Annual Program Report
2007-2008

Wildlife Diversity Program
Division of Wildlife Management
NC Wildlife Resources Commission

1751 Varsity Drive
Raleigh, NC 27606

CONTENTS

Annual Performance Report

State: North Carolina

Project Number: T - 9
Amendment Number: 1

Period Covered: July 1, 2007 – June 30, 2008

Grant Title: State Wildlife Grants T-9 (Planning)

Project Title: Sensitive Species Data Management

Objective:

Efficiently collect, manage, and catalog data on sensitive species across the state in form that is readily accessible and useable in planning processes and by field biologists on a daily basis.

A. Activity

This year, we have made progress on several long-term projects:

1. We completed development and deployment of data entry forms for GPS units to facilitate collection of Aquatics data and upload into the Aquatics Database. This will reduce data entry error and save time (data will not have to be collected in the field and copied into the database later).
2. We are building a comprehensive, spatially-explicit biological database to store all data collected by the Wildlife Diversity Program. Currently, biological data is collected and stored locally across the state in 14 separate databases. This will bring all biological data together in one location, allowing better data protection, more opportunities for analysis of data from different species/projects, and easier access to data from organizations outside of NCWRC. It will be developed in stages, converting one database at a time. We have been coordinating with the IT department to convert the Aquatics database first, with other databases to follow in the coming year.
3. We are developing a project-tracking database to catalog effort (hours spent and actions completed) towards goals outlined in the Wildlife Action Plan. Currently, we are vetting a prototype version of the database with biologists to ensure that all requirements are met.
4. We developed a near real-time map of listed aquatic non-game species. This map is linked to the server-based Aquatics database.
5. We provided technical support for currently deployed GPS/GIS hardware and software to field biologists in the Wildlife Diversity program.
6. We provided technical assistance using GIS/GPS technologies to Wildlife Diversity Program Biologists.

In addition, staff attended the Organization of Fish and Wildlife Information Managers (OFWIM) and GAP Conferences.

B. Target Dates for Achievement and Accomplishment

The project is on schedule and all accomplishments have been met within target date of achievement.

C. Significant Deviations

There were no significant deviations from either the schedule or planned activities of the project.

D. Remarks

None

E. Recommendations

In the coming year we are scheduled to accomplish the following:

- Complete conversion of the Aquatics Database to the comprehensive Biological Database format.
- Complete conversion of 3-4 other species-specific databases to the comprehensive Biological Database format.
- Complete and deploy the Project-Tracking Database
- Continue to provide technical support for GPS/GIS hardware and software to field biologists

F. Estimated Cost

$ 38,140

Prepared by: Scott Anderson, Lead GIS Biologist,
Division of Wildlife Management

Annual Performance Report

State: North Carolina **Project Number:** T - 9
Amendment Number: 1

Period Covered: July 1, 2007 – June 30, 2008

Grant Title: State Wildlife Grants T-9 (Planning)

Project Title: Surveys of Priority Amphibians and Reptiles in the Piedmont of North Carolina

Objective:

1. Compile information from various sources (state and federal government, Natural Heritage Program, private individuals) regarding the distribution and status of amphibians and reptiles in the Piedmont region.
2. Develop survey and inventory strategies for target amphibians and reptiles outlined in the Wildlife Action Plan.
3. Conduct inventories of target amphibian and reptiles on state game lands and other public and private lands in the Piedmont.

A. Activity

Over the past year, the Piedmont Herpetology Survey project continued several projects begun in 2007 and implemented several new projects and numerous site surveys to assess the status of amphibians and reptiles. Studies that were continued from 2007 include: 1) a study aimed at determining the distribution and status of target amphibian species in seeps and floodplain pools in the Triangle region and 2) surveys of amphibians and reptiles at the Pee Dee National Wildlife Refuge and Caswell Game Land. Other projects conducted during the past year included: 1) a survey of Gulf Coast spiny softshell turtles in the Yadkin-Pee Dee drainage; and 2) identification and surveys of ephemeral ponds on Sandhills Game Land. A study of eastern box turtle home range and habitat use on the Sandhills Game Land was also begun early in 2008. Additionally, this project collaborated with Duke University to complete a study on the effects of urbanization on amphibians and reptiles in the Sandhills region.

Triangle Region Amphibian Assessment

The objective of this project is to document and assess the status of amphibian and reptile populations, focused on salamanders, associated with seepage and ephemeral pool communities in the Triangle region of NC (Raleigh, Durham, and Chapel Hill areas). Capture data obtained during this study will be compared to local and landscape factors to determine how land use surrounding seepage and pool habitats affects amphibian and reptile diversity and relative abundance. This information should be useful for land planning in the region. In 2007, we set up coverboard sampling sites at 6 seepage communities and 8 ephemeral pool communities (Figure

1). All sites have been checked for animals monthly since October, 2007. Additionally, seining surveys were completed in the spring of 2008 to determine larval amphibian presence and abundance.

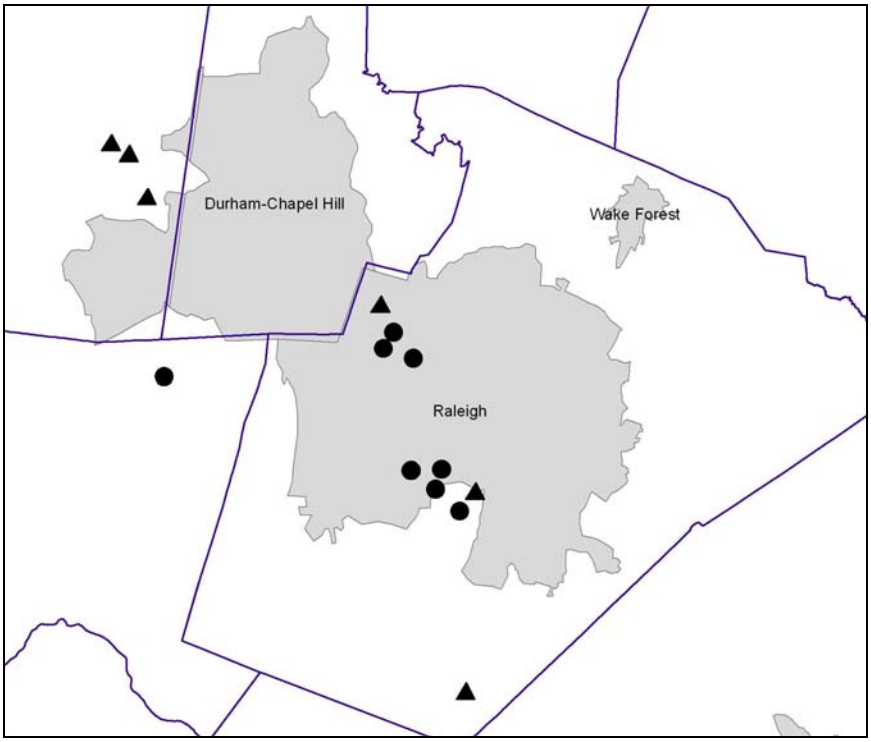

Fig 1. Locations of seepage (triangles) and ephemeral pool (circles) communities surveyed for amphibians and reptiles in the Triangle region of NC. The gray area represents urban boundaries, and the black lines are county boundaries.

Through June of 2008, 224 amphibians and reptiles were captured beneath coverboards at seepage and pool sites. A total of 21 species of amphibians and reptiles were documented, including 10 species of salamanders – nearly all of the salamander species likely to occur in these habitats. Five of the salamander species encountered were only encountered in seepages, illustrating the importance of these small and rare habitat features on the landscape. The study will continue for at least another year, but preliminary analyses suggest that there is a strong negative relationship between a pond's distance from the nearest paved road and the number of amphibian and reptile species the pond supports (Figure 2).

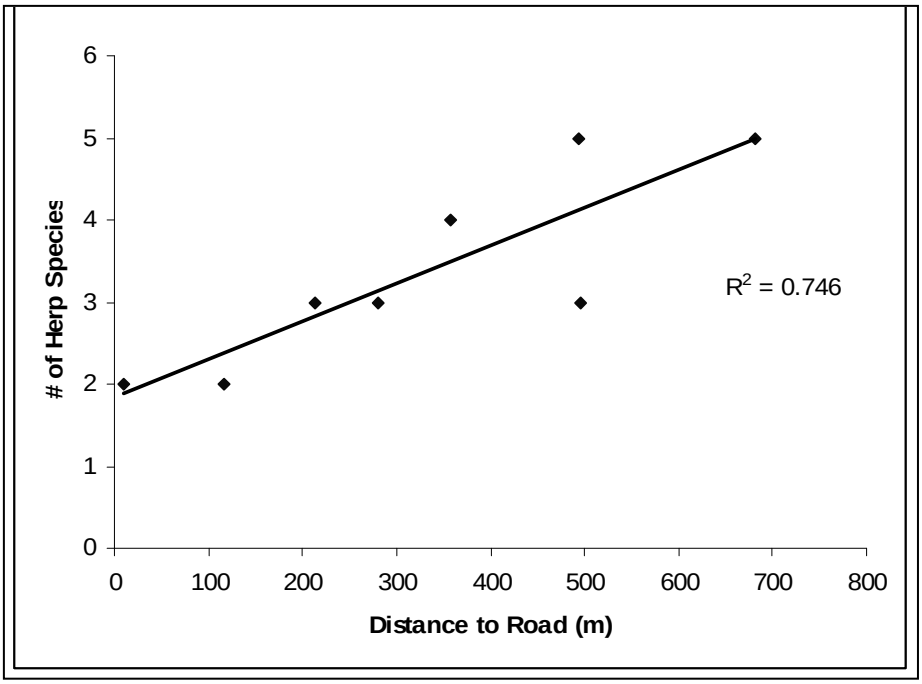

Fig 2. Amphibian and reptile species richness at ephemeral pools compared to distance to the nearest paved road.

Amphibian and Reptile Inventory of the Pee Dee National Wildlife Refuge

The 8,400 acre Pee Dee National Wildlife Refuge in Anson and Richmond Counties contains a variety of habitats important to amphibians and reptiles. Because of its location on the edge of the Piedmont and the influence of the Pee Dee River corridor, the refuge likely contains species usually restricted to the Coastal Plain. The refuge contains 3,000 acres of contiguous bottomland hardwood forest – the largest remaining bottomland hardwood tract remaining in the central Piedmont. A survey of the amphibians and reptiles of the refuge was suggested in the refuge's biological review (USFWS, 2006), but refuge staff time limitations has impeded such an effort. A survey of the refuge by WRC staff will provide information on amphibian and reptile distribution and status to refuge staff, providing information that can be used for sound habitat management.

Trapping arrays were set up in July 2007, and included wooden and metal coverboards and PVC pipes for treefrogs. All sites have been surveyed approximately monthly since October, 2007. Thus far, 98 individuals of 23 species of amphibians and reptiles have been captured during surveys (Table 1). Priority species captured thus far include ribbon snake, *Thamnophis sauritus*, eastern box turtle, *Terrapene carolina*, spotted salamander, *Ambystoma maculatum*, and marbled salamander, *Ambystoma opacum*. Surveys will continue for another year, but early results suggest that the Brown Creek floodplain supports a rich diversity of amphibians and reptiles, whereas uplands near fields are dominated by common snakes and lizards.

Table 1. Amphibians and reptiles captured during surveys of the Pee Dee National Wildlife Refuge, Anson and Richmond Counties, 2007-2008.

Common Name	**Scientific Name**	**Number Captured**
Frogs		
Northern Cricket Frog	*Acris crepitans*	5 (+ hundreds observed)
American Toad	*Bufo americanus*	1
Cope's Gray Treefrog	*Hyla chrysoscelis*	4
Green Treefrog	*Hyla cinerea*	16
Spring peeper	*Hyla crucifer*	1
Squirrel Treefrog	*Hyla squirella*	5
Salamanders		
Spotted Salamander	*Ambystoma maculatum*	3
Marbled Salamander	*Ambystoma opacum*	16
White-spotted Slimy Salamander	*Plethodon cylindraceus*	3
Snakes		
Southern Copperhead	*Agkistrodon contortrix*	4
Eastern Wormsnake	*Carphophis amoenus*	4
Black Racer	*Coluber constrictor*	11
Redbelly Watersnake	*Nerodia erythrogaster*	1
Brown Snake	*Storeria dekayi*	1
Red-bellied Snake	*Storeria occipitomaculata*	1
Ribbon Snake	*Thamnophis sauritus*	1
Lizards		
Carolina Anole	*Anolis carolinensis*	5
Little Brown Skink	*Scincella lateralis*	4
Turtles		
Painted Turtle	*Chrysemys picta*	3
Eastern Box Turtle	*Terrapene carolina*	2
Slider	*Trachemys scripta*	1 (+ many observed)
Species Observed but Not Captured		
River Cooter	*Pseudemys concinna*	numerous
Southeastern Five-lined Skink	*Eumeces inexpectatus*	several observed
Eastern Kingsnake	*Lampropeltis getula*	1 observed

Amphibian and Reptile Inventory of Caswell Game Land

An inventory of the amphibians and reptiles of Caswell Game Land, Caswell County, was initiated in 2005 and continued during FY 2007-08. Transects of wood and tin coverboards and PVC pipes were rearranged in early 2007 to better represent habitat types that occur on the property. Currently, there are 11 transects in various habitats including bottomlands, oak woodland, thinned oak woodland, and thinned pine woodlands– in part, to coincide with management activities associated with Cooperative Upland habitat Restoration and Enhancement (CURE) management activities. The northern Piedmont (NC counties bordering Virginia) has

been relatively neglected with regard to amphibian and reptile survey efforts compared to other parts of the state; thus, this survey is important in providing some insight into the distribution and relative abundance of species in this area.

During the past year, surveys have not resulted in any new Wildlife Action Plan target species discoveries at Caswell. Since the survey began, 31 amphibian and reptiles species have been documented on the Game Land, out of about 53 species likely to occur in the northern Piedmont. The most commonly encountered species included Cope's gray treefrog, *Hyla chrysoscelis* (142 captures), green frog, *Rana clamitans* (93 captures), marbled salamander, *Ambystoma opacum* (65 captures), and black racer, *Coluber constrictor* (36 captures). Wildlife Action Plan target species encountered on the Game Land include marbled salamanders, broadhead skinks, mole kingsnakes, white-spotted slimy salamanders (part of the "*P. glutinosus*" complex), and eastern box turtles. Some notable species that were not encountered during our surveys included corn snakes, eastern kingsnakes, slender glass lizards, and spotted salamanders. We will likely phase out the survey of Caswell Game Land over time, instead focusing on surveying specific sites using on-the-ground searches during peak times of amphibian and reptile activity to attempt to document some "missing" species and to delineate important habitat for Wildlife Action Plan target species. We are also analyzing our capture data with regard to how species are distributed among various habitat types. This information will help to guide land management on the property.

Gulf Coast Spiny Softshell Turtle Surveys

The Gulf Coast spiny softshell (*Apalone spinifera aspera*) is a turtle about which little is known in North Carolina. In North Carolina, the species apparently only occurs in the Yadkin-Pee Dee and Catawba drainages in the Piedmont. During 2007, 17 sites were surveyed along the Pee Dee River and several larger tributaries. Surveys involved scanning rivers from bridge crossings, spending at least 15 minutes at each site and using a pair of binoculars to view turtles. In addition, a canoe survey was conducted on the Pee Dee River from Blewett Falls to near the South Carolina border. Softshells appeared to be most abundant in the Pee Dee River from Blewett Falls dam to about 2 miles downstream. Softshells were also observed (2 individuals) in the Rocky River, Anson County, up to about 12 miles from its confluence with the Pee Dee. Another turtle was captured on the Uwharrie River, Montgomery County, approximately 3 miles from its confluence with the Pee Dee. Preliminary results suggest that softshells are mainly associated with the lower portion of the Pee Dee River and a limited distance upstream into several of the larger tributaries. However, trapping efforts in the future are needed to further delineate populations and to assess the status of this species. We are currently not sure of the status or distribution of softshells in the lakes created by hydro-electric dams along the Pee Dee. Softshells are also known to occur at several locations along the Catawba River drainage, including Lake Norman, and future efforts at trapping various sites would help to assess the turtle's status in that river system as well.

Sandhills Game Land Ephemeral Pond Research

Ephemeral ponds in the Sandhills region of North Carolina can be highly productive amphibian breeding sites and support rare species such as Carolina gopher frogs, *Rana capito*, and tiger salamanders, *Amybstoma tigrinum*. Natural ponds in the Sandhills were historically mainly open and grassy because of the influence of frequent fires burning through pond basins during dry years. However, most Sandhills ponds have grown hardwoods over the past several decades, probably because of a history in the 1970s and 1980s of fires being kept out of most of these habitats. Examination of aerial photographs of some ponds clearly shows increased canopy closure since the 1950s. Examples of open, grassy and hardwood-encroached ponds are shown in Figure 3. Research has shown that hardwood encroachment into naturally open ponds can reduce hydroperiods and lead to the decline of some amphibian species adapted to breeding in open ponds, including gopher frogs. We were interested in documenting all ponds on the Sandhills Game Land and assessing their status, both in the amount of hardwood encroachment and the species of amphibians still using these ponds. With this information, we will consider management options for each ephemeral pond with the final goal of increasing breeding site quality for rare amphibians, especially Carolina gopher frogs. Gopher frogs are only known to breed in 2 ponds on the Sandhills Game Land, so increasing available breeding habitat in the area will help to ensure that populations remain viable.

Figure 3. Open, grassy (left) and hardwood-encroached (right) ephemeral ponds on the Sandhills Game Land.

In 2007, the Piedmont biologist began inventorying all ephemeral ponds on the Sandhills Game Land by examining aerial photographs, conducting on the ground searches, and by asking Game Land and NC Museum of Natural Sciences personnel about ponds they have come across in the area. By the early part of 2008, we identified 12 natural ephemeral ponds on the Game Land, most of which are degraded because of previous lack of fire management and attempts to drain some ponds through ditching. Now that we have likely identified most of the natural ponds on the Game Land, we are conducting surveys to identify amphibian species breeding in each pond, using frog call and dipnet surveys. Initial frog call surveys revealed few priority species, while dipnet surveys documented breeding activity by tiger salamanders at 4 sites and a few gopher frog egg masses at one site. These surveys will continue through the spring of 2009. After evaluating the amphibian assemblage at each pond and each pond's hardwood encroachment status, we will consider management options that will increase breeding habitat quality.

Fire Ant Predation on Native Amphibians

At a newly discovered pond on the Sandhills Game Land, the Piedmont biologist documented the first record of Mabee's salamander, *Ambystoma mabeei*, on the Game Land. Unfortunately, this discovery was also coupled with the first documented case of predation by red-imported fire ants (a non-native species) on Mabee's salamanders, a State Wildlife Action plan priority species. Out of 26 juvenile salamanders found at the breeding site, 21 of them (81 %) were being attacked by, or had already been killed by, fire ants. We also documented fire ant predation on 4 juvenile eastern spadefoots, *Scaphiopus holbrookii*. Fire ants are known predators on a variety of reptiles and other wildlife (see Allen et al. 2004), but this is the first documentation of fire ant predation on Mabee's salamanders and eastern spadefoots. A scientific publication documenting fire ant predation will be submitted this year. We are currently considering approaches to assess the threat of fire ants on Sandhills region amphibians, as fire ant populations appear to have spread rapidly into amphibian breeding habitat on the Sandhills Game Land within the past few decades.

Surveys of Sandhills Game Land Aquatic Habitats

The Sandhills Game Land has been surveyed for amphibians and reptiles by numerous biologists for years. However, some aquatic habitats on the Game Land have received relatively little attention, especially small streams and impoundments. We deployed aquatic funnel traps to determine their effectiveness in capturing target amphibian and reptile species, especially targeting mud snakes, *Farancia abacura*, greater sirens, *Siren lacertina*, and rainbow snakes, *Farancia erytrogramma*. Traps were deployed at 7 sites throughout the Game Land and traps were checked at each site for 8-28 days. In total, we deployed traps for 3534 trap nights. Twelve species of amphibians and reptiles were captured, including 2 specimens of mud snakes and numerous carpenter frogs, *Rana virgatipes*, another target species in the Wildlife Action Plan (Table 2). We did not encounter either greater sirens or rainbow snakes at any sites. Our results indicate that funnel traps were useful at capturing frogs, newts, and several turtle species. However, either the species we were targeting are very rare on the Sandhills Game Land or funnel traps are not an adequate way of surveying for these species. We will continue to alter trap design in an attempt to adequately sample species such as mud and rainbow snakes.

Table 2. Results of aquatic funnel trapping in various habitats on the Sandhills Game Land during 2008. **Denotes target species in the Wildlife Action Plan.

Site	# Traps	# Nights	Species
Broad Acres Lake (Impoundment)	66	28	Slider – 5 Broken striped Newt – 5 Common Musk Turtle – 17 **Mudsnake – 1 Two-toed amphiuma – 1 Bullfrog – 1
Little Dismal (Ephemeral Pool)	25	14	Broken striped Newt – 14 Green Frog – 1 **Carpenter Frog – 10 Southern Leopard Frog – 2 Snapping Turtle – 1 Eastern Cottonmouth – 1
Drowning Creek (Large Stream)	14	14	Common Musk Turtle – 2 Snapping Turtle – 1 Green Frog – 1
Gum Swamp (Medium Creek)	20	14	Common Musk Turtle – 3 Green Frog – 1
Watson Drain (Small Perennial Stream)	20	19	Eastern Cottonmouth – 1 **Mudsnake – 1 Green Frog – 5 Southern Leopard Frog – 1 Lesser Siren – 1
Whiskey Drain (Small Perennial Stream)	20	16	Green Frog – 2
Whiskey Drain II (Small Perennial Stream)	20	8	Green Frog – 1

Box Turtle Habitat Use and Home Range

Eastern box turtles, *Terrapene carolina,* are a target species in the State Wildlife Action Plan, mainly because populations are thought to be declining, but also because we know little about their status and habitat needs in the state. Several studies throughout the box turtle's range have documented drastic declines in box turtle populations over several decades, because of habitat loss and fragmentation, road mortality, loss of eggs and juveniles by subsidized predators, and collection for the pet trade. In 2007, a group from various agencies and institutions throughout North Carolina, The Box Turtle Collaborative, organized to examine the status of box turtles in the state. This group is taking a multi-faceted approach to box turtle conservation in the state, including education and outreach, distribution surveys, population studies, and research on habitat use and movements of turtles in various regions. The Sandhills region is an area where box turtles have not been studied to any extent. Therefore, we recently set out to examine habitat use and home range of box turtles on Sandhills Game Land using radiotelemetry. The objectives of the study are to:

1) Determine home range of box turtles on Sandhills Game Land and compare data to other regions of the state and country – it is hypothesized that home

range of turtles will be larger in the Sandhills because of the relatively dry, sandy environment and patchiness of food resources;
2) Determine habitats that are most used by box turtles compared to the availability of those habitats on the landscape (e.g., small fields, woody and open drains, upland longleaf);
3) Determine microhabitat features that are important for various aspects of the life history of box turtles (e.g., stumps, coarse woody debris, nesting, and overwintering habitat).

Our goal is to radiotrack up to 10 box turtles (5 females, 5 males) for 1 year on Sandhills Game Land. At each telemetered location, we are recording numerous variables related to micro- and macro-habitat. Data from this study will be used to guide management of various habitats on the Game Land, but also to guide and inform land conservation and management activities in the greater Sandhills region. At the time of writing this report, 2 of 3 turtles that have been tracked for over a month have used areas of near 60 acres, much higher than the typical 2-10 acre home ranges reported in previous studies from other ecoregions.

Other Target Species

In addition to more focused projects outlined previously in this report, an effort has been made to document other target amphibians and reptiles at historic or previously unreported sites. The first step to this process has been to gather locality data for target species from various sources, including the NC Natural Heritage Program, NC Museum of Natural Sciences, through conversations and meetings with State Parks and USDA Forest Service biologists, and by contacting amateur herpetologists with knowledge of animal locations.

A number of records for target species have been obtained by the Piedmont biologist through roadcruising and visual surveys. Other records have come from amateur herpetologists who shared their information with the biologist. A list of target species discovered this year is presented in Table 3. A database for species observed and/or captured in the Piedmont is currently being maintained.

Research on impacts of development on priority reptiles in the Sandhills

WRC contracted with Duke University to conduct a study on the impacts of development and other landscape-scale factors on populations of priority snakes, other amphibians and reptiles, and their predators. A summary of this work is attached in Appendix A.

Other Activities

We are continuing to develop partnerships with numerous organizations, both public and private, to conserve amphibian and reptiles in the Piedmont. The Piedmont biologist attended 3 meetings that focused on the conservation of wildlife, and presented a talk at the SE PARC meeting. Other activities included taking part in several working group meetings, including NCPARC working groups and a Box Turtle working group organized at UNC-Greensboro. Site visits and meetings also occurred between the biologist and various Piedmont stakeholders, including US Fish and

Wildlife Service, Uwharrie National Forest, North Carolina Zoo, Duke Forest, NC State Parks, NC Museum of Natural Sciences, and private landowners.

Table 3. List of species identified as targets in the Wildlife Action Plan that were encountered during FY 2008 in the North Carolina Piedmont during general surveys.

TARGET SPECIES OBSERVED	COMMON NAME	SITE(S) AND COUNTY
Terrapene carolina	Eastern Box Turtle	Jordan Lake Game Land (Chatham); Duke Forest (Orange); Umstead State Park (Wake); Sandhills Game Land (Scotland/Richmond); Rockingham (Richmond); Diggs Tract (Richmond); Chapel Hill (Orange)
Ambystoma mabeei	Mabee's Salamander	Sandhills Game Land (Scotland)
Elaphe guttata	Corn Snake	Sandhills Game Land (Scotland); Troy (Montgomery)
Ambystoma talpoideum	Mole salamander	HWY 52 (Stanly)
Crotalus horridus	Timber Rattlesnake	Diggs Tract (Richmond)
Lampropeltis getula	Eastern Kingsnake	Ball Mountain (Davidson)
Eumeces laticeps	Broadhead Skink	Badin Dam (Montgomery); Sandhills Game Land (Scotland)

B. Target Dates for Achievement and Accomplishment

The Triangle amphibian and reptile status assessment project and a survey of the Pee Dee National Wildlife Refuge will continue through 2009. We will complete data analysis in late 2009 or early 2010 and expect to publish these results in scientific outlets. The study on habitat use and home range of box turtles will continue for 1 year, ending late in 2009. We will also continue to examine the status of Sandhills ephemeral ponds for at least 1 more year and will consider habitat management options as we analyze trends in the use of ponds by various amphibian species.

Finally, the Piedmont biologist will continue to conduct surveys for target amphibians and reptiles at historic sites and suitable habitat throughout the Piedmont. Some species where major data gaps exist concerning their distribution include Gulf Coast spiny softshells, northern gray treefrogs, pygmy rattlesnakes, and several of the large-bodied snakes. Recruitment of volunteers and collaboration among researchers will help to fill in these data gaps.

C. Significant Deviations

None

D. Remarks

None.

E. Recommendations

This project should continue as planned in order to meet long-term project objectives.

Wildlife Resources Commission biologists should continue collaborating with other agencies, academic researchers, volunteers, and the general public in conducting surveys, research, and land management activities. This would not only provide better data to our biologists, but also help to avoid overlap in survey and research activities.

F. Estimated Cost

$ 95,251 (including in-kind contributions)

G. References

Allen, C.R., D.M. Epperson, and A.S. Garmestani. 2004. Red imported fire ants effects on wildlife: A decade of research. American Midland Naturalist. 152(1): 88-103.

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Prepared by: Jeff Humphries
Piedmont Wildlife Diversity Biologist
NC Wildlife Resources Commission

Appendix A: Duke University work supported by the NC Wildlife Resources Commission

Executive Summary:

Wildlife encounter rates along gradients of urbanization in the North Carolina Sandhills

Ron Sutherland
Ph.D. Student, Duke University
rws10@duke.edu

and co-authors/field assistants:
Whit Baker
Phil Dunning

Final report in partial fulfillment of the

COOPERATIVE AGREEMENT

Between the

NORTH CAROLINA WILDLIFE RESOURCES COMMISSION

and

DUKE UNIVERSITY, DURHAM, NORTH CAROLINA

June 26, 2008

Executive Summary

Rapid urbanization threatens the survival of native wildlife species worldwide. In order to fully grasp the implications of the ongoing growth of urban areas on biodiversity, conservationists need to be able to quantify the response patterns of a wide range of different species to the intensification of urban land use. In this study, we set up two road-based transects across full gradients of urbanization and habitat loss in the diverse longleaf pine forests of the Sandhills region of North Carolina, USA.

With funding provided by the NC Wildlife Resources Commission, we drove the transects repeatedly at night in the field seasons of 2006-2007, tallying all vertebrate animals encountered (live or dead). The first transect (driven in 2006 and 2007; 76km long) ran from the urban areas of Southern Pines and Pinehurst down to the remote and relatively pristine habitats associated with the state-owned Sandhills Gamelands. The second transect (driven only in 2007; 91km long) began at the terminus of the first transect in the Gamelands, and then stretched down to the urban zones of Hamlet and Rockingham. A total of 3920 vertebrate animals were observed on or near the road routes after driving a total of 16,037 km. We also plotted the locations of 632 nightjars (ground-nesting nocturnal birds; e.g. whip-poor-wills) that we heard while driving the transects in both years. In addition, in 2007 we surveyed for the nightjars and for quail (a high-priority game species that also nests on the ground) using 75 point count locations distributed along the first road route.

Regression tree analysis (a robust, nonparametric technique with minimal assumptions) was used to statistically interpret the data from the road surveys and bird point counts. The regression trees modeled the animal observation rates for a given 1km road segment or point count as a function of seven habitat variables measured within corresponding 1km buffer zones for each segment. We also modeled snake and bird encounter rates as a function of mesopredator mammal observations.

Our results reveal that snake, amphibian, nightjar, deer, rabbit, and quail observation rates are negatively associated with increasing levels of traffic and impervious surface. Conversely, mesopredator mammals (and domestic cats in particular) responded slightly positively to increasing urbanization, and negatively to protected area coverage. Both ground-nesting birds and snakes showed signs of negative correlations with mesopredator encounter rates, although these trends were not always significant due to high variability in the mesopredator data.

Future studies will be needed to confirm the logical assumption that animal encounter rates measured via roadcruising provide a reasonably accurate estimation of the relative abundance of the different animal groups. If our results do reflect actual animal abundance trends along the gradients of urbanization we sampled, then it seems clear that many native vertebrates in the Sandhills will continue to rapidly retreat from the onslaught of urban development.

To help prevent this future scenario of diminishing wildlife abundance in the remaining fragments of the once magnificent longleaf pine forests of the southeastern USA, we recommend the adoption of aggressive new strategies for blocking the spread of urbanization into our most pristine rural environments. In particular, we detail three creative options for enhanced wildlife habitat conservation that would be particularly effective at maintaining large, cohesive tracts of forest ecosystems in North Carolina.

Note: a group of 6 key figures is included at the end of this abbreviated executive summary file, along with an overview map of the study area and road routes used in 2006-2007

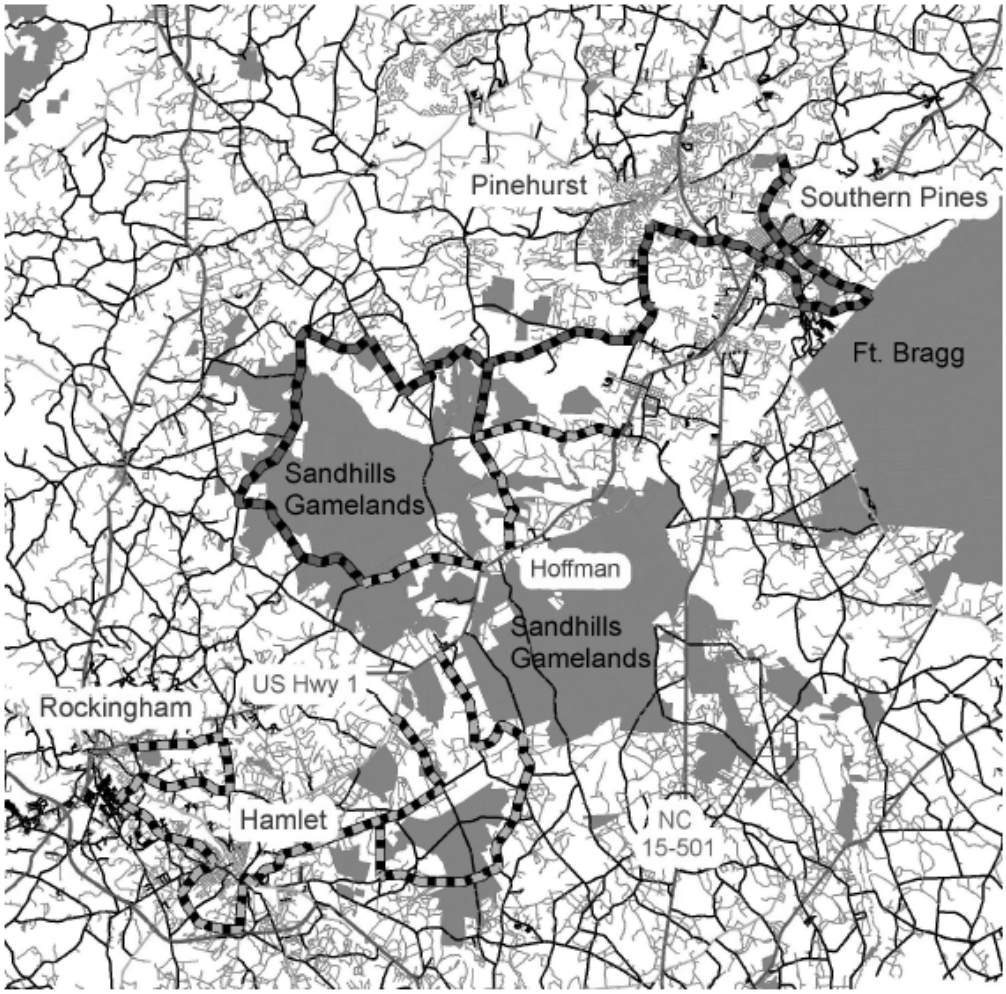
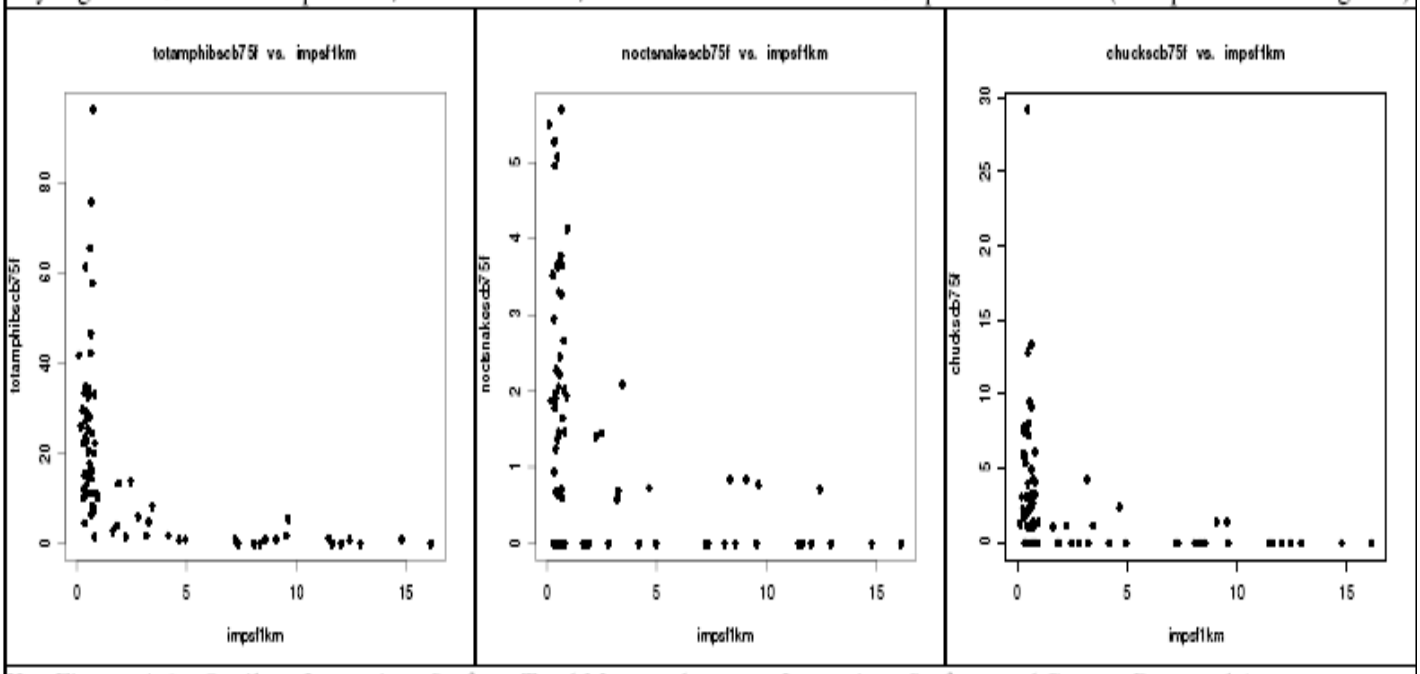
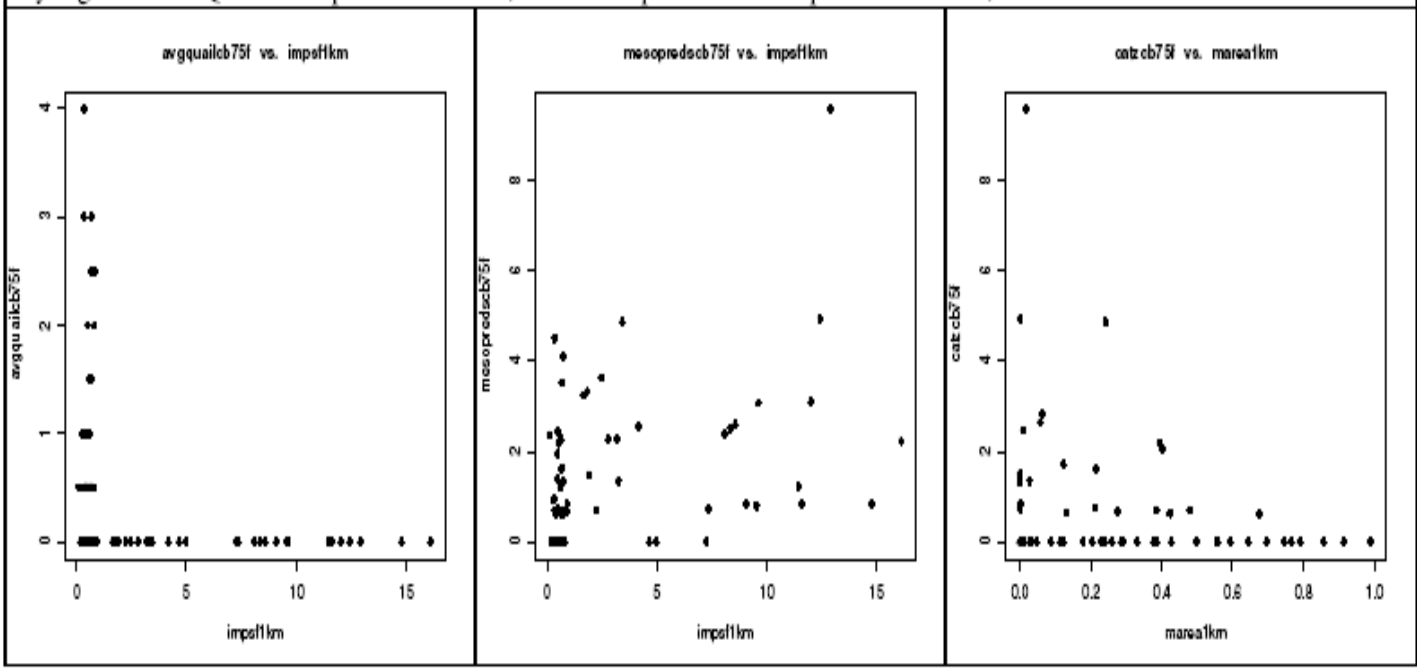


Figure 1. Overview Map showing the location of the road transects we drove in the Sandhills. The blue dashed route was driven in 2006 and 2007, the orange dashed route was only driven in 2007. Protected areas are shown as green polygons, and the names of the relevant urban areas are indicated in red text.

Key Figures 1-3: Total amphibians, nocturnal snakes, and chuck-will's-widows vs. Impervious Surface (each pt = one road segment)



Key Figures 4-6: Quail vs. Impervious Surface, Total Mesopredators vs. Impervious Surface, and Cats vs. Protected Area



Appendix B.

Final Report

Ecology, Conservation, and Management of a Bog Turtle Population in the Western Piedmont of North Carolina

Shannon E. Pittman and Michael E. Dorcas

Herpetology Laboratory
Department of Biology
Davidson College

DAVIDSON

Davidson Herpetology

Purpose

This report details the efforts and results of field activities conducted from 1 April to 15 December 2007 to study the ecology of a population of bog turtles (*Glyptemys muhlenbergii*) at a meadow bog in the Piedmont of North Carolina.

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Cover Photograph

Bog Turtle (*Glyptemys muhlenbergii*) photographed by Michael E. Dorcas

For additional information, please contact:

Shannon Pittman Department of
Biology Davidson College
Davidson, NC 28035-7118 334-
477-6624
shpittman@davidson.edu

or

Michael E. Dorcas, Ph.D. Associate Professor of Biology Department of Biology Davidson College Davidson, NC 28035-7118 704-894-2727 704-894-2512 FAX
midorcas@davidson.edu
http://www.bio.davidson.edu/dorcas

Ecology, Conservation, and Management of a Bog Turtle Population in the Western Piedmont of North Carolina

By: Shannon E. Pittman and Michael E. Dorcas
21 December 2007

Herpetology Laboratory
Department of Biology
Davidson College

EXECUTIVE SUMMARY

This report describes an in-depth ecological study of a bog turtle (*Glyptemys muhlenbergii*) population in the Piedmont of North Carolina. Included in this report are results from surveys conducted between 2 April 2007 and 4 August 2007, radiotelemetry conducted between 5 May 2007 and 15 December 2007, and analyses of historical population data. We captured a total of 13 bog turtles (5 males, 7 females, and 1 juvenile) and found the shell of one dead, marked turtle. We are currently continuing to radiotrack 9 turtles: 3 males and 6 females. Probing and visually searching appeared to be more effective sampling techniques than trapping. However, trapping typically yielded more turtles per hour of effort. We found that although turtles moved frequently within the bog, only 1 of 11 turtles has traveled a considerable distance through upland, forested landscape away from the bog. Analysis of historical data suggested a 7% annual decline in adult population size through time. We conclude that intensive habitat management and continued monitoring of the bog turtle population at Friday Bog is essential for ensuring the survival of this population.

OBJECTIVES

The objectives of this project were to 1) examine the activity patterns, movements, and habitat use of bog turtles, 2) use historical data to model the population dynamics of these bog turtles from 1992 to the present, 3) examine the effects of season on activity and detectability of bog turtles, and 4) develop baseline data to be used in future studies examining the effectiveness of habitat restoration at Friday Bog.

DESCRIPTION AND METHODS

Fieldwork performed at Friday Bog included probing, trapping, and radiotracking bog turtles. Concurrent probing and trapping enabled us to determine the most effective method of monitoring these turtles and how this was affected by season and turtle activity. Time spent trapping and probing per month is shown in Table 1. Twenty-four traps were placed throughout the bog during each trapping session and were checked daily.

We radiotracked 11 turtles (5 males and 6 females) 3 times per week and recorded macrohabitat and microhabitat variables and GPS coordinates at each turtle relocation from April through July. Radiotransmitters and temperature dataloggers (Ibutton thermochrons) were placed on turtles at first capture following 1 May using marine grade epoxy. Thermochron Ibuttons record and store temperature data at 30 minute intervals. These data will allow us to determine surface activity times and will enable us to better understand the thermal biology of these turtles. Other temperature dataloggers were placed in deep and shallow mud and on the surface for comparisons of mud and basking temperatures. Because the temperature dataloggers currently remain on the carapaces of the turtles, these data are not presented in this report. In July, one of our male, radiotracked turtles dispersed from the bog and died. In August, we lost one male turtle as a result of apparent radiotransmitter failure. Therefore, from August through December we radiotracked 9 turtles (3 males and 6 females). Table 2 provides details of radiotransmitter attachment for each turtle.

For every turtle captured, we determined minimum and maximum carapace and plastron lengths, shell depth, nuchal length, mass, approximate age, and sex. We continued the marking system implemented at Friday Bog by Project Bog Turtle researchers Dennis Herman and Jim Green. On 30 May 2007, 4 female turtles were removed from the bog and x-rayed at a veterinarian's office to determine whether these turtles were gravid. The turtles were returned to the bog later the same day.

We also compiled historical data on bog turtles at Friday Bog collected by Jim Green and other members of Project Bog Turtle to examine how population size and survivorship may have changed throughout time. Because this site has undergone natural succession since the initiation of the study in 1992, we predicted that the bog turtle population at Friday Bog declined as the site became less suitable.

We applied the Pradel (Pradel 1996) and Jolly-Seber (Jolly, 1965; Seber, 1965) models in program MARK 3.1 (White and Burhham, 1999) to annual recapture data from the 15-year period (1992-2007) to estimate adult population growth, recruitment, survivorship, and turtle abundance at Friday Bog and to investigate temporal variation in these rates. We tested for goodness of fit of the models using the bootstrapping test, and we found that the data was not

overdispersed. We used the quasi-likelihood adjusted Akaike's Information Criterion, adjusted for small sample size (QAICc), for model comparison, and for determination of the most parsimonious model for the dataset. Model comparison was based on differences in QAICc values (Δ QAICc). We used QAICc weight as a measure of relative support for each model.

