Very High	High	Medium	-
High		Very High	Very High	High	Medium	-
Medium		High	High	Medium	Medium	-
Low		Medium	Medium	Medium	Low	-
-		-	-	-	-	-

Leader = High

		<----Ability to Motivate Key Constituencies--->			
		Very High	High	Medium	Low	-
Very High		Very High	High	High	Medium	-
High		High	High	Medium	Medium	-
Medium		High	Medium	Medium	Low	-
Low		Medium	Medium	Low	Low	-
-		-	-	-	-	-

(Left axis label for both tables: < Ease >)

Feasibility

Leader = Medium

<----Ability to Motivate Key Constituencies--->

	Very High	High	Medium	Low	-
Very High	High	High	Medium	Medium	-
High	High	Medium	Medium	Low	-
Medium	Medium	Medium	Medium	Low	-
Low	Medium	Low	Low	Low	-
-	-	-	-	-	-

< Ease >

Leader = Low

<------- Lead Individual/Institution ----->

	Very High	High	Medium	Low	-
Very High	Medium	Medium	Low	Low	-
High	Medium	Medium	Low	Low	-
Medium	Low	Low	Low	Low	-
Low	Low	Low	Low	Low	-
-	-	-	-	-	-

< Ease >

Cost

CostRank	CostThreshold ('000's)
Low	1
Medium	10
High	100
Very High	1000
-	<0.01

Suggested $ benchmarks for U.S. projects:

> $1,000,000	*Very High*
> $100,000	*High*
> $10,000	*Medium*
> $0	*Low*

Cost of Capital (Interest Rate)　　　0%

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Overall Strategy Rank = f (Benefits, Feasibility and Cost)

Benefits = Very High

<------------------ Feasibility ------------------>

Cost		Very High	High	Medium	Low	-
	Very High	Very High	High	High	Medium	-
	High	Very High	Very High	High	Medium	-
	Medium	Very High	Very High	Very High	High	-
	Low	Very High	Very High	Very High	Very High	-
	-	-	-	-	-	-

Benefits = High

<------------------ Feasibility ------------------>

Cost		Very High	High	Medium	Low	-
	Very High	High	Medium	Medium	Low	-
	High	High	High	Medium	Low	-
	Medium	Very High	High	High	Medium	-
	Low	Very High	Very High	High	High	-
	-	-	-	-	-	-

Benefits = Medium

<------------------ Feasibility ------------------>

Cost		Very High	High	Medium	Low	-
	Very High	Medium	Low	Low	Low	-
	High	Medium	Medium	Low	Low	-
	Medium	High	Medium	Medium	Low	-
	Low	Very High	High	Medium	Medium	-
	-	-	-	-	-	-

Benefits = Low

<------------------ Feasibility ------------------>

Cost		Very High	High	Medium	Low	-
	Very High	Low	Low	Low	Low	-
	High	Low	Low	Low	Low	-
	Medium	Medium	Low	Low	Low	-
	Low	High	Medium	Low	Low	-
	-	-	-	-	-	-

Project Resource Measures

Cap_Rank	CapThreshold
Low	0.1
Medium	2
High	3
Very High	3.5

Appendix B-40

Summary of Active Threats
Sandhills Landscape

Threat Status for Targets and Site

Active Threats Across Systems	Red Cockaded Woodpecker - Public	Red Cockaded Woodpecker - Private	Sandhills Longleaf Forest Mosaic	River Terrace Communities	Streamhead Pocosins/Seeps/Wetland Depression	Blackwater Streams		Overall Threat Rank	Total Score
Primary home development	-	Very High	Very High	High	High	Medium	Medium	Very High	5.53
Fire suppression	Low	Very High	Very High	High	High	-	-	Very High	5.52
Forestry practices	Low	Very High	Very High	High	-	Medium	Medium	Very High	5.22
Second home/resort development	-	High	High	-	-	-	-	Very High	5.00
Pine Straw Production	-	-	-	-	-	-	-	High	2.00
Invasive/alien species	-	-	-	Low	High	Medium	Medium	High	2.00
Livestock production practices	Low	-	-	High	High	Medium	Medium	Medium	1.40
Golf course construction and maintenance	-	-	-	-	-	-	-	Medium	0.40
Wastewater treatment	-	-	-	-	-	-	-	Low	0.20
Military training	-	-	-	-	Medium	-	-	Low	0.03
Grazing practices	Low	High	High	Low	High	Low	Low	Low	0.03
	-	-	-	-	-	-	-	-	0.00
	Low	Very High	Very High	High	High	Medium	Medium	Very High	

Handwritten notes: "Conversion to horse farms"; "Very High Very High"; "Medium"; "?"

Threats

Critical Threats Rankings

Degree of Threat

Threat bars (from top):
- Primary home development
- Forestry practices
- Pine Straw Production
- Livestock production practices
- Wastewater treatment
- Grazing practices

Legend:
- Very High
- High
- Medium
- Low

Strategies by Target
Sandhills Landscape

*Strategies that apply to mostly Persistent Stresses (With Historical Sources) are in **bold italics**.*

Strategies Across Systems	Red Cockaded Woodpecker - Public	Red Cockaded Woodpecker - Private	Sandhills Longleaf Forest Mosaic	River Terrace Communities	Pocosins/Seeps/Wetland Depression	Black Water Streams			Strategy Benefit Rank	Total Score
Permanently protect "no regret" sites identified by partnership	-	Very High	Very High	-	-	-	-	-	Very High	5.00
Analyze existing data. If analysis shows effectiveness with re	-	Very High	Very High	-	-	-	-	-	Very High	4.60
Build capacity of Ft. Bragg, WRC, USFWS and TNC/NC to	Low	Very High	Very High	-	-	-	-	-	Very High	4.52
Review and integrate public and private land management p	-	Very High	Very High	-	-	Medium	-	-	Very High	4.50
Expand acquisition to fill in "gap" by aggressively seeking mi	-	Very High	Very High	-	High	-	-	-	High	3.00
Establish minimum 660 foot buffer for timber harvests.	-	-	-	High	High	Medium	-	-	Medium	1.20
Continue moratorium of livestock production capacity in NC.	-	-	-	-	-	Medium	-	-	Medium	1.20
Buy buffer using NC Clean Water Management Trust Fund g	-	High	High	High	-	Low	-	-	Medium	1.03
Provide incentives to private land owners to use manual labo	-	High	High	High	High	-	-	-	Medium	1.00
Monitor for invasives, particularly "cogon" grass and remove	-	-	High	-	-	-	-	-	Medium	1.00
Aggressively seek mitigation money to restore diverse herb	-	-	-	-	-	-	-	-	Medium	1.00
Eliminate use of plows and develop contingency plans for wi	-	-	-	High	High	-	-	-	Medium	1.00
Prescribed fires executed to slowly burn into river terraces.	-	-	-	High	High	-	-	-	Medium	1.00
Monitor microstegium, honeysuckle and privet. Remove the	-	-	-	-	-	-	-	-	Medium	1.00
Analyze groundwater table and effect of pumping on aquifer.	-	-	-	-	-	-	-	-	Medium	1.00
NC Division of Forestry expand/emphasize private landowne	-	-	-	-	-	-	-	-	Medium	1.00