FINAL DRAFT

Project Title:

Phase II
Writing Site Management Plans and Prescribed Burn Plans,
Monitoring Recovery Populations,
to
Meet Recovery Criteria for
Golden Sedge
(*Carex lutea* LeBlond)

Photo credit: Gulf South Research Corporation

Report submitted to:
U.S. Fish and Wildlife Service
Raleigh Field Office, North Carolina
In partial fulfillment of agreement number: 401819G534

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Management Plan for Recovery of Golden Sedge (*Carex lutea* LeBlond) at Sandy Run Savannas State Natural Area Maple Hill, North Carolina

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I. Introduction and Project Summary

Golden sedge (*Carex lutea*) was collected originally and described by Richard LeBlond et al. (1994) from specimens collected in 1990 at The Neck Savanna, now part of Sandy Run Savannas State Natural Area (SARU). The species has been found only in Onslow and Pender counties, North Carolina. Suiter and LeBlond (2007) characterized this perennial graminoid in detail as part of a draft species recovery plan. Within the mid-Atlantic region *C. lutea* resembles *C. flava* -- a species of calcareous seeps in the Virginia mountains -- in appearance, but is distinguished from the latter by yellowish green pistillate scales and a terminal (staminate) spike of 17-39 mm in length (Weakley 2008). Genetic research by Dereig et al. (2008) found that golden sedge is related most closely to species endemic to northern states -- *C. cryptolepis* (scattered locations from Wisconsin to Maine) and *C.* sp. nov. (Indiana, Ohio, and Michigan).

The United States Fish and Wildlife Service (US FWS) designated golden sedge as a federally endangered species on 22 February 2002 (US FWS, 2002). North Carolina status also was listed as endangered that year by the North Carolina Natural Heritage Program (NCNHP) (Buchanan and Finnegan, 2008).

The species is restricted to wet savanna/hardwood ecotones, open wet savannas, and very poorly drained soils adjacent to or in shallow drainage ditches. The pine savanna very wet clay variant natural community type described by Schafale (1994) is an example of such a habitat. Known soil series include: Foreston (Aquic Paleudult), Grifton (Typic Ochraqualf), Stallings (Aeric Paleaquult), and Woodington (Typic Paleaquult) (Barnhill, 1990 and 1992; LeBlond, 1999 and 2000; Suiter and LeBlond, 2007) (Appendix A). Glover (1994) found a significant correlation between golden sedge occurrence and locally higher soil pH values (i.e., mean of inhabited sites was 6.7, while uninhabited sites was 6.3) within The Neck Savanna (formerly Lanier Quarry Savanna), but she concluded that one factor was not sufficient to explain species distribution. However, subsequent soil analysis of three golden sedge populations by Taggart and Long (2012) found that mean pH values within populations were very strongly (4.7) to moderately (5.7) acid for topsoils and moderately (5.8) to slightly (6.5) acid for subsoils. Root-rhizome depth for three specimens was 6-8 cm, thus topsoil was the primary influence. Weakley (2008) described golden sedge occurrence and associated species in the following excerpt:

> "*Carex lutea* LeBlond, Golden Sedge. Cp (NC): wet savannas shallowly underlain by coquina limestone, with open canopy of *Taxodium ascendens, Pinus palustris*, and *Liriodendron tulipifera*; rare (US Species of Concern, NC Rare). May. Endemic to Pender and Onslow counties, NC, where associated with other narrow endemics, such as *Thalictrum cooleyi* and *Allium species 1*, and other rare species, such as *Plantago sparsiflora*, *Parnassia caroliniana*, *Rhynchospora thornei*, and others."

Only nine sites with golden sedge populations have been documented in Onslow and Pender counties (Suiter and LeBlond, 2007; NCNHP, 2009). Several records are within existing or soon to be added SARU tracts depicted in Figure 1: Hancock, Haws Run Mitigation Site, O'Berry,

and The Neck Savanna. A map of golden sedge population locations within these tracts is given in Figure 2 (page 10).