RESULTS AND DISCUSSION

We captured a total of 13 individual turtles (5 males, 7 females, and 1 juvenile), 2 of which were not previously marked. We also found the shell of one dead male turtle. Table 2 provides a summary of the capture history of each of these turtles. Most of the turtles captured were older turtles (over 30 years old), and only one turtle under the age of 8 was found. On July 27, we found 1, 3-year old turtle in a hummock of grass in the middle of the bog. This turtle was processed and was marked number 6.2. Ten of the 14 turtles (including the shell) were initially captured over 10 years ago.

Detection

Traps have overall been less effective than probing, because we captured more turtles by probing than by trapping. Of the 13 turtles captured, only one was initially captured in a trap. However, 8 of the 13 were captured in a trap at least once throughout the study after their initial capture. Our data thus far suggest that probing/searching is a better method for capturing individual turtles than trapping. However, we captured more turtles per hour of effort in May, June, and July/August than we did probing (Figures 1 and 2) suggesting that trapping may be effective during periods of high activity for turtles (May or June).

Radiotelemetry

Radiotracking of turtles showed that the majority of turtles resided in the bog almost exclusively, and that certain parts of the bog were more highly frequented than others. For example, two large piles of debris and dead branches at the south end of the bog were used extensively by nearly all turtles. Turtles also readily entered an outlet that drains the bog into the stream. Three turtles moved distances greater than 10 meters away from the bog. A female (1.1) moved approximately 20 meters away from the bog in a stream and returned. A male (1.6) moved to an adjacent bog (i.e., the "annex") approximately 60 meters south of the main bog and resided there for 1.5 weeks until 26 June, when it moved back into Friday Bog. Another male (2.4) traveled extensively through upland forested habitat approximately 500 meters northeast of the bog and into a semi-residential area. This turtle crossed a railroad and at least two open fields before reaching its final location on June 18. After 18June 2007, the turtle traveled back in the direction of the bog but was apparently unable to cross the railroad track a second time and was found dead on 21 June 2007. We found the maximum distance moved per day of turtles that remained in the bog was 11.0 m, and the minimum was 4.2 m during the spring and summer (Figure 3).

With the onset of winter, all turtles left the bog to reside in the stream on the southern side of the bog by late October. One turtle (1.6) moved from the stream back to the bog on November 10 and remained in the same hole as of December 15. Turtle activity decreased substantially during the winter. Turtles chose overwintering sites either underneath the bank of the stream or under leaf litter adjacent to the stream (Figure 3).

Historical and Current Demography

A total of 57 turtles (20 males, 28 females, and 9 juveniles) was captured at Friday Bog between the years 1992 and 2007. Figure 4 shows the number of turtles captured each year and the number in each age group. Sampling effort during the year 1994 correlated most strongly with sampling in 2007. Table 3 gives an estimation of the number of sampling trips each year between 1992 and 2006. Thirty-one turtles were captured in 1994, while only 13 turtles were captured in 2007.

Comparisons of past and current population demography did not reveal any strong differences in ratios of males to females. We determined that 3 out of 5 females were gravid in May 2007. In 2007, we found proportionally fewer juvenile turtles than expected compared to juvenile ratios in the early 1990s. We also found fewer unmarked turtles than we expected. However, as a result of the long life span and sedentary tendencies of bog turtles, the lack of unmarked turtles may not be directly indicative of population decline.

Population Growth

For population growth analysis, we used constant adult survivorship, time-specific recapture, and constant population growth, as this was the most parsimonious model as determined by QAICc. Adult survivorship was estimated to be 0.896 (SE = 0.22, 95% confidence interval: 0.845-0.932) and population growth 0.935 (SE = 0.02, 95% confidence interval: 0.894-0.977). Recapture probabilities varied temporally. We used the same model of constant adult survivorship and population growth in the Jolly-Seber model and found an initial population size of 46 (SE = 3.72) turtles. Jolly-Seber models predicted the current adult population at Friday Bog to be 17 turtles.

Because this population has been steadily decreasing by approximately 7% per year since 1992 and adult survivorship is relatively high, it is likely that this decline is a result of low juvenile recruitment. Several factors could be contributing to this low level of recruitment: 1) female turtles are not laying eggs, 2) the nests are not viable, or 3) juveniles are not surviving to adulthood. We did not locate any nests during the sampling period in 2007. Because bog turtles nest within the bog, nests require high quality bog habitat. The changing vegetation and hydrology of the bog between 1992 and 2006 may have contributed to the low juvenile recruitment by providing low quality habitat for turtle nests.

Recommendations

Extensive habitat management at Friday Bog may increase the size of this population by improving habitat quality for nests and hatchling turtles. However, long-term population viability at Friday Bog remains uncertain due to isolation and adjacent habitat fragmentation. Life history characteristics of bog turtles require high adult survivorship and relatively high nest survival. Without immigration into the bog during periods of favorable environmental conditions combined with the inevitable loss of turtles due to dispersal, the population viability of bog turtles at Friday Bog will remain uncertain. We recommend continued management of bog habitat, especially by maintaining hydrological conditions favorable to bog turtles and control of wood vegetation. We also strongly recommend continued monitoring of this population in order to determine the effects of the habitat management on this bog turtle population over time.

ACKNOWLEDGEMENTS

For their assistance in the field, we thank: Jeff Beane, Jessika Dorcas, Taylor Dorcas, Zachary Dorcas, Grant Connette, Jim Green, Allison Hamilton, Leigh Anne Harden, Amy Jendrek, Carolyn Kiss, Andrew Martens, Austin Mercadante, Donald Pittman, Steven Price, Thomas Thorp, and Sharon Wilson. For their advice about data analyses, we thank J.D. Willson and Brian Todd. We also thank Jim Green for his assistance in the field, expert advice, and help acquiring historical data. We thank Dennis Herman for detailed datasheets, advice, and support of the project. Thanks to Lori Williams for field equipment, advice, and support. Also, thanks to Ann Somers for her advice, support, and help acquiring historical data. We thank Dr. John Schaaf for allowing us to use his xray facility. For financial support, we thank the North Carolina Wildlife Resource Commission, The Catawba Lands Conservancy (Sharon Wilson), The US Fish and Wildlife Service (Lauren Fogo), the National Science Foundation, and the Department of Biology at Davidson College.

Tables

Table 1. Hours of sampling per month.

Month	Person Hours Probing	Trap*Days
April	14.5	75
May	36	240
June	24.5	240
July/August	27	240

Table 2. Capture history of each turtle captured in 2007.

Turtle ID Number	Initial Capture Date 2007	First Historical Capture	Age	Sex	Number of Times Captured Before 2007	Date of Radiotransmitter Attachment	Notes
0.7	05/26/2007	06/14/1992	35+	Male	7	Not radiotracked	DEAD – shell only
1.1	05/26/2007	09/14/1992	35+	Female	9	05/26/2007	Gravid
1.2	04/04/2007	09/14/1992	35+	Male	5	05/08/2007	
1.6	05/12/2007	05/07/1993	24+	Male	5	05/12/2007	Left Bog
2.2	05/10/2007	06/25/1993	34+	Female	8	05/10/2007	Gravid
2.4	06/08/2007	06/29/1993	18+	Male	9	06/08/2007	Travelled 5 00 meters, died
2.8	04/05/2007	04/13/1994	26+	Male	7	05/12/2007	
3.6	06/19/2007	06/10/1994	18	Female	1	06/19/2007	
3.9	05/03/2007	06/14/1994	33+	Male	7	05/03/2007	
4.2	04/02/2007	04/28/1995	15	Female	2	05/04/2007	
5.3	05/06/2007	04/23/2004	12+	Female	2	05/06/2007	
5.7	05/10/2007	04/22/2006	12	Female	1	05/10/2007	Gravid
6.1	04/04/2007	04/04/2007	8	Female	0	Not radiotracked – not captured after May 1st	New turtle
6.2	07/27/2007	07/24/2007	3	Unknown	0	Not radiotracked – too small	Youngest found

Table 3. Number of sampling trips per year. Each trip consisted of between 1 and 4 hours of active searching by 1 to 4 biologists. Note that amount of sampling effort varied considerably between years.

Year	Trips
1992	9
1993	27
1994	59
1995	20
1996	8
1997	5
1998	9
1999	3
2000	2
2001	6
2002	2
2003	3
2004	3
2005	5
2006	10
2007	~70

Figures

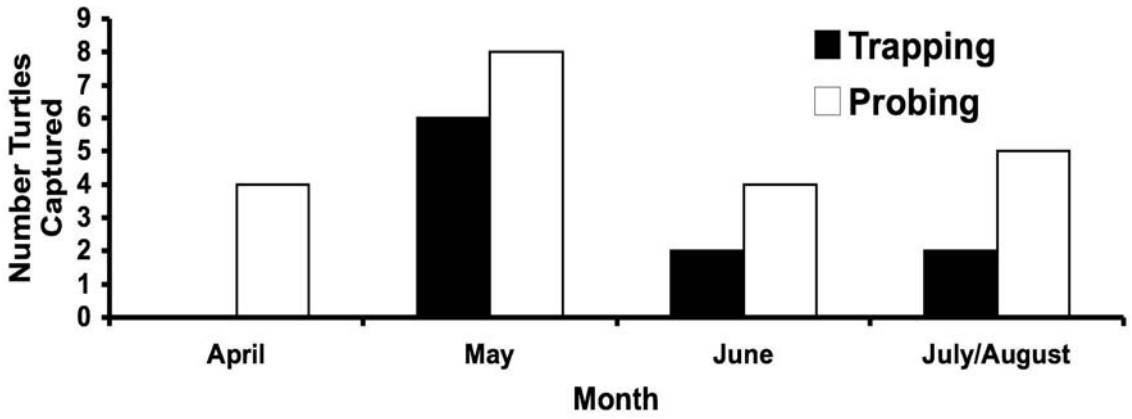

Figure 1. Number of turtles captured by trapping and probing. Note that more turtles were always captured by probing than by trapping.

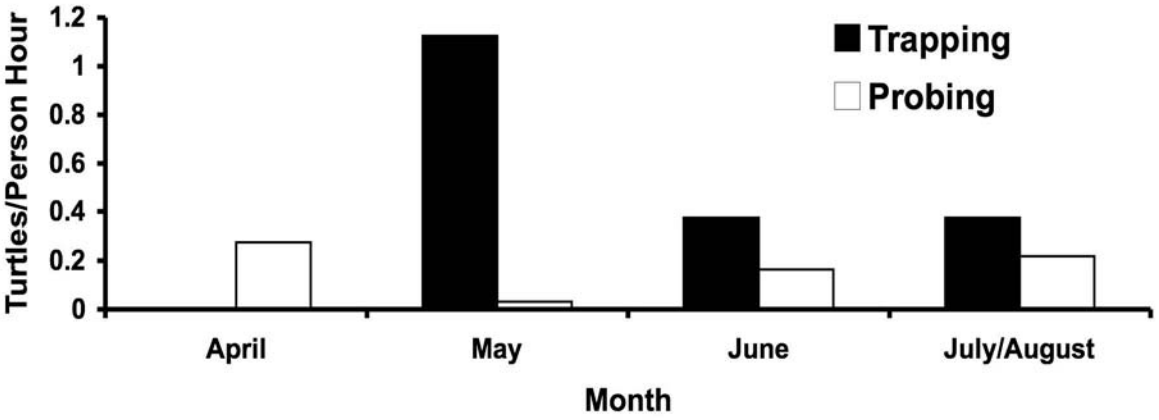

Figure 2. Number of turtles captured per hour of effort for trapping and probing. Included in these data is the time it took to set out traps and check them. Note that during the month of May, trapping was considerably more time effective than probing.

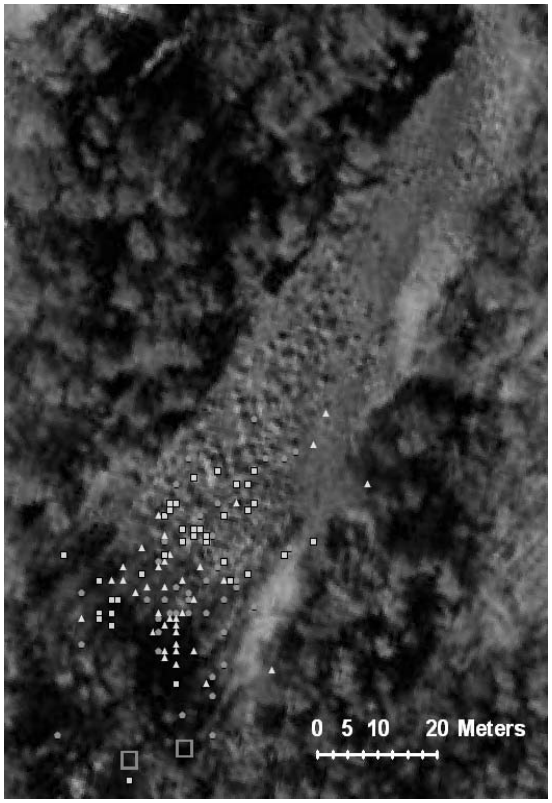

Figure 3. Relocations of 3 turtles throughout the spring and summer. Each color symbol represents one turtle. Most turtles exhibited movements comparable to the 3 turtles represented in this figure. The exception is 2.4, which dispersed from the bog and died. The open red squares indicate the approximate localities of overwintering sites highly frequented by 8 out of the 9 turtles.

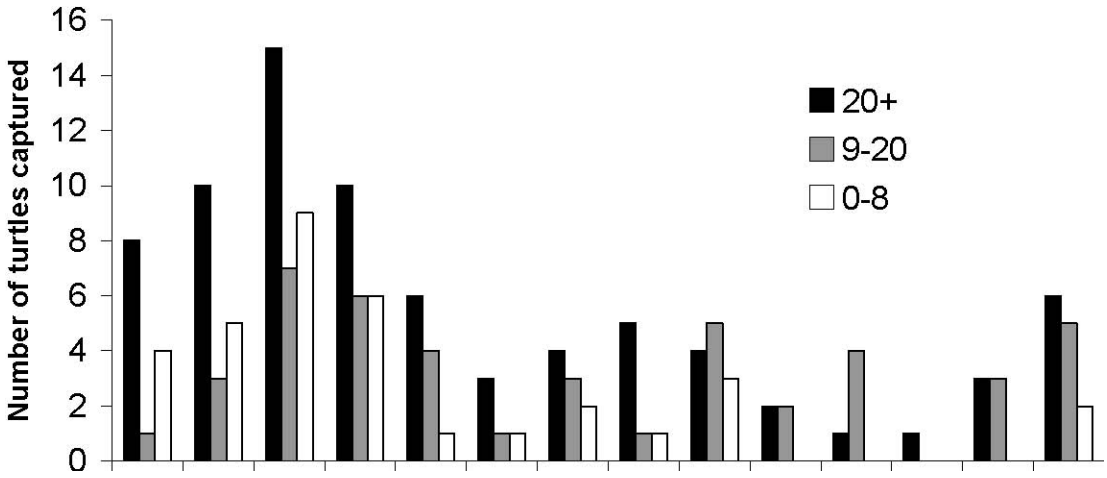

Figure 4. Number of individual turtles captured in each age group from 1992 to 2007. Note that years 2000 and 2002 were excluded due to the fact that no turtles were captured during these years.

Volunteer Hours

Volunteer	Total Hours
Jeff Bean	2 hours
Jessika Dorcas	2 hours 50 minutes
Michael Dorcas	23 hours 10 minutes
Taylor Dorcas	3 hours 45 minutes
Zachary Dorcas	1 hour 30 minutes
Grant Connette	6 hours 55 minutes
Jim Green	2 hours
Alexandra Greer	2 hours 30 minutes
Allison Hamilton	3 hours
Leigh Anne Harden	2 hours
Amy Jendrek	2 hours
Carolyn Kiss	1 hour 10 minutes
Andrew Martens	2 hours
Austin Mercadante	3 hours 30 minutes
Donald Pittman	3 hours
Shannon Pittman -not while funded	~80 hours
Steven Price	8 hours
Thomas Thorp	2 hours
Sharon Wilson	1 hour 30 minutes

Annual Performance Report

State: North Carolina **Project Number:** T - 9
Amendment Number: 1

Period Covered: July 1, 2007 – June 30, 2008

Grant Title: State Wildlife Grants T-9 (Planning)

Project Title: Survey of Priority Amphibians and Reptiles in the Coastal Plain of North Carolina

Objective:

1) To coordinate and carry out surveys of selected reptile and amphibian populations listed as priorities by the North Carolina Wildlife Action Plan in order to clarify their status and distribution.
2) To provide technical guidance to governmental agencies and private entities based on findings from baseline surveys and other research.

A. Activity

A biologist was hired on August 1, 2007 to focus on Coastal Plain herpetology inventory and monitoring. The main focus of this year's work has been to gather and update data on the distribution of amphibians and reptiles in the Coastal Plain region from various data sources and implement new survey and research projects throughout the region. The new biologist met with a large number of individuals and organizations throughout the state to develop partnerships and coordinate efforts to study amphibians and reptiles in the Coastal Plain.

Priority species for the Coastal Plain as described in the North Carolina Wildlife Action Plan include 23 amphibians and 38 reptiles (Table 1). The 23 amphibians include 14 salamanders and 9 frogs. The 38 reptiles include 23 snakes, 11 turtles, 3 lizards and the American alligator. Five of the 11 turtles are sea turtles and were not surveyed in this project. The NC Wildlife Resources Commission currently has a different program directed towards sea turtles and other staff were responsible for tracking those species.

Table 1. Priority Reptiles and Amphibians for the Coastal Plain of North Carolina. E – Endangered, T – Threatened, SC – Special Concern, SR – Significantly Rare.

Reptile	**State Status (Federal Status)**	**Reptile**	**State Status (Federal Status)**
Canebrake rattlesnake	SC	Common rainbow snake	
Pygmy rattlesnake	SC	Glossy crayfish snake	SR
Eastern diamond-backed rattlesnake	E	Black swamp snake	SR
Northern scarletsnake		Carolina watersnake	SC
Corn snake		Broad-headed skink	
Southern hog-nosed snake	SC	Eastern glass lizard	
Eastern hog-nosed snake		Mimic glass lizard	SC
Mole kingsnake		Eastern box turtle	
Eastern kingsnake		Spotted turtle	
Scarlet kingsnake		Gulf coast spiny softshell	
Outer banks kingsnake	SC	Eastern chicken turtle	SR
Eastern smooth earthsnake		Striped mud turtle	
Pine woods littersnake		Loggerhead sea turtle	T(T)
Eastern coachwhip	SR	Green sea turtle	T(T)
Northern pinesnake	SC	Atlantic hawksbill sea turtle	E(E)
Southern crowned snake		Kemp's ridley sea turtle	E(E)
Eastern coral snake	E	Diamond-backed terrapin	SC
Common ribbonsnake		Leatherback sea turtle	E(E)
Eastern mudsnake		American Alligator	T(T)
Amphibian	**State Status (Federal Status)**	**Amphibian**	**State Status (Federal Status)**
Southern dusky salamander		Greater siren	
Eastern tiger salamander	T	Eastern lesser siren	
Spotted salamander		Striped southern chorus frog	
Marbled salamander		Ornate chorus frog	SR
Four-toed salamander	SC	Brimley's chorus frog	
Northern slimy salamander		Barking treefrog	
Mabee's salamander	SR	Pine barrens treefrog	
Many-lined salamander		Carolina gopher frog	T
Three-lined salamander		River frog	SC
Dwarf salamander	SC	Eastern spadefoot	
Sandhills salamander		Oak toad	SR
Neuse River waterdog	SC		

Surveys

Survey sites in 2007 and 2008 included both public and private lands and waters. Game lands surveyed include Holly Shelter, Stones Creek, Suggs Mill Pond, Bladen Lakes State Forest, Croatan National Forest, Green Swamp, and Juniper Creek. Private lands surveyed included Resource Management Services, Inc. and Progress Energy Carolinas, Inc (Sutton Lake). Survey techniques implemented included artificial cover transects, aquatic funnel trapping, turtle trapping, dip-netting, frog call monitoring, road cruising, and general habitat searching. 56 species (16 amphibians and 40 reptiles) were observed this year, of which 21 were priority species (Table 2).

Artificial Cover Transects

Artificial coverboard transects were expanded from the previously established transects at Croatan National Forest in 2005 to game lands and private lands throughout the southeastern Coastal Plain. Coverboard material consists of old roofing tin which can withstand periodic prescribed fire. A total of 34 transects of 15 coverboards each are established on Croatan National Forest (7), Stones Creek (2), Holly Shelter (5), Sutton Lake (3), Bladen Lakes State Forest (9), and Suggs Mill Pond (8) for a total of 510 cover boards. Transects were deployed in upland habitats, particularly longleaf pine, and were checked at least once monthly. More frequent checks were conducted during the spring and fall when weather conditions were more conducive to their use by snakes. A total of one amphibian and 13 reptile species have been observed under coverboards (**priority species**); Southern toad (*Bufo terrestris*), Carolina anole (*Anolis carolinensis*), Southeastern five-lined skink (*Eumeces inexpectatus*), ground skink (*Scincella lateralis*), Eastern fence lizard (*Sceloporus undulatus*), six-lined racerunner (*Cnemidophorus sexlineatus*), black racer (*Coluber constrictor*), rat snake (*Elaphe alleghaniensis*), **corn snake (*Elaphe guttata*), Eastern kingsnake (*Lampropeltis getula getula*), mole kingsnake (*Lampropeltis calligaster rhombomaculata*), Southeastern crowned snake (*Tantilla coronata*), and Carolina pygmy rattlesnake (*Sistrurus miliarius*)**. Priority snake species were marked, sexed, measured, and weighed to gain detailed information on individuals and populations.

Aquatic Funnel Trapping

Aquatic funnel traps (modified Gee minnow and eel traps) were deployed in various lotic and lentic aquatic habitats for amphibians and aquatic snakes. Five amphibian and two reptile species were captured using this method; Southern cricket frog (*Acris gryllus*), green frog (*Rana clamitans*), **ornate chorus frog (*Pseudacris ornata*)**, **Carolina gopher frog (*Rana capito capito*)**, two-toed amphiuma (*Amphiuma means*), banded watersnake (*Nerodia fasciatus*), and cottonmouth (*Agkistrodon piscivorous*). Priority snake species were marked, sexed, measured, and weighed to gain detailed information on individuals and populations.

Table 2. Priority species encountered during 2008 in the NC Coastal Plain.

Priority Species	***Common Name***	***Site (County)***
Amphibians		
Bufo quercicus	Oak toad	Green Swamp (Brunswick), (Columbus)
Hyla gratiosa	Barking treefrog	Green Swamp; Juniper Creek (Brunswick)
Pseudacris ornata	Ornate chorus frog	Suggs Mill Pond (Bladen)
Rana capito capito	Carolina gopher frog	Holly Shelter (Pender)
Plethodon glutinosus	Slimy salamander	Croatan NF (Jones)
Reptiles		
Sistrurus miliarius miliarius	Carolina pygmy rattlesnake	Holly Shelter (Pender), Croatan NF (Carteret)
Cemophora coccinea	Northern scartletsnake	Sutton Lake (New Hanover)
Elaphe guttata	Corn snake	Holly Shelter (Pender), Juniper Creek (Brunswick), Croatan NF (Carteret), Bladen Lakes SF (Bladen), (Columbus)
Heterodon platirhinos	Eastern hognose snake	Suggs Mill Pond (Bladen)
Masticophis flagellum	Coachwhip	Bladen Lakes SF (Bladen), Suggs Mill Pond (Bladen)
Lampropeltis calligaster rhombomaculata	Mole kingsnake	Croatan NF (Carteret)
Lampropeltis getula getula	Eastern kingsnake	Holly Shelter (Pender), Croatan NF (Carteret), (Brunswick), (Martin), (Bladen)
Lampropeltis triangulum elapsoides	Scarlet kingsnake	Suggs Mill Pond (Bladen), Croatan NF (Carteret)
Tantilla coronata	Southeastern crowned snake	Bladen Lakes SF (Bladen), Sutton Lake (New Hanover)
Thamnophis sauritus	Common ribbonsnake	Holly Shelter (Pender)
Farancia abacura	Eastern mudsnake	(Pender), (Onslow)
Ophisaurus ventralis	Eastern glass lizard	Holly Shelter (Pender), Croatan NF (Carteret), Sutton Lake (New Hanover)
Terrapene carolina	Eastern box turtle	Croatan NF (Carteret)
Deirochelys reticularia	Eastern chicken turtle	Suggs Mill Pond (Bladen)
Kinosternon baurii	Striped mud turtle	Croatan NF (Carteret)
Alligator mississippiensis	American alligator	Juniper Creek (Columbus), Holly Shelter (Pender)

Turtle Trapping

Turtle trapping was conducted for a workshop at Croatan NF but generally was not initiated this year. Species trapped over two trap nights include yellow belly slider (*Trachemys scripta*), Eastern mud turtle (*Kinosternon subrubrum*), and **Striped mud turtle (*Kinosternon baurii*).**

Dip Netting

Dip netting was conducted opportunistically at various locations on game lands, particularly in breeding ponds. No priority species were sampled using this method.

Frog Call Monitoring

Frog calls provide an efficient way to document species occurrence and a statewide volunteer monitoring program, the Calling Amphibian Survey Program (CASP), following the North American Amphibian Monitoring Program (NAAMP) protocol was established in 2005. One route was run this year and two were ground-truthed. A summary of the CASP program will be included in the Partners for Amphibian and Reptile Conservation (PARC) SWG Project. In addition, road cruising at night on or after rains provided information on the distribution of three priority species; **oak toad (*Bufo quercicus*)**, **barking tree frog (*Hyla gratiosa*), and ornate chorus frog (*Pseudacris ornata*)**.

Road Cruising

In addition to the priority anuran species listed above, eight priority species were detected during road cruising surveys; **American alligator (*Alligator mississippiensis*), chicken turtle (*Deirochelys reticularia*), corn snake, Eastern mud snake (*Farancia abacura*), Eastern kingsnake, coachwhip (*Masticophis flagellum*), Eastern box turtle (*Terrapene carolina*), and Eastern ribbon snake (*Thamnophis sauritus*)**.

General Habitat Surveys

Turning natural cover and other visual encounter surveys yielded four priority species; **Southeastern crowned snake, Northern scarlet snake (*Cemophora coccinea*), scarlet kingsnake (*Lampropeltis triangulum elapsoides*), Carolina gopher frog, and slimy salamander (*Plethodon glutinosus*)**.

Technical Guidance

Coastal Wildlife Diversity staff coordinated with various groups across the state involved with reptile and amphibian research and monitoring including: NC Museum of Natural Sciences, Natural Heritage Program, NC State Parks, University of North Carolina at Wilmington, The Tortoise Reserve, and Department of Defense facility Camp Lejeune.

Staff provided information and materials on amphibians and reptiles to commercial foresters and assisted with the development of the Cape Fear Arch Conservation Plan. In addition, technical guidance was provided to the public through Reptile & Amphibian Day at the NC Museum of Natural Sciences.

B. Target Dates for Achievement and Accomplishment

The Coastal Wildlife Diversity Biologist will continue to conduct surveys for target amphibians and reptiles at historic sites and suitable habitat throughout the Coastal Plain over the next two years. Coverboard arrays will continue to be expanded and sampling these areas with other methods, especially drift fences, will be initiated. Recruitment of volunteers and collaboration among researchers will help to fill in data gaps.

C. Significant Deviations

None.

D. Remarks

None.

E. Recommendations

This project should be continued.

F. Estimated Cost

$50,628 (including in-kind contributions)

Prepared by:

Kendrick Weeks
Coastal Wildlife Diversity Biologist
Wildlife Diversity Program
Division of Wildlife Management
North Carolina Wildlife Resources Commission

Annual Performance Report

State: North Carolina **Project Number:** T - 9
Amendment Number: 1

Period Covered: July 1, 2007 – June 30, 2008

Grant Title: State Wildlife Grants T-9 (Planning)

Project Title: Urban Wildlife Management

Objective:

To follow the Urban Wildlife Management Strategies set forth by the NC Wildlife Action Plan for the protection of quality open space and provision of proactive technical guidance to local governments, developers, and private landowners in rapidly urbanizing areas of the state.

A. Activity

The 2007-2008 fiscal year was the Urban Wildlife Project's third year of working to minimize the impacts of rapid urbanization on wildlife populations and habitats. Over the past three years, the Urban Wildlife Project piloted several approaches to address the objectives outlined in the "Urban Wildlife Management" chapter in the NC Wildlife Action Plan. Through these pilot efforts, the Urban Wildlife Project has established a focused set of program goals and objectives that guided our work over the past fiscal year. The main goal of the Urban Wildlife Project is to help North Carolina's communities proactively conserve important species, habitats, and ecosystems alongside human population growth and development. Project objectives for the past year included:

1) To provide proactive technical guidance to local governments on how to design land use planning methods that will conserve important species and habitats alongside development.
2) To provide technical guidance to local governments on how to improve inventory, mapping, and management of priority species and habitats on parks and open space properties.
3) To participate in partnership efforts to achieve conservation of species and habitats in urbanizing areas.
4) To provide technical guidance to developers on how to create wildlife-friendly development projects.

Over the past year, the Urban Wildlife Biologist has been working toward these goals and objectives through the following project approaches.

1) Proactive Technical Guidance to Local Governments--The Urban Wildlife Project has continued to focus the bulk of its efforts on proactive technical guidance to local governments in

the rapidly urbanizing Triangle Region. During the 2007-2008 fiscal year, the Urban Wildlife Biologist provided technical guidance to local governments on:

- 17 development proposals in Wake, Chatham, and Orange counties
- Chatham Parks and Recreation Master Plan
- Wake County Parks and Recreation Master Plan
- Harris Drainage Basin Land Use Study
- 3 ordinance issues in Chatham County
- 3 ordinance issues in Wake County
- the Big Woods Park site plan in Chatham County
- the City of Raleigh's Comprehensive Plan
- 1 land acquisition project in Wake County

Short and long-term outcomes from these efforts are being documented. Long-term, on-the-ground outcomes often take years to become apparent. However, the following short-term outcomes have emerged:

- Comments on individual subdivision proposals in Wake County were taken into consideration by planning staff and included in staff notes. In at least one instance, the developer was directed to accommodate our request as much as possible.
- In Chatham County, comments on subdivision proposals are being used by the county's Environmental Review Board to request environmental assessments and generate recommendations for the Board of Commissioners.
- The Chatham County Board of Commissioners adopted 2 ordinance revisions that integrated comments from the Urban Wildlife Biologist.
- The Urban Wildlife Project's recommendations and GIS layers were integrated into the Harris Drainage Basin Land Use Study.
- The original design of the Big Woods Park site in Chatham County was revised to better protect sensitive wildlife resources by reducing the number of proposed ballfields and maintaining a rock outcrop and a wooded area adjacent to Game Lands in natural cover.
- Comments on the 600+ acre Proctor Farm land acquisition project in Wake County were used to support the county's purchase of this property for permanent open space.

2) Participation in conservation partnership efforts--The Urban Wildlife Biologist is continuing to participate in and support regional conservation partnership efforts. During the 2007-2008 reporting year, the Urban Biologist:

- Participated in meetings of the Chatham Conservation Partnership (CCP).
- Chaired the CCP map committee
- Participated in activities of the Wake Nature Preserves partnership
- Participated in the formation of the Johnston County Green Infrastructure partnership
- Participated in program committee for the 1st annual NC Urban Forestry conference

Outcomes from these partnership efforts include:

- Creation of a GIS database on Chatham County's FTP site that contains 100+ conservation data layers. This database provides a common source of conservation data for use in planning and conservation efforts in the county.

- Integration of the most relevant conservation data layers into Chatham County's online GIS system. This system now displays important conservation data layers, which are being used by county staff, its consultants, and other stakeholders in various land use planning efforts.
- Development of criteria to classify and manage parks and open spaces in Wake county containing Wildlife Action Plan priority habitats as nature preserves
- Work toward completing a comprehensive wildlife inventory and creation of a habitat management plan for 1,000 acres of protected open space along Marks Creek in eastern Wake County. The goal is for the "Marks Creek" project to serve as a pilot through which a process will be refined to inventory and develop habitat management plans for other parks and open spaces across Wake County.
- Development of a service learning infrastructure at NCSU to benefit the Wake Nature Preserves partnership efforts
- Inclusion of speakers on urban wildlife issues into the NC Urban Forestry conference program

3) Development of the Green Growth Toolbox (GGT)—One of the Urban Wildlife Project's primary projects during the past year has been finalizing development of the Green Growth Toolbox. The Green Growth Toolbox—which consists of a handbook, GIS dataset, website, and training workshop--is a technical assistance tool designed to help local governments plan for growth in a way that will minimize impacts on priority habitats and species. Development of this project began during the 06-07 fiscal year, and is scheduled to be released in September 2008. During the past year, the Urban Wildlife Project:

- Facilitated peer review of the GGT by over 30 stakeholders
- Revised the GGT based on feedback from reviewers
- Coordinated editing, layout, and graphic design with the WRC's publications staff
- Worked with the WRC's Information Technology department to develop a website
- Facilitated multiple meetings with relevant WRC staff to receive approval for this project and discuss implementation

We will begin documenting outcomes from this project when we enter the implementation phase during the 2008-2009 fiscal year.

4) Technical guidance to developers—While the Urban Wildlife Project's main focus has been on providing technical guidance to local governments, guidance has been provided to developers where requested. During the 07-08 fiscal year, the Urban Wildlife Biologist drafted comments for the new Preston Development project in Chatham County, and interacted numerous times with this developer's representative. In addition, she worked with Triangle Land Conservancy and other partners to develop a "conservation assessment" for the Southwest Shore of Jordan Lake. This "conservation assessment" will be presented to the developer and the community. In addition, the Urban Biologist engaged in 4 other interactions with developers or their consultants. The Urban Wildlife Project is contributing to the creation of a Wildlife Friendly Development certification program that will provide incentives and guidance to developers to minimize negative impacts on wildlife and priority habitats.

5) Outreach to other stakeholders—During the past year, the Urban Wildlife Project delivered 5 presentations to students at NCSU and two boards of commissioners meetings.

B. Target Dates for Achievement and Accomplishment

During the 2008-2008 FY, the Urban Wildlife Pilot Project will continue to build partnerships and provide an important link between conservation planning efforts and local land use planning processes. Target dates for accomplishments in 2008-2009 include:

- Fall 2008→Publicly "release" the Green Growth Toolbox and begin implementation
- Fall 2008→Initiate work group to develop conservation thresholds for groups of priority terrestrial species in the Wildlife Action Plan.
- Spring 2009→Draft document presenting conservation thresholds for terrestrial wildlife prepared.

C. Significant Deviations

None

D. Remarks

None

E. Recommendations

This project should be continued during the next period, July 1, 2008 – June 30, 2009. It is critical to incorporate biological data and conservation science into the local land use planning process today so patterns of conserving wildlife habitat are established that will benefit future generations. At this time, this project is leading the way in North Carolina to develop a proactive and effective approach to integrating conservation science and land use planning.

F. Estimated Cost

$ 67,664 (including in-kind contributions)

Prepared By:

Jacquelyn Wallace
Urban Wildlife Biologist
Wildlife Diversity Program, Division of Wildlife Management
NC Wildlife Resources Commission

Annual Performance Report

State: North Carolina

Project Number: T - 9
Amendment Number: 1

Period Covered: July 1, 2007 – June 30, 2008

Grant Title: State Wildlife Grants T-9 (Planning)

Project Title: Partners in Amphibian and Reptile Conservation

Objective:

Coordinate a North Carolina chapter of Partners in Amphibian and Reptile Conservation (NCPARC) to promote herpetological conservation and assist with planning herpetological conservation initiatives.

A. Activity

NCPARC holds an annual meeting and has three technical working groups which meet regularly and discuss various aspects of reptile and amphibian conservation relevant to their respected areas. NCPARC maintains an interactive website that allows members to keep up-to-date on the three working groups' projects and news related to amphibians and reptiles in North Carolina (**www.ncparc.org**). Wildlife Resources Commission (WRC) staff continue to network with various agencies and the public to establish relationships and discuss potential future collaboration. Staff also interact with other NC WRC biologists to assist them with projects and help facilitate communication of WRC projects with outside groups and agencies. The primary focus of this project is to facilitate communication and coordination among all parties interested in reptile and amphibian conservation. To that end, a significant amount of time was spent on emails and phone calls connecting with the various partners and potential partners of NCPARC. Additionally, a newsletter has been created and sent out periodically to keep the NCPARC membership abreast of upcoming meetings, projects, and conservation issues.

NCPARC Annual Meeting

NCPARC held its fourth annual meeting in March, 2008 on the coast at Trinity Center in Salter Path, NC. Another great success, the two-day meeting was widely attended by state and federal agency personnel, university affiliates, and the general public. There were a total of 59 attendees. General goals of NCPARC annual meetings are to: 1) bring new folks into the herp conservation fold; 2) show attendees "what you can do for herps and conservation through PARC"; 3) bring members up-to-speed on new NCPARC, SEPARC, and PARC initiatives; 4) get participants involved in the initiatives of the NCPARC working groups; and 5) facilitate communication and cooperation among members.

New for this year was a "Task Team" format. The presenters each gave short presentations and then the rest of the time was used to brainstorm within the group about additional issues, problems, and potential solutions. Each Task Team then reported back to the main group later in the meeting with a brief overview of any potential outcomes or products. Additionally, each of these task teams has continued working on issues related to their topic throughout the rest of the year. Six Task Teams and three Field Workshops were offered during the meeting arranged around the theme of "Habitat for Herps and Humanity – Threats to Conservation of Imperiled Species." Each of these sessions is detailed below:

1. Eastern Diamondback Rattlesnakes
Jerry Reynolds (NC Museum of Natural Sciences) provided an overview of the Eastern diamondback rattlesnake (*Crotalus adamanteus*) and issues surrounding the conservation of this species from a historical perspective. Zach Orr (Randolph Rattlesnake Refuge and Research Center) gave his perspective on this species from his work in the field with all three native rattlesnakes. Jerry and Zach moderated discussion of conservation challenges for the Eastern diamondback rattlesnake along with potential goals for NCPARC to pursue.

2. Sea Turtles
Matthew Godfrey (NCWRC) gave an overview of conservation threats to sea turtles in coastal waters of NC. Wendy Cluse (NCWRC) provided current information regarding strandings of sea turtles along NC's coast. Blake Price (NC Division of Marine Fisheries) then discussed by-catch issues and strategies to address this. Matthew and Wendy moderated discussion of issues surrounding sea turtle conservation and the group tried to address what NCPARC can do to help.

3. 2008 - The Year of the Frog
The Association of Zoos and Aquariums (AZA) has designated 2008 as the Year of the Frog in an effort to increase awareness of amphibian declines and conservation needs. Windy Kent (NC Aquarium at Pine Knoll Shores) gave an overview of the Year of the Frog educational effort. Windy, Keith Farmer (NC Aquarium at Fort Fisher) and Peyton Hale (NC Museum of Natural Sciences) each discussed programs and initiatives that their respective facilities are undertaking to promote this AZA project.

4. Diamondback Terrapins
Kendrick Weeks (NCWRC) gave an overview of conservation threats to diamondback terrapins in coastal waters of NC. Andy Wood (Audubon North Carolina) and Dave Lee (The Tortoise Reserve) discussed upcoming derelict crab pot (DCP) research opportunities regarding DCP effects on diamondback terrapin populations. Emphasis was on methodology for effective DCP location and removal, by-catch inventory and localized educational awareness campaigns designed to bring about long-term solutions. Blake Price (NC Division of Marine Fisheries) discussed efforts to reduce crab pot by-catch. Kendrick then moderated a group discussion regarding terrapin conservation issues, current research and research needs.

5. Wildlife Crossings
Lori Williams (NCWRC) gave a presentation addressing the challenges roads present to reptiles and amphibians in general and specifically what types of strategies various states have designed to facilitate wildlife crossings. Dennis Herman and Anne Burroughs (both with NC Department

of Transportation) detailed projects by NCDOT as well as informed the group about the process involved in adding wildlife crossings to the design of a road. A group discussion was then moderated by Lori discussing how NCPARC can be more involved in helping with roads and conservation of amphibians and reptiles.

6. Important Herp Areas
Ron Sutherland (PhD student at Duke University) gave an overview of the potential to create a system for designating "Important Herp Areas" for North Carolina. The concept would be similar to that of the Important Bird Area (IBA) designation from Audubon. Ron is also leading this working group on the national PARC level and discussed the progress of that group as well. Janice Allen (Coastal Land Trust) gave examples of how IBAs have helped with conservation planning in the past and offered suggestions on what would be needed for an "IHA" system to succeed. Representatives from both The North Carolina Natural Heritage Program and The Nature Conservancy were also on hand to lend their expertise as well, and the merits of different design options were actively discussed. By the end of the session, plans were well underway to start identifying a first draft of Important Herp Areas for North Carolina.

Field workshops were based on the format used at the 2007 NCPARC Annual Meeting using field explorations to demonstrate and discuss various research, conservation, and educational techniques:

7. Field Sampling Techniques in Coastal Habitats – Croatan NF
Kendrick Weeks and Jeff Hall (both with NCWRC) led a trip into nearby Croatan National Forest. The group explored the Patsy Pond area examining the techniques of minnow trapping, dipnetting and turtle trapping. Additionally, the group investigated some nearby cover board sites and discussed this technique as well.

8. Bioblitz Techniques – Theodore Roosevelt Natural Area
Ed Corey (NC Division of Parks and Recreation) led a bioblitz into the Theodore Roosevelt Natural Area. Several target species included timber rattlesnake, pine woods snake (this area was the type locality for the species), northern scarlet snake, and diamondback terrapin. Other likely species included eastern glass lizard, northern black racer, and southeastern five-lined and broadhead skinks.

9. Year of the Frog – Pine Knoll Shores Aquarium
Windy Kent and Brian Dorn (both with Pine Knoll Shores Aquarium) led this “behind-the-scenes” tour of the Pine Knoll Shores Aquarium. Of particular interest was the Year of the Frog exhibit and educational materials. The group was also able to view a feeding and animal program.

Just as in 2007, a poster session was popular and provided a lot more information about reptile and amphibian conservation projects statewide. This allowed for discussion and collaboration on how researchers and educators across the state are conducting their work.

NCPARC Working Groups and Steering Committee

The work of the NCPARC biologist on this project is to facilitate planning, coordination, and communication among reptile and amphibian conservation organizations, agencies, and individuals that will, in turn, conduct the work necessary to achieve our wildlife action Plan goals for reptiles and amphibians across the state. As such, NCPARC has formed a steering committee and working groups to further guide specific activities. The project biologist facilitates planning, coordinates and recruits representatives to participate, and communicates outcomes from those meetings and initiatives. The following are summaries of the work of the committees and workgroups during the project year.

Research, Inventory, Monitoring, and Management Working Group Summary
The Research, Inventory, Monitoring & Management (RIMM) working group continued development of several projects including an on-line registry of herpetologists, the Carolina Herp Atlas (www.carolinaherpatlas.org), and a bibliography of relevant literature on North Carolina amphibians and reptiles. A new initiative of the group was to present current data regarding the chytrid fungus *Batrachochytrium dendrobatidis* (*Bd*) and interactions with amphibians. Presentations were given at several RIMM meetings about *Bd* and various ongoing projects in North Carolina. The RIMM group continues to discuss research needs regarding this potential threat to amphibian populations.

Policy, Regulation, and Trade Working Group Summary
For issues surrounding the legal status of reptiles and amphibians, NCPARC utilizes the Policy, Regulation & Trade (PRT) working group. PRT members continued to work on a variety of projects including: freshwater turtle harvest limits, reviewing all North Carolina regulations affecting reptiles and amphibians, and considering the issue of potentially dangerous animals (giant constrictors, venomous reptiles, and crocodilians). This last issue is one that the group has spent much time on in an effort to draft a fair and balanced system for permitting or licensing owners who keep certain potentially dangerous animals. Several newer projects have been taken on as well. The PRT group has been considering the need to review the North Carolina Division of Marine Fisheries Blue Crab Management Plan and how this plan affects diamondback terrapins. Invasive species are also being discussed by the group sparked initially by discussions surrounding issues with boas and pythons in Florida. Lastly, PRT members have begun discussions about exotic food markets in North Carolina and whether or not they pose a threat to native reptiles and amphibians. Future research is needed and collaboration with the North Carolina Department of Agriculture is expected.

Education and Outreach Working Group Summary
Education and outreach about reptiles and amphibians is one of the most important facets of NCPARC. Largely perceived as dangerous or of little environmental or economic value, convincing the general public of the worthiness of conserving these animals is a significant challenge. Members of the Education & Outreach (EO) working group have spent many hours giving talks to organizations, attending festivals, visiting schools, and presenting workshops about the conservation of reptiles and amphibians. A sampling of these events includes: the Carolina Reptile and Exotic Animal Shows in Raleigh, Waterfest at Lake Crabtree County Park in Raleigh, Health and Fitness Day in Raleigh, Scales and Tails weekend at Ft. Fisher Aquarium,

Reptile and Amphibian Day at the NC State Museum of Natural Sciences, Frog Fest at Crowder Park in Raleigh, Reptile Day at Davidson College, Earth Day events, and Turtle Day at Bass Lake Park in Holly Springs. Other initiatives of the EO working group have included producing brochures and signage, pursuing press releases and the media in general, promoting publications of PARC such as the Habitat Management Guidelines for Amphibians and Reptiles of the Southeastern United States, and maintaining an outreach registry of all available individuals and facilities that currently provide reptile and amphibian programs.

NCPARC Steering Committee summary

The NCPARC Steering Committee was originally composed of 10 members: 1) the NCPARC Coordinator, 2) the chair of the RIMM working group, 3) the chair of the PRT working group, 4) the chair of the EO working group, 5) a representative from the NC Museum of Natural Sciences, 6) a representative from the NC Herpetological Society, 7) a representative from the NC Wildlife Resources Commission, 8) a representative from industry, 9) a representative from nonprofits, and 10) a representative from universities and colleges. During this cycle, the Steering Committee decided that it needed to add an eleventh member to prevent an even vote. This eleventh position is labeled as an at-large position potentially with ties to the herpetoculturist community. A likely candidate was suggested, approached, and accepted this position. After adding to its membership, the Steering Committee decided to elect a chair from among its members. Additionally, members voted to change the status of NCWRC representatives on the committee (currently two) from full voting members to advisors with no voting privileges. Issues discussed by the Steering Committee included a greater need to include Steering Committee members in planning of meetings and events, reviewing PRT working group recommendations, and approval of an NCPARC endorsement letter for recommendations regarding take of turtles from the families Chelydridae and Kinosternidae.

