

Fire Management and Research for Biodiversity in the Green Swamp

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Abstract.—The Nature Conservancy has conducted prescribed burns for two decades in North Carolina's Green Swamp to enhance and maintain species biodiversity in the longleaf pine (*Pinus palustris*) savannas and ecotones. The surrounding pocosins, however, have been left alone. Increasingly, dense shrub growth in the pocosin suppresses herbaceous species and increases the risk of serious wildfires. Two experimental burns have shown that it is possible to safely conduct prescribed burns in pocosins. Continuing studies will monitor the vegetation response to fire and map the vegetation and fuels to predict fire behavior, leading to a better fire management plan for the Green Swamp based on its historic fire regime.

In managing more than 1,500 natural areas (6.8 million acres) throughout the United States, The Nature Conservancy (TNC) examines the processes that have shaped and are shaping the ecosystems targeted for conservation within its program. The Nature Conservancy uses prescribed fires where this tool will contribute to the perpetuation of species and ecosystems. The Nature Conservancy has increased its ecological burning for ecological reasons to just over 70,000 acres, or 450 burns per year, in 44 states over the last decade. Fire exclusion and altered fire regimes have been identified as threats in 45% of sites where TNC actively is working and over 600,000 acres presently are targeted for burning. The North Carolina TNC Chapter has 14 preserves with 25,000 acres under fire management, ranging from longleaf and pond pine (*Pinus serotina*) ecosystems to Carolina bays, Piedmont prairie remnants, and a lone mountain seepage bog. In the 1980's, TNC began its fire management by burning longleaf pine savannas during the winter months. This is the traditional prescribed burning season in the region because during this time fire behavior is most predictable and controllable. As the chapter's staff gained experience with prescribed burning, a shift to conducting burns designed and timed to mimic fire regimes under which the natural communities evolved occurred, also while protecting and promoting associated indigenous rare species. In North Carolina, this meant that the TNC's statewide prescribed burns are now conducted year-round, but with emphasis on the growing season to mimic wildfires as a key ecological process.

Role of Fire in the Ecology of the Green Swamp

The Green Swamp is a 17,000 acre preserve in the southeastern Coastal Plain of North Carolina. The

majority of the preserve (about 85%) supports pocosin and pond pine woodlands on organic soil (Figure 1). Only a small portion of the preserve has mineral soils that support longleaf pine communities or loblolly pine (*Pinus taeda*) plantations (currently being restored back to longleaf pine communities). Fire and hydrology have shaped the longleaf pine/pocosin (shrub bog) ecosystems in the coastal Carolinas, including the Green Swamp, and creating assemblages of species (communities) with specific components and characteristics (Christensen 1981). For example, the Green Swamp is renowned for the high diversity of herbaceous species in savannas where more than 30 species per square meter can occur (Walker and Peet 1983), including endemics such as Venus flytrap (*Dionea muscipula*) and rough-leaf loosestrife (*Lysimachia asperulifolia*). Frequent fires (1–10 year return intervals) are critical to maintaining the open character of the savannas (Christensen 1981). These open conditions also are an important environmental factor for the health and persistence of associated rare species such as the red-cockaded woodpecker (*Picoides borealis*) and Venus flytrap moth (*Hemipachnobia subporphyrea*) as noted by Hall and Schweitzer (1993).

Fire naturally has occurred in the pocosins, occasionally burning into the peaty soils during drought periods (Hungerford et al 1998). Pocosin fires open up shrub areas allowing for a mixed-age mosaic of vegetation with a variety of herbaceous species, including the federally threatened rough-leaf loosestrife to become established. The historic fire regime under which pocosins developed is estimated between 5 to 30 years (Wells 1946; Frost 1995). Fire also stimulates root sprouting and reproduction and increases nutrient levels in the nutrient-poor soils of the pocosin (Schafale and Weakley 1990). The Green Swamp has a range of high and low pocosin communities, varying with respect to time since the last fire, the depth of their peat soils, the saturation and nutrient content of the soil, and the species they support. Low and high pocosins harbor such rare species as Cotton grass (*Eriophorum virginicum*), laurel (*Kalmia cuneata*), rough-leaved loosestrife, arrow arum (*Peltandra sagittifolia*), beak rush (*Rhynchospora alba*) and a sphagnum (*Sphagnum fitzgeraldii*) (Schafale and Weakley 1990).

In the absence of fire, all the Green Swamp communities lose species diversity and build up accumulations of fuels that can lead to a risk of more intense and more damaging wildfires. Moreover, with fire suppression, hardwood shrubs encroach on the formerly isolated savannas, shading out other species, with a similar loss of species that favor open conditions in the pocosins.