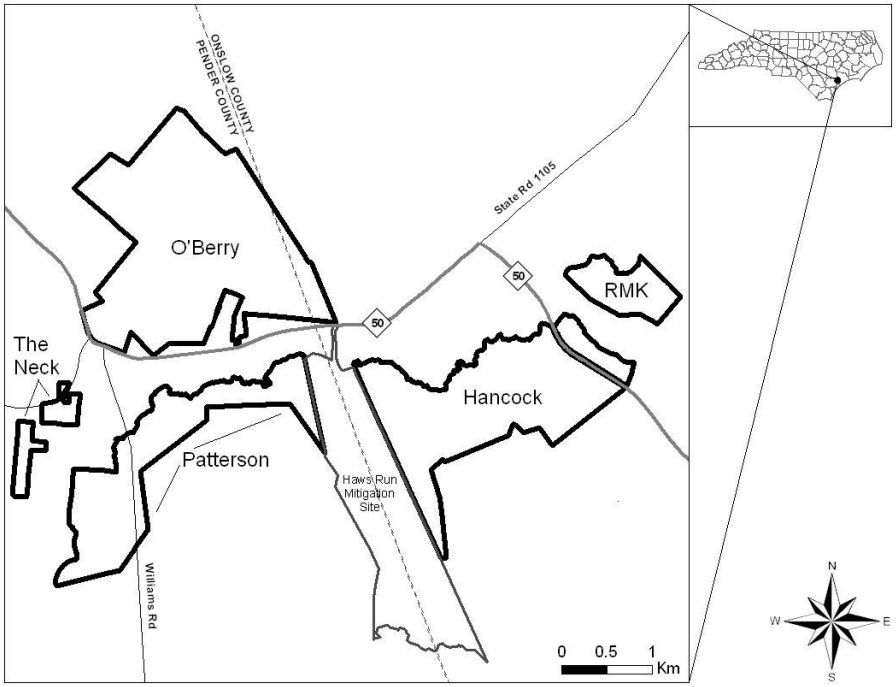

Figure 1. Location of Sandy Run Savannas State Natural Area and constituent tracts in the North Carolina Coastal Plain. Current SARU tracts have dark boundaries; Haws Run Mitigation Site will be added in the near future. Tract areas in hectares/acres include (clockwise): RMK (52.47 ha./129.5 ac.), Hancock (291.65 ha./720.37 ac.), Haws Run Mitigation Site (238.68 ha./589.55 ac.), Patterson (187.89 ha./464.1 ac.), The Neck Savanna (27.28 ha./67.37 ac.), and O'Berry (415.93 ha./1,027.35 ac.).

The management plan outlines steps to: a) augment golden sedge populations, b) restore golden sedge habitats, and c) monitor golden sedge populations. Primary management tools are prescribed burns, drainage modification, and habitat restoration. Plans will describe methods to augment and restore golden sedge populations at four SARU tracts with known populations. Monitoring will help determine population viability and project success as required by the recovery process.

II. Management Plan for the Recovery of Golden Sedge (*Carex lutea*) at Sandy Run Savannas State Natural Area

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North Carolina Division of Parks and Recreation Mission and Responsibilities:
The North Carolina Division of Parks and Recreation (NCDPR) is a state agency within the North Carolina Department of Environment and Natural Resources. The NCDPR mission is: "…to conserve and protect representative examples of the natural beauty, ecological features and recreational resources of statewide significance; to provide outdoor recreational opportunities in a safe and healthy environment; and to provide environmental education opportunities that promote stewardship of the state's natural heritage." Within the park system of 72 properties are 19 state natural areas that are the least developed sites, set aside to protect rare or fragile natural resources. Natural area development is limited to public access/facilities and interpretive programs that do not compromise a given site's ecological integrity (NCDPR, 2009). The NCDPR policy concerning natural resource management is to allow habitats in park properties to evolve through natural processes; however, intervention (e.g., prescribed burning, habitat restoration) may occur "…to correct or compensate for the disruption of natural processes caused by human activities…." (McKnelly, 1995).

Site Characterization Relative to Golden Sedge Populations:
Sandy Run Savannas State Natural Area (SARU) is located in the southeastern coastal plain of North Carolina and encompasses approximately 1,214 hectares (2,998 acres) in western Onslow and northeast Pender counties adjacent to Camp Lejeune Marine Corps Base. Currently, SARU proper includes six tracts with management responsibility allocated to the NCDPR. A seventh tract – Haws Run Mitigation Site, owned by the North Carolina Department of Transportation, will be added to SARU in the near future and thus is included in the aforementioned total area and subsequent management discussion (Figure 1).