Professional Training and Technical Guidance

The NCPARC biologist helped plan and facilitate ten workshops on reptile and/or amphibian identification, management and conservation held at the following locations: Camp Agape near Fuquay-Varina, Camp Chestnut Ridge near Burlington, Lake Waccamaw State Park, Carolina Beach State Park (2), and Weyerhaeuser's Cool Springs Environmental Education Center near New Bern (5). These workshops continue to be well attended due to continuing demand from both resource managers and land owners as well as the general public. In addition to these workshops, presentations on NCPARC were given to many groups throughout the state. The NCPARC biologist also responded to numerous calls and emails from the public regarding general reptile and amphibian identification and ecology.

The NCPARC biologist participated in other areas of guidance and/or training as well. He regularly contributed to PARC Joint National Steering Committee conference calls. Staff attended a three-day training in Tennessee for the Southeast Habitat Management Guidelines (SE HMG) produced by PARC to help plan for a future SE HMG workshop to be held in North Carolina jointly with North Carolina State University. To provide a greater understanding of issues surrounding the chytrid fungus *Bd,* the NCPARC biologist attended the PARC sponsored Symposium on *Bd* held in Arizona. This facilitated idea exchange, provided an assessment of the current status of anurans around the world related to this fungus, and a further understanding

of the potential for future impacts. Potentially all of these elements may help craft recommendations and make decisions in the future regarding anurans in NC and possible impacts. The NCPARC biologist presented a summary of the *Bd* Symposium to the NCWRC Nongame Wildlife Advisory Committee. Staff also met with staff at Camp Lejeune Marine Corps Base to discuss management recommendations for reptiles and amphibians and to survey potential habitat for Eastern diamondback rattlesnakes. Finally, the NCPARC biologist met with private landowners to discuss habitat management recommendations for amphibians, specifically establishment of ephemeral wetlands.

B. Target Dates for Achievement and Accomplishment

All activities are on target and on schedule.

C. Significant Deviation

None.

D. Remarks

None.

E. Recommendations

This project should be continued.

F. Estimated Cost

$ 140,089 (including in-kind contributions)

Prepared By: Jeffrey G. Hall, Partners in Amphibian and Reptile Conservation Biologist
Wildlife Diversity Program, Division of Wildlife Management

Annual Performance Report

State: North Carolina

Project Number: T - 9
Amendment Number: 1

Period Covered: July 1, 2007 – June 30, 2008

Grant Title: State Wildlife Grants T-9 (Planning)

Project Title: Statewide Calling Amphibian Survey Program

Objective:

1. Continue to develop and implement a system for conducting a statewide calling anuran survey following NAAMP protocols.
2. Establish the protocol and means to establish routes and conduct surveys.
3. Continue volunteer recruitment, training, and administration to conduct surveys.
4. Assist with development and distribution of training CDs of frog calls.
5. Conduct pilot-study years of calling amphibian program.
6. Use initial results as baseline data upon which to base future sub-state, statewide, regional and national scale analyses.

A. Activity

The North Carolina Calling Amphibian Survey Program (CASP) has grown dramatically during this past year. In 2006, NC had sixty-one original random routes generated through the North American Amphibian Monitoring Program (NAAMP). Due to perceived high demand of routes from observers and a need to cover more areas of the state not covered by previous routes, seventy-four additional random routes were created for North Carolina. Along with four nonrandom routes, this brings the total number of routes in the state to 139. Of these routes, 103 were assigned among 105 observers (some observers double up on routes) for the 2007 field season. Observers (mostly volunteers) were responsible for running at least three surveys of each route during the 2007 season corresponding to three different windows of breeding activity. However, only fifty-six of the assigned observers were able to pass the on-line quiz through NAAMP in order to verify their data. Of these fifty-six observers, forty-eight of them actually sent data through either the mail or via on-line entry for fifty-five routes. Although only 40% of the total available routes, it is more than double the twenty-three routes that were run in 2006.

As in 2006, most volunteers entered their data and metadata directly into the NAAMP website and the local database CASPAD was used to import data and metadata directly from text files downloaded from NAAMP. This database, now a geo-database, allows for one-time data entry and is continually updated. The CASP web page at the NC Partners in Amphibian and Reptile Conservation (PARC) website continues to be frequently updated with a map of assigned and unassigned routes statewide (www.ncparc.org).

Through efforts by the CASP coordinator and the NCPARC Education and Outreach working group, recruitment of volunteers continued heavily leading up to the 2008 field season. Public interest has been maintained in CASP and as a result, the observer database has increased from 130 to 151. Also, largely through the assistance of CASP observers, thirty-two routes were ground-truthed in early 2008.

Data Analysis

In this second year of piloting the CASP program, twenty-five of the thirty anurans occurring in the state were detected. Although this is the same number of species that was detected in 2006, two of the species were new in 2007 while two species detected in 2006 were not detected in 2007. Mountain chorus frog (*Pseudacris brachyphona*) and ornate chorus frog (*Pseudacris ornata*) were both new CASP species detected in 2007 – both are priority species within the North Carolina Wildlife Action Plan. Additional priority species detected in 2007 included: oak toad (*Bufo quercicus*), barking treefrog (*Hyla gratiosa*), Brimley's chorus frog (*Pseudacris brimleyi*), and Southern chorus frog (*Pseudacris nigrita*). The two species detected in 2006, but not in 2007 were gray treefrog (*Hyla versicolor*) and Eastern spadefoot toad (*Scaphiopus holbrookii*). These two are also priority species. Over the two year period, only three of the thirty native frog species were not detected: Pine Barrens treefrog (*Hyla andersonii*), gopher frog (*Rana capito*), and river frog (*Rana heckscheri*). As these three frogs are the most specialized of the anuran species occurring in the state, detecting them may not be accomplished through randomized routes.

Of the twenty-five species detected in 2007, eleven species were detected in the mountains, sixteen in the piedmont, and twenty-two species in the coastal plain (Table 1).
As in 2006, spring peepers (*Pseudacris crucifer*) were the most common anuran detected and were detected at greater maximum indices in all regions of the state (Table 1). Other commonly detected species included Southern toad (*Bufo terrestris*), green treefrog (*Hyla cinerea*), Cope's gray treefrog (*Hyla chrysoscelis*), Southeastern chorus frog (*Pseudacris feriarum*), bullfrog (*Rana catesbeiana*), and Fowler's toad (*Bufo fowleri*).

Table 1. Maximum Calling Index of Anuran Species by Region. Index: 1 = individuals can be counted, there is space between calls; 2 = calls of individuals can be distinguished but there is some overlapping of calls; 3 = full chorus, calls are constant, continuous and overlapping; CP- coastal plain, P- piedmont, MT- mountains.

Species	CP	P	MT
Acris crepitans	1	3	1
Acris gryllus	3	3	
Bufo americanus		3	3
Bufo fowleri	2	3	1
Bufo quercicus	1		
Bufo terrestris	3	2	
Gastrophryne carolinensis	2	2	
Hyla chrysoscelis	2	3	3
Hyla cinerea	3	3	
Hyla femoralis	3		
Hyla gratiosa	1	3	
Hyla squirella	3	2	
Pseudacris brachyphona			2
Pseudacris brimleyi	3		
Pseudacris crucifer	3	3	3
Pseudacris feriarum	1	3	2
Pseudacris nigrita	1		
Pseudacris ocularis	1		
Pseudacris ornata	1		
Rana catesbeiana	2	3	2
Rana clamitans	2	2	2
Rana palustris	3	2	2
Rana sphenocephala	3	3	
Rana sylvatica			3
Rana virgatipes	2		
TOTAL SPECIES	**22**	**16**	**11**

Data from the 2008 season is still undergoing entry and review and will not be available for analysis until after November 2008.

Professional Training

CASP frog call identification workshops continued in the late winter and early spring of 2008. These workshops were designed to recruit volunteers and improve data quality and were developed in conjunction with the NCPARC Education and Outreach working group. Eight workshops were held using combined elements of PowerPoint presentations explaining the CASP protocols as well as general anuran ecology, calling phenology, and tips for remembering calls; auditory clips of frog calls; and night time field work listening for calling frogs. CASP staff helped plan and facilitate five of these workshops held at the Pechmann Wildlife Education Center near Fayetteville, the North Carolina Zoo near Asheboro, the Fort Fisher Aquarium, River Park North near Greenville, and Howell Woods Environmental Learning Center near Four Oaks. Three additional CASP workshops were held and CASP staff assisted with registrations at

Davidson College near Charlotte, Falls Lake State Recreation Area near Raleigh, and at the Roanoke Island Aquarium in Manteo. All of these trainings were well attended and this facet of the program will likely continue to grow.

Responding to requests for technical guidance from Camp Lejeune Marine Corps Base, CASP staff met with staff from the base to discuss CASP protocols and explore potential for CASP routes to be established on the base. Camp Lejeune staff were also interested in learning about potential training opportunities for staff on base. The CASP coordinator was also asked to comment on and help review current NAAMP protocols with USGS staff. Due to the successful nature of the NC CASP program, USGS hopes to capitalize on this and incorporate some of its design into the national program for use by other states.

B. Target Dates for Achievement and Accomplishment

All activities are on target and on schedule.

C. Significant Deviation

None.

D. Remarks

None.

E. Recommendations

This project should be continued.

F. Estimated Cost

$29,082 (including in-kind contributions)

Prepared By: Jeffrey G. Hall
Partners in Amphibian and Reptile Conservation Biologist
Wildlife Diversity Program
Division of Wildlife Management

Annual Performance Report

State: North Carolina

Project Number: T - 9
Amendment Number: 1

Period Covered: July 1, 2007 – June 30, 2008

Grant Title: State Wildlife Grants T-9 (Planning)

Project Title: Piedmont Game Land Songbird Surveys

Objectives:

The objective of this project is to establish baseline data (species presence, abundance, habitat use, and productivity) for songbirds, on which to base planning, population monitoring, and evaluation of management actions on state-owned game lands in the Piedmont of North Carolina.

A. Activity

In the past fiscal year, we completed data collection and analysis for the 2007 breeding season, conducted migration surveys in the fall of 2007 and spring of 2008, collected data for the 2008 winter bird surveys, and initiated field work for the 2008 breeding season. Full results from the 2008 breeding season will not be presented here because data collection and analyses are ongoing as of the writing of this report.

Breeding Bird Surveys

Nest searching, spot mapping, and point count surveys (Ralph et al. 1993) have been conducted on Sandhills and Caswell Game Lands since 2004. The objectives of these studies are to determine breeding bird relative abundance and distribution across large sections of the game lands; to assess territory densities, nesting effort, and reproductive success within key, limiting habitats; and to gather local information regarding the impacts of habitat management practices on breeding birds. The habitats of interest in this study are longleaf pine woodland, Sandhills drain (streamhead pocosin), and field trial grass/shrub openings on Sandhills Game Land and mature oak woodlands, thinned pine woodlands, and bottomlands (floodplain forests) on Caswell. Management activities of interest include timber thinning and groundcover restoration in longleaf pine, hardwood removal in Sandhills drains, and thinning in Caswell oak woodlands.

Point counts

Point count routes were established on the Sandhills and Caswell Cooperative Upland habitat Restoration and Enhancement program (CURE) areas in 2002. CURE is an attempt to improve early successional habitats across a ~5000 acre area of each Game Land through intensive forestry practices. Additionally, point count routes on Sandhills Block B south, Block C, Field Trial area, and the Caswell Frogsboro tract were initiated in 2004. A point count route for the

Caswell High Rock area was added in 2005. Surveys were conducted once for each route during the first 2 weeks of June following standard NCWRC point count protocols. These surveys will help to track broad changes in songbird populations across these Game Lands, and will allow for comparisons of management strategies that are implemented on a large scale.

On the Sandhills field trial route, the most frequently detected species from 2004-2008 included pine warbler, indigo bunting, eastern towhee, mourning dove, chipping sparrow, orchard oriole, Bachman's sparrow and field sparrow. On block C, the most frequently recorded birds from 2004-2008 were American crow, pine warbler, and mourning dove. On block B south, pine warbler, mourning dove, and blue jay were among the most frequently recorded in all years while in 2007 we heard greater numbers of quail. On the Sandhills CURE area from 2002-2008, pine warbler, Carolina wren, indigo bunting, and eastern bluebird have been the most frequently recorded.

Species of conservation concern recorded on Sandhills point counts included red-cockaded woodpecker, Bachman's sparrow, brown-headed nuthatch, and loggerhead shrike. Since the inception of surveys, we've recorded an increase in both the number of Bachman's sparrows detected and their distribution across the landscape on most of our point count routes (Tables 1 & 2). Bachman's sparrow abundance and distribution peaked on the field trial area in 2006 and decreased in the past few years. Bachman's sparrow populations on the CURE area are being more closely monitored through the CURE Songbird Surveys State Wildlife Grant project.

Table 1. Relative abundance of Bachman's sparrow (# birds per 10 survey points) detected during point count surveys, 2002-2008, Sandhills Game Land. Note that 2002 and 2003 point counts were only conducted on the CURE area.

	2002	2003	2004	2005	2006	2007	2008
CURE area	0	0.83	0.42	2.08	5.00	3.75	4.40
Block B south			1.74	0.43	3.48	3.04	5.22
Block C			1.36	0.45	4.55	4.55	3.18
Field trial			5.00	10.70	13.57	6.07	3.21

Table 2. Distribution of Bachman's sparrow across point count routes (% of points at which at least one bird was detected), 2002-2008, Sandhills Game Land. Note that 2002 and 2003 point counts were only conducted on the CURE area.

	2002	2003	2004	2005	2006	2007	2008
CURE area	0	4.2	4.2	20.8	37.5	25.0	37.5
Block B south			13.0	4.3	30.4	21.7	21.7
Block C			9.1	4.5	27.3	27.3	18.2
Field trial			38.5	57.1	71.4	35.7	25.0

Red-eyed vireo, indigo bunting, and northern cardinal were the most frequently encountered species on Caswell Game Land across all routes and years. Common yellowthroats have increased their distribution and relative abundance across Caswell Game Land, and notably on the CURE area (detected at 12% of points in 2002 steadily increasing to 56% of points in 2008).

Indigo buntings have increased dramatically on the CURE and High Rock routes, and have remained stable on the Frogsboro route. One of the biggest "winners" from CURE at Caswell seems to be yellow-breasted chat, which has dramatically increased both in relative abundance and distribution across the CURE area from 2002-2008, while counts have not changed significantly on the other two routes.

With CURE management, brown-headed cowbirds have increased their distribution on the CURE area. In 2002 no cowbirds were detected on the point count survey, and numbers have increased steadily over the years to where cowbirds were detected on a quarter of all survey points in 2008. Cowbird distribution has been steady on the Frogsboro route (detected on an average of 24% of survey points from 2004-2008) and may be increasing on the High Rock route (6% in 2005 up to 41% in 2008).

Species of conservation concern detected on Caswell point count routes include brown-headed nuthatch, hooded warbler, and Kentucky warbler. In 2005 a probable Bachman's sparrow was detected on the CURE area and in 2008 one was heard on the High Rock route.

Spot mapping

Spot mapping was conducted in 4 ha (~200 x 200m) plots in the upland woodland habitats, and in 2 ha (100 x 200m) plots in bottomland, drain, and field trial habitats. Plots were not selected randomly but were chosen to represent the best examples of a given habitat type or management practice on the game land. We selected habitats that were distinctive for each game land or thought to be particularly valuable for breeding birds. We also chose to evaluate management practices that were expending a lot of management resources, were controversial in some way, or for which there was some uncertainty about the impacts on bird populations.

On Sandhills Game Land there was universal agreement on the benefit for wildlife of thinning closed canopies pine plantations which had a history of pine straw raking and fire suppression. There was some uncertainty about the impacts of using intensive site prep after the thinning to remove the logging debris and then planting Atlantic Coastal Panicgrass (ACP) to restore groundcover. ACP is a grass native to the NC coast but not to the Sandhills and was chosen because it grows well in poor sandy soils and can provide both cover and food for birds. We also had questions about the impacts of mechanically removing hardwoods and other overstory trees next to Sandhills creeks or "drains". Also on Sandhills Game Land, a lot of management resources are dedicated to managing linear openings for bird dog field trials, including large-scale mowing to reduce groundcover to facilitate the running of field trials. The impacts of this intensive management on priority birds had not been studied before.

On Caswell Game Land, the CURE program is attempting to create large contiguous blocks of early successional habitat, yet half of the CURE area consists of mature hardwood forests. There was uncertainty about the practicality of management and the impact on some priority species of thinning mature (100+ year old) oak-hickory forests in order to create early successional habitat.

On Sandhills in 2004, 4 plots were established in open longleaf pine woodlands with native wiregrass groundcover ("natural longleaf"), 2 plots in thinned plantation woodlands (pine straw sales that were heavily thinned, intensively site-prepped, and then planted to ACP; "thinned

plantation"), 5 plots in drains with little hardwood overstory, open canopy, and lush herbaceous groundcover ("herbaceous drain"), and 5 plots in the field trial course which consists of long, linear openings with a mix of grasses, forbs and shrub thickets ("field trial"). In 2005 we added an additional 2 thinned plantation plots and established 2 plots in drains with a closed-canopy, hardwood and pine overstory and thick evergreen shrub understory ("woody drain"). In 2006 we added a 3rd woody drain plot. On Caswell, 5 plots were established in 2004 in thinned and burned pine woodlands ("Caswell thinned pine), 5 plots in hardwood floodplain forests ("bottomland"), 5 plots in mature upland oak woodland ("unthinned oak"), and 2 plots in thinned oak stands ("thinned oak"). One of the oak stands was thinned in early 2004 while the other was thinned in the summer of 2005 and was included as an "unthinned oak" plot in 2004.

Grid points were established every 50m within plots by flagging and spray-painting trees. Plots were visited once every 7-10 days between sunrise and noon on mornings without heavy precipitation or strong winds. The observer walked transects through the plot so that he or she would pass within 50 m of each grid point and recorded the location, sex, age and behavior of every bird observed. The behaviors that were recorded included carrying food, carrying nest material, giving alert calls or distraction displays, and all movements within the plot. Counter-singing between males of the same species and aggressive interactions between species were recorded to help distinguish territory boundaries. The observer spent approximately 25-60 minutes within each plot, walking at a slow pace, and stopping to make observations as needed.

At the end of the season, all observations were transferred to a master map for each plot and observations were color coded by date observed. A territory was determined if an individual had at least 3 detections that formed a cluster within a typical breeding cycle (21-45 days). Territories that were not completely contained within the plot were assigned the appropriate fraction of a territory. Each territory was assigned a Vickery index score from 1-7 which provides a measure of reproductive effort based on observed behaviors (Vickery et al. 1992).

We grouped species into nesting guilds based on where a species typically nests, based on the assumption that the availability of suitable nesting structure is a key factor in determining habitat suitability, and that structure requirements may be similar within guilds. These guilds included ground, shrub, mid-story, canopy, and cavity nesters. Birds that have specialized nest structure requirements (such as belted kingfisher), that do not build their own nests (brown-headed cowbird) or that predominantly use man-made structures for nesting (such as chimney swift and eastern phoebe) were not included in a guild.

Sandhills Game Land Spot Map Results

On Sandhills Game Land, the field trial habitat supported the greatest density of ground nesting birds, though pen-raised quail released on the field trial area likely artificially inflated this number. We observed similar densities of ground-nesters between thinned plantation and natural longleaf plots, and between woody and herbaceous drains. The greatest densities for this guild in most habitats were for bobwhite quail and Bachman's sparrow.

We observed higher densities of shrub nesters than any other guild in most habitats except natural longleaf, where canopy and cavity nesters were most abundant. We observed the greatest densities of shrub nesters in the field trial habitat (almost 2 territories per acre) followed closely

by herbaceous drain. It is interesting to note that we observed over twice the density of shrub nesters in herbaceous drains compared to woody drains, even though management of herbaceous drains reduces the amount of evergreen-shrubs. Even with mechanical disturbance and frequent fire, herbaceous drains still contained large numbers of shrubs. Natural longleaf plots had a longer history of fire than thinned plantations, and the shrub layer was predominantly absent from this habitat. The soil disturbance created by forestry and site prep activities seems to have favored a greater diversity of woody shrubs in thinned plantations compared to natural longleaf plots.

The species composition of the shrub-nesting guild varied between habitats. Some of the most abundant shrub nesters included indigo bunting, blue grosbeak, eastern towhee, common yellowthroat, northern mockingbird, brown thrasher, field sparrow, prairie warbler and yellow-breasted chat.

Mid-story nesters were most abundant in field trial plots, a result driven primarily by northern cardinal and orchard oriole. There were more midstory-nesting birds in herbaceous drains than woody drains, in part due to greater numbers of blue-grey gnatcatchers. The upland pine habitats contained relatively few mid-story nesting birds.

Surprisingly, the field trial area, which contains very few mature trees, had the highest density of canopy nesters. Many canopy nesters, such as eastern kingbird, mourning dove, and chipping sparrow, nested in the nearby woods but included part of the field trial in their breeding territory for foraging. There were not dramatic differences in canopy-nesting bird territory densities between Sandhills habitats.

Cavity nesters were the second most abundant guild on Sandhills Game Land. Herbaceous drains held the highest densities. Woody drains had similar densities to herbaceous drains. This result is re-assuring as one of the concerns over removing mature hardwoods from the herbaceous drains was that it might negatively affect cavity nesters. Thinned plantations contained similar cavity-nesting bird densities as natural longleaf. The species composition of this guild varied by habitat. Overall, the most abundant cavity nesters included Carolina wren, red-headed woodpecker, brown-headed nuthatch, Carolina chickadee, great-crested flycatcher, eastern bluebird, red-bellied woodpecker, northern flicker, and red-cockaded woodpecker.

Priority species varied in their habitat preferences (Figures 1-3). Natural longleaf plots held relatively high densities of brown-headed nuthatch, red-headed woodpecker, and Bachman's sparrow, and were the only habitat that contained red-cockaded woodpecker territories. Prairie warbler, field sparrow, and eastern kingbird were most abundant in field trial plots. High densities of many priority birds were found in herbaceous drains, and herbaceous drains supported greater territory densities of priority species than woody drains.

While thinned plantations supported similar overall bird densities as natural longleaf stands, natural longleaf supported higher densities of some priority species. Thinned plantation plots held greater numbers of more common species such as indigo bunting and chipping sparrow. Some species, such as great-crested flycatcher, tufted titmouse, and yellow-billed cuckoo were

found in the greatest numbers in woody drains and hooded warbler, white-eyed vireo, red-eyed vireo and ovenbird territories were only found in woody drains.

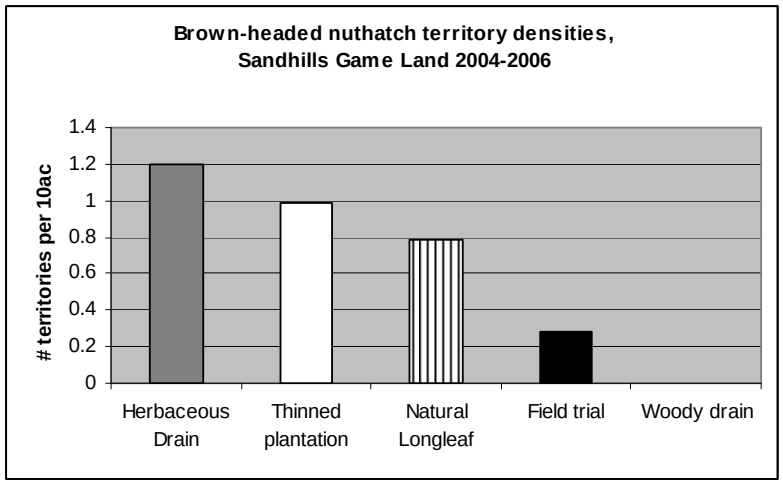

Figure 1. Territory density of brown-headed nuthatch by habitat, Sandhills Game Land 2004-2006.

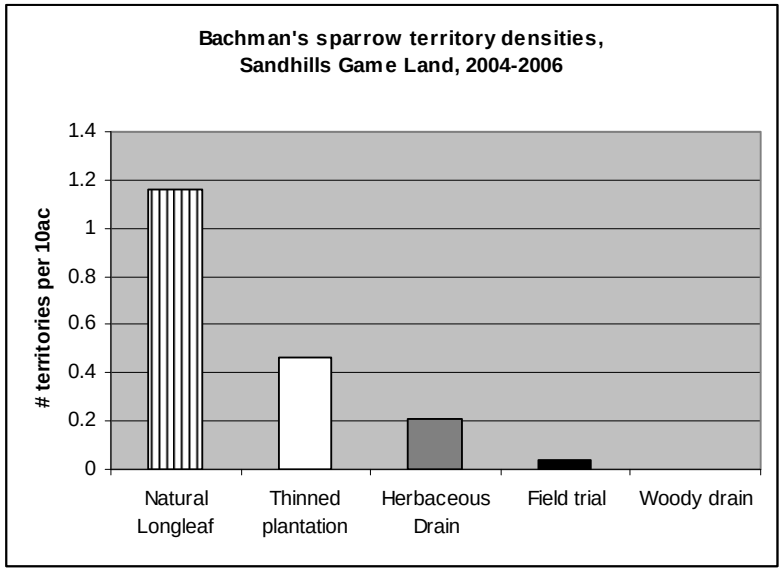

Figure 2. Territory density of Bachman's sparrow by habitat, Sandhills Game Land 2004-2006.

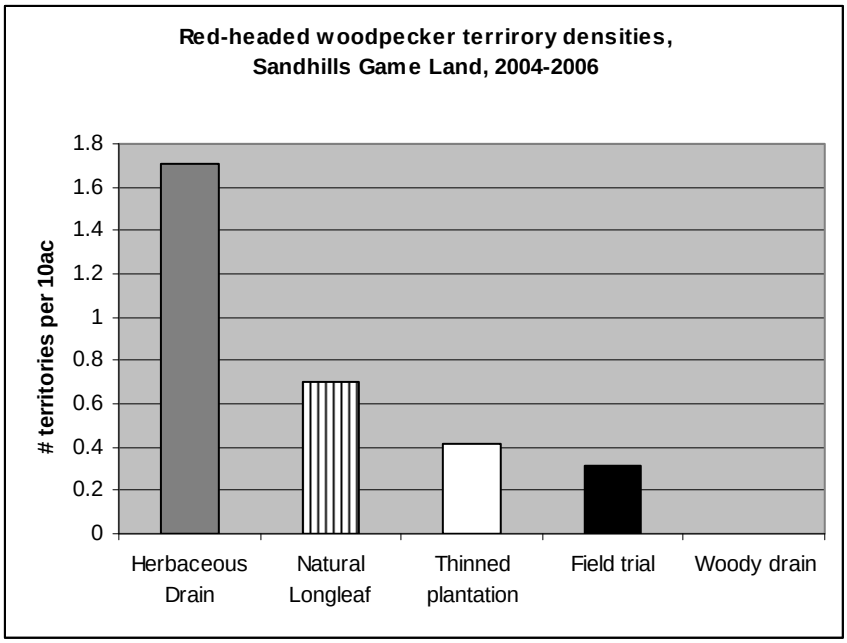

Figure 3. Territory density of red-headed woodpecker by habitat, Sandhills Game Land 2004-2006.

In their pre-treatment condition and in the first post-habitat establishment year (2004), plantation stands contained no Bachman's sparrow territories. We documented increasing densities of Bachman's sparrows in thinned plantations as the birds colonized these newly-available habitats (Figure 4).

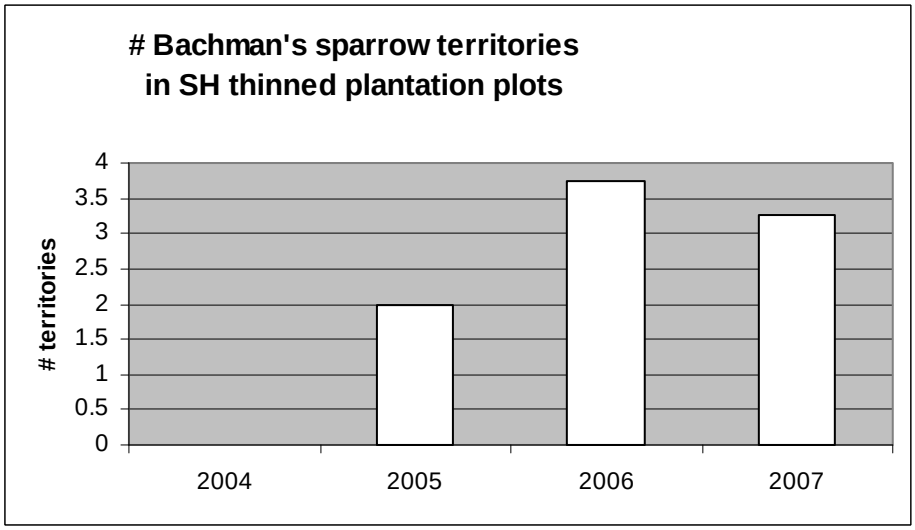

Figure 4. Number of Bachman's sparrow territories recorded in thinned plantation plots, Sandhills Game Land 2004-2007.

These spot map results suggest that the early successional habitat provided by the field trial supports high territory densities of a large number of birds. Natural longleaf pine habitats are

valuable for several Sandhills specialists such as Bachman's sparrow, brown-headed nuthatch, and red-cockaded woodpecker. Thinning pine plantations and planting the understory in Atlantic Coastal Panicgrass produces great benefits over pre-treatment conditions. After understory establishment, thinned plantations support similar densities of many species as natural longleaf plots, and can support higher numbers of shrub nesters. Converting woody drains into herbaceous drains through intensive habitat management appears to benefit many species, including several priority birds; however there are a few species which may not benefit.

Caswell Spot Map Results

More species established a territory (at least 1 territory established in at least one year) in thinned oak stands (33 species), than in unthinned oak (21 species) over the 4 years from 2004-2007, indicating that thinning hardwoods can increase stand-scale species diversity. Seventeen species established territories in thinned oak plots but not unthinned oak, including the Wildlife Action Plan priority species brown-headed nuthatch, field sparrow, northern bobwhite quail, prairie warbler, yellow-breasted chat, and red-headed woodpecker. Five species established territories in unthinned oak stands, but not thinned oak, including the priority species Acadian flycatcher, wood thrush, and yellow-billed cuckoo. Unthinned oak supported higher densities of red-eyed vireo (0.41 territories per acre in unthinned vs. 0.21 territories per acre in thinned oak), ovenbird (0.25 vs 0.02), wood thrush (0.20 vs 0), Acadian flycatcher (0.10 vs 0), and scarlet tanager (0.06 vs 0.03). Thinned oak had higher densities of indigo bunting (0.20 in thinned oak vs 0.01 unthinned) and summer tanager (0.10 vs. 0.04).

From 2004-2007, 31 species established a territory in bottomland plots. Bottomlands contained the highest territory densities for canopy, cavity, mid-story, and ground nesters. Within bottomland plots, red-eyed vireo (0.65 territories/acre) had by far the highest territory density, followed by northern cardinal (0.33), Carolina wren (0.33) and Acadian flycatcher (0.32). Bottomland was the only habitat in which we recorded territories for Louisiana waterthrush, Kentucky warbler, eastern phoebe, hairy woodpecker, yellow-throated warbler, and red-shouldered hawk.

From 2004-2007, 37 species established a territory in thinned pine plots, the most of any Caswell habitat. Thinned pine contained the highest density of shrub nesters. The most abundant species in thinned pine included indigo bunting, eastern towhee, pine warbler, and common yellowthroat. We observed the greatest numbers of brown-headed cowbird in thinned pine.

Nest searching and monitoring

The spot mapping plots were searched for nests approximately once every 2 weeks. Searching was done through systematic searches and using behavioral clues (alarm calls, following bird with nesting material or food, etc). Additional nests were found incidental to other field activities. Active nests were marked and revisited once every 3-4 days on Sandhills and once per week on Caswell to determine nest fate. Reproductive success was calculated using the Mayfield method (Mayfield 1961, 1975).

In 2007 we documented 245 nests of 37 species on Sandhills and Caswell Game Lands (175 nests were documented in 2007, 125 in 2005 and 186 in 2004). In 2007, 82 nests of 22 species were found on Caswell Game Land and 163 nests of 27 species on Sandhills.

On Sandhills Game Land, the field trial plots had the greatest nest abundance (measured as # nests found per hour of searching) while the remaining habitats had similar nest abundance. It is worth noting that our search efficiency was greatest for shrub and midstory nests, and thus total nest abundance may be underrepresented for plots with a greater proportion of ground and canopy nests which are harder to find.

Nest abundance increased dramatically from 2004-2007 in thinned plantation plots. These plots were thinned in 2003 and 2004, and in 2004 and 2005 the understory was dominated by Atlantic Coastal Panicgrass. In 2006 and 2007, more emergent shrubs were present, allowing for greater use by shrub-nesting birds.

On Caswell, thinned pine habitats supported the highest nest abundance, while the 3 hardwood forest types had similar nest abundance. Nest abundance in thinned oak stands increased dramatically in 2006 & 2007. In 2004 and 2005, understory vegetation had not yet responded to timber thinning and very few nests were found (0.08 nests/hour searching for 2004 and 2005 combined). By 2006, grass and shrub cover increased and more nests were found (2.82 nests/hour searching), though with only 2 thinned oak plots, sample sizes are small.

Sample sizes limited comparisons of nest success only to shrub nests. Daily survival rates did not differ ($Z \leq 1.39$, $P \geq 0.16$) for shrub nests on Sandhills Game Land between years. Daily survival rates did not differ ($Z \leq 0.46$, $P \geq 0.64$) for shrub nests on Sandhills GL between field trial, herbaceous drain, and thinned plantation habitats (the 3 habitats with sufficient sample size), 2004-2006.

Depredation was the leading cause of nest failure on Sandhills Game Land, followed by abandonment. In most cases of depredation the predator could not be identified. A few nests were lost to management activities (controlled burning and mowing). Cowbird parasitism was not a major source of nest failure on Sandhills Game Land. Parasitism rates were higher on Caswell Game Land but do not seem to be a major source of nest failure.

No patterns have been identified to help explain what made nests vulnerable to depredation or abandonment. There was no difference in nest height (1.16 vs. 1.07m) or height of the plant the nest was placed in (2.03 vs. 2.06m) for successful vs. unsuccessful shrub nests.

Across all habitats on Sandhills Game Land, nest success appeared to be relatively high for blue grosbeak, northern cardinal and northern mockingbird; intermediate for gray catbird, brown-headed nuthatch, brown thrasher and indigo bunting; and relatively low for field sparrow and eastern towhee (Table 3). Other studies have indicated that field sparrows suffer relatively low nest success (Marcus 1998, Best 1978, Easely pers. com), contributing to concern for the long term viability of field sparrow populations. Across all habitats on Caswell Game Land, nest success was very high for all species with sufficient sample size (Table 4).

Table 3. Mayfield nest success by species, for all habitats combined, 2004 - 2007, Sandhills Game Land, minimum 77 exposure days. DSR = Daily Survival Rate, the probability of a nest surviving for one day, and Var DSR is the variance associated with the DSR estimate. Nest success is the percentage of nests that are initiated that will fledge at least one young.

Species	# nests	exposure days	DSR	Var DSR	Nest success
Blue Grosbeak	31	360	0.9667	0.00009	44%
Northern Cardinal	17	177	0.9661	0.00019	43%
Northern Mockingbird	19	224	0.9688	0.00014	42%
Gray Catbird	13	139	0.9568	0.00030	30%
Brown-headed Nuthatch	12	152	0.9671	0.00021	29%
Brown Thrasher	24	244	0.9508	0.00019	26%
Indigo Bunting	31	318	0.9465	0.00016	25%
Field Sparrow	10	77	0.9221	0.00093	15%
Eastern Towhee	23	161	0.9128	0.00050	9%

Table 4. Mayfield nest success by species, for all habitats combined, 2004 - 2007, Caswell Game Land, minimum 83 exposure days. DSR = Daily Survival Rate, the probability of a nest surviving for one day, and Var DSR is the variance associated with the DSR estimate. Nest success is the percentage of nests that are initiated that will fledge at least one young.

Species	# nests	Exposure Days	DSR	Var DSR	Nest Success
Wood Thrush	15	195.5	0.9945	0.00003	87%
Indigo Bunting	14	182	0.9897	0.00005	75%
Northern Cardinal	11	83.5	0.9880	0.00014	74%

Across all habitats we found the greatest numbers of nests of indigo buntings. Nesting success for indigo bunting was significantly higher at Caswell Game Land than Sandhills.

Migration surveys

The Atlantic and Mississippi Valley avian migration routes are host to hundreds of species of migratory birds on their way north in spring and south in fall through North America. It is not well understood the extent to which migrants use the Sandhills and Piedmont regions for staging and "refueling" during migration. In order to obtain a little more information in this vein, we began recording observations of migrants in 2004. In addition, data from various avian studies being conducted in these regions were searched for sightings of "pass through" migrants (those species that are not thought to breed or winter in the Sandhills or Piedmont regions of North Carolina).

During the spring and fall migration passing periods (about mid March to mid June and late July to late October respectively) we made occasional visits to 3 sites representing 3 key habitats on Sandhills Game Land: creek bottom (large drain), upland longleaf forest, and fields and hedgerows within the field trial area. These sites were visited for 10-45 minutes and all observed birds were recorded. In addition, migrants were recorded when observed during spot map

surveys and during other field activities in the region (not limited to the Game Land). At Caswell Game Land, migrants were recorded when observed during field activities, and 27 bird inventory visits to the Game Land were made by the Partners In Flight Biologist between March 2003 and June 2007.

Sandhills Migration Results

Of the 78 documented sightings of 32 migrant bird species in the Sandhills region between fall of 2003 and spring of 2007 (Table 5), 23 sightings were in wetland or drain habitats, 16 were associated with lakes, 7 were associated with fields, and 32 were in forested upland habitats, primarily longleaf pine (Figure 22). The fact that half of the migrants were observed in association with creeks, lakes, and wetlands, though these habitats make up less than 10% of the Sandhills landscape, suggests that these habitats may be particularly important to migrants moving through the Sandhills.

Table 5. Pass-through migrants (birds that neither breed nor over-winter) observed in the Sandhills region, fall 2003 – spring 2007.

Warblers	Shorebirds/waterbirds	Other species
Bay-breasted warbler	Greater yellowlegs	Bank swallow
Blackburnian warbler	Lesser yellowlegs	Baltimore oriole
Blackpoll warbler	Snowy egret	Blue-headed vireo
Black-throated blue warbler	Solitary sandpiper	Broad-winged hawk
Black-throated green warbler	Spotted sandpiper	Bobolink
Cape May warbler		Grey-cheeked thrush
Chestnut-sided warbler		Merlin
Magnolia warbler		Pine siskin
Palm warbler		Rose-breasted grosbeak
Tennessee warbler		Scarlet tanager
Worm-eating warbler		Swallow-tailed kite
Yellow warbler		Swainson's thrush
		Veery
		Willow flycatcher
		Warbling vireo

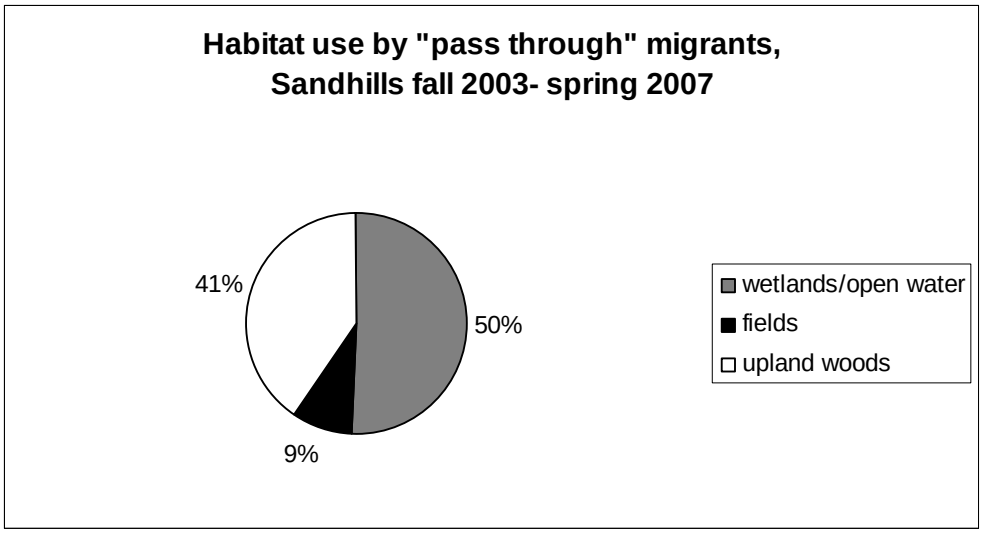

Figure 22. Habitats in which migrants were observed, Sandhills region 2003-2007.

Caswell Migration Results

There were 70 "pass through" migrants of 19 species observed on Caswell Game Land between May 2003 and June 2007 (Table 6). The majority of these were observed in upland forest habitats (77% of observations), with the bulk seen in mature hardwood or mixed hardwood-pine forests. Warblers were the most frequently observed migrant group, followed by thrushes. The most frequently observed species were black-throated blue warbler, Swainson's thrush, and black-throated green warbler.

Table 6. Pass-through migrants (birds that neither breed nor over-winter) observed on Caswell Game Land, spring 2003 – spring 2007.

Warblers	**Other species**
Blackburnian warbler	Baltimore oriole
Blackpoll warbler	Broad-winged hawk
Black-throated blue warbler	Philadelphia vireo
Black-throated green warbler	Rose-breasted grosbeak
Blue-winged warbler	Swainson's thrush
Canada warbler	Veery
Cape May warbler	Willow flycatcher
Chestnut-sided warbler	Warbling vireo
Magnolia warbler	
Worm-eating warbler	
Yellow warbler	

Winter bird surveys

Winter songbird surveys were conducted for this study on three ~5000 acre areas in conjunction with the winter bird surveys conducted on the Caswell and Sandhills CURE areas for the CURE Songbird and Habitat Surveys SWG project. On Sandhills Game Land, surveys were conducted on the CURE area from 2003-2008, on the southeast portion of block B from 2004-2008, and on

the field trial area in 2004. On Caswell Game Land, surveys were conducted on the CURE area and on the Frogsboro tract from 2004 - 2008. These surveys were designed to evaluate management practices at the 5000 acre "landscape" scale as well as at the 3-50 acre "forest stand" scale, in addition to providing inventory data.

Densities of wintering birds were measured using a strip transect technique. Up to four, 20 x 100m transects were surveyed within each management unit. Forest stands and fields were stratified by habitat type and randomly selected. Habitats on Sandhills included natural longleaf, restored longleaf, drain, field, and hedgerow while on Caswell we surveyed pine, hardwood, mixed pine/hardwood, and field. Management practices included timber thinning, clearcuts, controlled burning, herbicide applications, and grass and forb plantings.

Two observers spaced 10m apart recorded each bird seen or heard within the transect, taking care to avoid double-counting birds. The initial transect within a management unit started at a random distance (0-100m) and direction from a convenient location (i.e. next to a road). Subsequent transects were spaced 0-50m from the previous transect and did not come within 90 degrees of the previous transect. Surveys were conducted between January 15 and March 6, between sunrise and noon on mornings with no precipitation, wind <20 mph, and temperature 32 – 60 degrees F.

Results on focal wintering birds at both Caswell and Sandhills Game Lands are presented in the CURE Songbird and Habitat Surveys annual report. A more detailed analysis of all wintering species is pending as of the writing of this report.

Communicating Results

In the past year staff communicated results of songbird surveys to 9 groups and approximately 698 people. Results were communicated primarily to school groups, conservation groups, and natural resources managers through formal talks, programs, and field trips.

B. Target Dates for Achievement and Accomplishment

The 2008 breeding season surveys have been completed, migration surveys will be conducted in the fall of 2008 and spring of 2009, and winter bird surveys will be conducted in January 2009. Field data collection for the nest searching and monitoring, spot mapping, and winter bird survey components of this project will be complete by February 2009. In the coming year we plan to more thoroughly analyze the data, develop reports and publications for lay and professional audiences, and evaluate whether additional surveys are needed to answer critical conservation questions. Long term surveys will continue indefinitely.

C. Significant Deviations

None

D. Remarks

None

E. Recommendations

This project should be continued during the next period.

F. Estimated Cost

$36,864 (including in-kind contributions)

G. Literature Cited

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Prepared By: Jeffrey Marcus, Piedmont Wildlife Diversity Supervisor
Division of Wildlife Management

Annual Performance Report

State: North Carolina

Project Number: T - 9
Amendment Number: 1

Period Covered: July 1, 2007 – June 30, 2008

Grant Title: State Wildlife Grants T-9 (Planning)

Project Title: Western NC Bat Surveys

Objective:

1. To document the diversity of bat species utilizing significant caves, mines, and other roost structures throughout western North Carolina
2. To survey additional habitats potentially occupied by state or federally listed bats
3. To establish baseline information on western North Carolina bat population relative abundance through regular mist-netting and hibernacula surveys
4. To provide technical guidance related to bat populations and their habitats for use by the public, cooperating state and federal agencies, and in support and revision of North Carolina's Wildlife Action Plan

A. Activity

During fiscal year 2007-2008, Wildlife Diversity staff continued efforts to identify significant bat roosts and gather baseline information on species distribution and relative population status throughout western North Carolina. In order to accomplish objectives, a variety of different survey techniques were employed including hibernacula counts at caves and mines, summer and transitional/migratory roost surveys at bridges and structures, and summer mist net surveys at various non-roost sites.

Survey efforts for winter roosts were prioritized based on historical significance, recently acquired data, and recommendations of regional agencies and bat conservation organizations (e.g. USFWS, USFS, NPS, TNC, SBDN). High priority sites are scheduled to be surveyed every two years and contain state and/or federally listed species. Medium priority sites will be surveyed every three years and contain large numbers of non-listed bats, some special concern species, and/or potentially threatened and/or endangered species records. Low priority sites will be surveyed in a four year rotation and contain occasional special concern species and/or low number of bats, but have the potential of becoming significant.