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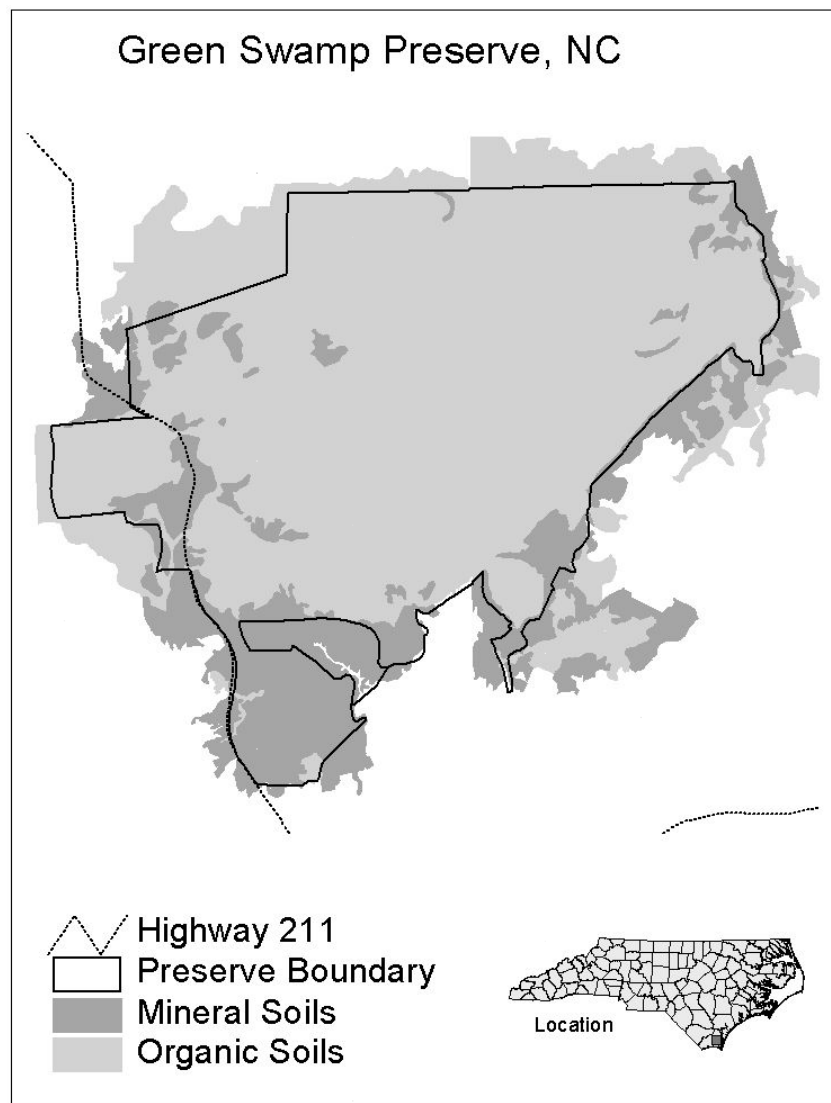


Figure 1.—Soil type and preserve boundary of the Green Swamp, North Carolina

The majority of the Green Swamp last burned during a 1932 wildfire; small portions of the pocosins burned in 1955, 1982, and 1990 as wildfires. The fire frequency on most of the preserve has been reduced through active fire suppression and lack of prescribed burning on a landscape level for the past 50 years. The heavy fuel accumulation (15-25 tons/acre) in the pocosins increases the risk of severe fires that could burn deeply into the peat during drought conditions.

The Nature Conservancy has conducted frequent prescribed burns in the longleaf pine savannas and pine plantations close to the highway since the early 1980s. Prescribed burning of savannas in the Green Swamp has been based on timber management burns during the dormant season. By burning within 2 days of a rain event, when the organic soils are saturated, the pocosins served as a natural fire breaks rather than establishing

destructive plow lines. Such natural fire breaks avoid soil disturbance, especially in the ecotone between savannas and pocosin, where many rare and endangered occur. Most of the isolated, interior savannas and the pocosin, however, have burned only accidentally within the past century (Kologiski 1977, McIver 1981).

Developing a Fire Management Plan for the Green Swamp Preserve

The Nature Conservancy has become increasingly aware that the limited burning conducted in the past two decades was not consistent with stated organizational ecosystem conservation goals. Therefore, TNC developed the following fire management goals for the Green Swamp in 1995: (1) to restore and maintain communities in a spatially and temporally heterogeneous pattern using prescribed burns as a



Figure 2.—Aerial view of two experimental pocosin burns in the Green Swamp. Only the surface fuels burned in the foreground. The burn unit in the back shows the peat burn unit one year after a burn.

management tool to mimic fire regimes under which these communities evolved while protecting and promoting the rare species associated with them; (2) to shift from the traditional dormant season to year-round prescribed burning, but conducting more burns in the growing season to mimic wildfires as a key natural process; (3) to plan and time burns to restore and maintain the mosaic and diversity of habitats in different successional stages to support the species indigenous to the Green Swamp; (4) to expand prescribed burning to the entire preserve, and include isolated savannas and pocosins, at least on an experimental basis; (5) to use research and monitoring as part of the proposed fire management plan to evaluate the effectiveness of the prescribed burning regime and redirect management as necessary to accomplish the management goals (Bucher and Gintoli 2001).