The history of SARU land use consists of land clearing, ditching, and associated modifications for pulp and/or timber plantations (H. McIver, The Nature Conservancy in North Carolina, pers. comm., 2006). The Nature Conservancy in North Carolina, who acquired most of the tracts before transfer to the NCDPR, planted some harvested areas with longleaf pines (see Appendix B-5) and performed a few prescribed burns until 2007.

Isolated pine savannas, flatwoods, and tracts too wet for silviculture serve as reference sites for natural plant communities as classified by Schafale and Weakley (1990) and described by LeBlond (1999, 2000) and Taggart (2010). These communities include: coastal plain small stream swamp forest – blackwater type, mesic pine flatwoods, nonriverine swamp forest, pine savanna, small depression pocosin, and wet pine flatwoods. A Progress Energy power line right-of-way that runs through the Hancock and Haws Run Mitigation tracts contains an excellent savanna understory, including golden sedge habitat, maintained by periodic cutting. Three floristic variants are present in pine savannas of the natural area: wet spodosol, wet ultisol, and very wet clay. Portions of the site received a national significance rating by the NCNHP for examples of the globally rare very wet clay variant that contained populations of two federally endangered species: *C. lutea* and *Thalictrum cooleyi* (Cooley's meadowrue) plus other rare plant populations (LeBlond, 1999 and 2000; NCNHP, 2009; Taggart, 2010).

Relative to additional protection for various SARU tracts, only The Neck Savanna is formally dedicated as a North Carolina State Nature Preserve while the Progress Energy power line right-of-way is a Registry Agreement (i.e., voluntary, non-binding) with the NCNHP. Other properties will be considered for designation in the near future (Ann Prince, NCNHP - Protection Specialist, pers. comm., 2009).

Because of its limited distribution within ecologically fragile habitats, golden sedge populations are vulnerable to a number of threats. Conversion of natural communities to human development (e.g., residential neighborhoods, roads, etc.) or agricultural/silvicultural activities would be most devastating. Suiter and LeBlond (2007) also noted that U.S. Army Corps of Engineers decisions concerning wetland permits have the potential to damage or extirpate local populations by way of habitat conversion or alteration. While such direct impacts are not an issue within a state natural area, potential threats of fire suppression, invasive species, and artificial drainage systems are present that can change species compositions over time by woody or non-native plant invasion and soil moisture modification. Also, populations within aforementioned power line easements would be negatively impacted by indiscriminate herbicide application and by use of heavy grinding equipment that causes plant damage/soil compaction and local drainage alterations. Potential consequences of any of these impacts would include reduction or extirpation of one or more golden sedge populations.

In addition to golden sedge, SARU contains many other rare species that would benefit from ecological management. Taggart (2010) collected a total of 590 vascular plant species from six natural and two human-influenced communities within the natural area. A total of 66 additional species were observed in past surveys of selected SARU tracts by LeBlond and Weakley (1991), LeBlond (1999, 2000) and the NCNHP (2009). Most notable are golden sedge and Cooley's meadowrue (*Thalictrum cooleyi*), both federally and state endangered, while Carolina grass-of-Parnassus (*Parnassia caroliniana*), pineland plantain (*Plantago sparsiflora*), and Thorne's beaksedge (*Rhynchospora thornei*) are state endangered. Of the plants collected, a total of 23 species with federal and/or state status are tracked by the NCNHP, while 29 other taxa are included on the state watch list (i.e., considered rare or poorly known, but not highest priority)

(Buchanan and Finnegan, 2008). Most of these rare species occur in savanna and pine flatwoods communities that need periodic fire and natural soil conditions for adequate maintenance of native plant populations, particularly the other federally endangered species -- Cooley's meadowrue (US FWS, 1994). In addition, roughleaf loosestrife (*Lysimachia asperulaefolia*), a savanna-pocosin ecotone plant with federal endangered species status, has been recorded (NCNHP, 2009) within one kilometer of the Haws Run Mitigation Site. This and other potential additions to the SARU flora should be sought following reintroduction of prescribed fire.