Hibernacula counts took place in January and February. Hibernating bats are sometimes difficult to identify due to roost location (e.g., height, obstructed views, mixed colonies). Identification of "out of reach" individuals and/or colonies was made to the best of the biologist's abilities based on bat size and coloration. If uncertain, bats were recorded as unknown or identified to genus if possible. To reduce disturbance of bats, the number of researchers was generally limited to 2 or 3 and minimal time was spent in the hibernacula.

Summer mist netting efforts were conducted from mid-May to mid-August. Additionally, two structures were searched for bat use, one of which was searched in late August and the other in mid September. The roost structures surveyed included a bridge and a house. Observed bats were identified and counted. Mist net surveys involved setting 2 to 7 mist nets at each site in suitable habitat and flight corridors. Net placement tended to be associated with natural stream corridors, logging roads, or other geographical/structural features that funneled bat activity. Mist nets were opened at dusk and generally run for 5 hours. All bats captured were identified, weighed, sexed, aged, and released. Only priority bat species were banded. Federally endangered bats were fitted with radio transmitters and tracked to roost trees. Emergence counts were conducted at each roost to determine number of individuals utilizing the roost. No surveys were conducted during precipitation events.

During hibernation counts, eight sites (4 caves/cave complexes and 4 mines) in three counties were surveyed (Figure 1 and Table 1). A total of 1206 bats were counted, representing six species (Table 2). One Indiana bat (state and federally endangered), 67 eastern small-footed bats (state special concern), and 35 northern long-eared bats (state special concern) were observed during these surveys.

Figure 1. North Carolina Wildlife Resources Commission hibernacula survey locations in the mountain region, January to February 2008.

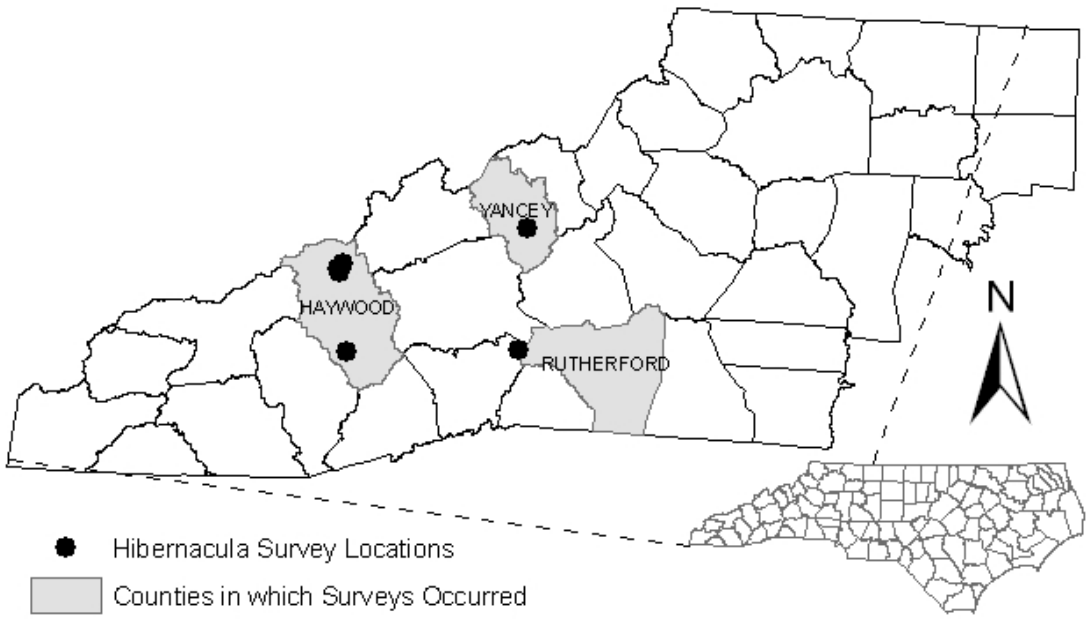


Table 1. North Carolina Wildlife Resources Commission bat hibernacula survey locations and species assemblages in the mountain region, January 15th to February 29th 2008.

Site Name	County	Ownership	Survey Date	Type	Species	N
Big Ridge Mine	Haywood	City of Waynesville	1/28/2008	Mine	Myotis lucifugus	304
					Myotis leibii	56
					Myotis septentrionalis	31
					Myotis species	3
					Myotis sodalis	1
					Pipistrellus subflavus	Many
						395
Raf Bat Cave	Haywood	USFS (Pisgah National Forest)	2/18/2008	Cave	Pipistrellus subflavus	**1**
Shelton Laurel Rd/Fines Creek Mine	Haywood	Private	2/18/2008	Mine	Pipistrellus subflavus	**9**
Wilkins Creek Mine	Haywood	Private	2/18/2008	Mine	Pipistrellus subflavus	**3**
Amazing Bat Cave	Rutherford	The Nature Conservancy	2/7/2008	Cave	Pipistrellus subflavus	**10**
Campbell's Cavern	Rutherford	The Nature Conservancy	2/7/2008	Cave	Pipistrellus subflavus	95
					Myotis species	32
					Myotis lucifugus	17
					Myotis leibii	6
					Eptesicus fuscus	1
						151
Bat Cave (Big and Little)	Rutherford	The Nature Conservancy	2/7/2008	Cave	Pipistrellus subflavus	77
					Myotis leibii	5
						82
Isom Mica Mine	Yancey	USFS (Pisgah National Forest)	2/25/2008	Mine	Myotis lucifugus	330
					Pipistrellus subflavus	220
					Myotis septentrionalis	4
					Eptesicus fuscus	1
						555

Table 2. North Carolina Wildlife Resources Commission summary of bat species observed during hibernacula surveys in the mountain region, January 15th to February 29th 2008.

Species	Number
Little Brown Bat (*Myotis lucifugus*)	651
Eastern Pipistrelle (*Pipistrellus subflavus*)	415
Eastern Small-footed Bat** (*Myotis leibii*)	67
Northern Long-eared Bat** (*Myotis septentrionalis*)	35
Myotis sp.	35
Big Brown Bat (*Eptesicus fuscus*)	2
Indiana Bat**** (*Myotis sodalis*)	1

*state significantly rare
**state listed special concern
***state listed threatened
****state and federally listed endangered

Twenty-two sites in four counties were surveyed with mist nets (Figure 2). A total of 120 net hours yielded 208 captures representing nine species (Table 3). Additionally, roost surveys were conducted at two sites in Buncombe and Swain Counties resulting in 13 bats captured or observed representing two species (Table 4). Combined efforts for mist net and roost surveys, excluding hibernacula surveys yielded 221 total bats representing nine species (Table 5). Significant captures or observations included four Indiana bats (state and federally endangered), 40 northern long-eared bats (state special concern), and 10 eastern small-footed bats (state special concern), 13 silver-haired bats (state listed as significantly rare), and four hoary bats (state listed as significantly rare).

Figure 2. North Carolina Wildlife Resources Commission mist net surveys in the mountain region, July 1, 2007 to June 30, 2008.

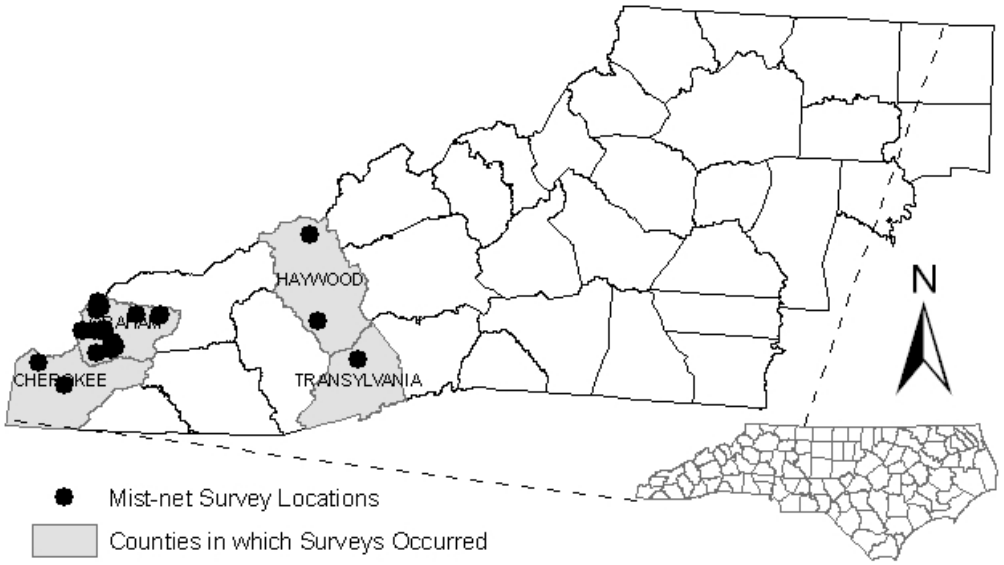


Table 3. North Carolina Wildlife Resources Commission mist net survey locations and bat species assemblages in the mountain region, July 1, 2007 to June 30, 2008.

Site Name	County	Ownership	Survey Date	Species	N
Haven Lane	Cherokee	Eastern Band	5/19/2008	Myotis septentrionalis	1
Rifle Range		of Cherokee	5/27/2008	None	0
		Indians			**1**
North Shoal Creek/FS 408	Cherokee	USFS (Nantahala National Forest)	5/28/2008	Myotis sodalis	**1**
Barker Creek	Graham	USFS	6/3/2008	Myotis septentrionalis	5
		(Nantahala		Lasionycteris notivagans	2
		National		Lasiurus borealis	2
		Forest)			**9**
Bear Creek	Graham	USFS	6/3/2008	Myotis septentrionalis	5
		(Nantahala		Lasiurus borealis	2
		National		Eptesicus fuscus	1
		Forest)		Lasionycteris notivagans	1
				Myotis sodalis	1
					10
John's Branch	Graham	USFS	6/2/2008	Lasiurus borealis	3
		(Nantahala		Lasionycteris notivagans	2
		National		Lasiurus cinereus	1
		Forest)		Myotis septentrionalis	1
				Myotis sodalis	1
			6/3/2008	Myotis septentrionalis	1
			6/17/2008	Myotis lucifugus	1
				Myotis septentrionalis	1
					11
King Meadows	Graham	USFS	6/2/2008	Myotis septentrionalis	4
Trail		(Nantahala		Lasiurus borealis	3
		National		Eptesicus fuscus	1
		Forest)		Lasionycteris notivagans	1
				Lasiurus cinereus	1
				Myotis lucifugus	1
					11
Laurel Branch	Graham	USFS	6/3/2008	Myotis lucifugus	7
FS 2537		(Nantahala		Myotis septentrionalis	2
		National		Eptesicus fuscus	2
		Forest)		Lasiurus borealis	2
				Pipistrellus subflavus	1
					14
Little Snowbird	Graham	Eastern Band	6/2/2008	Lasiurus borealis	3
Creek Park		of Cherokee		Lasionycteris notivagans	2
		Indians		Pipistrellus subflavus	2
					7

Table 3 (contd.). North Carolina Wildlife Resources Commission mist net survey locations and bat species assemblages in the mountain region, July 1, 2007 to June 30, 2008.

Site Name	County	Ownership	Survey Date	Species	N
Lower Cornsilk/FS 2385	Graham	USFS (Nantahala National Forest)	6/2/2008	Lasionycteris notivagans Lasiurus borealis	1 1 **2**
ORV Road/Santeetlah Creek	Graham	USFS (Nantahala National Forest)	6/2/2008	Myotis septentrionalis Myotis leibii	2 1 **3**
Rattler Ford	Graham	USFS (Nantahala National Forest)	6/2/2008	Myotis septentrionalis	**2**
Santeetlah Creek	Graham	USFS (Nantahala National Forest)	6/3/2008	Myotis septentrionalis Lasiurus borealis Myotis lucifugus	4 2 1 **7**
Santeetlah Creek 1	Graham	USFS (Nantahala National Forest)	6/2/2008	Lasionycteris notivagans Myotis lucifugus Lasiurus borealis Pipistrellus subflavus	2 2 2 1 **7**
Santeetlah Rock	Graham	USFS (Nantahala National Forest)	6/12/2008	Eptesicus fuscus Lasiurus borealis Myotis lucifugus	1 1 1 **3**
Stecoah Creek/FS 2537	Graham	USFS (Nantahala National Forest)	6/3/2008	Myotis septentrionalis Eptesicus fuscus Lasionycteris notivagans	3 1 1 **5**
Tapoco Trail	Graham	USFS (Nantahala National Forest)	6/2/2008	None	**0**
Upper Long Branch	Graham	Eastern Band of Cherokee Indians	6/3/2008	Myotis septentrionalis Lasionycteris notivagans Lasiurus borealis	2 1 1 **4**
Whigg Branch/FS 81C	Graham	USFS (Nantahala National Forest)	6/25/2008 6/30/2008	Lasiurus borealis Myotis septentrionalis Lasiurus cinereus Myotis sodalis Eptesicus fuscus Myotis lucifugus Lasiurus borealis	4 2 2 1 1 1 1 **12**

Table 3 (contd.). North Carolina Wildlife Resources Commission mist net survey locations and bat species assemblages in the mountain region, July 1, 2007 to June 30, 2008.

Site Name	County	Ownership	Survey Date	Species	N
Yellow Creek Gap	Graham	USFS (Nantahala National Forest)	6/18/2008	Myotis septentrionalis	3
				Lasiurus borealis	2
					5
Big Ridge Mine	Haywood	City of Waynesville	10/16/2007	Pipistrellus subflavus	50
				Myotis lucifugus	6
				Myotis leibii	1
				Myotis septentrionalis	1
					58
Pigeon River	Haywood	USFS (Pisgah National Forest)	7/23/2007	Myotis lucifugus	**2**
Davidson River/Pisgah Education Center	Transylvania	USFS (Pisgah National Forest)	7/11/2007	Myotis lucifugus	11
				Pipistrellus subflavus	2
			7/25/2007	Myotis lucifugus	19
				Lasiurus borealis	1
				Myotis septentrionalis	1
					34

Table 4. North Carolina Wildlife Resources Commission roost survey locations and bat species assemblages in the mountain region, July 1, 2007 to June 30, 2008.

Site Name	County	Ownership	Survey Date	Species	Number
311 Rocky Fork Road	Buncombe	Private	7/8/2007	Myotis leibii	**2**
Fontana Lake Bridge*	Swain	NCDOT	8/27/2007	Myotis leibii	5
				Myotis lucifugus	5
			9/17/2007	Myotis leibii	1
					11

* potential migratory or transitional roost surveyed outside typical summer and winter sampling timeframes

Table 5. North Carolina Wildlife Resources Commission summary of roost and mist net surveys in the mountain region, July 1, 2007 to June 30, 2008.

Species	Number
Little Brown Bat (*Myotis lucifugus*)	57
Eastern Pipistrelle (*Pipistrellus subflavus*)	56
Northern Long-eared Bat** (*Myotis septentrionalis*)	40
Eastern Red Bat (*Lasiurus borealis*)	30
Silver-haired Bat* (*Lasionycteris notivagans*)	13
Eastern Small-footed Bat** (*Myotis leibii*)	10
Big Brown Bat (*Eptesicus fuscus*)	7
Hoary Bat* (*Lasiurus cinereus*)	4
Indiana Bat**** (*Myotis sodalis*)	1

*state listed significantly rare
**state listed special concern
***state listed threatened
****state and federally listed endangered

B. Target Dates for Achievement and Accomplishment

On schedule.

C. Significant Deviations

None

D. Remarks

During fiscal year 2006-2007, hibernacula surveys in Haywood County at Big Ridge Mine revealed 108 eastern small-footed bats (state special concern) documenting the largest known hibernacula of this species in the southeast. This project year, Wildlife Diversity staff returned to the site to verify that last year's roost data was not just an anomaly. A total of 56 eastern small footed bats were observed. Although the number of bats observed this year was significantly lower than last year, it is possible that the bats shifted their roost location to an inaccessible part of the mine due to microclimate fluctuations. In order to gain a better understanding of microclimate conditions, temperature and humidity data loggers were installed at roost locations were eastern small footed bats were most concentrated. Hibernacula counts coupled with microclimate data collection should continue at this mine in an effort to gain more knowledge of roost characteristics, conditions, and relative abundance.

Another noteworthy finding during the hibernacula survey at Big Ridge Mine was the discovery of a male Indiana bat. The Indiana bat was observed roosting in a cluster of approximately 20 little brown bats. This occurrence documentation is the only known hibernation record for this species in Haywood County.

Wildlife Diversity staff hosted a two day bat blitz in early June 2008 in Graham County. Of the 22 sites surveyed this fiscal year 14 sites on USFS and Eastern Band of Cherokee Indian (EBCI) land were surveyed during the blitz. Participants/partners included the EBCI, USFWS, USFS, NCDOT, UNC Greensboro, NC Museum of Natural Sciences, SE Bat Diversity Network, and several volunteers from NC, KY, and Australia.

Mist net efforts this year yielded captures of four Indiana bats (state and federally endangered) at four different sites in Cherokee and Graham Counties, 40 northern long-eared bats (state special concern) at 15 sites in Cherokee, Graham, Haywood, and Transylvania Counties, two eastern small footed bats (state special concern) at two sites in Graham and Haywood Counties, 13 silver-haired bats (state significantly rare) at nine sites in Graham County, and 4 hoary bats (state significantly rare) at three different sites in Graham County. All sites where priority species were documented are new distribution records.

Radio telemetry surveys were conducted on one pregnant female and three male Indiana bats documenting two colonies. The female was captured in Cherokee County and tracked to a yellow pine snag which consisted of approximately 14 individuals. The three male bats were captured in Graham County. Of the three male bats fitted with transmitters we were only able to locate two, both of which were roosting in large hemlock snags. Emergence counts were conducted at one of the hemlocks that appeared to have more potential roost locations with better sun exposure. Thirty-one individuals were observed emerging from the large hemlock snag. Although a male Indiana bat was tracked to this roost tree, behavior of the bats during emergence suggests the roost is likely that of a maternity colony.

E. Recommendations

We continue to gather data which solidifies our understanding of the regional bat populations as a result of this work over the last several years. Much has been accomplished, but much remains to be done. We cannot rely upon individual counts of roost sites to determine their regional significance, nor can we gauge population changes through time against such data. We must continue to seek out significant bat roosts to periodically census. We must continue to cooperate with other agencies and individuals to compile bat data into our comprehensive database built for this project, and we must continue regular surveys of known bat roosts to develop the baseline from which we will assess population trends into the future.

F. Estimated Cost

$34,386 (including in-kind contributions)

Prepared By: Scott Bosworth
Division of Wildlife Management

Annual Performance Report

State: North Carolina

Project Number: T - 9
Amendment Number: 1

Period Covered: July 1, 2007 – June 30, 2008

Grant Title: State Wildlife Grants T-9 (Planning)

Project Title: Western NC Reptile Inventories

Objective:

1. To survey and monitor for rare and high priority reptiles throughout western North Carolina, including established sites, new sites, and "re-discovery" of historic sites.
2. To assess (when possible) the relative abundance as well as the requirements and availability of habitat for rare or poorly known reptiles throughout western North Carolina.
3. Provide information regarding the status and distribution of reptiles (technical guidance) to state and federal agencies and other organizations/individuals that will further the goals of the North Carolina Wildlife Action Plan as well as the individual landowners.

A. Activity

This year's activities included continued efforts on the bog turtle project, the design and implementation of a new statewide mark-recapture box turtle study, the set up of 10 artificial cover study sites designed to target priority snakes and lizards, and increased efforts with aquatic turtle trapping. There are 14 reptile species considered priority in the mountain region (Table 1). One species is federally and state listed as Threatened (bog turtle), five species are listed as Special Concern in North Carolina, and the others are considered priority species according to the North Carolina Wildlife Action Plan (NC Wildlife Resources Commission, 2005) due to possible declines and insufficient information about their distribution and status.

Table 1. North Carolina Wildlife Resources Commission target reptile species of western North Carolina.

Scientific Name	Common Name	State Status	Federal Status
**Apalone spinifera spinifera*	Eastern spiny softshell	SC	
**Glyptemys muhlenbergii*	Bog turtle	T	T (S/A)
**Crotalus horridus*	Timber rattlesnake	SC	
**Eumeces anthracinus*	Coal skink		
Heterodon platirhinos	Eastern hog-nosed snake		
Lampropeltis calligaster rhombomaculata	Mole kingsnake		
Lampropeltis getula getula	Eastern kingsnake		
Opheodrys vernalis	Smooth greensnake	SC	
Ophisaurus attenuatus longicaudus	Eastern slender glass lizard		
**Pituophis melanoleucus melanoleucus*	Northern pinesnake	SC	
**Sternotherus minor peltifer*	Stripe-necked musk turtle	SC	
Thamnophis sauritus sauritus	Common ribbonsnake		
Virginia valeriae valeriae	Eastern smooth earthsnake		
Terrapene carolina	Eastern box turtle		

SC = Special Concern Species
T = Threatened Species
* Tracked by NC Natural Heritage Program

Bog Turtles

During 2007-2008 we continued to compile existing data in cooperation with the largest and most active group of private citizen volunteers, Project Bog Turtle, made up of members of the North Carolina Herpetological Society. We entered historical and current data into a Microsoft Access™ database which will serve as the eventual permanent storage medium for all bog turtle data generated in the state. We also continued to communicate and foster working relationships with project collaborators including private groups, non-governmental organizations, federal agencies, and citizen volunteers. Other miscellaneous activities this year included obtaining proper permits for sampling on public and private property within the state, meeting with landowners to discuss options for protecting their land, and training new volunteers to assist with bog turtle surveys and trapping.

Bog turtle surveys began in April with extensive efforts from volunteers and inter-agency collaborators. Ninety-one bog turtles (including 46 new individuals) were captured during 62 site visits (Table 2). Compared to sampling efforts in 2006-2007, we sampled fewer sites this year but captured about the same number of turtles (Figure 1). The number of sites visited is lower than last year due to efforts to improve and standardize our data collection methods and due to a new bog turtle survey period planned for the end of September 2008 that will be summarized in next year's report. During surveys for bog turtles in McDowell County, a mud turtle (*Kinosternon subrubrum*) was found. This may be a new county record and is most definitely valuable information in terms of improving our knowledge of the distribution of this species in North Carolina.

Table 2. Summary by NC County of reported survey visits from July 1, 2007 – July 31, 2008 to known and potential bog turtle (*Glyptemys muhlenbergii*) sites, the number of new sites with bog turtles discovered, and the number of new and recaptured bog turtles found. Note that a multiple-day trapping period was only counted as one visit and that some sites were visited more than once.

NC County	Known Sites	Potential Sites	New Sites Discovered	Total Visits	New Turtles	Recaptured Turtles	Total Captures
Ashe	11	1	1	13	16	15	31
Avery	1	0	0	1	0	0	0
Buncombe	4	0	0	4	3	3	6
Burke	1	0	0	1	0	0	0
Clay	2	0	0	2	0	0	0
Gaston	1	0	0	1	0	8	8
Henderson	7	0	0	7	1	2	3
Macon	10	2	0	12	1	1	2
McDowell	2	0	0	2	1	0	1
Surry	1	4	0	5	0	0	0
Transylvania	3	0	0	3	0	0	0
Wilkes	11	0	0	11	24	16	40
TOTALS	**54**	**7**	**1**	**62**	**46**	**45**	**91**

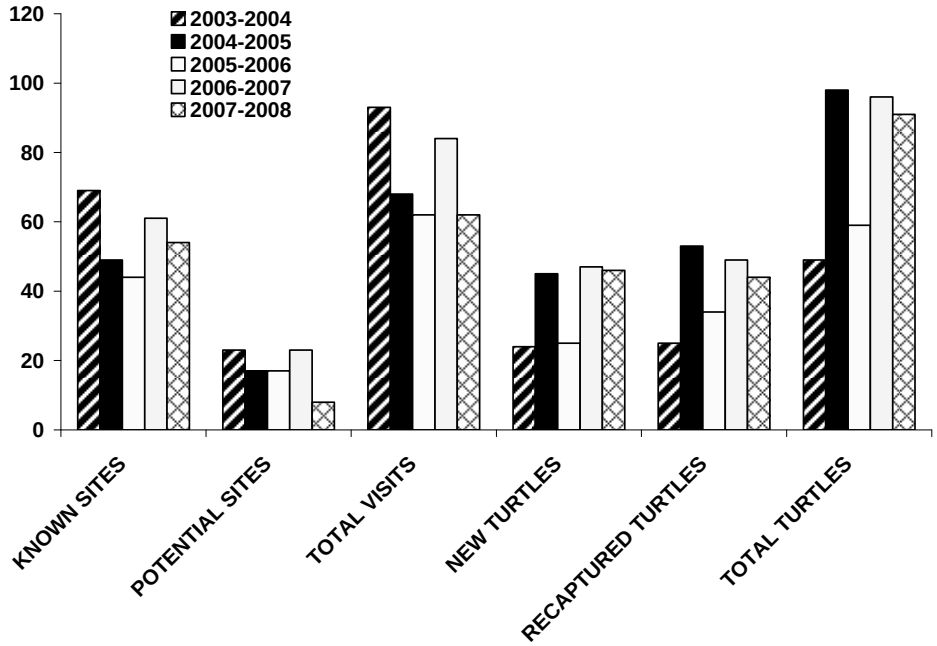


Figure 1. North Carolina Wildlife Resources Commission bog turtle site visits and survey results shown for every year beginning with the 2003-2004 fiscal year and up to the 2007-2008 fiscal year.

During the past year, we used trapping and mark-recapture techniques to sample known and potential bog turtle sites (Table 3). Six sites were trapped and a total of 10 turtles were captured, one of which was a previously unmarked turtle. We saturated every moist area at McClure's Bog with bog turtle traps in an effort to detect the presence of a bog turtle at this historic site, but no bog turtles were captured. We captured two bog turtles (one new, one recapture) at White Oak Bottoms in Macon County, thereby documenting the continued presence of this species at this wetland complex. No turtles were captured at the two potential new bog turtle sites that we trapped at (DuPont State Forest and 7-Falls Development).

Table 3. Sites trapped for bog turtles in FY 2007-2008. The site and county are shown, along with the number of trap nights, the number of new turtles found, and the number of recaptured turtles found at each site.

SITE	COUNTY	TRAP NIGHTS	NEW TURTLES	RECAP TURTLES
Dupont State Forest	Transylvania	500	0	0
Friday Bog	Gaston	336	0	8
McClure's Bog	Henderson	300	0	0
7-Falls Development	Henderson	460	0	0
White Oak Bottoms	Macon	400	1	1
Hurricane Creek	Macon	288	0	0
TOTALS		**2284**	**1**	**9**

Aquatic Turtles

The focus this year with aquatic turtles has been on stripeneck musk turtles (*Sternotherus minor peltifer*) and eastern spiny softshell turtles (*Apalone spinifera spinifera*), both of which are state listed Special Concern species in the mountain region of North Carolina. As very little is known about their biology, habitat use, and distribution and status in western North Carolina, our main objective has been to learn more about these species' distributions in this area and obtain basic information about their habitat use. We set turtle hoop traps on five occasions from May – October 2007 and once in July 2008, and plans are in place to trap three more times during August and September 2008. Traps were set for three trap nights during each trapping event. This trapping method is more effective for the stripeneck musk turtle than the eastern spiny softshell. As so little is known about the stripeneck musk turtle, the two areas with known populations will be trapped on an annual basis to learn more about these populations and improve our understanding of their habitat use.

In total, five locations were trapped, with one site trapped two times (Table 4). All turtles captured were measured and marked before released as an effort to learn more about both the rare and common aquatic turtle species in the mountain region. Other species captured include the snapping turtle (*Chelydra serpentina serpentina*), common musk turtle (*Sternotherus odoratus*), and painted turtle (*Chrysemys picta picta*). Of special note is the capture of three new species and/or subspecies to North Carolina, including an adult map turtle (either *Graptemys ouachitensis* or *Graptemys geographica*) in Shuler Creek within the Hiwassee River drainage, and two juvenile cumberland sliders (*Trachemys scripta troosti*) and one adult red-eared slider (*Trachemys scripta scripta*) in the French Broad River near Huff Island (Madison Co.).

Table 4. Aquatic Turtle Trapping between May 2007 and July 2008 for stripeneck musk turtles (*Sternotherus minor peltifer*) and eastern spiny softshell turtles (*Apalone spinifera spinifera*).

Trapping Site	County	Month/Year	Target species (# captured)
French Broad River at Biltmore Estate	Buncombe	May 2007	Apalone spinifera spinifera (2)
French Broad River and ponds at Broadmoor Golf Course	Henderson	July 2007	Apalone spinifera spinifera (1)
French Broad River at Paint Rock Creek	Madison	August 2007	Sternotherus minor peltifer (6)
Shuler Creek	Cherokee	August 2007	Sternotherus minor peltifer (5)
Sandy Bottoms pond	Buncombe	October 2007	none captured
French Broad River at Paint Rock Creek	Madison	July 2008	Sternotherus minor peltifer (2)

Box Turtles

Box turtles, the state reptile of North Carolina, are believed to be declining across the state due to several different threats, potentially including habitat loss, road mortality, the pet trade, and disease. Little is known about the status of most box turtle populations in North Carolina and surveys, monitoring, and research are needed to increase our knowledge of this species. The general feeling among biologists in the state is that they are likely declining in many areas, but that some populations may still be doing fairly well. There is a need to learn more about both the healthy and the declining populations.

A state-wide box turtle project encourages the public to submit locality information of box turtles to the NC Partners in Amphibian and Reptile Conservation website (www.ncparc.org) via the Carolina Herp Atlas (www.carolinaherpatlas.org). This information could be useful in expanding our knowledge of the box turtle's distribution in North Carolina and in alerting us to particular problem areas for box turtles (e.g., roadways, railroad tracks), so that we can mitigate the problem if possible. These data will be compiled and summarized in the coming years.

In an effort to better understand the box turtle's status and presumed declines, a collaborative box turtle research group, called "Box Turtle Connection," was formed in 2007 in order to begin planning a state-wide mark-recapture study on box turtles. Representatives of this group include staff from NCWRC, NC State Parks, UNC-Greensboro, Duke University, NC Museum of Natural Sciences, NC Zoo, and Davidson College. The main research objectives of this group are to gather baseline data, as well as information about activity levels, health status, landscape level influences, and to compare among ecosystem types across the state. In April 2008, we held a training session at Haw River State Park with the project leaders of the 2008 pilot year of the Box Turtle Connection study. There are currently 14 project leaders across North Carolina, each running their own mark-recapture study. The data from this year will be evaluated in order to improve our study set up for the following study year. Additional project leaders will be invited in the coming years to join the Box Turtle Connection group. Two box turtle project leaders signed on for the pilot year and are currently collecting data in western North Carolina.

Priority Snakes and Lizards

Visual encounter surveys and road cruising surveys, as well as reported records from other biologists yielded locality information for several other priority reptile species (Table 5). The focus this fiscal year for priority snakes and lizards (Table 1) was on setting up an artificial cover study at 10 sites, while also documenting snakes found alive or dead on the road or through visual encounter surveys. Most of these species are either rare, relatively difficult to detect, or both, so even the best sampling techniques are limited. The best techniques for these species involve visual encounter surveys, road cruising, and setting up artificial cover in ideal habitats. All three methods have been employed this fiscal year.

Table 5. Target snake and lizard species documented in western North Carolina in FY 2007-2008, method employed to find the species, and site and county where observed.

Target Species Observed	Common Name	Sampling Methods	Site (County)
Crotalus horridus	Timber rattlesnake	Road cruising, Visual encounter surveys	Chimney Rock State Park (Rutherford); Black Rock Cliff (Avery); Armstrong Hatchery (McDowell); DuPont State Forest (Transylvania); Pisgah National Forest - Pisgah District (Transylvania); Green River Gameland (Polk)
Eumeces anthracinus	Coal skink	Drift fence/funnel trapping	Green River Gamelands (Polk)
Heterodon platirhinos	Eastern hog-nosed snake	Drift fence/funnel trapping	Green River Gamelands (Polk)
Lampropeltis getula getula	Eastern kingsnake	Road cruising, Visual encounter surveys	Brushy Mountains (Wilkes); Hwy 64 (Transylvania)
Thamnophis sauritus sauritus	Common ribbon snake	Visual Encounter Surveys	Idlewild (Ashe)

Artificial cover is one of the best ways to document snake and lizard species in an area. Placing artificial cover can attract snakes and lizards due to the cover it provides, the potential prey under the cover (e.g., rodents), and because the reptiles can use the cover to thermoregulate as the cover warms up more quickly than the surrounding areas. Artificial cover can be made of many different materials, including plywood and tin and aluminum roofing sheets. In this case, between 35 and 40 sheets of 4 ft x 2 ft sections of tin were placed in transects approximately 20-25 m apart at each site. Artificial cover was set up at ten sites in western North Carolina to target priority snake and lizard species (Table 6). The initial aim with this study is to learn more about the distribution of both rare and common snakes and lizards in the mountain region. Historical data was the main basis for selection of sites, with availability of suitable habitat, property ownership, and accessibility of the property important factors as well. Several of the tin cover sites were set up on WRC game land property with the aim of learning more about the snakes and lizards present on these lands. An advantage of doing this work on land owned and/or managed by the NC WRC is that we have the ability to manage the property.

Table 6. Sites in western North Carolina set up with artificial cover (tin) for a snake and lizard study. GL = Gameland; SP = State Park; NF=National Forest.

Site	**County**	**Property owner**
North Mills River	Henderson	USFS - Pisgah NF
Sandy Bottoms	Buncombe	UNC-Asheville
Pilot Mountain SP	Yadkin	NC State Parks
Chimney Rock SP	Rutherford	NC State Parks
John's River GL	Burke	NC WRC
Nantahala GL	Cherokee	USFS - Cherokee NF
Sandy Mush GL	Buncombe	NC WRC
South Mountains GL	Rutherford	NC WRC
Table Rock Fish Hatchery	Burke	NC WRC
Tulula bog	Graham	NC DOT/EEP

Northern pine snakes, *Pituophis melanoleucus melanoleucus*, have not been sighted in many years in western North Carolina. This species was likely always relatively rare in the mountains and the NC Natural Heritage Program has only three official documented records of this species in the mountain region. The most recent sighting of this species was in 1983, when a newspaper article showed a photo of a pine snake killed by a citizen of the Pleasant Valley Community in Cherokee County. Signs were placed again this year in the Murphy area asking citizens to contact NCWRC if they spotted a pine snake in western North Carolina. Signs were displayed in hunting and fishing stores, farming supply shops, and convenience stores. To date, no observations have been reported.

In collaboration with Western Carolina University, Balsam Mountain Preserve, and the Waynesville Watershed, we have started a radio-telemetry study with timber rattlesnakes (*Crotalus horridus*) to locate dens. In 2007-2008, four snakes were tracked in an effort to locate den sites. While the study has provided interesting movement data, no dens have been located yet and no additional snakes have been added to the study yet.

Finally, staff participated in several important meetings with volunteers, non-governmental organizations, and other state and federal agencies and gave presentations to the public about priority reptiles. At the Project Bog Turtle annual meeting, we provided a summary of sampling activities, results, and habitat management projects underway or planned for the upcoming year. Data compilation and management are integral to successfully meeting the objectives of this project. Outreach efforts to past and current researchers, collectors, and other stakeholders continue to be an invaluable source of data supporting the project. Results of these activities led to collaborative projects, several volunteer contributions, and increased efficiency in achieving project objectives.

B. Target Dates for Achievement and Accomplishment

On schedule

C. Significant Deviations

None

D. Remarks

In summary, in the bog turtle project this year, 62 site visits were made to bog habitats, including trapping efforts for bog turtles at six sites (Table 3), resulting in the observance of 46 new and 45 recaptured bog turtles (Table 2). Bog turtle presence was confirmed at a new site in Ashe County. Trapping efforts yielded nine recaptured bog turtles and one new turtle. In FY 2007-2008, fewer site visits were made, but about the same number of turtles were captured as last year (FY 2006-2007).

In the aquatic turtle surveys and trapping project, three eastern spiny softshell turtles (*Apalone spinifera spinifera*) and 13 stripeneck musk turtles (*Sternotherus minor peltifer*) were captured. In addition, three new species and/or subspecies were caught, including an adult map turtle (either *Graptemys ouachitensis* or *Graptemys geographica*), two juvenile cumberland sliders (*Trachemys scripta troosti*) and one adult red-eared slider (*Trachemys scripta elegans*).

An ambitious state-wide mark-recapture box turtle study, the Box Turtle Connection, was initiated in 2007-2008, with the assistance of 14 project leaders and collaboration of many partners throughout the state. Another major accomplishment was getting 10 artificial cover sites set up in western North Carolina to target and learn more about the priority and common snakes and lizards in this region.

Projects with timber rattlesnakes and pine snakes are also off to a good start, with public involvement and multi-group collaboration being a major aspect of both of these projects. Records submitted by the public and government agencies have proven invaluable for both of these projects.

E. Recommendations

Much has been accomplished in the last year in terms of increasing our knowledge of the distribution and population status of priority reptiles in western North Carolina, but it is only a beginning. Reptiles, like many amphibians, are often very difficult to find and even the best available techniques are limited for many species. For these reasons, this project needs to encompass several sampling iterations across the range, over multiple years, to provide us the basic distribution and status information necessary to work toward goals established in the North Carolina Wildlife Action Plan (NC Wildlife Resources Commission, 2005).

Numerous historical sites still need to be inspected to assess current land use and status of bog habitat, particularly sites that have not been visited in many years. We might find that many sites have indeed been lost to succession, development, draining, or other impacts. It is imperative that we attempt to locate and survey all known sites. Historical road records should

also be investigated to attempt to find new sites and sources for migrating turtles and possibly to fill in distributional gaps. Our list of potential sites continues to grow as we spend more time in rural areas looking for bog habitats as well as conducting surveys for other taxa in the mountain region. Searches in counties where no known records occur but are in close proximity to known sites (e.g., Haywood, Jackson, Cleveland, Rutherford) should continue to be a priority in order to determine the true range of bog turtles in western North Carolina.

We should continue to nurture positive relationships with private individuals and landowners in order to offer technical guidance and to influence land use practices that will foster long-term protection of bog turtle habitats. There are a host of tools and partner organizations (e.g., land trusts) available to achieve permanent conservation status for bog turtle habitats. Examples of these tools include conservation easements and land acquisition. We must continue to seek and pursue opportunities to employ these methods to permanently protect suitable habitat. As we develop relationships with private landowners, more opportunities for easements and acquisitions will become evident and should be pursued.

Data sharing, collaboration, and coordination of survey efforts must continue with academic researchers, other state and federal agencies, NGOs, and private individuals. Finally, we must find ways to continue to recruit volunteers in order to maximize resources, area covered by surveys, and probability of detecting all target species.

F. Estimated Cost

$101,044 (including in-kind contributions)

G. References

North Carolina Natural Heritage Program. 2006. Natural Heritage Program list of the rare animal species of North Carolina. Raleigh, North Carolina.

North Carolina Wildlife Resources Commission. 2005. North Carolina wildlife action plan. Raleigh, North Carolina.

Prepared by: Gabrielle J. Graeter
Mountain Wildlife Diversity Biologist
NC Wildlife Resources Commission

Annual Performance Report

State: North Carolina

Project Number: T - 9
Amendment Number: 1

Period Covered: July 1, 2007 – June 30, 2008

Grant Title: State Wildlife Grants T-9 (Planning)

Project Title: Western NC Amphibian Inventories

Objective:

1. Compile existing information from all sources (e.g., state, federal, universities, private individuals) regarding the current status of amphibian species in western North Carolina.
2. Conduct inventories to locate and assess populations of rare species.
3. Survey for common, though poorly documented amphibians to assess their populations and trends.
4. Provide information regarding the status and distribution of amphibians to state and federal agencies and other organizations/individuals.

A. Activity

The western region amphibian species list, modified in 2008 with the addition of newly added watch list species from the NC Natural Heritage Program (2008), is composed of 49 salamander species and 15 frog species. Twenty-one salamander species and one frog, mountain chorus frog (*Pseudacris brachyphona*), are all designated as priority species in the NC Wildlife Action Plan (2005). Six salamander species considered State Rare and two watch list species are targets but are not identified as priorities at this time (Table 1).

Data compilation and management are integral to successfully meeting the objectives of this project. Reviewing pending permit applications and reports provide needed data and a means to control data acquisition and impacts of the acquisition on local populations. Outreach efforts in the form of technical guidance workshops and volunteer opportunities offered to past and current researchers, collectors, and other stakeholders continue to be an invaluable source of data and partnerships supporting the project. Results of these activities led to collaborative projects, several volunteer contributions, and increased efficiency in achieving project objectives.

Project sampling methods included visual encounter surveys of specific habitats like rock outcrops, timed day searches of natural cover objects in terrestrial and aquatic habitats, nighttime searches of surface-active salamanders, coverboard searches, and auditory surveys (Heyer et al., 1994).

Table 1. North Carolina Wildlife Resources Commission target salamander species of western North Carolina.

SCIENTIFIC NAME	COMMON NAME	FED STATUS	STATE STATUS
**Ambystoma maculatum*	Spotted Salamander		
**Ambystoma opacum*	Marbled Salamander		
**Ambystoma talpoideum*	Mole Salamander		SC
**Aneides aeneus*	Green Salamander	FSC	E
**Cryptobranchus alleganiensis*	Hellbender	FSC	SC
**Desmognathus aeneus*	Seepage Salamander	FSC	SR
Desmognathus folkertsi	Dwarf Blackbelly Salamander		SR
Desmognathus imitator	Imitator Salamander		W
Desmognathus imitator pop. 1	Imitator Salamander - Waterrock Knob Pop.		SR
**Desmognathus marmoratus*	Shovelnose Salamander		
Desmognathus santeetlah	Santeetlah Dusky Salamander		SR
**Desmognathus wrighti*	Pigmy Salamander	FSC	SR
**Eurycea guttolineata*	Three-lined Salamander		
**Eurycea junaluska*	Junaluska Salamander	FSC	T
**Eurycea longicauda*	Longtail Salamander		SC
**Hemidactylium scutatum*	Four-toed Salamander		SC
**Necturus maculosus*	Common Mudpuppy		SC
Plethodon amplus	Blue Ridge Gray-cheeked Salamander		SR
**Plethodon aureolus*	Tellico Salamander		SR
**Plethodon chattahoochee*	Chattahoochee Slimy Salamander		SR
Plethodon cheoah	Cheoah Bald Salamander		SR
**Plethodon glutinosus*	Northern Slimy Salamander		W
Plethodon jordani	Jordan's Salamander		W
Plethodon meridianus	South Mountain Gray-cheeked Salamander		SR
**Plethodon richmondi*	Southern Ravine Salamander		W
Plethodon shermani	Red-legged Salamander		SR
**Plethodon ventralis*	Southern Zigzag Salamander		SC
**Plethodon wehrlei*	Wehrle's Salamander		T
**Plethodon welleri*	Weller's Salamander		SC
**Plethodon yonahlossee* pop. 1	Crevice Salamander		SC

*NCWAP Priority Species
FSC = Federal Species of Concern
SC = Special Concern Species
SR = State Rare Species
E = Endangered Species
T = Threatened Species
W = Watch List Species

Green Salamanders

Staff completed another year of surveys for green salamanders (*Aneides aeneus*), a state endangered species, by surveying the same random subset (n=20) of all known sites since 2005,

with the exception of one location now in a private, gated development that is off-limits. Another randomly-chosen site will replace this one for surveys in 2008.

Staff and volunteers conducted three independent samples of each site to determine presence of green salamanders. Presence/absence data were analyzed using PRESENCE software to generate a detection probability. This metric will be tracked over time as a way to assess the viability of the disjunct green salamander populations in the state (Hickory Nut Gorge and Southern Blue Ridge). The calculated detection probability, or site occupancy rate, for 2007 was 82%, almost identical to that of 2005 and 2006 (81% each year). In an earlier three-year study (2002-2004), staff observed similar detection probabilities of 82-85%. Staff and volunteers will continue to sample the random subset of sites yearly, as well as survey all other known sites on a multi-year rotation. A total of 138 samples were conducted at randomly-chosen and historical green salamander sites and new, potential sites. Green salamanders were detected in 52 of the samples.

With the help of volunteers, three new locations were documented for green salamanders, two in Dupont State Forest (Henderson County) and one at the Carl Sandburg National Historic Site (NPS) in Henderson County. The observations at the Carl Sandburg property were especially significant because geographically they fell in the middle of the "distributional gap" between the Hickory Nut Gorge population and the Dupont State Forest population. In several other cases, where a known site was considered to be a "site complex" with numerous rock outcrops scattered across a large area, staff and volunteers detected green salamanders in new rocks within those complexes. Since beginning to monitor and inventory green salamanders in 2002, staff and volunteers have since tripled the number of known locations for this species, from less than 40 to now close to 120.

A highlight of the green salamander sampling season was the partnership struck between staff, the Highlands-Cashiers Land Trust, and a private developer to protect a key green salamander site ("Biscuit Rock", Highlands, NC, Macon County) and a buffer around it in a permanent conservation easement. The private developer will still be able to build a single-family home on the lot but will buffer and protect the rock outcrop and arboreal habitat on the site. Several other conservation partners and NGOs were apprised of the situation and also agreed in principal to the planned easement.

Aquatic Salamanders

In late summer 2007 a private landowner reported an observation of a common mudpuppy (*Necturus maculosus*) in the Ivy River (French Broad drainage) in Madison County, a new county record. In the spring of 2008, staff used baited minnow traps (n=186 trap nights) to survey for mudpuppies, but none were found. Aquatic survey techniques (rock-flipping, snorkeling, cobble searches, etc.) yielded a new site record for common mudpuppies in Ashe County, an update of a historical record for larval Junaluska salamanders (*Eurycea junaluska*) in Graham County, and updates of 10 out of 19 historical records for hellbenders (*Cryptobranchus alleganiensis*) in 5 counties (Table 2). In addition, 11 new sites for hellbenders were surveyed, with 5 of those resulting in new site records in 5 counties (Table 2).

Table 2. North Carolina Wildlife Resources Commission selected results for target salamander species from mountain region aquatic surveys, FY 2007-2008.