It became apparent to TNC staff that to effectively manage the longleaf pine/pondpine ecosystems from an ecological as well as a logistical perspective requires prescribed burning in the savannas as well as in pocosins. Fire is needed in pocosin habitat not only to maintain its inherent diversity but also to reduce the threat and risk of wildfires originating on the preserve and threatening adjacent plantations that could lead to potential impact of suppression activities requiring heavy equipment. However, conducting safe prescribed

burns in pocosin requires more information on prescribed burn parameters than is generally available.

The Nature Conservancy learned that the USDA Forest Service Intermountain Fire Science Lab (IFSL) was conducting a nationwide study examining prescribed burning issues in wetlands. In 1995, TNC developed a joint venture with the IFSL to use the Green Swamp as one of the research burn sites. The Green Swamp study goals are (1) to develop guidelines for prescribed pocosin burns that would not ignite organic soils and guidelines that could predict when peat fires would extinguish; (2) to understand the ecological consequences of suppressing peat fires versus allowing them to burn; and (3) to provide suppression agencies with better tools to predict the probability of severe peat fires on wildfires. In the course of this joint venture, IFSL staff gathered pre-burn peat moisture and surface topography data, sampled surface fuels, and monitored soil consumption and heat transfer during the burn. The Nature Conservancy staff gathered pre- and post-burn vegetation data. In cooperation with the North Carolina Division of Forest Resources (NCDFR), TNC conducted two experimental prescribed burns in the Green Swamp pocosin, on 9 September 1999 and 18 September 1999, to field test the predictive models for peat ignition developed by the IFSL, (Figure 2) document ignition patterns and heat transfer in organic soils and monitor



Figure 3.—Prescribed burn that burned into the Green Swamp pocosin and extinguished itself without suppression action.

vegetative response to peat burns and a surface burns to improve pocosin vegetation models (Bucher 1998). These carefully planned and implemented burns demonstrated that pocosins can be burned safely, even in drought conditions when a peat fires are more likely to occur. The data from these burns are currently being analyzed with published outputs planned by fall 2001. The two experimental burns (each about 10 acres) have provided data to customize fuel models and have helped establish parameters for burn plans, but methodologies to safely conduct prescribed burns on a larger operational scale of at least a several hundred acres are not yet realized.

In attempting to return fire to some of the isolated savannas, TNC staff observed significant differences in pocosin fuels and fire behavior in different areas of the preserve. Occasionally burns would move deeper into pocosin than anticipated, as in a February 1998 fire, whose path is shown on Figure 3. Rain was approaching as the fire burned in the pocosin. The fire was allowed to extinguish itself in the evening, after a flyover determined it would remain entirely on TNC property. Afterwards, TNC staff determined that there was a need for better vegetation and fuels information. In summer 2000, TNC began a vegetation mapping project of the Green Swamp and its surroundings with Duke University and the North Carolina Plant Conservation program. The goals of the mapping project were to capture the diversity in pocosin from an ecological as well as a fuels management perspective and develop classification methods that could easily be exported to other sites. We employed a remote sensing technique

using four fundamental variables (biomass, deciduousness, patchiness and soil type) and 65 vegetation plots to classify 7 types of vegetation in the Green Swamp: longleaf pine savanna; low-, medium-, and high-density low pocosin; high pocosin, pond pine woodland; and Atlantic white cedar (*Chamaecyparis thyoides*) forest (Kwasny 2001).

Summer 2001 will be used to ground-truth and correct the vegetation map. Personnel from IFSL will use the corrected vegetation map and gather additional fuel characteristics (such as crown-base height, crown bulk density, and fuel loading) to develop a fuels map and customized fuel models to enable the use of the Fire Area Simulator model (FARSITE). The FARSITE model is a deterministic fire growth simulator that applies fire behavior calculations to complex environmental conditions. It allows fuels, weather, and topography to vary spatially and temporally and produces maps of fire growth and behavior. It uses current and published fire behavior models to predict fire behavior (Finney 1998). After testing the accuracy of the vegetation maps and customized fuel models developed for the Green Swamp using recent fires, TNC hopes to better predict fire behavior in pocosin for the following: (1) to develop and test prescribed burn parameters using single source or single line ignition; (2) to simulate the effects of fuel mitigation along the preserve boundary that may be effective in reducing the threat of wildfires and increase the safety of prescribed burns on the preserve to plan fuel reduction projects; and (3) to predict potential fire growth and behavior of wildfires and effectiveness of suppression efforts. Moreover, TNC now has a

permanent weather station in the Green Swamp that provides data for the national fire danger rating system through a cooperative agreement with NCDFR. Current and accurate fuel moisture and weather data will be key components for fire behavior predictions of future burns and in case of wildfires.

Conclusions

Managing ecosystems using prescribed fire as a landscape process requires burning across the boundaries of natural communities and ecosystems to create a mosaic of habitats and maintain the diversity inherent to those systems. But any management plan, especially one that involves a change of practices, must be based on good observation and research. Setting goals and carefully monitoring the vegetation response and effectiveness of the management activities are essential to developing science-based, ecological land management. In its Green Swamp preserve, TNC and its partners are putting these important principles into practice.

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