The intent of this project is to protect, augment, and restore golden sedge populations within a mosaic of coastal plain natural communities at SARU. These habitats encompass a general moisture continuum (wetter to relatively drier) of: swamp forest (i.e., coastal plain small stream swamp – blackwater subtype and nonriverine swamp forest), small depression pocosin, wet pine savanna, and wet pine flatwoods (*sensu* Schafale and Weakley, 1990; Schafale, 1994).

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State Property Office
1321 Mail Service Center
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Physical Address: 116 W. Jones Street – 4th Floor
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Manager:
North Carolina Department of Environment and Natural Resources
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Funding:
North Carolina Division of Parks and Recreation:
The operations and resource management programs have yearly budget allocations for staff, equipment, and supplies to implement site-specific stewardship activities per approved management plans, cooperative agreements with other agencies (e.g., North Carolina Department of Forest Resources, The Nature Conservancy in North Carolina), or grants.

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Justification of Golden Sedge Population Augmentation and Habitat Restoration:
Questions from the article, "Plant rarity and endangerment in North America," were used to further assess proposed augmentation and restoration activities (Morse, 1996). The quotes are those questions listed in the article to consider prior to initiation of a reintroduction, introduction, or augmentation project with rare plant species.

"First, does the proposed action *benefit the species* (for example, by increasing its sites within its appropriate range and habitat, by increasing its abundance at its better sites, or by increasing the number of places in which it reproduces successfully)?"

Yes. The goal of the project is to restore habitats for golden sedge that will support viable populations within a multi-site context at SARU, which contains half of the known occurrences for the species.

"Second, does the action *benefit the site or place* (for example, by restoring a dominant or characteristic species of the habitat, by bringing back a rare species historically known there, or by helping restore an instance of a rare habitat or an ensemble of rare species)? On the other hand, might bringing this species to the site interfere with conservation of other significant species already there, disrupt habitat integrity, or make a different and more important reintroduction more difficult?"

Yes. The project seeks to use prescribed burns and habitat restoration (i.e., via drainage and/or vegetation modification) to enhance and expand golden sedge populations. Specifically, restoration of wet savanna community and its associated ecotones are high priority stewardship issues for this species and many others found at the site. Proposed actions will be totally compatible with and beneficial to intended natural area management for associated species and communities.

"Third, in the case of population restorations, does the action *benefit the population* of that species already at the site? For example, poorly conducted return of garden-grown material can bring in pests or diseases, and mixing of genotypes might (or might not) degrade local climate or

ecological adaptations."

Yes. Reintroduction is unnecessary as there are existing populations that simply need proper stewardship and restoration.

"Finally, and most important in the long view, does the proposed action *promote the opportunity for future adaptation and evolution* in this species and in the broader phylogenetic line to which it belongs? One possibility is that relict populations in microclimate refugia may retain characteristics lost by the species' persistence, adaptation, and evolution if past conditions return. On the other hand, geographically or ecologically marginal populations may be more likely than central populations to adapt or diverge into new taxa under novel conditions. In any case, great care should be taken to maintain the genetic distinctiveness of geographically or ecologically disjunct stands of species."

Yes. Extant populations will be maintained and hopefully expanded within the site. Genetic research on golden sedge has been performed by Derieg et al. (2008). Given the limited known range of the species, two adjacent coastal plain counties, SARU represents approximately half of these occurrences plus the north and east range limits. Further inter- and intra-population research opportunities will be available because all tracts are under permanent protection as a state natural area.

Action Planning:

A. SARU – overall management perspective

Extant SARU golden sedge populations are found typically in discrete ecotones and power line rights-of-ways; however, at least one occurrence is within an area of open wet savanna at the Haws Run Mitigation Site. The immediate goal is to enhance these populations and associated species to simulate, as best possible, natural or pre-settlement conditions. This will be accomplished in the short term by: 1.) use of prescribed fire on a rotational basis by the NCDPR and 2.) cutting of savanna understory when or where burning is not feasible. Winter-early spring burns will be needed at first to reduce fuel accumulations, but growing season burns would be most desirable in the future to restore natural coastal plain conditions (Frost, 1995; Sparks et al., 1998; Platt, 1999; Christensen, 2000). Although a common prescribed burn frequency guideline for longleaf pine-wiregrass savannas on public and private lands is three to five years, Gray et al. (2003) recommended two years for rare vascular flora found at Camp Mackall and Fort Bragg Military reservations within the sandhills regions of the North Carolina Coastal Plain. This suggested frequency coincides with a mid-range of the presettlement fire regime (1-3 years) for a majority of the southeastern coastal plain reported by Frost (1998).