TARGET SPECIES OBSERVED	COMMON NAME	SITE AND COUNTY
Cryptobranchus alleganiensis	Hellbender	New River SP_221 access (Ashe)
Cryptobranchus alleganiensis	Hellbender	SF New River_NRSP at Kings Creek (Ashe)
Cryptobranchus alleganiensis	Hellbender	SF New River_Todd (Ashe)*
Cryptobranchus alleganiensis	Hellbender	Flat Creek_Black Mtn. (Buncombe)*
Cryptobranchus alleganiensis	Hellbender	Shuler Creek_Jim Brown Rd. (Cherokee)*
Cryptobranchus alleganiensis	Hellbender	Santeetlah Creek_Horse Cove (Graham)
Cryptobranchus alleganiensis	Hellbender	Snowbird Creek_Hwy 143 bridge (Graham)
Cryptobranchus alleganiensis	Hellbender	Snowbird Creek_Big Snowbird Rd._campsite B1 (Graham)
Cryptobranchus alleganiensis	Hellbender	South Mills River_Mills River Baptist Church (Henderson)
Cryptobranchus alleganiensis	Hellbender	South Mills River_community center (Henderson)*
Cryptobranchus alleganiensis	Hellbender	Mills River_Hwy 280 bridge (Henderson)
Cryptobranchus alleganiensis	Hellbender	Nantahala River_3rd bridge upstream from power station (Macon)
Cryptobranchus alleganiensis	Hellbender	French Broad River_Champion Park_ Rosman (Transylvania)
Cryptobranchus alleganiensis	Hellbender	North Fork French Broad River_ Alligator Rock (Transylvania)*
Cryptobranchus alleganiensis	Hellbender	South Mills River_Turkey Pen Gap trailhead (Transylvania)
Cryptobranchus alleganiensis	Hellbender	Looking Glass Creek (Transylvania)
Eurycea junaluska	Junaluska Salamander	Santeetlah Creek_Rattler Ford (Graham)
Necturus maculosus	Common Mudpuppy	SF New River_NRSP at Kings Creek (Ashe)*

* New or Previously Unreported Record

Other Target Salamanders

Staff documented the continued presence of 13 target species at 11 different historical sites and 17 new, or previously unreported, sites (Table 3). Observations of common species were recorded and will be used in the future to track changes in community structure and relative abundance as salamander monitoring continues over time.

Table 3. North Carolina Wildlife Resources Commission selected results for several target salamander species from mountain region surveys, FY 2007-2008.

TARGET SPECIES OBSERVED	COMMON NAME	SAMPLING METHODS USED	SITE(S) AND COUNTY
Ambystoma maculatum	Spotted Salamander	visual encounter surveys; egg mass counts; nighttime surveys of surface active amphibians; coverboard surveys	Sandy Bottom Preserve (Buncombe); Bridal Veil Falls pools (Transylvania)*; Buck Creek pond (Clay); Buck Creek bog (Clay); Nottely River_Die Bend (Cherokee); Cold Mtn Game Land pool_Rt. 215 (Haywood); Chunky Gal bog (Clay); White Oak Bottom (Macon); DuPont SF bog (Henderson)*; Tallulah bog (Graham)*; Rainbow Springs pool (Macon); Richmond Hill Park (Buncombe)*; Rt. 191 roadside pools_Sandy Spring (Buncombe); Wayah Rd. swamp (Macon)*
Ambystoma opacum	Marbled Salamander	visual encounter surveys; coverboard surveys	Sandy Bottom Preserve (Buncombe); Vein Mtn. bog (McDowell)*;
Ambystoma talpoideum	Mole Salamander	visual encounter surveys; coverboard surveys; nighttime surveys of surface active amphibians	Sandy Bottom Preserve (Buncombe); Rt. 191 roadside pools_Sandy Spring (Buncombe)
Desmognathus aeneus	Seepage Salamander	visual encounter surveys; coverboard surveys	Jones Creek (Macon)*; Rainbow Springs creeks and seeps (Macon);
Desmognathus marmoratus	Shovelnose Salamander	visual encounter surveys; coverboard surveys	Rainbow Springs creeks and seeps (Macon);
Desmognathus wrighti	Pigmy Salamander	visual encounter surveys	Roan Mtn._Carvers Gap (Mitchell)*
Eurycea guttolineata	Three-lined Salamander	visual encounter surveys; coverboard surveys	Sandy Bottom Preserve (Buncombe); Rt. 191 roadside pools_Sandy Spring (Buncombe); Biltmore Estate bog (Buncombe)*; Pisgah Hatchery bog (Transylvania)*; Tallulah bog (Graham)*; Clear Creek_Lancaster Rd. (Henderson)*; DuPont SF bog (Henderson)*
Hemidactylium scutatum	Four-toed Salamander	visual encounter surveys; coverboard surveys; nighttime surveys of surface active amphibians	Sandy Bottom Preserve (Buncombe); Rt. 191 roadside pools_Sandy Spring (Buncombe); Rainbow Springs pool (Macon)
Plethodon aureolus	Tellico Salamander	incidental nighttime obs during bat survey	Shuler Creek_FR 408 off Joe Brown Rd. (Cherokee)*
Plethodon cheoah	Cheoah Bald Salamander	visual encounter surveys	Cheoah Bald_Bartram Trail_Appalachian Trail (Graham and Swain)*
Plethodon richmondi	Ravine Salamander	visual encounter surveys	New River SP_Wagoner (Ashe)
Plethodon shermani	Red-legged Salamander	visual encounter surveys; coverboard surveys	Rainbow Springs creeks and seeps (Macon); Cheoah Bald_Bartram Trail_Appalachian Trail (Graham and Swain)*; Firescald Ridge bog (Macon)*
Plethodon ventralis	S. Zigzag Salamander	Coverboard surveys	Richmond Hill Park (Buncombe)

* New or Previously Unreported Record

Frogs and Toads

Staff continued to coordinate the mountain region portion of the NC Calling Amphibian Survey Program (C.A.S.P.) by establishing all randomly-chosen routes (n=32) assigned by the North American Amphibian Monitoring Program (NAAMP), a project of the US Geological Survey (USGS). In addition, staff established five non-random routes in Cherokee, Clay, Buncombe, and Henderson Counties to target certain species or habitats of interest. This survey program will contribute data regarding species diversity and distribution across the mountains. As a Special Concern and priority species, mountain chorus frog continues to require further study. Previously, only seven records were known, all in Cherokee County. On the rainy night of March 19, 2008, staff verified the continued presence of this species at four out of six historical locations, and documented eight new locations in Cherokee County (Table 4). Digital sound recordings were made to confirm species identity.

Table 4. North Carolina Wildlife Resources Commission selected results for mountain chorus frog (*Pseudacris brachyphona*) from auditory surveys in Cherokee County, North Carolina, March 19, 2008.

SITE	SITE STATUS	HABITAT TYPE
Candy Mtn. Rd. at Rt. 294	New	Roadside ditches; ditched pasture
Caney Crk. Rd. at Setting Sun Ln.	Historical	Roadside ditches
Crisp Rd. at Caney Crk. Rd.	New	Small frog pond; ditched pasture
Martin's Crk. Rd. at Crisp Rd.	New	Ditched pasture; remnant wetland
Hedden Rd. at Rockridge Rd.	Historical	Roadside ditches
Hedden Rd. at Summit Ln.	Historical	Roadside ditches; remnant wetland
Hiwassee Dam Access Rd._box 754	New	Ditched pasture; remnant wetland
Rt. 294 at Taylors Ferry Ridge	New	Ditched pasture; remnant wetland
SW of Rt. 294 near Upper Bear Paw Rd.	New	Roadside ditches
Upper Bear Paw Rd._pasture NE side of Rt. 294	New	Ditched pasture; remnant wetland
0.5 mi. Upper Bear Paw Rd. from Rt. 294	New	Ditched pasture; remnant wetland
0.2 mi. NW Crystal Cove_Lower Bear Paw Rd.	Historical	Ditched pasture; remnant wetland; former farm pond

B. Target Dates for Achievement and Accomplishment

On schedule

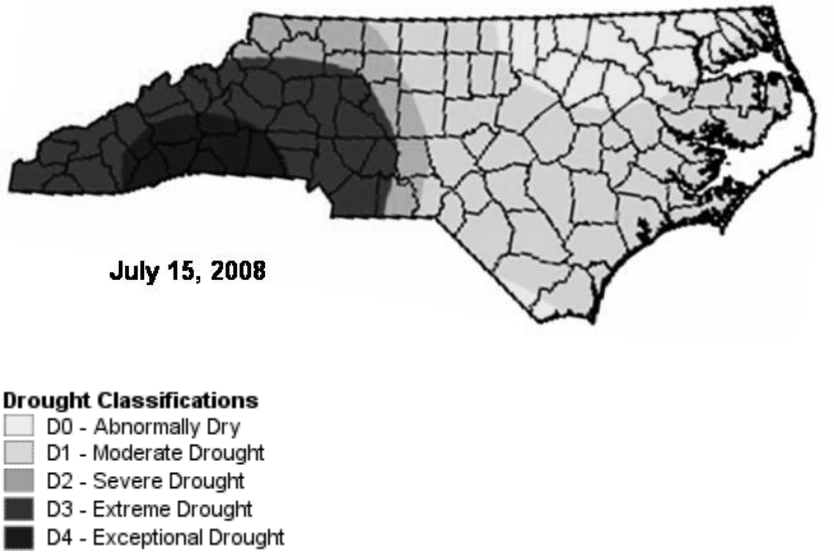
C. Significant Deviations

None

D. Remarks

The historic drought the NC mountain region suffered in 2006-2007 continued in 2008 (Figure 1). Drought conditions only added to the challenge of finding most of our target amphibians. Although a few early spring rains allowed some amphibians to breed, temporary aquatic habitats quickly dried later in the spring and into the summer, stranding many drying egg masses and likely tadpoles or larvae. The effects of three years of consistent drought on local amphibian populations are unknown, particularly in the southwestern counties.

Figure 1. Map of North Carolina depicting drought classification zones; in 2008 the mountain region experienced severe to exceptional drought (NCDWR, 2008).



The majority of historical and newly discovered sites for mountain chorus frogs are in highly disturbed and high-risk sites, such as in ditched and degraded wetlands or roadside ditches. It will continue to be crucial for understanding the status of this species in the state to search for additional occupied sites and monitor closely those deemed at highest risk. Road mortality could be high at roadside ditch sites as well as threats from routine ditch maintenance activities by NC Department of Transportation staff or private landowners. As ditches in pastures (or former wetlands) are maintained by landowners, or as more remnant bogs and wetlands are converted to pasture land or sold for development, the future health and status of mountain chorus frog populations in the state are tenuous. Also, persistent drought conditions might further jeopardize this species.

E. Recommendations

The inherent low detection probability of salamanders (especially rare species) will always provide logistical challenges to overcome in pursuit of project objectives. Since many sampling iterations may be required to document the presence of some of our target species, staff should continue to seek collaboration among researchers and other conservation partners if we hope to meet long-term project goals and objectives.

Salamander taxonomy continues to change. Staff must learn about current research being done in the mountain region and investigate published results regarding taxonomic changes. Target species and locations could change in the future as researchers continue to revise salamander taxonomy.

It is likely that drought patterns will continue or become more frequent in the foreseeable future due to climate change, which will further tax a landscape consistently being developed, fragmented, and degraded. Creating aquatic habitats for amphibians, restoring existing aquatic habitats, and buffering intact corridors around these habitats should be a top priority, as well as long-term monitoring to gauge effects such activities on local amphibian populations. Undoubtedly, these actions will require seeking additional funding and project partners.

F. Estimated Cost

$63,211 (including in-kind contributions)

G. References

Heyer, W.R., M. A. Donnelly, R. W. McDiarmid, L. C. Hayek, and M. S. Foster, eds. 1994. Measuring and monitoring biological diversity: standard methods for amphibians. Smithsonian Institution Press, Washington, D.C., USA. ……

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Prepared by: Lori A. Williams
Mountain Wildlife Diversity Biologist

Annual Performance Report

State: North Carolina

Project Number: T - 9
Amendment Number: 1

Period Covered: July 1, 2007 – June 30, 2008

Grant Title: State Wildlife Grants T-9 (Planning)

Project Title: Western NC Small Mammal Surveys

Objective:

1. To document the continued existence of selected small mammals in western North Carolina
2. To survey for additional locations occupied by those species
3. To assess qualitatively or quantitatively (if possible) the relative abundance of those species

A. Activity

Wildlife Diversity staff resumed survey efforts of select small mammal communities throughout western North Carolina (hereafter termed mountain region). The primary objectives of this project are to document the continued existence of selected mammals at historic locations and survey for additional locations occupied by those species. Species occurrence records in the mountain region were compiled from the NC Natural Heritage Program BCD database (Table 1). Areas previously surveyed in 2003-2007 were mapped using ArcGIS in conjunction with historical locations of target species from the Natural Heritage Program BCD database. Information provided by the ArcGIS map not only identified historical sites that still need verification of the species continued existence but also displayed distributional data gaps for these species.

During this project year, survey efforts were primarily directed towards the expansion of known distributions of rock voles (*Microtus chrotorrhinus carolinensis*), rock shrews (*Sorex dispar*), and water shrews (*Sorex palustris punctulatus*). Wildlife Diversity staff also worked to develop effective survey methods for least weasels (*Mustela nivalis*). An additional survey effort was directed towards verifying continued existence of Allegheny woodrats (*Neotoma magister*) at a historical location.

Table 1. North Carolina Wildlife Resources Commission small mammal project target species, their status, and occurrence records in the mountain region.

Common Name	Scientific Name	NC Status	US Status	Occurrence Records(NC)
Rock Vole	*Microtus chrotorrhinus carolinensis*	SC[1]	FSC[3]	27
Oldfield Mouse	*Peromyscus polionotus*	SR[2]		2
Allegheny Woodrat	*Neotoma magister*	SC	FSC	17
S. Appalachian Woodrat	*Neotoma floridana haematoreia*	SC	FSC	29
Southern Bog Lemming	*Synaptomys cooperi stonei*			10
Rock Shrew	*Sorex dispar*	SC		16
Water Shrew	*Sorex palustris punctulatus*	SC	FSC	9
Least Weasel	*Mustela nivalis*	SR		11

[1] Special Concern
[2] Significantly Rare
[3] Federal Species of Concern

Shrew and vole survey sites were initially selected from occurrence records plotted on the ArcGIS map, but actual sampling locations were determined by visual inspection of suitable habitat at each site. Water shrews utilize the immediate edge of swift-flowing streams with rocks, logs, crevices, and shrubs (Beneski and Stinson 1987). Thus, trapping for water shrews occurred along stream edges in suitable habitats. Rock shrew habitat is generally comprised of wooded, talus slopes with cool, moist, moss-covered rocks (Kirkland 1981). Similarly, rock voles are commonly associated with high elevation sites containing rocks, talus, water, mosses, and forbs (Martin 1971). Therefore, trapping for these species occurred simultaneously in suitable habitats.

Least weasel surveys were primarily conducted at locations with recently verified occurrence records in order to adequately test experimental survey techniques. Throughout its range, least weasels have been documented in variety of habitats from hedge rows on the edges of grassy/cultivated fields to open forest and woodlands. Least weasel habitat selection is determined by local distribution of small rodents (Sheffield and King 1994). Survey efforts in areas with recent occurrence records, were focused in blackberry patches within a cultivated field and adjacent to a chicken coop. Additional surveys were conducted in overburden (rock and coarse woody debris) along the edges of an apple orchard where small rodent abundance was theoretically high.

Allegheny woodrats are typically associated with rocky habitats above 550 m (Ray 2000). Woodrat surveys conducted this project year occurred in rocky habitat at a historical location in

an effort to document continued existence. Specific trap locations within the rocky habitat were selected based on the presence of middens.

Survey methods vary greatly depending on species targeted. Museum Special snap traps are effective in capturing voles and mice. Tomahawk traps are commonly used to capture larger rodents including many species of rats. Pitfall traps have been described as very efficient in capturing shrews (MacLeod and Lethiecq 1963, Wolfe and Esher 1981). However, recent data collected from Wildlife Diversity staff suggests snap traps may be more efficient and effective in capturing rock shrews in the mountain region of North Carolina. Therefore, pitfall traps were used as the sampling method for water shrew, whereas snap traps were used for rock voles, and rock shrews. Snap traps were baited with peanut butter and oats. Tomahawk traps were baited with apple slices to capture woodrats.

Experimental survey methods for least weasels included use of a remote sensor camera, weasel boxes, pitfall traps, and Sherman live traps. A Recon Outdoors Extreme 5.0 digital scouting camera was mounted approximately 30 cm above the ground and 1-2 m from bait. Both still and video modes were used. Weasel boxes used were rectangular plywood boxes with 6 cm diameter holes cut on each end. Two plastic PVC pipe (6 cm diameter x 150 cm) pieces were recessed into each end of the box where a rat trap with a large modified pan was placed below the opening. Pitfall traps used were 10x51 cm PVC pipe sections installed slightly below ground level. All traps and camera stations were baited with frozen feeder mice, least weasel bedding and scat, mouse bedding, chicken liver, or peanut butter and oats.

Fifteen locations including one historical location and 14 new locations in six counties were surveyed (Figure 1). A total of 1043 trap nights (425 snap, 280 pitfall, 271 Sherman, 33 camera, 24 box, and 10 Tomahawk) yielded 110 mammal captures representing 12 species, three of which were target species (Table 2 and Table 3). Southern bog lemmings (*Synaptomys cooperi stonei*) comprised 2.7 percent (N=3) of the sample, whereas, rock shrews and Allegheny woodrats each comprised 1 percent (N=1) (Table 2). No water shrews, rock voles, or least weasels were captured this fiscal year.

Figure 1. Small mammal survey locations in western North Carolina, July 1, 2007 to June 30, 2008.

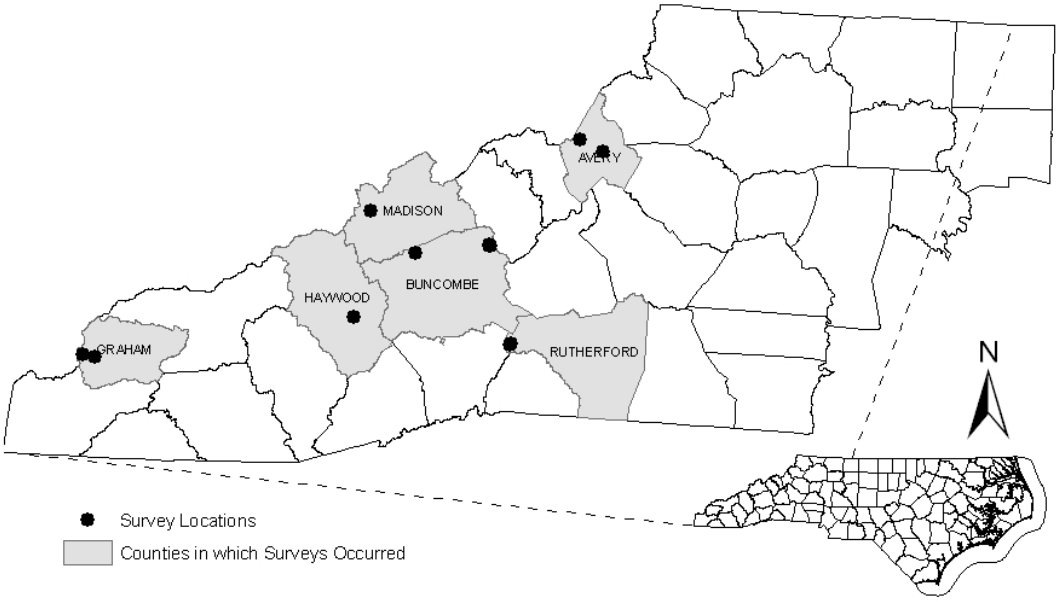

Table 2. North Carolina Wildlife Resources Commission summary of mountain region small mammal captures, July 1, 2007 to June 30, 2008.

Species	N	% of Total Capture
Deer Mouse (*Peromyscus maniculatus*)	42	38.1
Southern Red-backed Vole (*Myodes gapperi*)	13	11.8
Smoky Shrew (*Sorex fumeus*)	13	11.8
White-footed Mouse (*Peromyscus leucopus*)	10	9.1
Hispid Cotton Rat (*Sigmodon hispidus*)	9	8.1
Eastern Cottontail (*Sylvilagus floridana*)	4	3.6
Woodland Jumping Mouse (*Napaeozapus insignis*)	4	3.6
Unknown sp.	4	3.6
Southern bog lemming (*Synaptomys cooperi*)	3	2.7
Northern Short-tailed Shrew (*Blarina brevicauda*)	2	1.8
Masked Shrew (*Sorex cinereus*)	2	1.8
Rock Shrew (*Sorex dispar*)*	1	1.0
Virginia Opossum (*Didelphis virginiana*)	1	1.0
Peromyscus sp.	1	1.0
Allegheny Woodrat (*Neotoma magister*)**	1	1.0

* state listed special concern

** state and federally listed special concern

Table 3. North Carolina Wildlife Resources Commission small mammal survey locations and species assemblages in the mountain region, July 1, 2007 to June 30, 2008.

Site name	County	Property	Start Date End Date	Species	N
Little Hump Mountain	Avery	USFS	27-Aug-07	*Peromyscus maniculatus*	18
Access Trail			30-Aug-07	*Myodes gapperi*	2
Boulderfield I				*Peromyscus sp.*	1
					21
Little Hump Mountain	Avery	USFS	27-Aug-07	*Peromyscus maniculatus*	8
Access Trail			30-Aug-07	*Myodes gapperi*	6
Boulderfield II				*Sorex cinereus*	1
				Sorex fumeus	1
					16
Kentucky Creek	Avery	State Park	14-Apr-08 20-Apr-08	*Blarina brevicauda*	**2**
Walker Falls	Buncombe	USFS	13-Nov-07	*Sorex fumeus*	6
			15-Nov-07	*Peromyscus maniculatus*	5
				Myodes gapperi	1
				Sorex cinereus	1
				Sorex dispar	1
					14
Walker Falls	Buncombe	USFS	13-Nov-07	*Peromyscus maniculatus*	7
Boulderfield			15-Nov-07	*Myodes gapperi*	1
					8
Walker Falls Cliff	Buncombe	USFS	13-Nov-07 14-Nov-07	*Neotoma magister*	**1**
Walker Falls Outcrop	Buncombe	USFS	13-Nov-07 15-Nov-07	*None*	**0**
Sandy Mush/Cedar	Buncombe	NCWRC	05-May-08	*Sylvilagus floridana*	3
Hill Field			08-May-08	*Synaptomys cooperi*	2
				Sigmodon hispidus	1
			12-May-08		
				Sigmodon hispidus	3
			15-May-08	*Unknown sp.*	2
				Didelphis virginiana	1
				Sylvilagus floridana	1
			12-Jun-08		
				Sigmodon hispidus	5
			19-Jun-08	*Unknown sp.*	2
					20
Whigg Branch	Graham	USFS	05-Sep-07 07-Sep-07	*Peromyscus maniculatus*	4
				Myodes gapperi	3
				Napaeozapus insignis	1
					8

Table 3 (contd). North Carolina Wildlife Resources Commission small mammal survey locations and species assemblages in the mountain region, July 1, 2007 to June 30, 2008.

Site name	County	Property	Start Date End Date	Species	N
Cherohala Skyway/Wright Creek	Graham	USFS	04-Sep-07 05-Sep-07	*Synaptomys cooperi*	**1**
Pressley Mountain	Haywood	Private	10-Aug-07 20-Aug-07	*None*	**0**
Chimney Rock Apple Orchard A	Henderson	State Park	04-Feb-08 07-Feb-08	*Peromyscus leucopus*	**10**
Chimney Rock Apple Orchard B	Henderson	State Park	04-Feb-08 07-Feb-08	*None*	**0**
Chimney Rock Apple Orchard House	Henderson	State Park	04-Feb-08 07-Feb-08	*None*	**0**
Long Mountain Branch	Madison	USFS	12-May-08 20-May-08	*Sorex fumeus*	6
				Napaeozapus insignis	3
					9

B. Target Dates for Achievement and Accomplishment

On schedule.

C. Significant Deviations

None

D. Remarks

Wildlife Diversity staff continue to capture target species at new and historical locations throughout the mountain region. Rock shrews were discovered at a new location in Buncombe County. Likewise, persistence of southern bog lemmings was documented at two new locations in Graham and Madison Counties. Additionally, continued existence of Allegheny woodrats was confirmed at a historical location in Buncombe County.

Although least weasel surveys have not been successful, we continue to gather information from citizens and other NCWRC personnel that have incidentally observed, captured, or killed this species. In July 2007, two weasels were observed and photographed in a basement window well by the resident in Buncombe County. Both weasels were able to escape after a stick was placed in the window well. Two other weasels were observed in January 2008, one incidentally killed by a NCWRC staff during routine field management at Sandy Mush Game Land in Madison County. The weasels dispersed from under a rock that was being moved by a tractor. One weasel ran under the tractor tire and the other disappeared into a small burrow. Wildlife diversity staff will continue to experiment with different survey techniques in areas where weasels are known or likely to occur.

Notable accomplishments have been made not only by verifying continued existence of target species at historical locations, but by filling in distributional gaps. However, many historical occurrence records still need verification and many distributional gaps remain. Survey efforts during fiscal year 2008-2009 will primarily be directed towards least weasel, rock vole, Allegheny woodrat, and water shrew.

E. Recommendations

Survey efforts should continue throughout western North Carolina to document the presence and distribution of special concern small mammal species. Through the achievements of this research, it may become apparent that some species are more common than currently recognized and should be considered for delisting, while other species may undoubtedly need stronger conservation efforts. The current species list (Table 1) is only a fraction of those mammalian species in North Carolina that warrant further study. As surveys are completed and species removed from the current list, consideration should be given to include additional species of which scant population status and distributional information exists.

F. Estimated Cost

$ 29,392 (including in-kind contributions)

G. References

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Prepared By: Scott Bosworth
Division of Wildlife Management

Annual Performance Report

State: North Carolina

Project Number: T - 9
Amendment Number: 1

Period Covered: July 1, 2007 – June 30, 2008

Grant Title: State Wildlife Grants T-9 (Planning)

Project Title: Peregrine Falcon Inventory

Objectives:

1. Determine the number of breeding peregrine falcon pairs that attempt to nest in North Carolina (regardless of land ownership)
2. Document the production of peregrine offspring from those sites
3. Comply with the USFWS's monitoring plan for the American peregrine falcon

A: Activity

This report summarizes the 2008 nest survey activities of NCWRC staff and volunteers, providing information regarding the number of territorial pairs and their breeding activity. Surveyed sites include those with previous peregrine nesting activity, sites with suitable habitat, and those with reported peregrine sightings.

The inventory followed protocol set forth in the U.S. Fish and Wildlife Service Monitoring Plan for the American Peregrine Falcon (USFWS 2003). Efforts focused on 13 territories: nine territories where pairs of falcons have been present the past nine years, a site that was newly occupied in 2004 (Buzzard's Roost), a previously used site used this year by the Table Rock pair (NC Wall), a site that was in use for a second year in a row after three years of peregrines being absent (Hanging Rock State Park), and a site discovered in 2007 (Dunn's Rock). Only two secondary sites were checked for falcon activity, but time constraints prevented thorough four-hour observation sessions. Due to staff and volunteer shortages (attributed to rising gas prices) considerably less time was spent observing falcon sites this year compared to last year (230 hours in 2008 versus 300+ hours in 2007) (Table 1). The observation hours do not reflect total effort expended by NCWRC personnel on the peregrine program, only the actual time spent observing at each site. It should be noted that not all of the potential nest sites in western North Carolina were surveyed this year. Given time and budget constraints, complete coverage is impossible. It is quite possible that there were additional nesting sites of which we were unaware.

Table 1. Peregrine Falcon survey efforts at territories in western North Carolina, 2008.

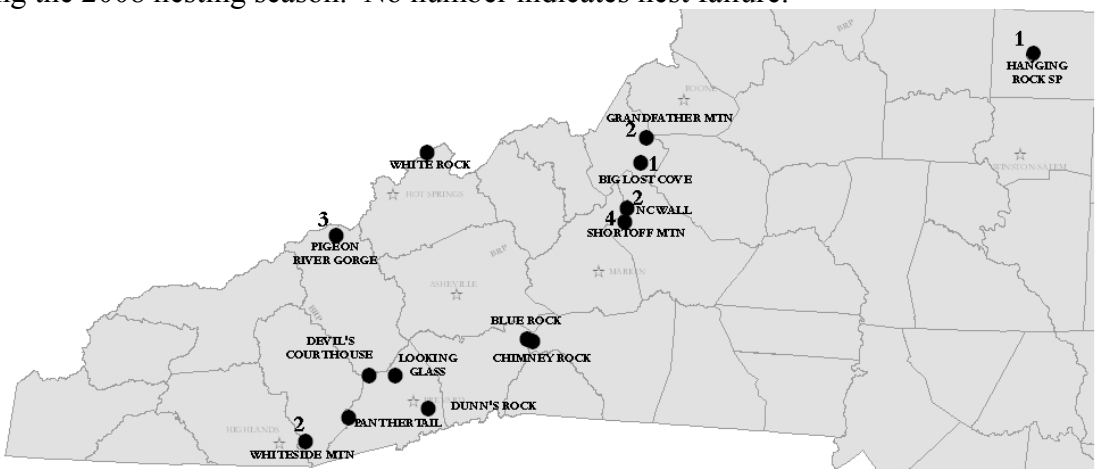
SITE	OBSERVER HOURS	FALCONS OBSERVED	PAIR PRESENT	DETECTED NESTLINGS >28 days old	OBSERVED FLEDGED
Big Lost Cove	25.25	Yes	Yes	No[a]	Yes-1
Hickory Nut Gorge (Blue Rock and Chimney Rock)	33.25	Yes	Yes	No	No
Devil's Courthouse	27.75	Yes	Yes	No	No
Grandfather Mountain	24.0	Yes	Yes	Yes[b] -2	No
Hanging Rock State Park	19.5	Yes	Yes	No[a]	Yes-1
Shortoff Mountain	8.0	Yes	Yes	Yes[b] -4	No
Table Rock [1]	6.0	No	No	No	No
NC Wall	20.5	Yes	Yes	Yes-2	Yes-2
Looking Glass Rock	19.25	Yes	Yes	No	No
Panthertail Mountain	18.0	Yes	Yes	No	No
Pigeon River Gorge	6.0	Yes	Yes	Yes[b] -3	No
Whiterock	8.5	Yes	Yes	No	No
Whiteside Mountain	5.0	Yes	Yes	No[a]	Yes-2
Dunn's Rock	10.0	Yes	Yes	No	No
TOTAL SITES	230.0	13 Sites	13 Sites	4 sites	4 Sites

[a] nestlings never detected; first detected after fledging

[b] at last observation session, nestlings were old enough to count toward nest success (>28 days, per USFWS protocol), but had not yet fledged.

The map of western North Carolina (Figure 1) shows the geographical distribution of the nesting territories as well as the number of nestlings detected at each site. The two sites in the Linville Gorge (Shortoff Mountain and North Carolina Wall) are the two closest nest sites, approximately 2.8 miles apart. Prior to this, the two closest known sites, also in Linville Gorge, were 4.3 miles apart.

Figure 1. Peregrine falcon territories in North Carolina, showing number of nestlings detected during the 2008 nesting season. No number indicates nest failure.



Site Summaries- Primary Sites

Nine of the thirteen territories have had a relatively consistent history of occupancy over the past ten years. Table 2 is a summary of our observations at each site that peregrines attempted to nest in 2008. The date given is the first time each listed stage was observed, and not necessarily the exact date of onset. In most cases, each stage had probably begun prior to the date shown. The notes below the table give more details about each site.

Table 2. North Carolina Wildlife Resources Commission initial observation dates of nesting chronology phases for peregrine falcons at 14 sites in western North Carolina, 2008.

SITE	BONDED PAIR	INCUBATION	CHICKS	FLEDGLINGS Date (Number)	CONFIRMED FAILURE
Big Lost Cove	March 21	April 18	June 2**	June 25 (1)	
Chimney Rock	March 17	March 20 (suspected)			May 27
Devil's Courthouse	April 8	April 22 (suspected)			May 22
Grandfather Mountain	March 10		May 30 (2)	*	
Hanging Rock State Park	March 3		**	June 13 (1)	
Shortoff Mountain	March 12	March 12	April 30 (4)	*	
Table Rock	*Moved to NC Wall*				*Moved to NC Wall*
NC Wall	April 16	April 30	May 29	July 11 (2)	
Looking Glass	March 6	March 28			April 25
Panthertail Mountain	March 6				April 10
Pigeon River Gorge	Feb 26	April 2	May 14 (3)	*	
White Rock Cliff	April 17				July 3
Whiteside Mountain	April 10	April 10	**	May 19 (2)	
Dunn's Rock	March 6				June 5

* Confirmed nestlings >28 days of age earlier in season, but unable to document fledging.

** Suspect nestlings present but unable to obtain a nestling head count until after fledging.

Big Lost Cove (Avery County)

- Result: at least one (1) fledgling.
- Observations: A pair of falcons nested on the lip of a ledge at the base of a section of low-angle rock on the far southwest end of the cliff complex (above a section of white rock we refer to as the amphitheater). We documented incubation, brooding, and defecation by nestlings, but a shrub on the ledge obscured our view of the number or age of the nestlings. We were not able to obtain an accurate head count because they had fledged by the time we returned on June 25. At least one fledgling was active below the cliff during a late season observation session.
- History: Falcons were first discovered at this site in 1997 and have reared eight chicks. They were successful for 4 of the first 5 years. This year was the first successful nesting attempt since 2001.

Chimney Rock (Hickory Nut Gorge, Rutherford County)

- Result: Nest failure
- Observations: A second year male and adult female were on territory at Chimney Rock this year. Signs of incubation and possible food delivery were documented between late March and early May on a ledge where the only previous successful nesting attempt was made. This ledge is above pieces of old climbing equipment. Subsequent observations were of just one bird at a time, neither exhibiting signs of attending a nest.
- History: Only once (1990) during the monitoring program has a pair been successful in raising chicks in Hickory Nut Gorge. The male's age and inexperience may have contributed in part to this nest failure.

Devil's Courthouse (Transylvania County)

- Result: Nest failure
- Observations: The resident pair was extremely elusive until incubation was suspected in late April. By late May, nest failure was evident. The pair remained on territory, frequently perching on the eyrie ledge and roosting on a lower ledge after nest failure.
- History: The pair at Devil's Courthouse has been successful eight of the last nine years raising a total of fourteen chicks. This cliff is a popular tourist attraction on the Blue Ridge Parkway and an easy place for birders to get a good view of the falcons' breeding and chick-rearing activities.

Grandfather Mountain (Avery County)

- Result: Two (2) nestlings
- Observations: The resident male and previous resident female (recognized by distinct facial pattern) were on territory in March, but had not yet settled on a nest ledge. In early April, NCWRC received two reports of a dead falcon on the side of NC 105 between Foscoe and Invershiel. On May 30th, a second year female and adult male were found tending nestling in the traditional eyrie on Lydia Peak. Nestlings were observed at around six weeks of age on two occasions in late June by NCWRC and Grandfather Mountain staff.
- History: Grandfather Mountain is very remote with plenty of rock faces, forcing us to spend a lot of time each year trying to locate the eyrie. This was the first successful nesting attempt since 2003. A total of nine chicks have been raised here.

Hanging Rock State Park (Stokes County)

- Result: at least one (1) fledgling
- Observations: Territory occupancy was documented March 3rd. There is not a clear vantage point to this eyrie and there was not adequate coverage during the late nestling stage in early June. We were not able to obtain an accurate head count because they had fledged by the time we returned. One fledgling was observed on June 13th above the eyrie. Poor flight skill and begging behavior suggested that it had only very recently fledged.
- History: Falcons returned to Hanging Rock in 2007 after a three year absence and have been successful three times (2001, 2007, and 2008) raising at least three chicks, though nestlings were only heard, not seen, in 2007 and we suspected they were less than 28

days old at the time. The falcons face considerable competition from the many ravens and vultures in the area.

Shortoff Mountain (Linville Gorge, Burke County)

- Result: Four (4) nestlings
- Observations: The eyrie was in the same location as last year. Four 4-week old nestlings were observed quite early this year on April 30th.
- History: Linville Gorge was the site of the first nesting attempt since the restoration program began. A pair has been in the gorge at NC Wall, Shortoff, or Gold Coast every year since. Although falcons were largely unsuccessful at first, they have produced 21 fledglings in the past nine years.

Table Rock (Linville Gorge, Burke County)

- Result: Pair moved to NC Wall
- Observations: The pair was not in residence during early visits to the nest site. On April 16th a pair of ravens was found feeding older nestlings in a pothole just above the right turn on climbing route 33. That same day, we located the falcons on a nearby cliff, NC Wall.
- History: USFS personnel reported seeing a peregrine in the vicinity of Table Rock in February 2005. Nesting was first documented in 2006. Observation of a gray fox near the eyrie following nest failure in 2007 is evidence that this eyrie is vulnerable to terrestrial predators.

North Carolina Wall (Linville Gorge, Burke County)

- Result: Two (2) fledglings
- Observations: The pair was located at North Carolina Wall on April 16th following two unsuccessful observation sessions at nearby Table Rock. The eyrie is on the main face of NC Wall, on the lower half of the cliff to the left of the "Direct Action" climbing route. This was the last nest of the season, with onset of egg laying in mid to late April. During a July 10th observation session, it was apparent that the young had only recently fledged.
- History: North Carolina Wall is the site of the earliest post-reintroduction nesting attempts in Linville Gorge (1987-2000). Falcon activity shifted to Shortoff Mountain in Linville Gorge in 1998 and 2000. North Carolina Wall and Shortoff Mountain are now the two closest known nesting sites, less than three miles apart.

Looking Glass (Transylvania County)

- Result: Nest failure
- Observations: Incubation was confirmed March 28th, but signs of nest failure were evident during subsequent visits in April and May.
- History: In 1957, Looking Glass hosted the last known pair of falcons before the species was extirpated from North Carolina. Until very recently, Looking Glass has been one of the most productive sites during the monitoring program. A total of 31 chicks have fledged here, including 16 in the past nine years. The scavenged remains of an adult male peregrine were found at the base of the rock at the end of the 2006 nesting season. There is the possibility that nesting would suffer if a new male was in residence. However, this cannot be proven. Other factors such as climbing and increased

recreational bouldering within the closed area could have contributed to nest failure, and some previously unnoticed climbing equipment was noted above the eyrie in May. The U.S. Forest Service posted new brown closure signs, in keeping with their sign standards. Unfortunately, these are very difficult to see and may contribute to further violations of the closure. Continued cooperation from the climbing community is essential for falcons at this site.

Panthertail Mountain (Transylvania County)

- Result: Nest failure
- Observations: The resident pair was in constant battle with a pair of common ravens that attempted to nest on the upper right side of the cliff. There was never any conclusive evidence that the falcons started nesting.
- History: This is the first incidence of nest failure at this site since 1998. Falcons were first successful at Panthertail in 1995. Since then, 27 chicks have fledged from this site. The landowners have considered developing some of the surrounding area. Past efforts have been made to work with them to minimize the disturbance by having construction take place in the non-breeding time of the year. We hope to keep the development as far from the eyrie as possible. However, no recent contact has been made.

Buzzard's Roost (Pigeon River Gorge, Haywood County)

- Result: Three (3) nestlings
- Observations: The pair returned to the successful 2007 eyrie. Though spacious, the eyrie is exposed to people walking on the path on top of the cliff. Territory occupancy was documented on February 26th, incubation on April 2nd, and nestlings on May 14th.
- History: In 2004, a pair established a territory but nesting was not documented. The pair raised three young during their first nesting attempt in 2005, but experienced nest failure in 2006 when they switched to a nearby ledge. In 2007, they raised four nestlings; the first brood of four in western North Carolina since 2004 when four young were raised at Shortoff Mountain.

White Rock (Madison County)

- Result: Nest failure
- Observations: A second year female and adult male were on territory at White Rock this year. Courtship behavior and copulation were observed in late May, and the female was still on territory exhibiting courtship behaviors in early July.
- History: Peregrines produced five fledglings in two successful nesting attempts in the early 1990's at White Rock, but have struggled in recent years. In 2001, the female was a sub-adult. In 2002, both were adults, but never made a confirmed nesting attempt. In 2004, the pair raised a single chick in a re-nesting attempt, the first success since the early 1990s.

Whiteside Mountain (Jackson County)

- Result: Two (2) nestlings
- Observations: The pair switched ledges once again and used a ledge coined "the Superman eyrie" by staff and volunteers (an S-shaped ribbon of black rock can be seen just above the eyrie and accounts for the name). This is along a climbing route known as

"Promised Land". Only two site visits were made this year; once on April 10th to confirm incubation and again on May 19th to count nestlings. Unfortunately, they had already fledged so an accurate head count was not possible. Two fledglings were observed flying after one of the adults on several occasions during that observation session. This was the only successful nest in the southern mountains this year.

- History: This enormous cliff has been the most successful peregrine falcon breeding site in North Carolina since the beginning of the restoration program in 1984. The size and complexity of the cliff often make it difficult to locate and observe the eyrie. Cooperation from climbers is also needed at this site. A total of 43 chicks (26 in the past nine years) have fledged at Whiteside.

Dunn's Rock (Transylvania County)

- Result: Nest failure
- Observations: There was abundant evidence throughout April that the pair was not nesting. In mid May we observed a possible nest exchange or food delivery. However, subsequent visits proved that the nesting attempt failed.
- History: Prior to 2007, this site had not been checked in five years, and was previously a raven eyrie. There is no way to know when the cliff was usurped by peregrines. The top and bottom of the cliff are owned separately by private landowners. Prior to the discovery of the peregrines, a conservation easement for the top half of the cliff was already being developed. NCWRC biologist obtained permission from landowners below the cliff to watch from their yards. The pair raised two young in 2007; however we were unable to obtain a nestling count after nestlings reached 28 days of age.

Site Summaries- Secondary Sites

Staff and time shortages only permitted surveys of two secondary sites. No sign of falcon activity was found at Chestoa View (Avery County) or Hickorynut Mountain (McDowell County). A broad-winged hawk and turkey vultures were active in front of the largest section of sheer vertical cliff at Chestoa View suggesting there were no falcons in residence. The project leader observed an adult peregrine falcon soaring low over Fontana Lake on May 5, 2008, near Evans Knob and the Flat Branch Boat Ramp during a bald eagle nest survey. We are not aware of any prominent cliffs in the vicinity; further investigation is needed of cliff habitat in the adjacent Great Smoky Mountains National Park.

Technical Guidance

Each year NCWRC provides technical guidance to landowners (e.g., USFS, state parks) and rock climbing groups on potential cliff closures. The USFS and N.C. State Parks post closure signs at their respective sites and establish seasonal closures during the nesting season. This year a new closure was established for the falcons nesting on North Carolina Wall. The USFS posted new, brown closure signs at Looking Glass Rock which are difficult to see and may be overlooked by climbers. The continued cooperation and understanding of climbers is appreciated, and all efforts are made to keep closures to a minimum. It is the goal of NCWRC to accommodate the climbing community with regard to cliff closures while ensuring the success of nesting falcons. Peregrine monitoring suffered the temporary loss of one long-time, exceptionally knowledgeable

volunteer who could only participate on a limited basis this year. Logistic constraints limited thorough coverage of the 13 nest sites by NCWRC staff. In addition to a few relatively new volunteers, a part time volunteer intern assisted with nest monitoring. Since July 2007, volunteers have contributed 396 hours to monitoring nests and accessing eyries; a considerable drop from last year's 544 hours.

B. Target Date for Achievement and Accomplishment

On schedule.

C. Significant Deviations

None

D. Remarks

Population Parameters: Western North Carolina –vs.- National Average

The U.S. Fish and Wildlife Service defines nest success as the percentage of occupied territories in a monitoring region with one or more young >28 days old (USFWS 2003). Productivity is the number of young observer at >28 days old per occupied territory. In North Carolina, nesting success was again lower than the 1999-2002 national average, and productivity dropped below the bounds of the national average (Table 3). Productivity of 1.0 – 2.0 should result in at least a stable population. Despite these nest data, there were three second year falcons on territories this year. These numbers will be sent to the USFWS to combine with results from the southeastern region and then compared to national numbers.

Table 3. North Carolina Wildlife Resources Commission peregrine falcon population health indices; western North Carolina – vs – national average.

	TERRITORIAL OCCUPANCY	NEST SUCCESS	PRODUCTIVITY
North Carolina (2008)	100% (13 of 13 sites)	53% (7 confirmed of 13 pairs)	**1.15 (15 young/13 nesting pairs)
National Average (recent years)	84%	68%	1.2 – 1.9

* Young fledged at three sites before we could obtain a complete count of nestlings (Hanging Rock, Whitesides, Big Lost Cove), so productivity may have been higher than 1.0.

Population Parameters in WNC: 2008 –vs- Past Years

This year's nest survey was compromised by the inability to obtain a complete count of young at Whiteside Mountain, Hanging Rock State Park, and Big Lost Cove. Young had fledged at these three sites by the time we returned for a nestling head count. It is possible additional fledglings were missed. Population parameters are based on thirteen sites, with the following two assumptions: that the Chimney Rock and Blue Rock sites can be lumped together as the Hickory

Nut Gorge territory, and that nests at Grandfather Mountain, Buzzard's Roost, and Shortoff actually fledged chicks, given that nestlings were last detected at >28 days of age based on direct visual assessment. Though the USFWS considers nesting a success when young reach 28 days of age, nestlings still face many hazards before they leave the nest.

This was a dynamic nesting season for peregrine falcons in western North Carolina, characterized by a number of apparent changes in nesting pairs and nest success. For a change, pairs in the northern counties faired better than pairs in the southern counties. Notably, pairs at Big Lost Cove and Grandfather Mountain had successful nesting attempts for the first time since 2001 and 2003, respectively. Nest success was confirmed at another northern site, Hanging Rock State Park, after some uncertainty last year. Among southern nest sites, only Whiteside Mountain was successful. Looking Glass experienced nest failure for the second year in a row. Panthertail Mountain is typically a highly productive site. However, the resident pair was in constant battle with a pair of common ravens. Ravens nested at Panthertail in the early years of the peregrine falcon reintroduction program, but peregrines usurped the cliff from ravens in 1993 and have nested there successfully 11 of the past 16 years. Devil's Courthouse nest failed for unknown reasons for the first time since falcons began nesting there in 1999. These failures significantly impacted what would have otherwise been a productive year for western North Carolina falcons, given the returned success at the northern sites.