Another long-term goal will be restoration of existing and former plantation areas, which encompass the majority of state property, toward savanna community types found at SARU reference sites (i.e., unplowed savannas and power line rights-of-ways). Expansion of SARU savanna area would provide niches for additional golden sedge populations. Restoration of pine savanna communities from extant and harvested plantations has been pursued by a number of researchers (e.g., Brockway

et al, 1998; Coffey and Kirkman, 2006; Platt et al., 2006; Kirkman et al., 2007). Protocols and information from these and similar studies could be used to develop strategies for restoration efforts in discrete test areas which, if successful, could be applied toward larger scale restoration efforts. In particular, careful thought and experimentation will have to be directed toward how past soil disturbance (e.g., bedding) and drainage activities can be rectified. Given that most of SARU has been affected by past silivicultural activities to varying degrees (e.g., Appendix B, photos 7 & 8), such restoration should be a long-term goal to revitalize the original landscape and its associated biodiversity. Golden sedge populations definitely would benefit from such a comprehensive program, but more immediate and focused actions are needed to protect known populations of the species at the present time.

B. Tract-Specific Management (see Figure 2 on page 10 for population locations)

1. Hancock Tract

a. Progress Energy Power line corridor northeast of NC 50 (Appendix B, photo 1a)
This site has been maintained as a clearcut by periodic use of a mechanical grinder according to an easement with Progress Energy and has been registered voluntarily with the NCNHP. Being a wet savanna ecotone adjacent to a small stream swamp forest community, invasion by shrubs and hardwood saplings has occurred rapidly since the last cut in April 2008. Stewardship of golden sedge and associated savanna species populations at this site would be ideal if cutting were replaced by prescribed burning (i.e., provided Progress Energy was agreeable) to simulate more natural conditions and to avoid use of heavy equipment. Such a burn was performed by the Division of Parks and Recreation in February 2010. Cutting has served as an adequate fire surrogate, but soil compaction by Progress Energy vehicles could harm golden sedge populations in this corridor. Also, fire is the only way to prevent colonization by non-fire-adapted flora and invertebrates that could threaten population integrity. No herbicides will be sprayed; however, chemicals could be applied carefully to kill woody species (e.g., painting of stumps).

b. Ditch off main entrance road, ca. 0.64 km. west of NC 50 gate (Appendix B-1b)
Occurrences of the species at this location and in the vicinity (NCNHP, 2009) were in transitions from either drainage ditches or savanna-like understory to swamp forest communities. Prescribed burning in thoughtfully determined compartments will be the primary means to maintain and augment these populations. Where golden sedge is present on the bank of a functioning drainage ditch, consideration should be given to blocking the ditch in a manner that restores a more natural hydrology in accordance with the original soil series. The intent would be to expand these populations; however, this action should be undertaken with caution to avoid flooding that could negatively impact known occurrences.

2. Haws Run Mitigation Site

a. East-west ditch ca. 200 m. SW of entrance gate (Appendix B-2a)

Golden sedges are generally found along the bottom of this ditch. No extensive modification is needed other than fire and/or mechanical removal of shrubs and trees as they encroach along the edges and within the ditch proper.

b. South savanna area (Appendix B-2b)

South of the ditch is an extensive wet savanna distinguished by the presence of numerous broadleaf whitetop sedges (*Rhynchospora latifolia*). Clumps of golden sedge are scattered throughout this area. Although much of the Haws Run Mitigation Site was plowed or otherwise disturbed in anticipation of a plantation complex, native species gradually returned after plans were not implemented (Richard LeBlond, NCNHP – retired Coastal Plain Inventory Specialist/Botanist, pers. comm., 2008). However, the presence of small to medium-sized loblolly pines (*Pinus taeda*), various wetland hardwoods (e.g., *Acer rubrum var. trilobum, Liquidambar styraciflua, Nyssa biflora*), and tall shrubs (e.g., *Morella cerifera*, *Baccharis halimifolia*) strongly indicate the need for prescribed fire and some mechanical removal (e.g., cutting and painting of stumps with an appropriate herbicide).

3. The Neck Savanna (Appendix B-3)

This holotype location for the species (LeBlond et al., 1994) has populations in ecotones between savanna and nonriverine swamp forest communities associated with the circumneutral Grifton soil series. These populations are found off an unpaved road that runs from Lee Road cemetery through the former quarry area and include: 1.) a north-south plowline (discovery site) located on the west side of the road ca. 50 m south of the cemetery, and 2.) a spur road south and east of the quarry area. No sedges were observed at the latter site in May 2011. Only one small area (ca. 1-2 hectares) was burned within the two Neck Savanna tracts before State Parks acquision because of opposition by local residents (Hervey McIver, The Nature Conservancy in North Carolina – Protection Specialist, pers. comm., 2007). However, a burn that included the first population was completed by the Division of Parks and Recreation in February 2010. Careful reduction burns will be needed to gradually restore herb dominance in savanna and flatwoods communities. Prolonged fire suppression within savanna-swamp forest ecotones may necessitate mechanical removal of some well-established woody species while fuel levels are reduced by winter burns.

4. O'Berry Tract – Watkins Savanna and vicinity (Appendix B-4)

Existing/former populations of golden sedge (NCNHP, 2009) within the O'Berry tract also are found in ecotonal habitats -- wet edges of a swamp forest, drainage ditch bank, and pine plantation. LeBlond (2000) documented numerous rare species in addition to golden sedge at Watkins Savanna located in the southern portion of the property. However, this area has lost its savanna physiognomy because of fire suppression. The most immediate need for all of these populations will be mechanical removal of woody vegetation to prevent further shading from tree and shrub invasion. Prescribed burning may then be implemented to restore, maintain, and enhance these populations plus those of other wet savanna species. Much of this tract contains loblolly pine (*Pinus taeda*) plantations, some thinned in 2009 by The Nature Conservancy in North Carolina. Such parcels could serve as ideal sites for

ecosystem restoration, although remnant plantations and loblolly pine-dominated successional areas are found on the Hancock, Haws Run, Patterson, and RMK tracts as well (see Appendix B-6).