Also of note this year was the presence of three, mated second year falcons holding down territories: a female at Grandfather Mountain, a female at White Rock Cliff, and a male at Chimney Rock. Age was estimated by plumage characteristics suggesting an incomplete prebasic molt, resulting in retention of some juvenal feathers. These three individuals appeared half way between an adult and a fledgling in plumage with the following characteristics: head/nape- brownish gray; face- brownish gray and white; back- gray; secondaries and wing coverts- brown; primaries- gray; rump and tail- brown; belly- barring is heavier than adult and lighter than fledgling; skin around eyes and base of bill is gray, not yellow. Of these three, only the second year female and her mate at Grandfather Mountain were successful in raising young. This was a considerable feat given the falcon's age and inexperience combined with the site's elevation (~5400-5500 feet), west-facing aspect, unprotected ledge, and some of the most severe weather in the mountain region. The other two second year birds and their mates managed to hold down territories through nesting season but were not successful in nesting. It is not extraordinary to witness failure of newly established young pair such as this, however it does inspire hope that the birds will try again next season.

Table 4 shows annual territory occupancy and number of young produced at each site. This is the full dataset encompassing the history of the monitoring and restoration program, from 1987-2008. Figure 2 provides a graphical summary of these data. A total of 188 chicks have now fledged in the wild since 1988 (Table 4). After a decrease in productivity in the late 1990's, the past nine years have been particularly strong (Figure 3). In fact, the number of young peregrines fledged from 2000-2008 (130) is over half (69%) of the overall total. If productivity remains this high, there should be additional nesting pairs and a growing population, as evidenced by the presence of three immature birds on territory this year.

Table 4. Peregrine falcon productivity at selected sites in western North Carolina, 1987-2008.

YEAR	STATUS	Big Lost Cove	Chimney Rock	Grandf. Mtn	Hanging Rock State Park	Shortoff Linville Gorge	Table Rock Linville Gorge	NC Wall Linville Gorge	Looking Glass	Panthertail Mountain	Devil's Courthouse & Victory Wall	Whiterock Cliff	Whitesides Mountain	Buzzard's Roost	Dunn's Rock	TOTAL (including sites not listed here)
1987	Territorial Pairs							1								1
	Pairs Rearing Young															
	# Wild Young															
1988	Territorial Pairs							1	1			1	1			4
	Pairs Rearing Young												1			1
	# Wild Young												1			1
1989	Territorial Pairs		1					1	1			1	1			5
	Pairs Rearing Young								1							1
	# Wild Young								2							2
1990	Territorial Pairs		1	1				1	1			1	1			6
	Pairs Rearing Young		1					1				1	1			4
	# Wild Young		3					2				2	3			10
1991	Territorial Pairs		1					1	1			1	1			5
	Pairs Rearing Young												1			1
	# Wild Young												1			1
1992	Territorial Pairs		1					1	1			1	1			5
	Pairs Rearing Young											1	1			2
	# Wild Young											3	2			5
1993	Territorial Pairs		1					1	1	1		1	1			6
	Pairs Rearing Young								1							1
	# Wild Young								4							4
1994	Territorial Pairs		1					1	1	1		1	1			6
	Pairs Rearing Young								1				1			2
	# Wild Young								3				3			6
1995	Territorial Pairs							1	1	1			1			4
	Pairs Rearing Young								1	1			1			3
	# Wild Young								4	2			3			9
1996	Territorial Pairs							1	1	1			1			4
	Pairs Rearing Young							1		1			1			3
	# Wild Young							1		2			4			7

Table 4. Continued.

YEAR	STATUS	Big Lost Cove	Chimney Rock	Grandf Mtn	Hanging Rock State Park	Shortoff Linville Gorge	Table Rock Linville Gorge	NC Wall Linville Gorge	Looking Glass	Panthertail Mountain	Devil's Courthouse & Victory Wall	Whiterock Cliff	Whiteside Mountain	Buzzard's Roost	Dunn's Rock	TOTAL (including sites not listed here)
1997	Territorial Pairs	1	1					1	1	1			1			6
	Pairs Rearing Young	1(?)							1							2
	# Wild Young	2(?)							2							4
1998	Territorial Pairs	1	1			1			1	1		1	1			7
	Pairs Rearing Young	1	1(?)													2
	# Wild Young	1														1
1999	Territorial Pairs	1	1	1				1	1	1	1	1	1			9
	Pairs Rearing Young	1								1			1			3
	# Wild Young	3								2			3			8
2000	Territorial Pairs	1	1	1	1	1			1	1	1	1	1			10
	Pairs Rearing Young			1		1			1	1	1		1			6
	# Wild Young			2		2			3	3	3		3			16
2001	Territorial Pairs	1	1	1	1	1			1	1	1	1	1			10
	Pairs Rearing Young	1			1	1			1	1	1		1			7
	# Wild Young	1			1	2			3	3	3		3			16
2002	Territorial Pairs	1	1	1	1	1			1	1	1	1	1			10
	Pairs Rearing Young			1		1			1	1	1		1			6
	# Wild Young			2		3			2	3	1		3			14
2003	Territorial Pairs	1	1	1	1	1			1	1	1	1	1			10
	Pairs Rearing Young			1		1			1	1	1		1			6
	# Wild Young			3		1			3 (4?)	2	2		2 (3?)			13
2004	Territorial Pairs	1	1	1	1	1			1	1	1	1	1	1		11
	Pairs Rearing Young					1			1	1	1	1	1			6
	# Wild Young					4			1	2	1	1	3			12
2005	Territorial Pairs	1	1	1		1			1	1	1	1	1	1		10
	Pairs Rearing Young					1			1	1	1	1	1	1		7
	# Wild Young					3			1	3	1	2	3	3		16
2006	Territorial Pairs	1	1	1		1	1		1	1	1	1	1	1		11
	Pairs Rearing Young					1	1		1	1	1	1	1			7
	# Wild Young					2	3		3	3	1	1	2			15
2007	Territorial Pairs	1	1	1	1	1	1		1	1	1	1	1	1	1	13
	Pairs Rearing Young				1	?				1	1	1	1	1	1	7
	# Wild Young				?	?				2	2	1	2	4	2	13
2008	Territorial Pairs	1	1	1	1	1		1	1	1	1	1	1	1	1	13
	Pairs Rearing Young	1		1	1	1		1					1	1		7
	# Wild Young	1+		2	1+	4		2					2+	3		15
	Years with Pair	12	18	11	7	10	2	13	21	16	10	18	21	5	2	166
TOTAL	Successful Pairs	5?	2?	4	2	9?	1	3	12	11	8	6	17	3	1	84
	Young Produced	8?	3	9	2?	21?	3	5	31	27	14	10	43	10	2	188

Figure 2. North Carolina Wildlife Resources Commission data regarding peregrine falcons hacked, pairs observed, and number of offspring in North Carolina, 1984-2008.

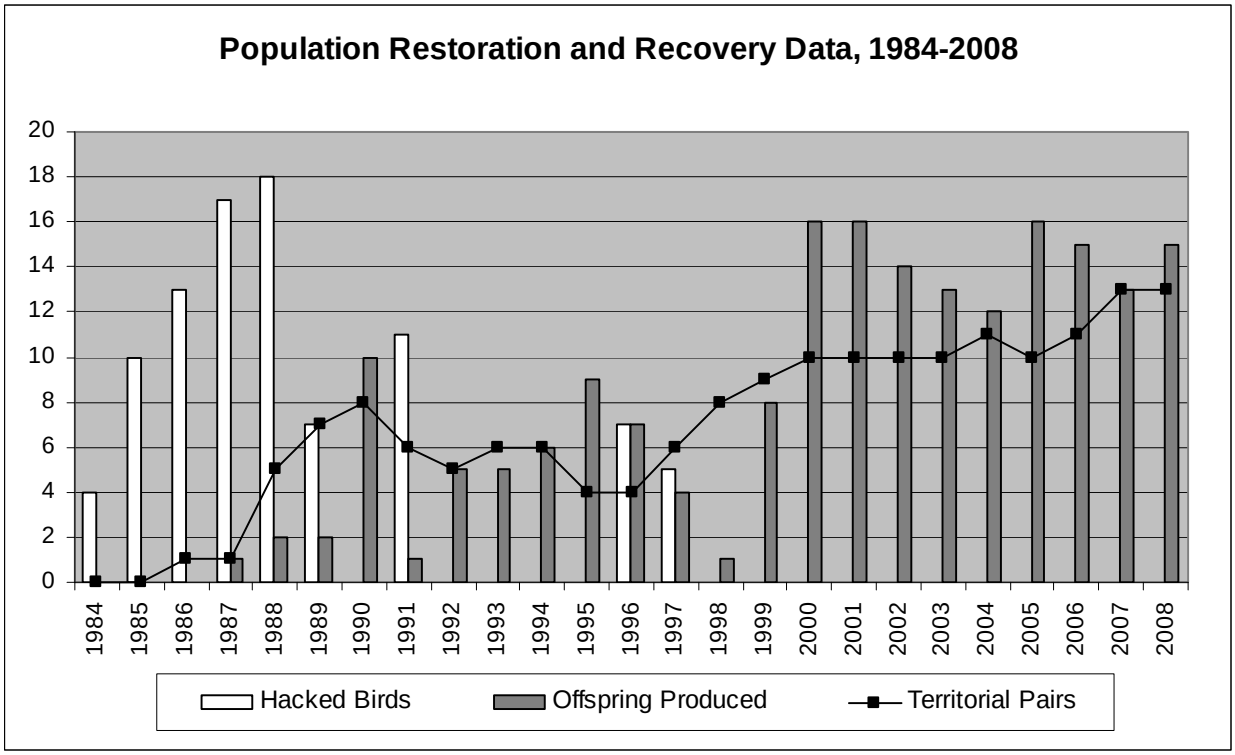
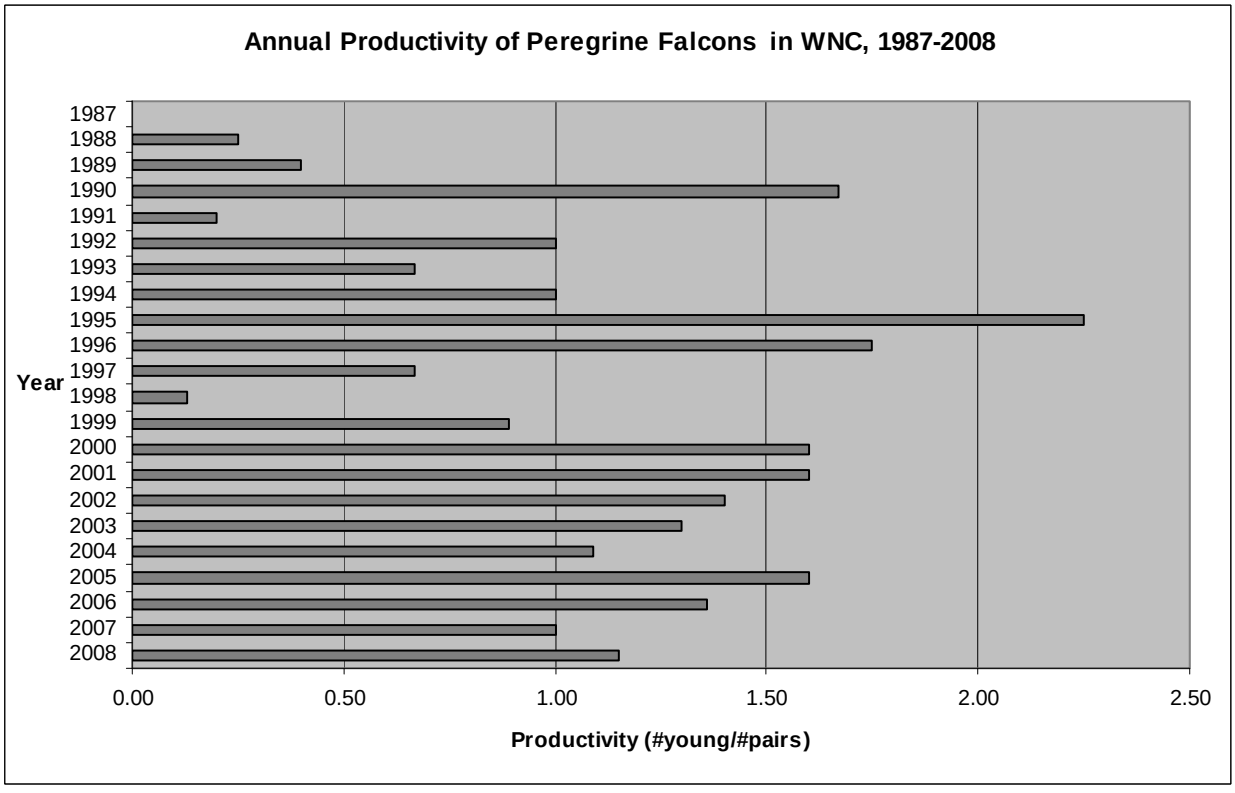


Figure 3. Annual productivity of peregrine falcons, 1987-2008.



Contaminants monitoring and banding

The USFWS Monitoring Plan for the American peregrine falcon also calls for contaminant monitoring. This component requires entering nests, banding nestlings, collecting addled eggs and shell fragments, and collecting feather samples. Given the small size of North Carolina's peregrine population and difficulties associated with accessing the nests, a systematic removal of the first clutch of eggs at each site does not seem prudent. Instead, unhatched eggs are likely to be collected opportunistically during site visits after completion of nesting. A decision has yet to be made on the practicality of banding eyases in the nest. Time constraints, difficult access, and dangerous conditions for those involved may prevent implementation of this aspect of nest monitoring.

E. Recommendations

This inventory should continue on an annual basis. Considerable effort should also be made to locate currently unknown nesting sites. NCWRC should experiment with alternative methods of capturing and banding young outside of the nest.

F. Estimated Cost

$15,857 (including in-kind contributions)

G. References

Cade, T. J., J. H. Enderson, and J. Linthicum. 1996. Guide to management of Peregrine Falcons at the eyrie. The Peregrine Fund, Boise, ID.

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U.S. Fish and Wildlife Service. 2003. Monitoring Plan for the American Peregrine Falcon, A Species Recovered Under the Endangered Species Act. U.S. Fish and Wildlife Service, Divisions of Endangered Species and Migratory Birds and State Programs, Pacific Region, Portland, OR. 48 pp.

U.S. Fish and Wildlife Service. 2004. 2003 Results of the U.S. Fish and Wildlife Service Monitoring Plan for the American Peregrine Falcon. U.S. Fish and Wildlife Service, Divisions of Endangered Species and Migratory Birds and State Programs, Pacific Region, Portland, OR. 52 pp.

Prepared by: Chris Kelly
Division of Wildlife Management

Annual Performance Report

State: North Carolina **Project Number:** T - 9
Amendment Number: 1

Period Covered: July 1, 2007 – June 30, 2008

Grant Title: State Wildlife Grants T-9 (Planning)

Project Title: Western North Carolina Songbird Inventory

Objectives:

To inventory neotropical migrant and resident songbird species across western North Carolina by establishing baseline data (species and relative abundances) of songbirds on public and private lands, and assessing their populations through time and changing habitats.

A. Activity

Game land Songbird Surveys

The inventory system was modified this year to reflect survey needs and time and personnel constraints. Surveys were conducted, following the established point system layout and protocol (Kelly, 2007) on two of the three game lands that have traditionally been surveyed annually. This year, Cold Mountain game land and the Green River Cove Road section of Green River game land were surveyed. Thurmond Chatham game land and the Big Hungry section of Green River game land will be surveyed in 2009.

This modification freed up time to conduct other priority bird surveys, including: (1) initial surveys of Needmore game land (Macon-Swain counties), (2) coordination and expansion of a western region nightjar survey that incorporates estimates of detection, and (3) focal songbird surveys (golden-winged warbler, Appalachian yellow-bellied sapsucker) including golden-winged warbler pre-treatment surveys within an oak-regeneration study area on Cold Mountain game land. These changes reflect goals stated previously (Kelly 2007), namely: (1) to continue to survey bird populations using the existing point count networks; (2) to expand the bird survey project to and within other state game lands, public lands, and privately owned lands in the western region and (3) to perform additional analyses of habitat occupancy and population trends on state-owned game lands.

Green River game land

Because only half of the game land was surveyed this year, analyses of species trends utilize the data set from the Green River Cove Road section. Relative to the Big Hungry side, the Green River Cove Road side is characterized by a greater component of young clear cuts and open fields and food plots. Surveys of Green River game land in 2008 yielded 550 individual birds,

comprising 56 species (Table 1). The five most abundant species of neotropical migrants in 2008 were red-eyed vireo, black-throated green warbler, scarlet tanager, indigo bunting, and hooded warbler. House wren was a new addition to the list of species detected on point counts. Two species of non-breeding migrants were detected on the game land for the first time, veery and blackburnian warbler. Additional non-nesting migrants detected in mid May included rose-breasted grosbeak, Swainson's thrush, and blackpoll warbler. The game land's species total is 84, including both breeders and non-breeders, some of which were not detected this year on point counts and therefore not included in Table 1.

Table 1. Green River game land bird relative abundance, based on point counts 2005- 2008 from Green River Cove Section only.

Species[1]	**Number detected 2008**	**Number detected 2007**	**Number detected 2006**	**Number detected 2005**
Red-eyed vireo	79	80	85	89
Black-thr. green warbler	35	35	46	36
Eastern tufted titmouse	35	29	38	31
Scarlet tanager	35	20	25	21
American crow	24	20	30	22
Indigo bunting	24	17	19	26
Hooded warbler	23	34	32	18
Carolina wren	19	44	56	33
Worm-eating warbler	17	22	16	18
Acadian flycatcher	16	33	27	24
American goldfinch	16	11	10	16
Prairie warbler	16	13	16	8
Wood thrush	16	10	16	9
Mourning dove	15	7	8	1
Pileated woodpecker	14	16	15	13
Blue-headed vireo	11	8	9	13
Carolina chickadee	10	13	18	8
Yellow-breasted chat	10	15	4	3
Blue jay	9	15	4	10
Cedar waxwing	9	0	12	0
Blue-gray gnatcatcher	8	10	15	13
Eastern towhee	8	7	4	4
Pine warbler	8	3	4	5
Black and white warbler	7	10	5	10
Ovenbird	7	4	9	12
Red-bellied woodpecker	7	12	7	6
Yellow-throated warbler	7	7	6	6
Downy woodpecker	6	2	10	8
Northern cardinal	6	10	18	9
White-breasted nuthatch	6	3	8	4
Eastern wood-pewee	5	3	6	4
Louisiana waterthrush	4	2	2	5
Wild turkey	4	1	0	1
Great-crested flycatcher	3	0	1	1
Swainson's warbler	3	3	5	0

Brown-headed cowbird	2	4	3	1
Blue grosbeak	2	2	1	0
Canada goose	2	0	2	0
Common yellowthroat	2	1	2	0
Field sparrow	2	6	2	3
Ruby-thr. Hummingbird	2	4	4	2
Swainson's thrush	2	0	0	0
American redstart	1	2	5	7
Belted kingfisher	1	0	1	0
Blackburnian warbler	1	0	0	0
Blackpoll warbler	1	0	0	0
Chipping sparrow	1	1	0	4
Chimney swift	1	0	0	0
Eastern bluebird	1	0	0	1
Eastern kingbird	1	0	2	2
Eastern phoebe	1	2	3	2
Hairy woodpecker	1	1	1	0
House wren[2]	1	0	0	0
Yellow-billed cuckoo	1	0	3	4
Yellow-shafted flicker	1	1	2	0
Yellow-throated vireo	1	1	4	3
Whip-poor-will	0	4	0	0
Broad-winged hawk	0	0	0	4
White-eyed vireo	0	2	0	0
American robin	0	0	1	2
Barred owl	0	0	1	2
Common grackle	0	0	2	0
Summer tanager	0	0	0	2
Turkey vulture	0	0	0	2
Kentucky warbler	0	0	1	1
Northern parula	0	0	1	1
Cerulean warbler	0	0	0	1
Common grackle	0	0	0	1
Eastern screech owl	0	0	0	1
Total	550	550	627	533

[1] Species listed as conservation priorities in the NC Wildlife Action Plan are shown in bold font. Species with names in italics are migrants and should not be counted as breeders.
[2] Recorded one "new" species, house wren, not detected in previous years on a point count.

Cold Mountain game land

At Cold Mountain game land in 2008, 143 individuals of 33 species were detected (Table 2). Again this year, the species list included several mid to high elevation species such as black-throated blue, chestnut-sided, and blackburnian warblers, veery, and brown creeper. Song sparrow was observed for the first time this year. In the past five years of surveys, 44 species have been detected at Cold Mountain game land.

Table 2. Cold Mountain game land bird relative abundance for 2005-2008.

Species[1]	Number detected 2008	Number detected 2007	Number detected 2006	Number detected 2005
Ovenbird	15	12	15	11
Red-eyed vireo	14	21	20	14
Wood thrush	12	7	4	3
Blue-headed vireo	10	5	10	11
Black-thr. blue warbler	10	11	9	5
Black and white warbler	9	8	8	5
Black-thr. green warbler	8	14	15	10
Blackburnian warbler	6	9	10	4
Scarlet tanager	6	8	16	6
Acadian flycatcher	5	5	4	3
American crow	5	9	8	8
Brown creeper	4	3	3	0
Eastern wood pewee	4	4	3	3
Mourning dove	4	1	3	0
Slate-colored junco	4	3	2	3
American goldfinch	3	0	0	1
Eastern towhee	3	6	4	4
Indigo bunting	3	1	2	3
Carolina chickadee	2	4	5	0
Carolina wren	2	5	2	3
Golden-crowned kinglet	2	3	1	2
American robin	1	1	0	0
Blue jay	1	2	2	2
Chestnut-sided warbler	1	2	1	1
Downy woodpecker	1	2	1	1
Eastern tufted titmouse	1	4	7	0
Hooded warbler	1	4	5	1
Northern cardinal	1	1	0	0
Rose-breasted grosbeak	1	2	1	0
Ruby-thr. hummingbird	1	0	0	0
Song sparrow	1	0	0	0
Veery	1	2	2	1
White-breasted nuthatch	1	2	0	4
Pileated woodpecker	0	3	2	1
Common raven	0	2	0	0
Worm-eating warbler	0	1	1	0
Yellow-shafted flicker	0	1	1	0
Chimney swift	0	0	0	2
Eastern phoebe	0	0	0	1
Hairy woodpecker	0	0	0	0
Northern parula	0	0	0	1
Red-breasted nuthatch	0	0	0	0
Ruffed grouse	0	0	0	0
Pine warbler	0	0	0	0
Total	143	168	167	114

[1] Species listed as conservation priorities in the NC Wildlife Action Plan are shown in bold font.

Needmore game land

In an effort to assess bird species composition, habitat composition, and monitoring needs on Needmore game land, initial surveys were conducted on May 13 and June 9, 2008. The 4,500 acre, linear-shaped game land is located in Swain and Macon Counties, approximately 10 miles north of Franklin, NC spanning both sides of the Little Tennessee River. Areas surveyed were mostly river floodplains and adjacent fields and wildlife food plots along Needmore Road, Queen's Branch parking area, and access points off NC 28. Upland forests were *not* covered during these initial surveys; much survey work remains to obtain a more thorough representation of the avian community on this tract. Fifty-three species were seen or heard on the game land (Table 3).

Table 3. Needmore game land initial species list from two days of surveys in floodplains, fields, and food plots, May and June 2008.

Acadian flycatcher	**Northern bobwhite**[1]
American crow	Northern cardinal
American goldfinch	Northern parula
American redstart	Northern rough-winged swallow
Bald eagle[1]	**Orchard oriole**[1]
Black and white warbler	Osprey
Blackpoll warbler (migrant)	Ovenbird
Black-throated green warbler	Pileated woodpecker
Blue grosbeak	Pine warbler
Blue jay	Red-bellied woodpecker
Blue-gray gnatcatcher	Red-eyed vireo
Blue-headed vireo	Red-shouldered hawk
Broad-winged hawk	Red-tailed hawk
Canada goose	Ruby-throated hummingbird
Carolina chickadee	Ruffed grouse
Carolina wren	Scarlet tanager
Chipping sparrow	Song sparrow
Common yellowthroat	**Swainson's warbler**
Downy woodpecker	Tufted titmouse
Eastern bluebird	White-breasted nuthatch
Eastern kingbird[2]	White-eyed vireo
Eastern phoebe	Wild turkey
Eastern towhee	**Wood thrush**
Great blue heron	Yellow-breasted chat
Hooded warbler	Yellow-throated vireo
Indigo bunting	Yellow-throated warbler
Louisiana waterthrush	

[1] Species reported by other NCWRC biologists during period May 1-June 30, 2008.
[2] Species listed as conservation priorities in the NC Wildlife Action Plan are shown in bold font.

Sandy Mush game land

Inventory and monitoring efforts for northern bobwhite on Sandy Mush game land (Buncombe-Madison Counties) were initiated by a NCWRC Burnsville Wildlife Depot biologist in spring

2007. This survey also generated a breeding songbird list for habitats targeted in the bobwhite survey effort, generally open habitats and brushy edges. In an effort to further assess bird species composition for the North Carolina Birding Trail, and habitat composition and monitoring needs, Wildlife Diversity staff recruited local birders to compile species lists during birding forays to the game land throughout the year, resulting in a list of 110 species (Table 4).

Table 4. Sandy Mush game land bird list, compiled 2007-2008.

	SPRING	SUMMER	FALL	WINTER
Wood duck	X	X	X	X
Mallard		X		
Great-blue heron	X	X	X	X
Green heron		X		
Upland sandpiper	X			
Black vulture		X	X	
Turkey vulture	X	X	X	X
Osprey	X			
Sharp-shinned hawk			X	
Cooper's hawk			X	
Northern harrier			X	
Red-shouldered hawk	X	X	X	X
Broad-winged hawk	X	X		
Red-tailed hawk	X	X	X	X
American kestrel	X	X	X	X
Wild turkey	X	X	X	X
Ruffed grouse	X	X	X	X
Northern bobwhite	X	X	X	X
American woodcock	X		X	X
Mourning dove	X	X	X	X
Yellow-billed cuckoo		X		
Barn owl	X	X	X	X
Eastern screech owl	X	X	X	X
Great-horned owl	X	X	X	X
Barred owl	X	X	X	X
Chimney swift	X	X		
Ruby-throated hummingbird		X	X	
Belted kingfisher	X	X	X	X
Yellow-bellied sapsucker[1]	X		X	X
Red-bellied woodpecker	X	X	X	X
Downy woodpecker	X	X	X	X
Hairy woodpecker			X	
Yellow-shafted flicker	X	X	X	X
Pileated woodpecker	X	X	X	X
Eastern wood-pewee		X		
Acadian flycatcher		X		
Eastern phoebe	X	X	X	X
Great-crested flycatcher		X		
Eastern kingbird		X		
White-eyed vireo	X	X	X	

Red-eyed vireo	X	X	X	
Yellow-throated vireo		X		
Blue-headed vireo	X	X		
Blue jay	X	X	X	X
American crow	X	X	X	X
Barn swallow		X		
Carolina chickadee	X	X	X	X
Tufted titmouse	X	X	X	X
White-breasted nuthatch	X	X	X	X
Red-breasted nuthatch			X	X
Brown-headed nuthatch	X	X	X	X
Marsh wren			X	
Carolina wren	X	X	X	X
Winter wren			X	
Golden-crowned kinglet			X	X
Ruby-crowned kinglet			X	X
Blue-gray gnatcatcher		X		
Eastern bluebird	X	X	X	X
Hermit thrush			X	X
Wood thrush	X	X	X	
American robin	X	X	X	X
Gray catbird	X	X	X	
Northern mockingbird	X	X	X	X
Brown thrasher	X	X	X	X
Cedar waxwing	X	X	X	X
European starling	X	X	X	X
Nashville warbler			X	
Blue-winged warbler		X		
Northern parula	X	X	X	
Chestnut-sided warbler			X	
Blackburnian warbler	X			
Black-throated green warbler	X	X	X	
Yellow-rumped warbler			X	X
Pine warbler	X	X	X	X
Prairie warbler	X	X	X	
Black-and-white warbler	X	X	X	
American redstart			X	
Worm-eating warbler	X	X	X	
Common yellowthroat	X	X	X	
Kentucky warbler		X		
Louisiana waterthrush	X	X	X	
Ovenbird	X	X	X	
Hooded warbler	X	X	X	
Yellow-breasted chat	X	X	X	
Scarlet tanager	X	X	X	
Blue grosbeak		X		
Rose-breasted grosbeak			X	
Indigo bunting	X	X	X	
Northern cardinal	X	X	X	X

Eastern towhee	X	X	X	X
Chipping sparrow	X	X	X	X
Field sparrow	X	X	X	X
Fox sparrow			X	X
Grasshopper sparrow		X	X	
Savannah sparrow[1]			X	
Song sparrow	X	X	X	X
Swamp sparrow			X	X
White-throated sparrow	X		X	X
White-crowned sparrow			X	
Dark-eyed junco			X	X
Orchard oriole		X		
Eastern meadowlark		X		
Red-winged blackbird		X	X	X
Common grackle		X		
Brown-headed cowbird		X		
House sparrow	X	X	X	X
American goldfinch	X	X	X	X
Pine siskin[1]			X	X
House finch			X	X
Purple finch			X	X

[1] Species listed as conservation priorities in the NC Wildlife Action Plan are shown in bold font. Thus far there are only fall-winter records for yellow-bellied sapsucker, savannah sparrow, and pine siskin on the game land; only the breeding populations of these three species are considered conservation priorities.

Nightjar Survey

In an effort to begin addressing inventory needs for priority species, a nightjar survey was expanded across 20 mountain and western piedmont counties in Spring 2008, with special focus on the whip-poor-will (*Caprimulgus vociferus*). The whip-poor-will is listed as a priority species by Partners in Flight and North Carolina Wildlife Resources Commission (NCWRC). This species is also state listed in several northeastern states due to evidence of population declines. North Carolina lacks basic information about arrival and departure dates from the breeding ground, description and availability of suitable habitat, and population trends for this highly cryptic, nocturnal bird. The goals of the nightjar survey are to gain a better understanding of nightjar distributions and population trends in western North Carolina and to identify the factors that influence these populations so as to minimize population declines and implement conservation actions that benefit nightjars and their habitat. There are opportunities to incorporate this information into range-wide survey and conservation efforts (i.e., Southeast U.S. Nightjar Survey and Northeast Nightjar Monitoring Program).

Methods developed in 2007 by NCWRC, the Northeast Nightjar Monitoring Program, and the Southeast U.S. Nightjar Survey were employed in 2008. These survey methods incorporated a time-banding technique and double observers to generate estimates of detection probability. Timing of surveys around the lunar cycle, moonrise, and sunset was delineated in order to conduct surveys during peak calling times. Surveys needed to occur at dates and times when the moon was at least 50% full in May and June, above the horizon, and not obscured by clouds. Surveys also needed to take place after sunset. A study in eastern North Carolina demonstrated

that surveys conducted under this set of conditions were less variable and provided more statistical power to long-term monitoring results than surveys conducted on nights with different lunar and sky conditions (Wilson and Watts 2006). Appropriate survey dates (when the moon's face was at least 50% illuminated) were determined by consulting the U.S. Naval Observatory's sun and moon data web site. Thus, surveys were conducted once within a 17 day window around the May 12th full moon and once again within a 16 day window around the June 11th full moon. Listening counts were six minutes in duration and commenced after moonrise and civil twilight (times posted at U.S. Naval Observatory web site). A pair of observers working independently but in time-sync noted whether an individual whip-poor-will's call was heard or not heard during each of six 1-minute time bands, for each individual bird. Counts used an unlimited radius, so points are spaced 1 mile apart to minimize risk of double counting individuals.

The main objective of the 2008 season was to further our understanding of nightjar distributions in the western region by expanding the survey to other western counties using a growing volunteer network. This was accomplished by Wildlife Diversity staff working with Outreach staff to develop two separate press releases. In addition, NCWRC coordinated with the Southeast U.S. Nightjar Survey Network, using sections of existing Breeding Bird Survey routes as nightjar routes. Press releases generated a great deal of interest from the public. NC Audubon again generated volunteer interest in the northern mountain counties and western piedmont through its Adopt an Important Bird Area (IBA) program. Wildlife Diversity staff responded to over 50 inquiries about the project and ultimately registered 45 new participants for the double-observer survey. Training materials were distributed via email.

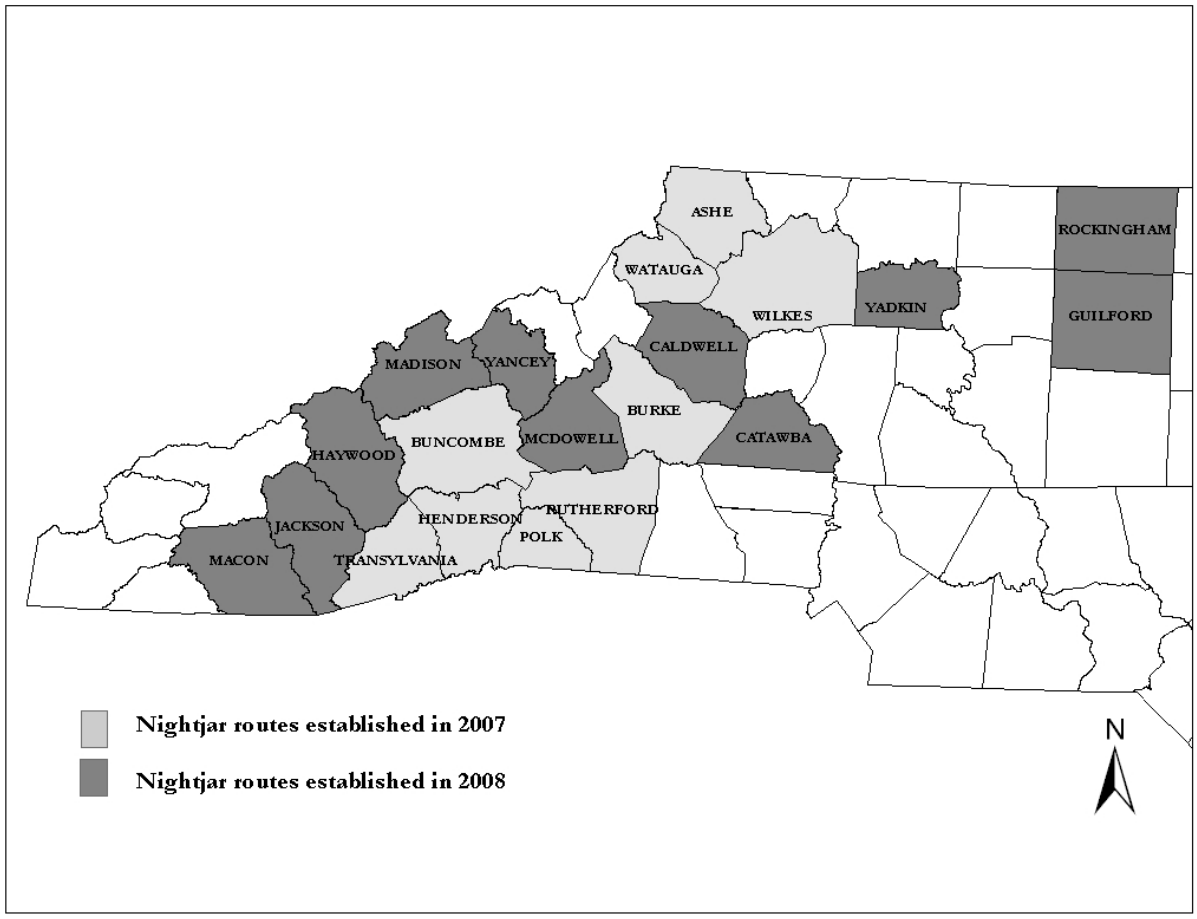
Twenty-four new nightjar routes were established in addition to 11 routes established in 2007, for a total of 35 routes representing 20 counties (Table 5, Figure 2). Eleven counties were surveyed for the first time this year. Routes were distributed primarily according to volunteer availability and suitability of elevations and roads. Routes consisting of ten points spaced at 1 mile intervals were laid out by volunteers. Volunteers provided written directions to each point along the route and they were given the option of geo-referencing points or providing some kind of map depicting the route. Where roads were not long enough to accommodate all ten points, remaining points were placed on spur roads. Routes were placed in areas that met all or most of the following criteria: (1) away from major roads and developed areas, (2) elevation at or below 3500 feet, (3) habitat mosaic of forest and open areas (latter including old fields, utility rights of way, agricultural fields, and barren lands). Current routes traverse NCWRC game lands (Sandy Mush and Green River), private property, Pisgah and Nantahala National Forests, State Parks, and National Parks (Blue Ridge Parkway and Great Smoky Mountains National Park).

Table 5. Distribution of nightjar survey routes, whip-poor-wills (WPWI), and chuck-will's-widow (CWWI) by sub-physiographic region.

Region	# of routes[1]	# routes with WPWI	# routes with CWWI
Mountains	18	16	1
Mountain-Foothills[2]	4	3	2
Western Piedmont	6	6	3
Northwestern Piedmont[3]	3	1	0

[1] Analyses are based on 31 of 35 routes for which data were collected according to protocol; two mountain routes and two western piedmont routes were dropped from analysis due to errors in data collection.
[2] Two in South Mountains area; one along Blue Ridge Escarpment
[3] Greensboro area

Figure 1. Twenty counties represented by western North Carolina nightjar survey, showing counties where survey was expanded in spring 2008.



A majority of the routes was surveyed during both survey windows (Tables 6 and 7); several observers were rained out during the May survey window. As noted, analyses are divided up into mountains-mountain foothills routes and western and northwestern piedmont routes. Analyses are based on 31 of 35 routes for which data were collected according to protocol. In the mountain and mountain-foothills region, more whip-poor-wills were detected in June than in

May (Table 6). However, results were skewed by one outlier route, the highly productive Fall Creek route (Wilkes County), which was only run in June and documented an impressive 23 whip-poor-wills. In the central and western piedmont region, more whip-poor-wills per route were recorded in May than in June with similar coverage in both survey windows (Table 7). Of the nine piedmont routes, three were in the Greensboro area, and whip-poor-wills were documented on one of those three routes. Chuck-will's widows were encountered on six routes in seven counties (Burke, Catawba, Caldwell, Madison, McDowell, Polk, Rutherford). Of these, chuck-will's widow was documented in the mountains proper in Madison County (Hot Springs area) and in Polk County (mountain-foothills); the remainder were found in the western Piedmont. Observers also tallied calling owls and documented the presence of eastern screech owl, great-horned owl, and barred owl.

Table 6. Mountain and Mountain-Foothills Regions summary of western NC nightjar survey results for 2008. WPWI = whip-poor-will. CWWI = chuck will's widow.

	May survey window	**June survey window**
# routes surveyed*	16 of 22	19 of 22
# WPWI	63	96**
# routes with WPWI	14 of 16	16 of 19
# WPWI per route with WPWI	4.5	6.0
# CWWI	5	0
# routes with CWWI	3 of 16	0 of 19

* Routes not surveyed in May are different than the routes that were not surveyed in June.
** The Fall Creek route was only run in June and picked up 23 WPWI, so skewed results considerably for that survey window.

Table 7. Western and Northwestern Piedmont Regions summary of NC nightjar survey results for 2008. WPWI = whip-poor-will. CWWI = chuck will's widow.

	May survey window	**June survey window**
# routes surveyed*	8 of 9	9 of 9
# WPWI	59	38
# routes with WPWI	6 of 8	6 of 9
# WPWI per route with WPWI	9.8	6.3
# CWWI	6	5
# routes with CWWI	3 of 8	2 of 9

* Routes not surveyed in May are different than the routes that were not surveyed in June.

Appalachian yellow-bellied sapsucker Surveys

NCWRC participated to a very limited extent in the Appalachian yellow-bellied sapsucker (*Sphyrapicus varius appalachiensis*) Working Group's effort to evaluate the conservation status of the sapsucker, a southern Appalachian endemic subspecies and North Carolina priority species (Ganier 1954; NCWRC 2005). Peak survey times are April 27 to mid May, when sapsuckers are most likely to respond to playbacks of drumming and calls, with a second, less productive survey period in late June. This season, three historic sites along the Blue Ridge Parkway in the Plott

Balsams (Haywood and Jackson Counties) were re-surveyed, and recent migration-season records were surveyed during the bird's nesting season on the Nantahala and Pisgah National Forests. Sapsuckers are frequently reported in late April at Wright Cove Overlook on the Cherohala Skyway (Nantahala National Forest, Graham County). This cove is undergoing rapid change with the die off of mature eastern hemlocks. A pair of sapsuckers was reported by another Wildlife Diversity section biologist on April 14, 2007 at Ed Top Boulderfield on the Appalachian Ranger District (Pisgah National Forest, Haywood County). This site was re-surveyed on May 1, 2008 using standard call-playback methods. No yellow-bellied sapsuckers were observed despite suitable habitat at some sites.

Golden-winged warbler Surveys

Golden-winged warbler is listed as a high priority species in numerous bird conservation plans (Southeast and North Carolina Partners in Flight, NC Wildlife Action Plan, Appalachian Mountain Joint Venture). NCWRC hosted a golden-winged warbler meeting in Asheville, NC in February 2008 to discuss survey, research, and management needs. Of particular interest was finding ways to collaborate on efforts already underway by Audubon North Carolina. As a result of this meeting, two projects are in development which expand upon Audubon North Carolina's efforts: (1) a re-survey of sites surveyed during the 2000-2001 Golden-winged Warbler Atlas Project survey (GOWAP) and (2) a nesting study to determine nest success and productivity in two or more core population areas in western North Carolina. Audubon North Carolina planned to conduct pre-treatment surveys on Three Top game land (Ashe County) in spring 2008 prior to a planned prescribed burn and shelterwood cut in the high elevation red oak forest. Three Top is the NCWRC game land with the nearest documented population of golden-winged warblers occurring down slope. Results are not yet available. NCWRC conducted pre-treatment surveys at Cold Mountain game land (Haywood County) prior to a planned oak regeneration study that will create early successional habitat. As expected in this forested landscape, no golden-winged warblers were detected.

Golden-winged warblers are regularly reported along the Cherohala Skyway (Nantahala National Forest, Graham County) during migration in late April. Following GOWAP survey protocol, NCWRC documented a singing male golden-winged warbler at Obadiah Gap Overlook, 3700 feet elevation, on June 3 and June 11. NCWRC provided technical guidance to the U.S. Forest Service about the potential to combine planned efforts to manage scenic vistas with efforts to create early successional habitat for golden-winged warblers along the Skyway.

B. Target Dates for Achievement and Accomplishment

On schedule

C. Significant Deviations

None

D. Remarks

Game land Songbird Surveys

At Green River game land, notable declines of over 50% from 2007 were found for Carolina wren (56% decline) and Acadian flycatcher (51% decline). Acadian flycatcher inhabits acidic cove forest and may be vulnerable to loss of eastern hemlock to hemlock woolly adelgid. Research is underway in other parts of western North Carolina to document impacts of hemlock decline on Acadian flycatcher populations. NCWRC will continue to monitor changes in the Acadian flycatcher population on Green River and other game lands that are losing hemlock. Unfortunately, hemlocks have not been treated for the adelgid. There was a notable increase of 75% in scarlet tanagers from past years, though the reason for this is unclear.

Numerous habitat modifications are underway at Cold Mountain game land as a result of two initiatives: a game land timber harvest and prescribed burn, and a U.S. Forest Service (USFS) cooperative oak regeneration study which will also utilize prescribed burning, thinning, and timber harvest. Continued surveys of the Cold Mountain bird point network may supplement a separate study of bird response to management of the USFS oak regeneration study.

Initial survey efforts of floodplains, fields, and food plots at Needmore game land resulted in the expected mix of species associated with early successional habitat, riparian areas, and edges. Given other concurrent bird survey efforts, there was insufficient time to survey the upland areas this year. Future survey efforts should expand coverage to other habitats and focus on efforts to monitor the response of priority bird species to the variety of management activities taking place on this tract. Unlike Green River and Cold Mountain game lands, where management activities are largely centered on silviculture, Needmore game land presents an opportunity to focus on bird response to management of fields and prescribed burning of dry pine ridges.

Twenty-two species listed as conservation priorities in the NC Wildlife Action Plan have been documented on Sandy Mush game land. The majority are species associated with early successional, edge, and shrub-scrub habitats (e.g., field sparrow, prairie warbler, Northern bobwhite). Others are associated with grasslands on the game land and surrounding pastureland (e.g., American kestrel, grasshopper sparrow, Eastern kingbird, and Eastern meadowlark) and some with forest (e.g., yellow-billed cuckoo, wood thrush, Eastern wood-pewee). Wildlife Diversity staff attended a field trip hosted by the Burnsville Wildlife Depot in October, 2007 to discuss management priorities on the game land. Wildlife Diversity staff recommended managing for shrub-scrub species with some management for grassland birds given the current and potential habitat on this tract. Given the emphasis on bobwhite management and the historic use of this tract as dairy farmland, management will be geared toward creating and maintaining early successional habitat in a regenerating clear cut, patchy shrubs, and soft field edges. To a lesser extent, there may be opportunities to manage fields in short grasses (for grasshopper sparrow, eastern meadowlark) and to expand native warm season grass fields for species that require more extensive open grassland.

Finally, Wildlife Diversity staff met with game land staff and a safety officer in November 2007 to discuss preservation of the old barns on Sandy Mush game land. Barn owl (*Tyto alba*), a

Wildlife Action Plan priority species, and eastern screech owl (*Otus asio*) roost in these barns. With the rapid rate of development in western North Carolina, such barns are being torn down. Preserving these barns ensures conservation of important habitat for a priority species, provides opportunities to learn more about conservation of a priority species, provides opportunities to experiment with management strategies that could benefit the species throughout the region, and demonstrates NCWRC's efforts to manage for all species on game lands.