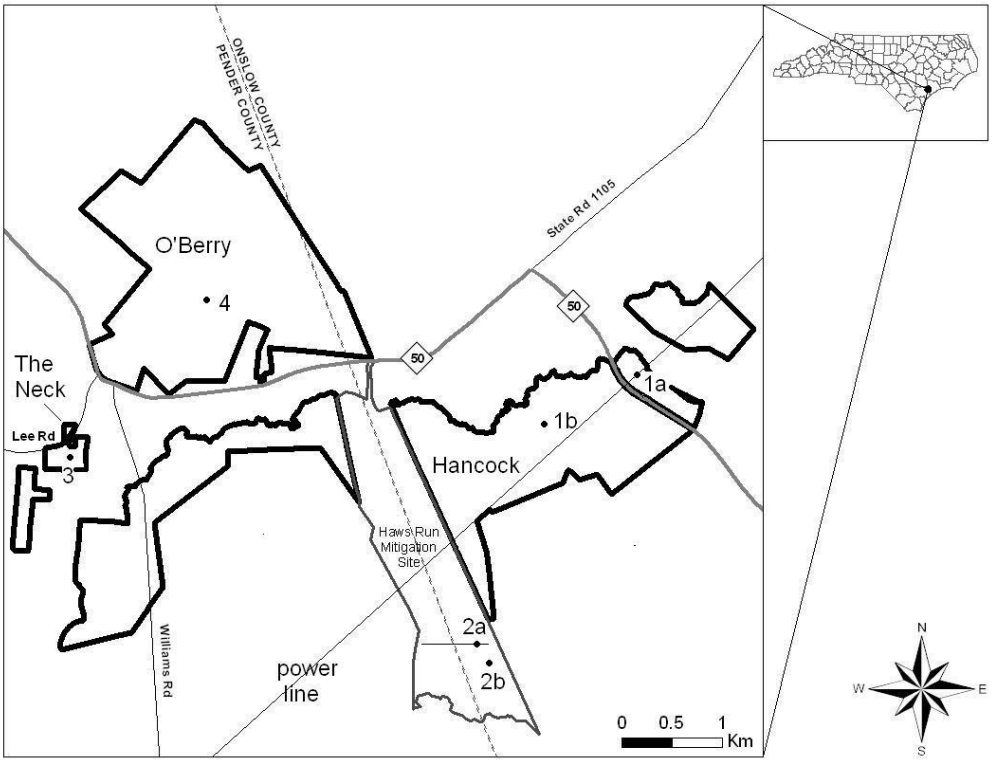

Figure 2. General locations of *Carex lutea* populations within Sandy Run Savannas State Natural Area. Current SARU tracts have dark boundaries; Haws Run Mitigation Site will be added in the near future. Population locations (clockwise): 1a – Hancock Tract, power line corridor; 1b – Hancock Tract, ditch off entrance road; 2a – Haws Run Mitigation Site, east-west ditch; 2b – Haws Run Mitigation Site, south savanna area; 3 – The Neck Savanna, ecotonal habitat; 4 – O'Berry Tract, edge of Watkins Savanna area.

Control of Exotic and Aggressive Native Species:

A total of 51 non-native or exotic species were documented at SARU (Taggart, 2010); however, none of these were observed in or appeared to be invading golden sedge habitats or savanna communities in general. Encroachment by native woody vegetation was the primary concern. Prescribed burning, mechanical removal of undesirable species, and other proposed restoration measures will ensure that exotic species will not be a problem. *Acer rubrum var. triloblum, Liquidambar styraciflua, Ilex spp., Morella cerifera, Pinus taeda,* and other native woody species that cannot be eliminated from *C. lutea* habitats by burning will require additional control measures that include mechanical removal and application of an appropriate herbicide on stumps.

Monitoring

(protocol and discussion to be derived from North Carolina Botanical Garden portion of the grant; golden sedge monitoring form will be placed in Appendix C).

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IV. Appendices

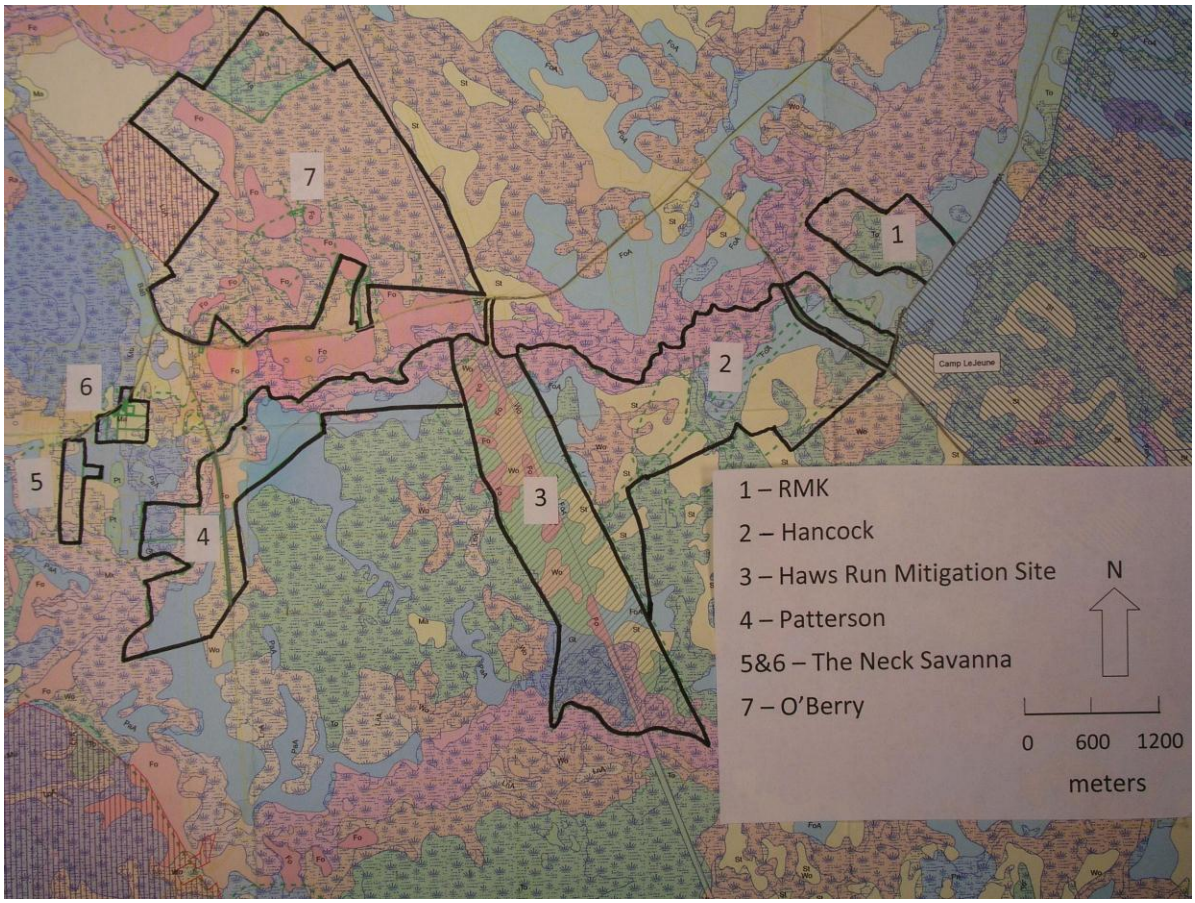
A. Soils Map of SARU (derived from Barnhill [1990, 1992] and prepared by The Nature Conservancy in North Carolina)