Nightjar Survey

The 2008 nightjar survey employed restricted survey windows, double observers, and a removal model (time banding) as means to estimate detectability of calling whip-poor-wills, in an effort to improve accuracy of the data. Based on previous studies of whip-poor-wills in North Carolina, detectability is maximized by restricting surveys to specific lunar windows (Wilson and Watts 2006). By using two simultaneous observers it is possible to estimate the proportion of birds missed by each person. Removal models divide the point count into multiple periods of equal length, during which the presence or absence of individual birds is recorded (Hunt 2007). The double observer approach was especially well suited for a night-time survey run by volunteers, as it added a safety component. However, it is not always possible to ensure that a pair of observers is recording observations independently.

The 2007 data from the eastern U.S., including western North Carolina data, were analyzed during this fiscal year by a biometrician contracted by the Northeast Nightjar Monitoring Program and provided the following insights: There appear to be two "calling types:" (1) birds that sing more-or-less continuously for the six minute period (detected in all six 1-minute periods) and (2) birds that are only detected in 1 to3 periods. Detectability was not affected by covariates such as cloud cover, wind, date (early/late), or number of birds at a stop. The removal method proved somewhat problematic at points where there were more than two whip-poor-wills calling, as it was difficult to sort out which bird called during each of the six 1-minute time intervals. This method is probably best suited for areas within the whip-poor-will's range where the species occurs at low densities and observers encounter few birds at a time. The 2008 data were analyzed by NCWRC to provide a simple summary of whip-poor-will and chuck-will's widow numbers, irrespective of the time-banding survey (Tables 6 and 7). These data will also be submitted to the national database managed by the Northeast Nightjar Monitoring Program.

The whip-poor-will is a model species for North Carolina's Wildlife Action Plan because one goal of the Plan is to keep common species common. With this survey, North Carolina is tying into broader efforts by the Southeastern U.S. Nightjar Survey and Northeast Nightjar Monitoring Program to track nightjars across their range in the Eastern U.S. Furthermore, it may be possible to adapt survey routes for other nocturnal bird (i.e., owl) surveys in the future, drawing on a growing volunteer pool. Recruiting and setting up new volunteers this year was a considerable effort and only half of those who inquired about the project (plus their field partners) ultimately participated. Next year, the goal will be to set up new routes in just a few western counties that are not yet represented.

E. Recommendations

The game land point count systems were designed to reflect the distribution of available habitats and to document baseline population status. There are two main issues to be addressed as modifications are made to these long-term efforts. First, recent research into detection issues demonstrates the need to conduct surveys in such a way that it generates an estimate of a species detection probability and improves the chances of ruling out a false absence when a bird is missed. Secondly, the game lands are a dynamic, constantly changing landscape undergoing intensive management making these tracts well suited for more focused study of a variety of management tools (prescribed burning, silviculture, mowing, herbicide) and management indicator or priority species listed in the NC Wildlife Action Plan. Recent bird conservation plans are moving away from "surveillance monitoring" in an effort to address bird population's response to conservation actions. There is a great opportunity here to focus survey efforts on conservation actions

We propose to continue to expand on our current bird inventory program. To that end, Wildlife Diversity staff began making modifications to the current program and met in November 2007 with partners from Audubon North Carolina and North Carolina Museum of Natural Sciences to prioritize mountain region bird projects. The group agreed that golden-winged warbler was a top priority species that could benefit from a collaborative survey and nesting study. NCWRC subsequently hosted a golden-winged warbler meeting in Asheville, NC in February 2008 to discuss survey, research, and management needs. In addition, NCWRC will expand mountain bird survey efforts in the coming years in collaboration with the Appalachian Mountain Joint Venture (AMJV). A project is being developed through AMJV to focus on response of avian communities to conservation actions taking place in spruce-fir forests, northern hardwood forests, and early successional habitats at high elevations. This project would consider effects of specific conservation actions, such as red spruce restoration and balds management, on priority birds in these habitats. Separate but related to this initiative, Wildlife Diversity staff presented examples of priority conservation actions for high elevation forests to the Southern Appalachian Man and the Biosphere conference in September 2007.

In addition to this year's roadside nightjar survey, we would employ a wider variety of survey methodologies across a broader geographic range to better detect species of conservation concern and/or priority species identified in the NC Wildlife Action Plan. Examples of other survey methodologies include but are not limited to spot mapping, transect surveys, broadcast call surveys, mist netting, and nest searching. Point count survey methods often miss priority species due to a number of factors including their distribution in rare habitats, some species' slower singing rates, and/or their activity patterns (e.g., nocturnal activity). Point count data on state-owned game lands will continue to be collected, analyzed, and incorporated into game land management plans. However, many priority species occur in habitat adjacent to and/or apart from publicly held lands. In order to develop a comprehensive management strategy, privately held lands will be surveyed in addition to public lands in order to collect baseline and inventory data on priority species throughout their known and historic ranges in western North Carolina.

F. Estimated Cost

$ 23,222 (including in-kind contributions)

G. References

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Prepared By: Chris Kelly
Division of Wildlife Management

Annual Performance Report

State: North Carolina

Project Number: T - 9
Amendment Number: 1

Period Covered: July 1, 2007 – June 30, 2008

Grant Title: State Wildlife Grants T-9 (Planning)

Project Title: Carolina Northern Flying Squirrel Inventory

Objectives:

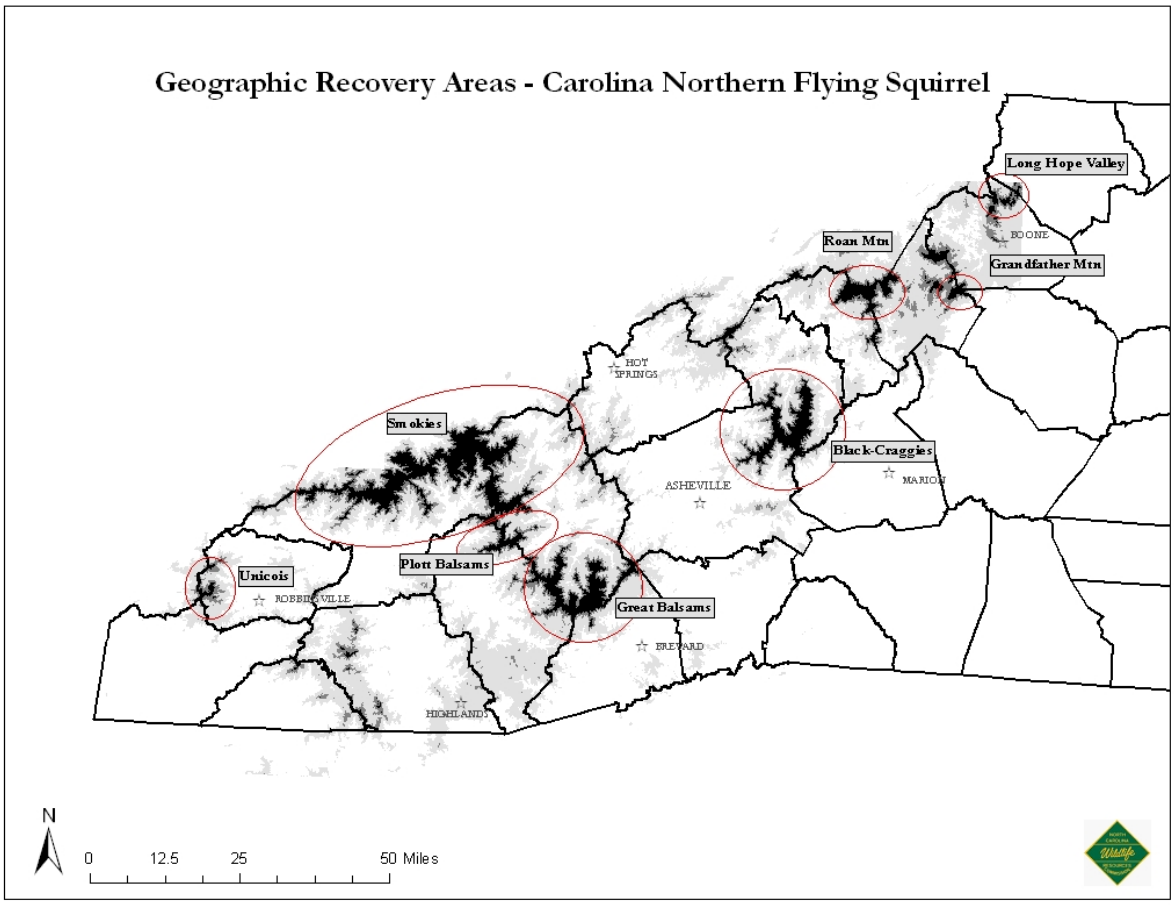
1. To survey all existing geographic recovery areas for the presence of *G.s. coloratus*.
2. To survey other areas of suitable habitat for *G.s. coloratus*.
3. To establish baseline information on relative abundance of the flying squirrel among and within the geographic recovery areas.
4. To assess NFSQ population trends through long-term monitoring in western North Carolina.
5. To provide technical guidance on NFSQ ecology and habitat, as well as on management activities that may affect the squirrel to cooperating federal and state agencies and private organizations.

A. Activity

Population surveys of the Carolina Northern Flying Squirrel, *Glaucomys sabrinus coloratus* (NFSQ), in western North Carolina are conducted primarily through the placement and checking of wooden squirrel boxes. Squirrel box locations were selected based on the presence of apparently suitable NFSQ habitat (Weigl et al. 1992, US Fish and Wildlife Service 1990) and whether roads or trails are present that would facilitate checking. Each box is *traditionally* inspected once annually during the winter, between January and March. When performing checks, each box is assessed for evidence of NFSQ use (either thinly-shredded yellow birch bark nesting material or observation of the squirrels themselves). Each captured NFSQ is weighed, measured, and ear-tagged before being released.

As identified in the US Fish and Wildlife Service (USFWS) report (USFWS 1990), there are eight Geographic Recovery Areas (GRAs) for the NFSQ in the western region (Figure 1). Boxes posted as part of this and other projects have been rolled into this one project. In recent years, seven of eight GRAs and two secondary sites have been surveyed once annually, although not all of the boxes originally posted are still being checked. Given limited time and resources, box transects with no, or limited, history of NFSQ use have either been dropped or are being surveyed on alternate years. The eighth and last GRA, Long Hope Valley (privately owned), has not been surveyed in conjunction with NCWRC projects due to owner concerns. Twenty new boxes were posted at Sugar Mountain Bog (North Carolina State Parks) in Avery County on April 20, 2008. This year, just three recovery areas were surveyed: Black-Craggy Mountains, Great Balsams, and Unicois Mountains.

Figure 1. Carolina northern flying squirrel Geographic Recovery Areas in western North Carolina.



In 2008, this project was significantly modified in order to obtain a better understanding of recent negative trends in captures. Because boxes are typically checked just once annually, it is a "hit or miss" survey. Squirrel captures in boxes may reflect actual population trends or they may reflect the influence of other factors on use of boxes, such as temperature and availability of natural dens. Traditionally, squirrel box surveys have proved more productive than trapping. However, both result in low detections of this rare, secretive, nocturnal species. Squirrels may evade detection and capture by denning in adjacent natural dens (trees) rather than using boxes. Using this method, we risk reporting "false absences"- incorrectly stating that flying squirrels were absent when in fact they were present in the habitat. The implications of this to conservation of a priority species and its habitat warrant modification of the survey design. In 2008, the survey was modified under the framework of an "occupancy survey". Occupancy studies typically entail repeat visits to sample sites rather than single visits (Bailey and Adams 2005, MacKenzie et al. 2002). Multiple visits allow the researcher to generate estimates of detection probability and occupancy rates. In order to free up time to conduct two visits per box transect, the occupancy survey was conducted in just one recovery area (Great Balsams) while the traditional once annual box checks were conducted in just two other recovery areas (Blacks-Craggies and Unicois). The remaining four recovery areas were not surveyed in 2008.

The occupancy survey consisted of three modifications: two visits per transect and collection of temperature and natural den data. Our observations suggest that temperature may influence their use of boxes over natural den sites. Availability of natural dens in the habitat surrounding a squirrel box may also influence their use of boxes. With some exceptions, it seems that greater availability of dens in an area has a positive influence on occupancy in the area, and a negative influence on detection at the box, or at least there may be more temporal variability in detection at the box because squirrels have the option of moving in and out of boxes and trees. A goal of the occupancy survey was to get a better handle on how temperature and availability of natural dens affects their use of boxes and how that affects our ability to determine presence/absence and to assess populations via box surveys. The objectives of the modified occupancy survey were to: (1) generate estimates of occupancy of sites; (2) estimate the probability of detecting a squirrel given its presence at a site, and (3) incorporate measures of temperature and natural den availability as covariates in an occupancy model using program PRESENCE 2.0 (Proteus Research and Consulting, Ltd 2002).

Transects in the Great Balsams were checked twice this year with a minimum of five days between visits to limit effects of disturbance. When developing an occupancy survey, data from a pilot study can be used to determine the optimal number of surveys needed (United States Geological Survey 2007). The need for two visits was determined based on analysis of three years of data from the existing dataset, assuming that occupancy did not change between years. Though this assumption was possibly violated, it did provide a reasonable starting point for determining the number of visits needed for an occupancy survey (L.Bailey, pers.comm.). In order to maintain continuity with the 13 year long once-annual mark-recapture survey, only animals captured during the first visit were marked with ear tags (and in some cases, tattooed). The purpose of the occupancy survey is to document presence-absence, not numbers, so there was no need to mark animals captured during the second visit. Hobo Pro Series data loggers (Onset Computer Corp, Bourne, MA) were set on a north-facing slope (Buckeye Creek transect) and on a south-facing slope (Reinhart Gap transect) at 5,440 feet elevation in the Great Balsams, and were programmed to record temperature and relative humidity every two hours from early January through mid March, 2008. NCWRC staff quantified availability of natural dens at two random boxes along each squirrel box transect. Den surveys consisted of paired plots with one plot centered on the box and one centered at a random compass bearing at a distance of 30m, resulting in four den plots per transect. Dens were assigned to diameter class and decay class, and presence of natural cavities was noted.

One final modification was implemented this year to address the issue of ear tag loss, a source of potentially significant error in interpreting the mark-recapture data. NCWRC attaches a uniquely numbered Monel No. 1005-1 tag (National Band and Tag, Newport, KY) to the right ear of each captured squirrel as part of the mark-recapture study. Throughout the duration of this study, recapture rates have been extremely low. Furthermore, animals with torn right ears have been captured often enough to cause NCWRC biologists to suspect that tag loss is an issue. Flying squirrels tend to lose ear tags at a higher rate than other small mammals, suggesting that a better marking method is needed (Fokidis et al. 2006). In response, NCWRC began double-marking squirrels this year using two different marking methods in order to estimate a rate of tag loss. We continued to tag the right ear with Monel tags and we tattooed the left ear with 1 to 2 single

alphanumeric characters. We used a Baby Animal Tattoo kit (Valley Vet Supply, Marysville, KS) to tattoo the left ear with a single 3/16" alphanumeric character.

Technical Guidance

NCWRC submitted comments on three National Park Service Environmental Assessments for projects located within the range of the Carolina northern flying squirrel along the Blue Ridge Parkway, including the Parkway general management plan, management of Parkway vistas, and a road repair. NCWRC began initial discussions with the U.S. Forest Service (USFS) in June 2008 regarding a proposed timber sale in the Unicoi Mountains GRA.

The U.S. Fish and Wildlife Service posted a notice in the Federal Register requesting information on this species as part of a five year status assessment. Since no previous status assessments had been done since listing in 1985, NCWRC provided a summary of findings of survey efforts conducted between 1996 and 2007.

Results

Between January and mid March, staff conducted routine checks of boxes in the Great Balsams, Black and Craggy Mountains, and Unicois Mountains and implemented a modified survey, checking boxes in the Great Balsam recovery area a second time. Results of these two larger efforts are reported separately below.

Routine annual box checks

Altogether, 73 NFSQs were detected including nine previously tagged individuals (Figure 2, Table 1). Sixty-one of these 73 animals were fitted with ear tags for the first time. Three of the 73 squirrels were either seen leaving the box or escaped before the observer could determine whether or not the animal had an ear tag.

The total number of NFSQ nests found in boxes in the three recovery areas surveyed increased slightly this year. In total, 155 boxes contained NFSQ nests, although just 32 of the 155 were occupied by NFSQs. Overall, across all GRAs, 31% of boxes were found to contain nest material identified as NFSQ nests (Table 2). However, only 20% of those nests and just 6% of all boxes we checked were occupied by NFSQs. Between 22 and 36% of boxes in the Black-Craggy Mountains, Great Balsams, and Unicoi Mountains contained nests. Especially noteworthy this year was the discovery that two of ten boxes at Elk Knob State Park and two of ten boxes at Beech Creek Bog Significant Natural Area contained finely shredded birch bark that closely resembled nests of NFSQs. However, these nests were classified as "unknowns," since NFSQs have yet to be documented directly (via capture) at these two locations. NCWRC received unconfirmed reports of northern flying squirrels at residences or yards in the town of Beech Mountain, NC (Watauga County). NFSQs were not known or previously thought to occur in these secondary sites. Survey efforts are being developed by NCWRC to confirm these as yet unsubstantiated reports.

Figure 2. North Carolina Wildlife Resources Commission new captures and recaptures of northern flying squirrels, excluding escapees, 2008.

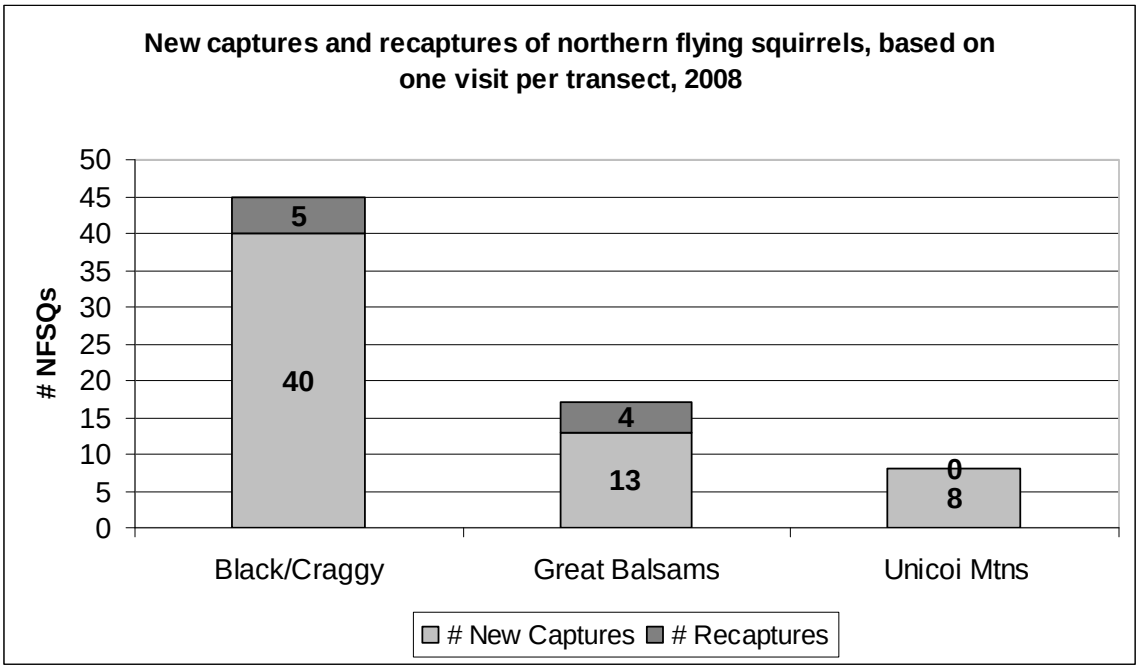


Table 1. North Carolina Wildlife Resources Commission northern flying squirrel capture summary, 2008.

Mountain Range/GRA	# Boxes Checked[1]	# NFSQ Detected	# Recaptures	# NFSQ Newly Tagged
Black & Craggy Mtns	200	**46**	5	40
Great Balsams	210	**17**	4	13
Unicoi Mountains	68	**10**	0	8
Beech Creek Bog SNA	10	**0**	0	0
Elk Knob State Park	10	**0**	0	0
Totals	**500 [844]**	**73**	**9**	**61**

[1] Detections defined as new captures, recaptures, and escapees.
[ ] = 2007 results

Table 2. North Carolina Wildlife Resources Commission northern flying squirrel nest summary, 2008.

Mountain Range/GRA	Number Boxes Checked	Number NFSQ Nests (occupied and unoccupied)	% Boxes with Nests	% Boxes occupied by NFSQs	% Nests occupied by NFSQs
Black & Craggy Mtns	200	63	32 %	8 %	27 %
Great Balsams	210	77	36 %	4 %	13 %
Unicoi Mountains	68	15	22 %	7 %	33 %
Beech Creek Bog SNA	12	0	0 %	0 %	0 %
Elk Knob SNA	10	0	0 %	0 %	0 %
Totals	**500**	**155**	**31 %**	**6 %**	**20 %**

Squirrel detections fluctuated once again this year. Captures in the Great Balsams returned to low levels seen in 2005 and 2006 (less than 30 captures per year), while captures in the Black Mountains continued to recover from low 2005 levels (Figure 2).

The following comparisons are intended to highlight changes in captures relative to effort (measured as number of NFSQ boxes checked) in select recovery areas. A capture decrease of 57% from 2007 in the Great Balsams is noteworthy given the fact that 24% of squirrel boxes are posted in this mountain range (Table 3). Captures were down 60% from 2004 levels. In the Black Mountains, where 29% of squirrel boxes are posted, detections were up 35% from last year. Squirrel detections were up 233% in the Unicois Mountains from last year, though this is based on a small squirrel box network.

Figure 2. North Carolina Wildlife Resources Commission detections of northern flying squirrels between 1996 and 2008 in three GRAs.

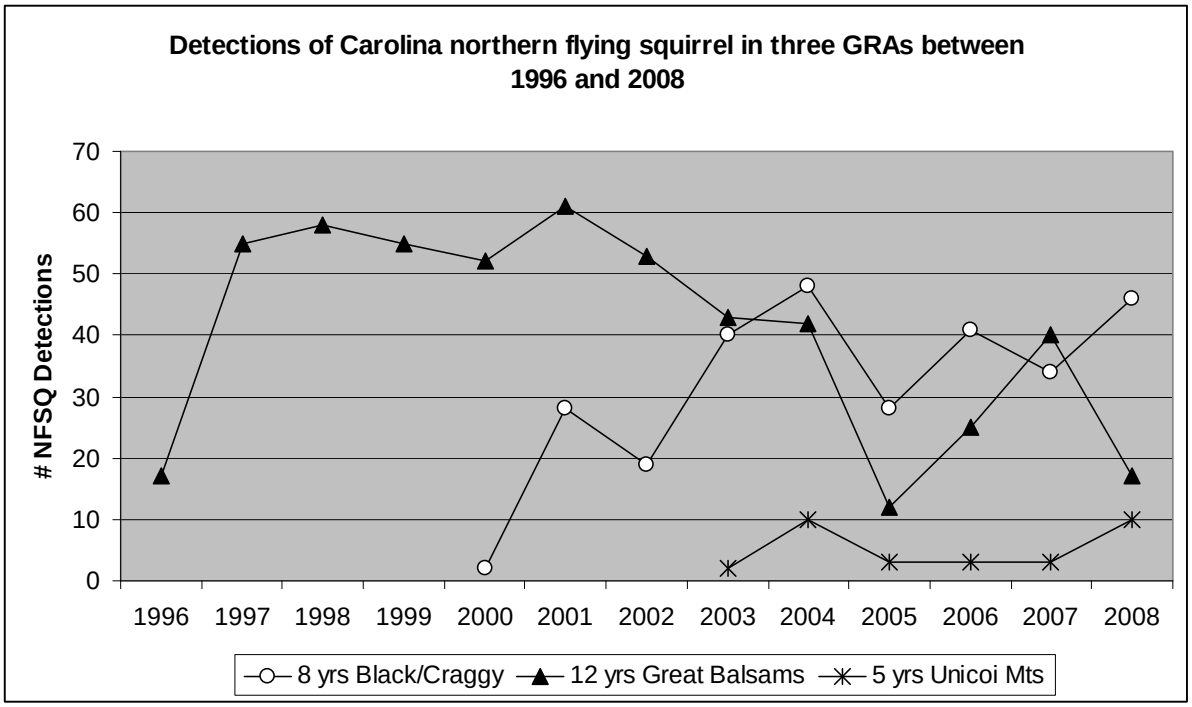


Table 3. North Carolina Wildlife Resources Commission percent change in detections of northern flying squirrels over the past four years by GRA.

Geographic Recovery Area	Percent change 2004 to 2005	Percent change 2005 to 2006	Percent change 2006 to 2007	Percent change 2007 to 2008	Percent change 2004 to 2008 (4 year change)
Black-Craggy Mtns	-42 %	46 %	-17 %	35 %	-4 %
Great Balsams	-67 %	79 %	60 %	-57 %	-60 %
Unicoi Mtns	-70 %	0 %	0 %	233 %	-30 %

A total of 27 squirrels were double marked with ear tags and tattoos. An additional six squirrels were just marked with tattoos, due to an ear tag plier malfunction. Two squirrels captured and tattooed on January 7, 2008 were recaptured February 12, 2008. Both characters were clearly visible on one squirrel; one character was not as legible on the other animal due to tattoo placement (Figure 3). It may be possible to only fit one character on the ear flap. Tattoos are used on wood rats with good mark-retention rates (Thomas 2005). NCWRC will document any recaptures of tattooed squirrels in the coming years to estimate a rate of ear tag loss. This can be used as a correction factor for estimating survival rates based on the mark-recapture data. NCWRC will also consider switching to tattoos using unique combinations of alphanumeric characters, left or right ear combinations, and ink colors.

Figure 3. Left: Tattoo "**A2**" examined five weeks after application. Right: Tattoo "**A2**" viewed upside down from outer surface of ear.

Modified occupancy survey in the Great Balsams

These modifications were made after preliminary examinations of the existing dataset and consultation with researchers familiar with or specializing in occupancy models at North Carolina State University and Patuxent Wildlife Research Center. There was a great effort to minimize impacts to the continuity of these long term survey efforts that are already years in development. The main goal was to ensure that our yearly efforts successfully address the objectives in light of potential confounding effects of site or sample variables or tag loss and their associated influence on how we interpret population trends. The decision to survey transects twice was based on a trial run of Great Balsam data from 2005-2007, which generated

estimates of occupancy rate (0.70) and detection probability (0.88). These levels indicated that two visits was the optimal number needed (United States Geological Survey 2007).

Fourteen transects in the Great Balsams were surveyed twice. Capture data were summarized in terms of numbers and in terms of detection-nondetection. Detection-nondetection is a more accurate term for presence-absence because it does not imply the assumption that a species is absent based on nondetection. Detection-nondetection was depicted as a "detection history" for each visit to each box transect, where "1" indicates squirrels were detected at least once on a transect, and "0" indicates squirrels were not detected on a transect (Table 4). Squirrels were detected during both visits at 36% of transects, neither visit at 43% of transects, and in just one of two visits at 21% of transects. Seventeen squirrels were captured and tagged during the first visit; 19 were captured but not tagged during the second visit and some were recaptures from visit one.

Table 4. Detection history and captures for 14 transects in the Great Balsams GRA visited twice during the 2008 occupancy survey. "1" indicates detection; "0" indicates no detections.

Transect	Detection-Nondetection visit 1	Detection-Nondetection visit 2	# Captures visit 1	# Captures visit 2
Beech Gap	1	1	3	1
Buckeye Creek	1	1	5	6
Graveyard Ridge	1	1	3	3
Little Sam Knob	1	1	2	3
Possum Hollow	1	1	3	1
Flat Laurel Branch	0	1	0	4
Haywood Gap	0	1	0	1
Reinhart Group	1	0	1	0
Bearpen Gap	0	0	0	0
Beartrail Ridge	0	0	0	0
Rich Mountain	0	0	0	0
Rough Butt Bald	0	0	0	0
Sweetwater Springs	0	0	0	0
Wet Camp Gap	0	0	0	0
Totals	6 of 14	7 of 14	17	19

A single-season model and a single-season, survey-specific model were run in program PRESENCE to generate estimates of detection probability based on two visits, and estimates of occupancy rate (ψ) adjusted for detection probability. The best fit model was the single-season model which explained 69% of the variability. Occupancy rate is the proportion of transects (sites) occupied by NFSQs based on detections. A *naïve* estimate of occupancy rate is one that has not been adjusted for detection probability. The naïve estimate of occupancy rate, 0.57, is based on squirrel detections at eight of fourteen sites over the course of two visits and is similar to occupancy adjusted for detection probability (ψ =0.60) (Table 5). Though the analysis did not select the single-season, survey specific model, naïve estimates for each visit are also presented here to illustrate the variability inherent in individual visits (Table 5). Naïve estimates of occupancy for separate visits are considerably different from the naïve and adjusted occupancy

rate (ψ) for combined visits. Again, these estimates of detection probability and occupancy rate suggest that the optimal number of visits needed in the Great Balsams is two per season.

Table 5. Naïve estimates of occupancy rate, occupancy rate adjusted for detection probability (ψ), and detection probability (*p*).

Occupancy Rate				
Naïve estimate visit 1	Naïve estimate visit 2	Naïve estimate combined visits	**ψ** (adjusted for ***p***) combined visits	Detection Probability, ***p*** (standard error)
0.43	0.50	0.57	0.60	0.76 (0.13)

Data analyses of the influence of temperature and den availability as covariates are on-going with assistance from a statistician. Temperature data were summarized in several ways that were thought to influence squirrels' use of nest boxes. These include: average, minimum, maximum, daytime (sunrise to sunset), and nighttime (sunset to sunrise), and absolute difference between minimum and maximum temperature one day before a survey and combined data for three days before a survey. Temperature may influence use of boxes directly, if squirrels become too hot in the boxes on warm days. Or its influence may be indirect, affecting parasite activity, fungal blooms, or other factors that might influence where a squirrel spends the night foraging in relation to a box and a squirrel's decision to use a box instead of a natural cavity. Den data measurements were translated into categories of low, medium, and high quality den habitat.

B. Target Dates for Achievement and Accomplishment

On schedule

C. Significant Deviations

None

D. Remarks

NCWRC will consider marking squirrels with tattoos using unique combinations of alphanumeric characters, left or right ear combinations, and ink colors. Due to the fact that we were sharing one tattoo kit, not enough animals were tattooed to likely yield future data on tag return rates. Therefore, it would be advisable to again double-mark animals in the 2009 cohort with ear tags and tattoos. Our ability to tattoo all captures is dependent on the availability of the Baby Animal Tattoo kit.

Unexplained declines in captures in the Great Balsams this year lend further support for conducting the Great Balsams occupancy survey in an effort to better understand these trends. This is the first season we have measured occupancy rate and detection probability. Given detection issues and low captures in some GRAs, it may be more useful to track changes in

squirrel *occupancy* of sites rather than tracking changes in squirrel *abundance*. The squirrel project could be modified under the framework of an occupancy model and our objective this year was to assess the feasibility of this, using the Great Balsams as an example. Reasons supporting a shift to occupancy surveys are: (1) data are corrected for detection probability, (2) captures are low, (3) recaptures are low, and (4) tag loss is an issue in the mark-recapture study. Low captures and recaptures are a problem particularly in the Roan Mountain, Grandfather Mountain, Plott Balsam, Great Smoky Mountains, and Unicoi Mountains recovery areas. Potential reasons not to shift to this approach are (1) need for multiple visits and (2) associated logistic limitations. We can at least use the estimate of detection probability generated this year to "correct" future capture data for detection probability in the Great Balsams.

NCWRC is also investigating alternative survey methods, all of which track changes in occupancy rather than abundance. Detection is a probability ranging from 0 to 1. When detection is close to 0 for a given survey method, a better survey method is needed. Detection based on box surveys in the Great Balsams was relatively high (0.76) indicating that box surveys are a reasonable approach in this recovery area. In other recovery areas, where there is less habitat and/or a smaller nest box network, this is not likely to be the case. For example, there were zero captures in Great Smoky Mountains National Park in 2006 and 2007 and only 1 capture at Roan Mountain in 2006 and 2 in 2007. When detection falls below 0.15, occupancy estimates are not valid and it is impossible to distinguish between where an animal is hard to detect compared to true absence (Bailey and Adams 2005, MacKenzie et al. 2002). Other survey methods are available and should be tested in order to identify a survey method with higher detection rates, for example, acoustic monitoring, track plates, hair traps, or cameras. NCWRC is consulting with researchers at Auburn University on the feasibility of using bat detectors to conduct acoustic monitoring of northern flying squirrels.

E. Recommendations

There is a need to better document distribution in some recovery areas as well as in secondary areas outside of recovery areas. Squirrel box surveys or other sampling methods should be continued and, when possible, extended. To manage time and logistic constraints, box transects that are currently nonproductive should be checked in alternate years or dropped altogether. Some box transects in the Smokies and Unicois need to be shifted to better represent suitable habitat and areas of planned habitat modification. Recent, unconfirmed reports of NFSQ in the northwestern counties, outside of recovery areas, suggest a need for surveys of "secondary sites" and elevations below 4,500 feet, which are currently not well-represented in the box survey network. Inventory work should be extended to Long Hope Valley, spruce bogs in the mountains, certain high elevation northern hardwood sites, the Town of Beech Mountain, and possibly additional locations. Continued squirrel box surveys as well as live trapping should be employed to survey Elk Knob State Park and Beech Creek Bog SNAs where NFSQs have never been documented, despite characteristic nest material in boxes.

The decision to shift current box monitoring in the Great Balsams or other areas to an occupancy survey will be based in part on findings from analysis of the data that incorporates den and temperature covariates, as well as logistical considerations. Analyses are expected to be

complete by December 2008. Depending on a number of logistical considerations and on the findings of this analysis, the four recovery areas not surveyed this year may be surveyed in 2009.

F. Estimated Cost

$42,033 (including in-kind contributions)

G. References

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Prepared By: Chris Kelly
Division of Wildlife Management

Annual Performance Report

State: North Carolina **Project Number:** T - 9
Amendment Number: 1

Period Covered: July 1, 2007 – June 30, 2008

Grant Title: State Wildlife Grants T-9 (Planning)

Project Title: Wildlife Diversity Federal Aid Coordination

Objective:

To establish and maintain management control systems adequate to meet requirements for administration of Federal-aid Programs other than P-R which are aimed at species with greatest conservation need.

A. Activity

Maintaining eligibility for participation in federal assistance programs

The Wildlife Diversity Coordinator worked with appropriate administrators to monitor the status of State laws necessary to participate in the Federal-Aid programs aimed at nongame species. No problems were encountered with regard to modification of existing laws that might jeopardize Program funding. Submission of active grants satisfied the requirement for "notice of desire to participate" in the Federal-Aid Programs.

Assuring that grant proposals submitted met program standards and consistency with state wildlife management goals.

The Wildlife Diversity Coordinator worked with senior staff to develop projects that met eligibility standards to be submitted for Federal-Aid. Projects were chosen that met the basic criteria for character and design and that utilized accepted wildlife conservation principals and practices. Projects that would yield benefits pertinent to the stated need and that could be accomplished within reasonable funding limits were proposed, submitted, and monitored.

Assuring that documentation is consistent with program standards**.**

The coordinator reviewed, edited, and compiled all documents that were submitted to the Regional Office, including several amendments to grants, interim and final reports, and new grant applications. This review assured that all documents were submitted within FWS deadlines with appropriate forms and other associated documents. The coordinator corresponded regularly with Federal Assistance Personnel to assure consistency with program standards and explore more coordinated approaches to review of grant documents.

Assuring that work funded was accomplished in an effective and efficient manner.

The coordinator supervised all senior staff directly and all other staff indirectly thereby facilitating the effort to assure that work was accomplished in an effective and efficient manner. Almost daily contact with senior staff and subsequent contact between field supervisors with their staff through the use phone calls and emails and numerous face-to-face meetings facilitated efficiency. Frequent communications and meetings among WRC personnel occurred with various program personnel to review progress, discuss issues, and coordinate the work on federal assistance projects throughout the year.

Assuring that adequate financial and property records are maintained.

The coordinator monitored the general program for financial accountability with program supervisors, administrators, and accountants on a regular and frequent basis. Inventories of property were maintained and checked by the coordinator and field supervisors. No problems were encountered. Program expenditures were monitored by the coordinator and regional supervisors to ensure compliance with the various federal assistance grant requirements and standards, and to ensure that expenditures were within grant limits.

Coordination of federal assistance program with other programs to eliminate duplication and minimize conflicts.

The coordinator, program manager, and regional supervisors coordinated with other regulatory agencies, both state and Federal, to assure that duplication of efforts and conflicting activities were prevented. No conflicts with or violations of state or Federal law were discerned during numerous review opportunities. Numerous coordination meetings with other agencies, organizations, and individuals provided opportunities to share information, facilitate cooperation, and avoid duplication of effort in the Wildlife Diversity Program's work. Regular review of federal assistance grants, projects, and plans ensured that the variety of federal assistance grants, and other funding source grants complement each other in pursuit of the NC Wildlife Action Plan goals.

B. Target Dates for Achievement and Accomplishment

Activities were accomplished as planned.

C. Significant Deviations

None

D. Remarks

None

E. Recommendations

In order to assure that Federal Assistance obligations are met in an efficient and timely manner, this project should continue.

F. Estimated Cost

$95,846

Prepared by: Chris McGrath, Wildlife Diversity Program Coordinator
Division of Wildlife Management

Annual Performance Report

State: North Carolina

Project Number: T - 9
Amendment Number: 1

Period Covered: July 1, 2007 – June 30, 2008

Grant Title: State Wildlife Grants T-9 (Planning)

Project Title: North Carolina Partners in Flight

Objectives:

The North Carolina Partners in Flight (NC PIF) Program will continue to develop and reinforce partnerships throughout the state, region, and Americas that will benefit bird conservation via increased communication, cooperation, and collaboration. Technical guidance will be provided to local, state and federal agencies, conservation organizations, private industries, academia, and concerned citizens on matters related to bird conservation. NC PIF will target natural resource professionals and land managers to provide training on monitoring techniques and bird management, and information will be provided to the public in a variety of ways to create better awareness about migratory birds and their habitats. PIF in North Carolina will continue to follow the vision, mission, goals, and objectives clearly outlined in the NC Bird Species Assessment and the Bird Conservation Plan for North Carolina Partners in Flight (Johns 2004 and Johns 2005) under the cooperative framework of the North American Bird Conservation Initiative, as well as the North Carolina Wildlife Action Plan (NCWRC 2005).

A. Activity

Coordination/Communication

A major goal of the NC Partners in Flight Program (NC PIF) is to help maintain or increase populations of migratory birds throughout the state and region through increased communication, cooperation, and collaboration via voluntary, creative partnerships. The NC PIF Biologist is charged with coordinating all Partners in Flight activities in the state for the Wildlife Resources Commission. Cooperation and collaboration among partners is imperative for the Partners in Flight Program to be successful, so the NC PIF Steering Committee and the State Working Group met in fall of 2007 and spring of 2008 to discuss projects, initiatives and other matters important to bird conservation. The NC PIF spring annual meeting was held during March of 2008 at Blue Jay Point County Park in Wake County, North Carolina. A regional fall NC PIF meeting was held in November of 2007 at Pocosin Lakes National Wildlife Refuge focusing on bird conservation efforts in the coastal region of North Carolina.

In addition the NC PIF Biologist met frequently during the period with members of the NC PIF Conservation and Management, Communications, and Monitoring and Research working committees to refine goals and objectives related to bird conservation for upcoming years and

periodically review progress related to ongoing projects. The NC PIF Biologist also attended a preliminary technical committee meeting of the Appalachian Mountains Bird Conservation Region (proposed to be a Joint Venture) in Roanoke, Virginia in August of 2007 and reviewed the Joint Venture Implementation Plan for the Appalachian Mountains Bird Conservation Region

NC Partners in Flight is heavily involved in many major initiatives and partnerships that directly relate to conservation of birds in North Carolina, the region, and the Americas. Partners in Flight was involved this past period with bird conservation efforts involving or related to the multi-agency Forest Landbird Legacy Program, the Ecosystem Science Support Project of the USFWS Roanoke-Tar-Neuse and Cape Fear Eco-team, the NC Birding Trail Initiative, Mecklenburg County Park and Recreation Department, NC State University's Breeding Bird Survey protocol research project, Howell Woods Environmental Learning Center, the power co-op EnergyUnited, Grandfather Mountain, NC Audubon's Important Bird Area Program, and Weyerhaeuser Company.

NC Partners in Flight remains involved with multi-state working groups related to bird species of high conservation concern including the Eastern Painted Bunting, Cerulean Warbler, Golden-winged Warbler, and Appalachian Yellow-bellied Sapsucker. During the period, the NC PIF Biologist attended Painted Bunting, Golden-winged Warbler and Rusty Blackbird regional working group meetings. The NC PIF Biologist was directly involved during the period with the development of several bird species profiles for the Conservation Education Division and he continues to serve on the NC Bird Scientific Council.

The NC PIF program continues to work toward implementation of important components of the NC Wildlife Action Plan, North American Bird Conservation Initiative, plus state and regional bird monitoring, research, and management plans that will further bird conservation throughout the region. The NC PIF Biologist worked throughout the period as a member of the Southeastern Partners in Flight (SE PIF) working group in cooperation with other state PIF coordinators on issues related to bird conservation in the region including the evolution and refinement of CP-33 monitoring protocols, and also reviewed and commented on the final draft of the US Fish & Wildlife Service Passerine Monitoring Protocol Draft, piedmont and mountain species and habitat components of the NC Natural Heritage Program Landscape Project, the Appalachian Mountains Bird Conservation Region Priority Bird Species List, and the Pee Dee National Wildlife Refuge Comprehensive Conservation Plan. The NC PIF Biologist also reviewed and refined the NC Bird Species Assessment and the NC Bird Monitoring and Research Summary.

The NC PIF newsletter has been produced since the program was first organized in 1993 in this state, and is now available electronically on the NC PIF web site. NC PIF newsletters were produced and distributed electronically during summer and fall of 2007 and winter of 2008. The NC PIF web site continues to expand and was reorganized during the period with the addition or refinement of several components, including new bird species management fact sheets on Bachman's Sparrow and Rusty Blackbird.

International Migratory Bird Day (IMBD) is the main venue that provides information to the public from the International Partners in Flight Program. IMBD has as a main objective each

year in North Carolina to help create better awareness about the importance of migratory birds through hands-on programs and events. Dozens of IMBD events were held again in 2008 in all physiographic regions of the state (including several all-day festivals), and the NC PIF Biologist continues to coordinate IMBD efforts in North Carolina, and also made presentations again at IMBD events in 2008. The NC PIF Biologist was a member of the Steering Committee of the NC Birding Trail and the Piedmont trail guide for North Carolina was finished and published this period.

An important function performed by the NC PIF Biologist is to give presentations to various public and professional groups on the Partners in Flight program and other topics related to bird conservation. During the period, at (27) different presentations or workshops, (559) participants were directly addressed by the NC PIF Biologist on a variety of topics that included: backyard habitat management for birds, bird identification techniques, forest management for birds, bird monitoring techniques, bird migration, habitat management for birds, and the NC PIF Program. Programs related to bird conservation were conducted for groups ranging from young children to senior citizens. The NC PIF Biologist worked again with NC State University undergraduate wildlife and forestry students at their summer camp on bird identification skills and bird monitoring techniques.

Surveys/Professional Training

The NC PIF Biologist continues to serve as the Breeding Bird Survey (BBS) coordinator for North Carolina. He conducted (7) BBS routes including replication of one route 3 times for an NC State University BBS research project, and assisted at a fall and winter banding stations in the coastal plain. The NC PIF Biologist participated in (4) Christmas Bird Counts and conducted Painted Bunting surveys at the coast. He also conducted bird inventory work at Caswell Game Land, Goose Creek State Park, Wake County's Harris Lake and Blue Jay Point County Parks, the NC Forest Service's Jordan Lake Educational State Forest, US Army Corps of Engineers property at the Jordan Lake Dam, Pee Dee National Wildlife Refuge, Seymour Johnson Air Force Base, Weyerhaeuser property in coastal NC with Weyerhaeuser foresters, and Energy United power coop right-of ways.

Workshops on bird identification, monitoring techniques and management options for landbirds were conducted for biologists for the 11th year in a row by the NC PIF Biologist during the period in all physiographic regions of the state. Several bird identification workshops were given for other natural resource professionals throughout the state. Workshops were also given by the NC PIF Biologist, sponsored by the NC chapter of The Wildlife Society, on bird and plant identification techniques. In addition, 2 cooperative workshops partnering with NC State University's Forestry Extension Department were conducted for natural resource professionals on native plant use by wildlife. The NC PIF Biologist also conducted the 2nd annual joint 2-day bird ID/training workshop partnering with the US Fish and Wildlife Service for Service and Wildlife Commission personnel at Pee Dee National Wildlife Refuge.

In all, (387) participants went through (36) bird identification and techniques workshops given by the coordinator including personnel from: Department of Defense, NC Forest Service, NC State Parks, NC Dept. of Transportation, US Fish and Wildlife Service, National Resources

Conservation Service, US Dept. of Agriculture Wildlife Services, US Army Corps of Engineers, NC Wildlife Resources Commission, several county and local governments, consulting foresters, plus university and college graduate students. This year CP-33 monitoring personnel attended bird ID workshops to specifically improve ID skills. Several biologists, natural resource managers or researchers running Breeding Bird Survey routes, participating in Christmas Bird Counts, or conducting bird monitoring or research in North Carolina have been through these training workshops conducted by the NC PIF Biologist over the last 11 years.

Research Partnership Reports

1-Work continued during this period on this research partnership between NC State University, US Geological Service, US Fish and Wildlife Service, The Nature Conservancy, the State Museum of Natural Sciences, the Wildlife Resources Commission, and NC PIF on productivity, and territory and food requirements of Swainson's Warblers in the Roanoke River region. NC PIF is helping to fund this research project which focuses on Swainson's Warbler and Kentucky Warbler, two priority species in the NC Wildlife Action Plan with a contract for services of $5,530.00 for FY 2007-2008.