B. Photographs of selected habitats within present and future SARU tracts

C. Golden Sedge (*Carex lutea*) Monitoring Form (North Carolina Botanical Garden)

APPENDIX A

SARU Soils Map (derived from Barnhill 1990 and 1992) and prepared by The Nature Conservancy in North Carolina



Soil Series

Fo = Foreston (coarse-loamy, siliceous, thermic Aquic Paleudult)
Gt = Grifton (fine-loamy, siliceous, thermic Typic Ochraqualf)
Ln = Leon (sandy, siliceous, thermic Aeric Haplaquod)
Ma = Mandarin (sandy, siliceous, thermic Typic Haplohumod)
Mu = Muckalee (coarse-loamy, siliceous, acid, thermic Typic Fluvaquent)
Pa = Pactolus (thermic, coated Aquic Quartzipsamment)
St = Stallings (coarse-loamy, siliceous, semiactive, thermic Aeric Paleaquult)
To = Torhunta (coarse-loamy, siliceous, acid, thermic Typic Humaquept)
Wo = Woodington (coarse-loamy, siliceous, thermic Typic Paleaquult)

APPENDIX B

Photographs of selected habitats within present and future SARU tracts

1a. Hancock Tract: (left photo) power line right-of-way looking NE from NC 50; (right photo) right-of-way and registry signs (N 34.63669˚ W077.61388˚) 27 July 2009 and 11 December 2009; (bottom photo) prescribed burn 19 February 2010

Photo credit: Brian Strong, NCDPR

1b. Hancock Tract: ditch off main entrance road, with golden sedge plants in fruit ca. 1.2 km. west of NC 50 gate (N 34.63184˚; W077.62489˚) 27 July 2009

2a. Haws Run Mitigation Site: east-west ditch 200 m. SW of entrance gate (N 34.61436˚; W077.63062˚) 24 September 2009

2b. Haws Run Mitigation Site: south savanna area (N 34.61409˚; W077.62953˚) 24 September 2009

3. The Neck Savanna: species discovery site; north-south plow line (N 34.63033°, W 77.67511°) 3 May 2011

4. Watkins Savanna: local depression along main entrance road within O'Berry Tract (N 34.64432˚; W077.66261˚) 29 December 2009

5. Example of harvested plantation area with longleaf pines: Hancock Tract south of NC 50 gate (N 34.63415˚; W077.61148˚) 11 December 2009

6. O’Berry Tract: example of extant pine plantation 0.7 km. northeast of NC 50 gate looking south (N 34.64499˚; W077.66132˚); 29 December 2009

APPENDIX C
Golden Sedge (*Carex lutea*) Monitoring Form (N.C. Botanical Garden)

(to be added)