'Investigating the productivity, territory size and food base of the Swainson's Warbler in an irregularly flooded bottomland hardwood system'
Interim Report submitted by: Neil Chartier, NC State University

This report covers the period of July 2007 – May 2008 and also includes information from earlier in 2007 for purposes of review. Field work began on 23 April 2007 continued through 31 July 2007. Nine infrared video cameras continuously monitored 28 Swainson's warbler (SWWA) nests. Preliminary results indicate 32% nest survival (9/28). Black rat snakes depredated 11 nests (41%), which accounted for 63% of all nest failures (n = 19). Ant spp. depredated three nests (10% of all nests; 16% of all nest failures). One nest was abandoned, and weather caused one other nest to fail. There was a 10% rate of Brown-headed cowbird parasitism (16% of nest failures). Young did not fledge from any of the parasitized nests.

Nest videos produced several interesting observations. A Yellow-breasted Chat visited a SWWA nest at 2200 h and the nest was abandoned the next day. A Carolina wren severely damaged a SWWA nest with two 6-d old nestlings while both SWWA parents were at the nest (the nest collapsed and failed the next day). Another Carolina wren interacted with (e.g., pecked, tossed, and attempted to brood) a 20-min old SWWA nestling.

Twenty-two SWWA young fledged from nine nests (average 2.4 young fledged per successful nest). In 2007, we recaptured 36% of the SWWA banded in 2006 (53% of the males, n = 17, and 27% of the females, n = 3). In 2007, 15 new males, 9 new females, 34 hatch-year birds were caught, color banded, and bled to collect DNA samples to examine extra-pair paternity in SWWA. In addition, radio telemetry was used on 20 birds to record territory sizes.

Also in 2007, we recaptured 6% of the KEWA banded in 2006 (25% of the males, n = 5 and no females). In 2007, 20 new males and 9 new females were caught and color banded. One glaring

conclusion from our field work was that KEWA nests along the Roanoke were nearly impossible to find, even with a transmitter deployed with one female. Thus, we have eliminated the comparison between KEWA and SWWA nest success from NCSU graduate student Neil Chartier's dissertation research.

In 2007, a total of 78 SWWA and 34 KEWA were banded.

During fall 2007 and winter 2006-2008, Chartier, who has a 2007-2009 Hofmann Fellowship from NCSU, refined his dissertation research (eliminating the nest survival comparison between KEWA and SWWA). He will continue to study SWWA nest survival and added a study of the occurrence of extra-pair paternity in SWWA to his dissertation research. In addition, 299 video tapes were viewed and inter-species interactions, depredation events, and duration time of parental behaviors (e.g., incubation, brooding, provisioning, nest guarding) were recorded.

Thirty-two radio transmitters were ordered in November 2007, and delivered by April 2008.

Chartier conducted interviews for field technicians in January 2008. Four full season technicians and one part-time technician were hired by March 2008.

Field work began 24 April 2008 with one field technician. By 12 May, the remaining four technicians started. By late May, 55 SWWA had been captured by target netting, with eight male recaptures from 2006, one female and eight male recaptures from 2007, and 38 newly banded birds (23 males, 11 females, and four hatch-year birds). Blood samples were collected from all SWWA captured. As KEWA are not target netted, by late May, only one new KEWA had been captured and color banded.

The first nests were found in early May 2008, and the first infrared video cameras were deployed. Three additional infrared video cameras were ordered and deployed by late May. By late May, 11 infrared video cameras have monitored 19 SWWA nests and documented one SWWA nest depredation by a Black rat snake. Two SWWA nests were abandoned, likely due to transmitter deployment on the incubating female SWWA. One nest has fledged one nestling. Brown-Headed Cowbirds parasitized three nests.

Transmitters were put on birds during the first week of May. By late May 2008, 20 transmitters have been deployed.

2- Work continued during this period on a monitoring and research partnership between Mecklenburg County Park and Recreation Department's Division of Natural Resources, the Wildlife Resources Commission, and NC PIF on bird monitoring and research in Mecklenburg County. NC PIF is helping to fund this research project which will improve our knowledge of several priority bird species at the county and regional levels listed in the NC Wildlife Action Plan and foster regional cooperation among agencies and organizations with a contract for services of $3,000.00 for FY 2007-2008.

'Avian Monitoring and Research in Mecklenburg County'

Interim Report submitted by: Don Seriff, Mecklenburg County Park and Recreation Department

Applied the results of a quantitative assessment of local breeding bird species' 'vulnerability to extirpation' to local and regional projects in order to provide a clear understanding of the impacts of the current rate of local growth and development on local bird fauna. Presented the assessment data at 5 'State of the Birds" presentations to public officials, the general public, and department staff and partners. This assessment is being provided to local agencies involved in conservation planning and is being used to target our Division's conservation efforts.

Prioritized and compiled entry of existing bird record data for Mecklenburg County from a variety of hard copy record formats and electronic database formats into a single Access database called Mecklenburg W.I.L.D. (Wildlife Identification Location and Documentation). Sources of the records were incidental observations recorded on field record data sheets, point count data sheets, bird banding datasheets, nest record cards, and others. A total of 24,965 bird records are now in the database and an additional 23,676 records have been entered into a spreadsheet and will be imported into the database in the future. All data is fully accessible for searching by query and is available for sharing with outside agencies.

Performed a literature search and a museum search for bird records and specimen records for the 14-county region around Charlotte. These data are to be used in upcoming bird-related check-lists and publications.

Conducted the 2007-2008 Greater Mecklenburg Winter Waterfowl Survey at 14 sites on 12 area lakes, averaging 14.4 species and 910.6 individuals per count with a total of 20 native waterfowl species documented.

Erected, installed and maintained 300 nest boxes for a target list of 14 cavity-nesting bird species and monitored them throughout the breeding season. High priority species were Prothonotary Warbler and Brown-headed Nuthatch, both of which are priority bird species in the NC Wildlife Action Plan. Staff assisted with monitoring and digital video recording of Barred Owl nests as part of an ongoing research study being conducted through a three agency partnership: Mecklenburg County DNR, UNC-Charlotte Biology Department, and the Carolina Raptor Center. Staff also assisted with banding screech owl nestlings in conjunction with a Davidson College Biology Department owl nest box study.

Provided technical assistance with a Bald Eagle hacking program in association with the Carolina Raptor Center. A single chick was successfully hacked and released and its movements will be tracked via radio-satellite telemetry.

Conducted our annual Breeding Bird Survey Route - # 63-017 and participated in the annual local Christmas Bird Count (Southern Lake Norman) covering two areas of the count circle.

Captured and banded birds as part of four bird banding demonstrations for International Migratory Bird Day, Catawba College, UNC-Charlotte Math & Science Education Network, and the UNC-Charlotte Summer Ventures Program.

3-The final payment of $1,500.00 occurred this period on a research partnership between the NC Museum of Natural Sciences, Mars Hill College, Audubon North Carolina, the Wildlife Resources Commission and NC PIF related to surveys for a status assessment of breeding Yellow-bellied Sapsuckers. NC PIF helped to fund this research project addressing a species of Special Concern and a priority species for the Southern Blue Ridge region of North Carolina in the NC Wildlife Action Plan with a contract for services for $3,000.00 for FY 2006-2007. The first payment of $1,500.00 occurred during the 2006-07 FY and the final payment during FY 2007-08. Attached is the project final report from the 2006-07 field season.

'*Surveys for a status assessment of breeding Yellow-bellied Sapsuckers'*
Summary Report submitted by: John A. Gerwin, NC State Museum of Natural Sciences and Scott M. Pearson, Mars Hill College

Assessment and monitoring of animal populations and communities is a common objective of state and federal conservation agencies interested in preserving biological diversity. The "Southern Appalachian" Yellow-bellied Sapsucker is a disjunct population of the nominate form, and occurs from southwest Virginia to the NC/GA border, and along the NC/TN state line. The complete distribution of this taxon in the southern Appalachians is unknown, as is much of its natural history. It is listed in NC as a species of Special Concern and is a priority species for the Southern Blue Ridge region of North Carolina in the NC Wildlife Action Plan.

In 2003 a group of interested parties formed the Southern Appalachian Yellow-bellied Sapsucker Working Group, to chart a course of action for gathering current data on this subspecies. Gerwin and Pearson received federal funding for field work that was done in 2004 and 2005. Several other agencies provided staff time for work done in GA, VA and TN. Many surveys were completed during these two years, along with intensive efforts to locate and monitor over 75 nests in the North Carolina mountains.

Among the three states reporting birds found (TN, VA, NC), the majority were found in North Carolina. About 200 sapsucker detections were submitted, and these data were combined with spatial land cover data for a first pass habitat/landform analysis. Results indicate the species is restricted primarily to an elevational range of 3800-4800 feet, within northern hardwoods, and usually on a slope just below ridgeline. Most data were gathered from public lands.

Data from ~75 nests show that breeding begins in mid April, when males return from unknown wintering grounds and begin their characteristic territorial drumming. By late April, most birds are excavating cavities. Egg laying usually begins by May 5th or so. Clutch size was 6 eggs in 2004, but mostly 5 in 2005 (likely due to late April snow and hard freeze). Most eggs hatch in early June, and fledging takes place in late June to early July.

Adults were found to be generally quiet, and thus, doing traditional "point count" or "transect" surveys was not feasible, because these methods rely on birds that are highly vocal. Instead, we found that using tape playback was the only feasible way to survey for the presence/absence of this taxon. As one might expect, certain times are better than others. Good times for tape playback surveys are late April-early May, and late May-~10 June. Both sexes will respond, but during incubation (~May 10-30) only one bird is "available". After the eggs hatch, the birds are

somewhat responsive again, until the young reach about 10-14 days of age, and then the adults are so busy feeding the young that they become less responsive. Playback can still be done, but the response time is much longer, and sometimes does not happen (based on playbacks done near known active nests).

Funding provided by the Wildlife Resources Commission via the NC Partners in Flight Program contributed to our on-going studies of this population of sapsuckers during this period, and to help us further understand its distribution throughout the North Carolina mountains. The modeling work being developed by a researcher at Mars Hill College is being done in concert with the NC GAP folks, as researchers try to fine-tune the approach to make it most useful for field work and conservation.

Survey efforts focused in some of those areas where our model predicts the occurrence of yellow-bellied sapsuckers. We also worked in some private landholdings, to "balance" out the database, which results are heavily based on public lands. We continued to use the tape/CD playback method, and survey times were targeted for the appropriate periods. All survey points were georeferenced with a GPS unit, and some qualitative vegetation data was recorded. These data will help fill in gaps in our understanding of this species distribution and relative abundance in North Carolina.

Five researchers did various surveys between late April and mid June in 2007. About 25 new "general" localities were checked; some of these were just one point, others were a small series of points. Five areas were visited that had previously had birds; all of those still did. We also received reports from several new localities.

Of the 25 new areas, birds were found in only 4 of them. One of these sites is a private tract owned by the Cantrell family, north of Sylva, and at least 4 pairs were found. It had been high graded a few years back, so it's a very interesting site, from a land use perspective.

4-A multi-state partnership involving North Carolina, South Carolina, Georgia and Florida focusing on the Painted Bunting (a species of special concern in the NC Wildlife Action Plan) is being partly supported by NC PIF with a contract for services for $5,000.00 with the NC Museum of Natural Sciences. The first payment of $2,500.00 was made this FY and the final payment of $2,500.00 will be made in late summer of 2008 upon receipt of a project report for the spring/summer 2008 field season from the NC Museum of Natural Sciences.

'Surveys and research for a status assessment of breeding Painted Buntings'
Principal Investigators: John A. Gerwin and Jamie Rotenberg

Project Background: Assessment and monitoring of animal populations and communities is a common objective of state and federal conservation agencies interested in preserving biological diversity. The "Southeastern" Painted Bunting is a disjunct population from the more common form in the mid- and southwestern U.S. It occurs from southeast North Carolina to NE Florida. It is listed in NC as a species of Special Concern, is a priority species according to Partners in Flight, and is a high priority bird species in the NC Wildlife Action Plan. Few studies have been

conducted on the life history of this species. Within NC, the species occurs within a narrow, ~1Km wide band along the coast from Carteret County to the SC state line. The species is frequent at bird feeders in urban settings.

In the early 2000's, a group of folks from numerous agencies across NC, SC, GA and FL gathered to begin discussing a coarse of action to gather solid data about the current population size, distribution, and demographics of this species and formed a painted bunting working group. With the assistance of statisticians at Patuxent, a survey study was designed, and partners began implementation during the breeding season of 2007. In addition, in 2005 Dr. Jamie Rotenberg at UNC-W began a "citizen science" project with people in the Wilmington area, to record Painted buntings at their feeders and submit their observations. This endeavor spread to include SC, and over 300 households reported buntings in 2006. In 2007, researchers used 2 technicians to band birds at private and public locations throughout the coasts of NC/SC. A coordinator was also hired with grant funds to deal directly with the 300+ "citizen scientists". A website was established via UNC-W for this more public project.

Preliminary Results: Approximately 100 points were surveyed in NC, and nearly 100 birds were detected. Many points fell in poor habitat, but were surveyed nonetheless. The SE Regional working group met to discuss sampling design issues. There is now have new satellite imagery available, and new habitat classification data. A new round of points will be generated for 2008.

The two banders captured nearly 1000 buntings, from Ft. Macon to the SC/GA state line. Many of course were new captures, but there were a number of recaptures from work previously done by Paul Sykes and Jamie Rotenberg. Many households were visited, as were major State Parks or natural areas, and 4 military bases, including Bogue Airfield and Camp Lejeune. Many birds reside in the Hammocks Beach St. park area, Camp Lejeune, and along the Pender and New Hanover county coastlines (e.g. Carolina Beach State Park).

Research Objectives: Funding provided by the Wildlife Resources Commission will contribute to our on-going studies of this population, and to help us further understand its relative abundance along the North Carolina coast. Partners will also continue our banding project and will choose a sub-sample of 12 NC sites – both residential and public – to use as capture sites over at least a 5 year period. Mark/recapture of buntings at the same sites over a longer time frame will provide insight into site fidelity, survivorship, and reproductive output. By having banding sites in two broadly different "habitats", researchers can compare results among these.

Many people feed birds in developed areas along the coast, and are reporting buntings. Partners see this as an opportunity to understand how a Special Concern species is "making a living" in these conditions. Researchers plan to use the Painted Bunting as a "conservation advocate", once there is data to do so more compellingly. The project uses the public in a "citizen science" fashion, which also saves money for other research topics for the working group. The working group plans to generate educational pamphlets based partly on monitoring results, and give various public talks.

Technical Guidance

During the period, the NC PIF Biologist was called upon to provide technical guidance on issues related to bird conservation for the Habitat Conservation Program and Division of Wildlife Management of the Wildlife Resources Commission, as well as various federal, state and local government agencies, conservation organizations, corporations and forest products companies. The *Forest Landbird Legacy Program* partnership between US Fish and Wildlife Service, National Resources Conservation Service and the Wildlife Resources Commission continued this period and featured contacts developed by participating biologists with landowners regarding this cost-share program designed to benefit forest landbirds. The NC PIF Biologist provided technical guidance, among others, to staff with the NC Forest Service, NC State Parks, US Army Corps. of Engineers, US Fish and Wildlife Service, US Dept. of Agriculture's Wildlife Services, Energy United, Grandfather Mountain and Wake County Parks, Recreation and Cultural Resources Dept. about bird monitoring issues on their lands.

The NC PIF Biologist provided technical guidance during the period to (24) private landowners regarding backyard management options for birds. University and college students from various universities in North Carolina and adjacent states contacted the coordinator for advice on project development or information on migratory birds, and hundreds of citizens contacted him for information on bird related issues on their property. Dozens of documents, drafts, plans and research proposals related to bird conservation from all types of agencies, groups, organizations, universities and industries were reviewed by the NC PIF Biologist during the period.

B. Target Dates for Achievement and Accomplishment

On schedule.

C. Significant Deviations

None

D. Remarks

None

E. Recommendations

This project should continue to help further bird conservation in the state and region.

F. Estimated Cost

$119,134 (including in-kind contributions)

G. References

Johns, M.E. 2004. *North Carolina Bird Species Assessment.* North Carolina Partners in Flight. 15 pp.

Johns, M.E. 2005. *A Bird Conservation Plan for North Carolina: A Bird Conservation Strategy by North Carolina Partners in Flight.* North Carolina Partners in Flight. 22pp.

North Carolina Wildlife Resources Commission. 2005. *North Carolina Wildlife Action Plan*. Raleigh, NC.

Prepared by: Mark Johns
Partners in Flight Biologist

Annual Performance Report

State: North Carolina **Project Number:** T - 9
Amendment Number: 1

Period Covered: July 1, 2007 – June 30, 2008

Grant Title: State Wildlife Grants T-9 (Planning)

Project Title: Coastal/Piedmont Region Waterbird Investigations

Objectives:

1. Continue evaluating the use of social attraction to attract colonial waterbirds to suitable nesting sites.
2. Establish baseline reproductive success of nesting terns, skimmers and shorebirds on dredge and natural islands with in the estuaries.
3. Collect baseline data on the population and distribution of nesting American oystercatchers and Wilson's plovers along the North Carolina coast.
4. Collect baseline data on inland heronries.
5. Obtain baseline information on the best techniques for creation of early succession habitat on dredged material islands.
6. Collect baseline data on species and relative abundance of non-breeding shorebirds.

A. Activity

Breeding Shorebird Surveys

During the 2007/2008 fiscal year we coordinated and completed a coast-wide survey for breeding American oystercatchers and Wilson's plovers. These surveys have been identified as a priority in the NC Wildlife Action Plan (NCWRC 2005). American oystercatchers and Wilson's plovers were both recently upgraded to species of special concern in North Carolina. Additionally, both are listed as species of high conservation concern in the U.S. Shorebird Conservation Plan (Brown et al. 2001). North Carolina Wildlife Resources Commission (NCWRC) regularly monitors other beach nesting species in the state including piping plovers (*Charadrius melodus*) and colonial nesting waterbirds. Given the declines that have been observed in other species of beach nesting birds, there is concern that American oystercatchers and Wilson's plovers could also be declining. Furthermore, research has shown very low reproductive success of American oystercatchers at some nesting areas in the state including Cape Lookout and Cape Hatteras National Seashores (Davis et al. 1998, McGowan et al. 2005). While reproductive success is inherently low for this species, it is unknown if current reproductive rates are high enough to sustain the population. Even less is know about nesting Wilson's plovers.

Coastal North Carolina extends approximately 311 miles from Virginia to South Carolina and lies in the heart of the breeding range for American oystercatchers and towards the northern extent for Wilson's plovers. Extensive habitat exists on North Carolina's barrier islands as well as within the sounds. We surveyed all available habitat including barrier island beaches and dredged material and natural islands within the estuaries. Surveys were conducted from April through late June in conjunction with coast-wide colonial waterbird and piping plover surveys and were accomplished primarily on foot and by boat. Given the extent of our coastline, it can be very difficult to complete surveys within the narrow breeding window and it would not have been possible without the help of partnering agencies and volunteers.

Results from the surveys have been compiled and entered into the NCWRC shorebird database. Table 1 shows the results from the 2007 surveys and provides a comparison with the first survey conducted in 2004. Similar numbers of Wilson's plovers and American oystercatchers were observed in both years, suggesting relatively stable populations at least over the short term, but surveys must continue in order to detect long term trends. A total of 701 American oystercatchers (337 pairs, 27 individuals) and 471 Wilson's plovers (232 pairs, 7 individuals) were counted over the course of the 2007 breeding season.

Table 1. Estimate of total number of American oystercatchers and Wilson's plovers in North Carolina in 2004 and 2007.

Species	Year	# of Pairs	# of Singles	Total # of Birds
American oystercatcher	2004	337	27	**701**
	2007	339	39	**717**
Wilson's plover	2004	232	7	**471**
	2007	240	5	**485**

Barrier islands continue to be important for both species and supported 83% of Wilson's plovers breeding in North Carolina and 43% of American oystercatchers (Figures 1 and 2). Not surprisingly, most of the barrier island nesters were found on undeveloped islands, although inlet spits on many developed islands continued to support nesting birds. A large percentage of the birds were found on just a few undeveloped beaches. Cape Lookout and Cape Hatteras National Seashores, Lea/Hutaff Island, Masonboro Island and Ft. Fisher/Bald Head Island supported 38% of the American oystercatchers and 66% of the Wilson's plovers in the state. Cape Lookout was again, as in 2004, the most important site overall with 19% of all American oystercatchers and 31% of Wilson's plovers.

Natural and dredged material islands within the estuaries were especially important for American oystercatchers in 2007. We saw a shift in habitat use from 2004 as the percentage of oystercatchers using these islands increased from 48% to 56% (Figure 1) while the percentage using barrier beaches declined from 50% to 43%. This could be in response to continued reduction in habitat quantity and quality at traditional nesting sites on barrier islands. Shell rakes along the Atlantic Intracoastal Waterway continued to support nesting oystercatchers, although it is unclear how successful birds are at these sites. Oystercatchers will also occasionally nests on

wrack on marsh islands. This was first observed in North Carolina in 1989 when three nests were discovered on wrack and may be a response to a loss of traditional nesting habitat on barrier island beaches (Shields and Parnell 1990). We found a total of two pairs breeding on wrack during this survey. Additionally, two pairs of American oystercatchers were found nesting on gravel roofs. Although Wilson's plovers did not utilize estuarine islands to the same extent that oystercatchers did, natural and dredge material islands are important nesting sites for this species. In 2007, 17% of the population was found on estuarine islands, which is similar to the proportion using these sites in 2004 (20%) (Figure 2).

Figure 1. Proportion of American oystercatcher pairs by site type in 2004 and 2007.

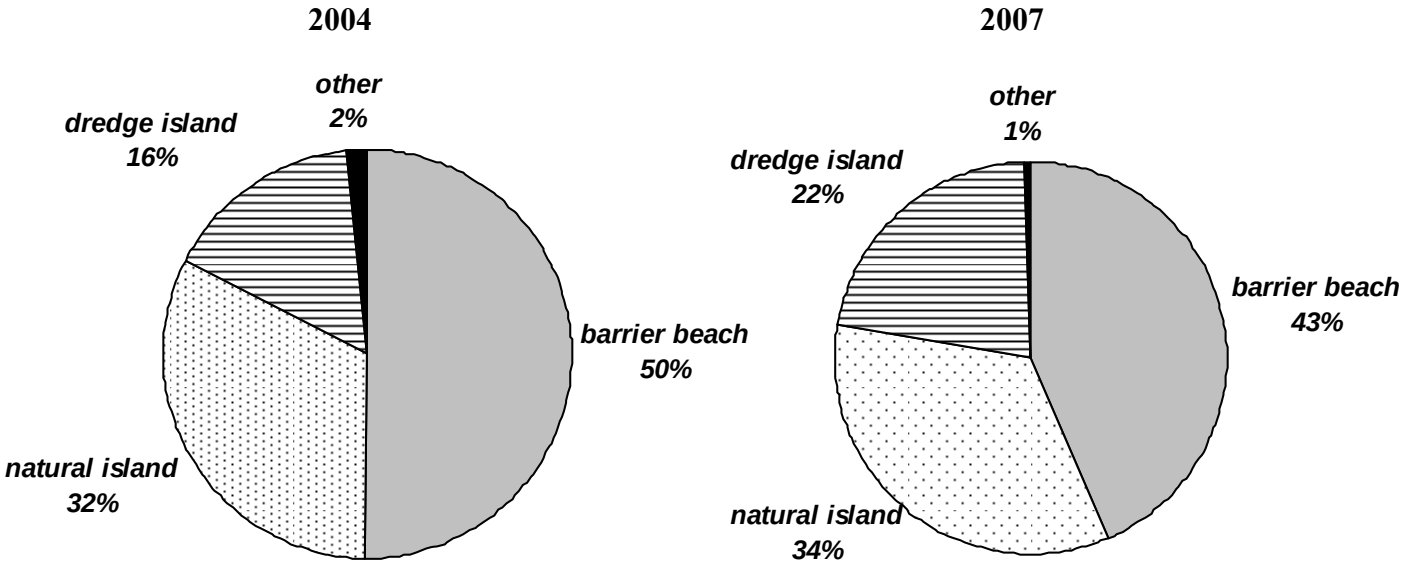
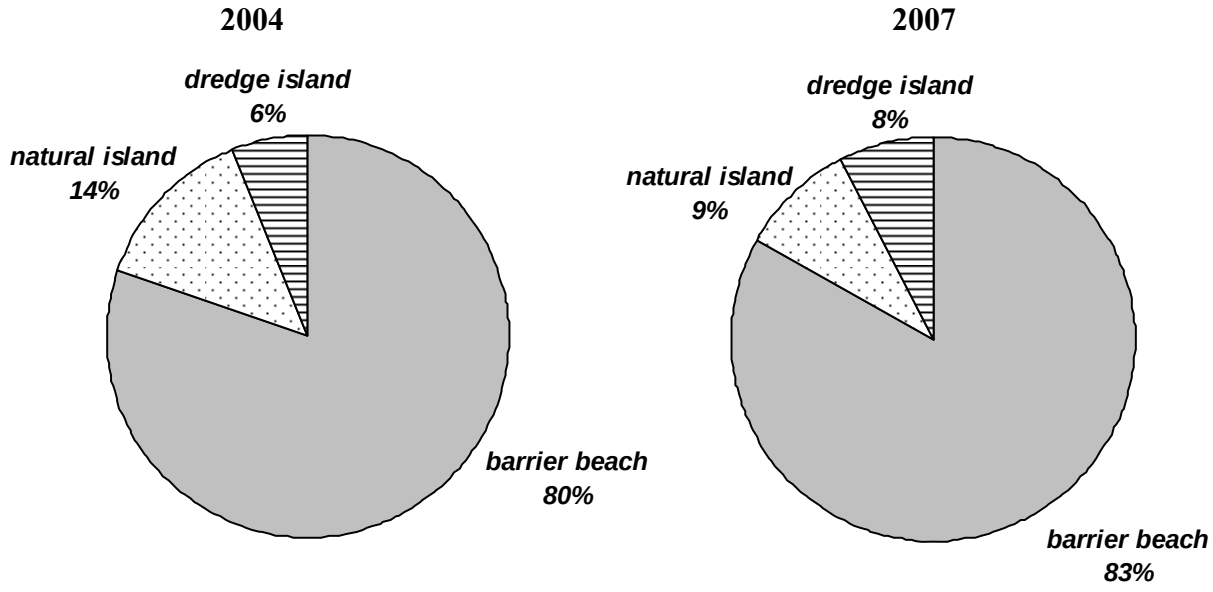


Figure 2. Proportion of Wilson's plover pairs by site type in 2004 and 2007.



The distribution of American oystercatchers and Wilson's plovers across the state is depicted in Figures 3 and 4. Nesting oystercatchers were found as far north as Bodie Island and south to the South Carolina border. Wilson's plovers were found nesting as far north as the south end of Ocracoke Island and south to the north end of Sunset Beach. No nesting shorebirds were found on the heavily developed barrier island beaches north of Bodie Island Spit or along heavy traversed beaches in Currituck County. There was also a paucity of nesting oystercatchers on the heavily developed islands in Brunswick County in the southernmost part of the state. The majority of American oystercatchers and Wilson's plovers were found from Carteret County south and were concentrated near inlets where many of the state's dredge islands are located as well as high quality habitat on many of the state's barrier island spits. As previously mentioned, remaining undeveloped barrier islands are extremely important for both species. Dredged material and natural islands in the southern Pamlico Sound, Back Sound behind Core Banks, Bogue Sound and the Cape Fear River supported the greatest numbers of birds within the estuaries.

Figure 3. Distribution of breeding American oystercatchers in North Carolina in 2007 on estuarine and barrier island sites.

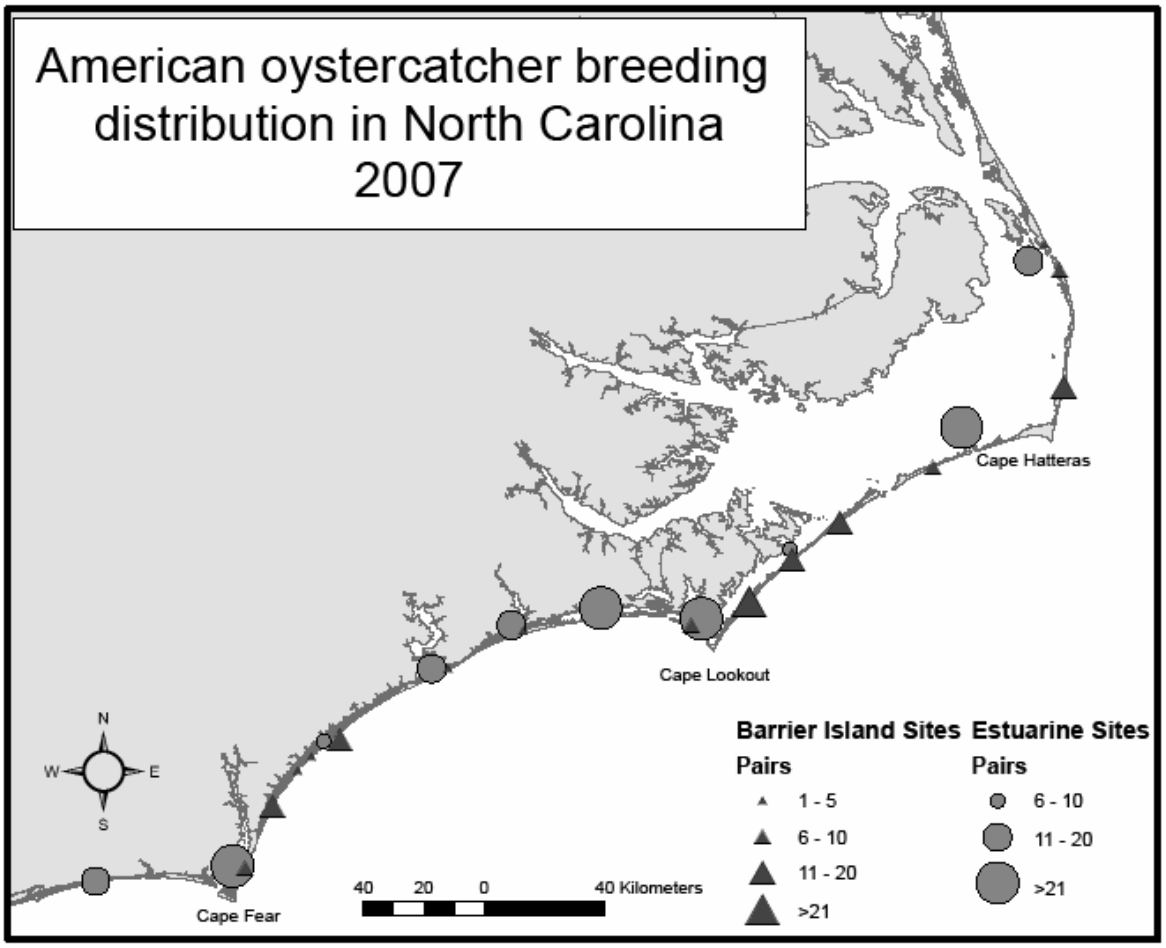
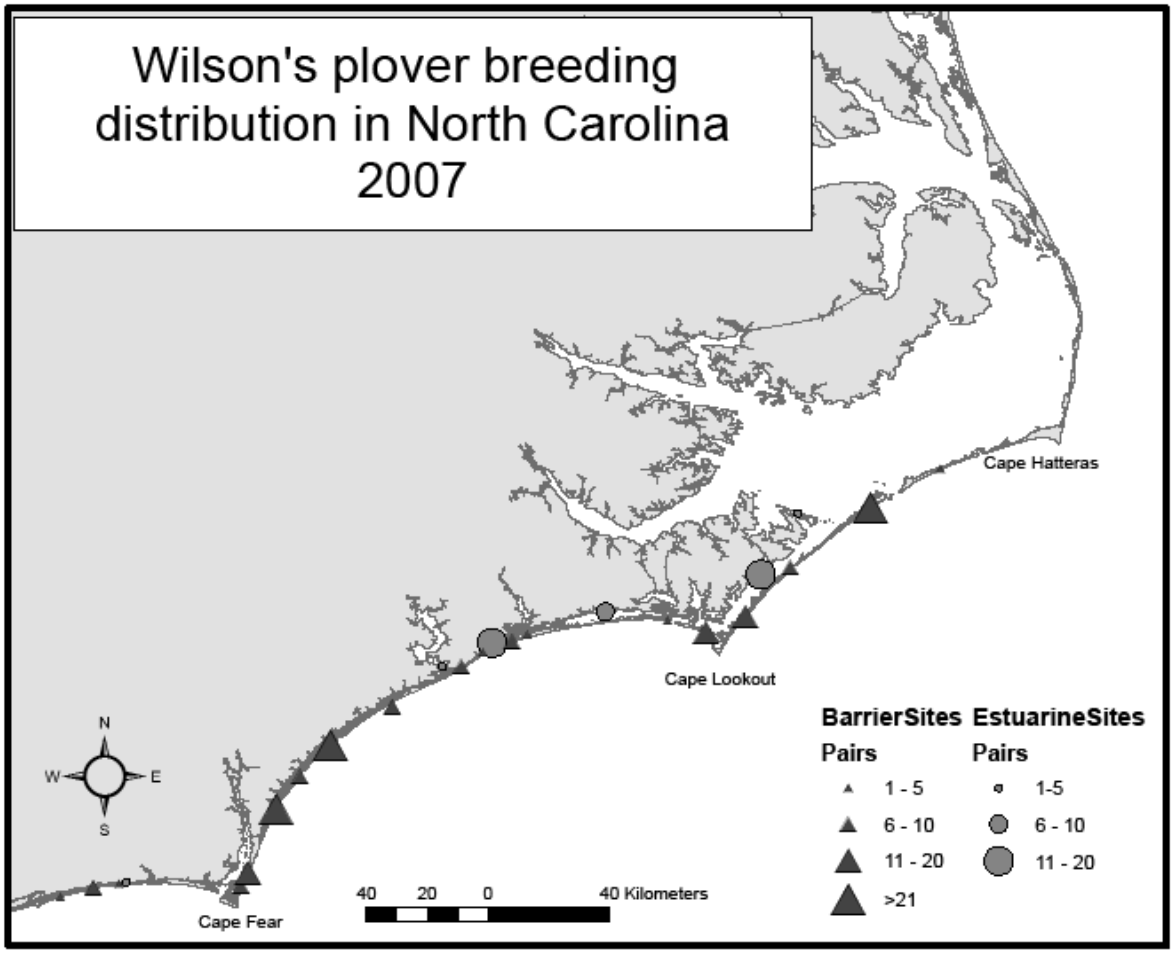


Figure 4. Distribution of breeding Wilson's plovers in North Carolina in 2007 on estuarine and barrier island sites.



Inland Heronry Surveys

The 2007/2008 fiscal year marked the beginning of a three year effort to survey inland heronries in the Coastal Plain and Piedmont. Herons and egrets are surveyed on a regular basis in our estuaries, but complete surveys for inland heronries are lacking. The last inland survey was conducted in 1996 and covered only portions of the Coastal Plain (Allen 1996). Wading bird rookeries are an important biological resource that can be vulnerable to development and human disturbance and it is important to collect data on the location of new heronries and status of existing heronries.

Aerial surveys were conducted during the spring of 2008. Biologists conducted five flights and completed surveys of the Lumber River Basin in the Coastal Plain and conducted seven flights and completed surveys of two thirds of the Yadkin/Pee Dee River Basin in the Piedmont. Photographs were taken of most colonies for verification of numbers and species. In addition to aerial surveys, Wildlife Diversity staff and partners conducted follow-up ground surveys at twelve sites in the Coastal Plain and Piedmont combined.

Data is currently being entered in to the colonial waterbird database and mapped with GIS and a full report will be given at a later date. There are some observations worth noting in this report. During the 2008 surveys a total of 56 new heronries were discovered along the two river basins. These were primarily colonies of great blue herons (*Ardea herodias*), but also included sites with great egrets (*Ardea alba)*, anhingas (*Anhinga anhinga)* and yellow-crowned night herons (*Nyctanassa violacea)*. Biologists were also able to check 34 known sites for nesting activity. The status of some previously known sites warrants further discussion. Lays Lake, located in Columbus County, continues to support a large colony of wood storks (*Mycteria americana)*. Additional wood storks were also observed along other portions of the Lumber River and we are hopeful that at least one additional nesting site exists; possibly along the neighboring Cape Fear River Basin, which will be surveyed nest year. Warwick Mill Bay was last surveyed in 1996 and at the time hosted a small colony of great blue herons and cattle egrets. During aerial and ground surveys it was found to host large numbers of cattle egrets (*Bubulcus ibis),* great egrets and anhingas as well as smaller numbers of little blue herons (*Egretta caerulea)*. Lastly, it was interesting to note the presence of anhingas at many of the colonies. It is extremely difficult to see nests of anhingas from the air and their presence was often discovered only after reviewing aerial photos, but they appear to be fairly abundant and widespread along the Lumber River Basin.

Non-breeding Shorebird Surveys

There is a concern for non-breeding shorebirds that utilize North Carolina's coastal habitats during spring and fall migration and during the winter months. Populations of many species of shorebirds appear to be experiencing significant declines (Brown et al. 2001). Additional data is needed throughout these species' ranges including in North Carolina to aide in developing conservation programs.

We participated in several shorebird surveys this fiscal year. International Shorebird Surveys were conducted at New Drum Inlet in the fall of 2007 and spring of 2008. This marks the forth consecutive year of surveys at this site. Surveys were conducted at least once per month during migration and as frequently as three times per month. The inlet complex is extremely important for migrating shorebirds. Observations of interest include one day counts of 1,654 Black-bellied plovers (*Pluvialis squatarola*), 457 sanderlings (*Calidris alba*), 1,534 dunlin (*Calidris alpina*), 329 short-billed dowitchers (*Limnodromus griseus*) and 51 piping plovers. Over 2,100 shorebirds were tallied during a single count in late October and undoubtedly many thousands of birds stop at this site during migration.

A coast-wide survey for red knots (*Calidris canutus*) was conducted during peak spring migration in May as part of a larger effort along the eastern seaboard to assess the status of knots and to identify key stop-over sites for the species. The *rufa* subspecies of the red-knot has declined dramatically over the past 20 years and in August of 2006 was designated as a candidate species for possible addition to the Federal list of endangered and threatened wildlife. Most of the coastline was surveyed from the air by employees of NCWRC and National Audubon Society. We surveyed the northern half of the coast where a total of 970 red knots were tallied from Bear Island to Bodie Island. The majority of birds were found on North Core Banks, Ocracoke Island and Hatteras Island.

Finally, weekly surveys for shorebirds and colonial waterbirds continue at Bogue Inlet in response to the Channel Relocation Project that was completed in 2004. Results from those surveys are incorporated into our database and will be included in future reports.

Coordination

Coordination with other agencies and individuals continues to be an important part of the Waterbird Project. Most species of colonial nesting waterbirds in North Carolina are very dependent on dredged material islands. The importance of these sites to nesting waterbirds will only increase as beach development continues to limit usable habitat on barrier islands. We continued to provide technical guidance in support of efforts to create bare sand habitat needed by many priority waterbird species. NCWRC staff worked closely with the US Army Corps of Engineers (USACOE) to direct the timing and placement of material on state-owned dredge islands in an effort to meet this objective and to benefit nesting waterbirds. Disposal is currently being planned for the fall of 2008 on several of the Oregon Inlet Islands and on Cora June Island located near Hatteras Inlet.

Several meetings were attended this fiscal year that are worth noting. The waterbird biologist attended and presented data at the American Oystercatcher Working Group meeting, the Southeast Seabird Working Group meeting, and the Piping Plover/Least Tern workshop. Staff also organized the annual NC Colonial Waterbird Committee meeting held in March. We continue to work as part of the Negotiated Rulemaking Team for the development of an Off-road Vehicle Management Plan for Cape Hatteras National Seashore. Lastly, several programs and workshops were given on colonial waterbirds and shorebirds including presentations to the Lower Neuse Birds Club, Wake County Audubon and the Hatteras Bird Club and workshops for staff at Cape Hatteras National Seashore and Fort Fisher State Recreation Area. Through these programs we educated over 100 individuals on issues related to the conservation and management of coastal birds.

B. Target Dates for Achievement and Accomplishment

All planned activities are on schedule.

C. Significant Deviations

None

D. Remarks

While 2008 was not a survey year for estuarine colonial nesting waterbirds, we made a couple of interesting observations during our work over the course of the season. Three state-owned islands supported large mixed tern/skimmer colonies this year: Island D located near Oregon Inlet, Cora June Island located near Hatteras Inlet, and New Dump Island located in Core Sound. These three islands likely supported a significant percent of state population of common terns,

gull-billed terns and black skimmers. All three species have experienced significant declines and are state listed as species of special concern. While we are unsure of the outcome on Island D, birds on Cora June Island and New Dump Island were very successful as evidenced by the presence of hundreds of large chicks on both islands in July.

E. Recommendations

- There is a clear need to continue collecting coast-wide data on American oystercatchers and Wilson's plovers to fully assess population status and distribution and to monitor future population trends. We plan to conduct coast-wide surveys every three years.
- Mammalian predators continue to depress reproductive success of beach nesting birds in North Carolina. During the shorebird surveys, we noticed several sites with many nesting American oystercatchers and Wilson's plovers, but very little evidence of nesting success. Sites such as Masonboro Island, Ft. Fisher State Park and Bald Head Island had ample evidence of mammals such as red fox and raccoons, but very few if any waterbird chicks. In fact, we noticed that pairs were done nesting by early June indicating that birds had already made several nesting attempts, but had failed completely. Not surprisingly, numbers of nesting shorebirds declined at these sites between 2004 and 2007. We should work with and encourage other agencies to remove over abundant mammals from important nesting areas and also attempt to identify sites where reproductive success is high and ensure the continued protection and management of those areas for shorebirds.
- Lays Lake and Warwick Mill Bay support two very important inland heronries and host the state's only known breeding wood storks. We should investigate opportunities and work with partners to protect these sites.

F. Estimated Cost

$112,581 (including in-kind contributions)

G. References

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Prepared By: Alex Houston – Assistant Waterbird Biologist
Susan Cameron - Waterbird Biologist
Wildlife Diversity Program

Annual Performance Report

State: North Carolina

Period Covered: 1 July 2007 – 30 June 2008

Grant Title: State Wildlife Grants T-8 (Implementation)

Project Title: CURE Songbird and Habitat Surveys

Objective:

The objective is to evaluate the impacts of the Cooperative Upland habitat Restoration and Enhancement (CURE) program on populations of early succession songbirds and their habitats identified in the NC Wildlife Action Plan.

A. Activity

In FY 2007 – 2008, surveys were conducted on 1 corporate, 4 private and 4 public CURE areas to assess the impacts of management activities on at-risk early succession bird species identified in the NC Wildlife Action Plan. Surveys included summer point count songbird surveys, useable habitat surveys, winter strip transect songbird surveys, photoplot surveys, and vegetation measurements in both winter and summer. This report summarizes information collected not only during this grant, but also contains information from previous years of bird study, and contains information and analysis of information collected through the concurrent Piedmont Game Land Songbird Survey Project. The work performed through this grant was designed to be complementary to the Piedmont Game Land Songbird Survey Project, not redundant, and appropriate charges were assigned to each project based upon work conducted on CURE portions of the game lands (activities charged to this project) or non-CURE portions of game lands (activities charged to the Piedmont Game Land Songbird Survey Project). However, in order to provide the best and most current information and context for that information, the reporting and interpretation of the results includes some information from both, as well as previous projects.

Introduction

The CURE program was initiated on 3 private land cooperatives in 2002, on 4 game lands in 2003, and on a corporate-owned private cooperative in 2007. Surveys were initiated in 2002 to assess the biological impacts of CURE and to allow for an adaptive management approach. Most of the surveys developed to evaluate the CURE program were designed to look at the trend in bird numbers from the year of, or prior to, habitat establishment through several years of habitat improvement. The 2007/2008 season represents the sixth year of habitat management for the private cooperatives and the fifth year for the CURE Game Lands. Changes were made to the breeding season bird survey with the transition to a second phase of funding and

implementation for the program (CURE II), but we attempted to maintain the integrity of long-term counts for quail on Rowland and Benthall. It should be noted that point count surveys demonstrate much year-to-year variability from factors unrelated to CURE. Because of the variability of observations and the short duration of the study, small yet biologically significant trends may not yet be statistically significant. Only large changes in counts are likely to be detected within the time frame of the study and several more survey years may be required before significant trends are possible to detect.

In 2007, modifications were made to some of the biological surveys on the private CURE cooperatives to adapt to management changes for CURE II. Changes to the private cooperative survey methodologies included the development of control sites, standardization of survey point locations, refinement of focal songbird lists, and the combination of breeding quail/focal songbird surveys. Survey modifications were made to improve our ability to measure the biological responses to CURE management and to adapt to the CURE II time frame, growth strategies, and funding. These changes applied knowledge and lessons-learned from CURE I, including findings from biological and human dimension surveys. Corporate and Game Land CURE Programs continued using existing survey designs and methodologies.

CURE II surveys will attempt to measure biological responses to habitat management with the 3 year funding time frame, while also trying to maintain consistency to historical CURE I data sets. To date, coastal cooperatives (Benthall and Rowland) have retained most of their original landowners and have generally maintained the cooperative landscape approach for CURE II. However in the Piedmont, CURE II efforts primarily consist of warm season grass (WSG) establishment within fields located across the focal area, not necessarily grouped in one "cooperative". Piedmont monitoring therefore used a field-scale approach to document the wildlife benefits of WSG establishment.

The CURE II monitoring strategy also attempted to be compatible, when possible, with the Northern Bobwhite Conservation Initiative, NC Partners In Flight priorities, and federal CP-33 (Conservation Reserve Program - Bobwhite Buffer Practice) monitoring plans. Many of the CURE II biological monitoring methodologies are modeled after the national CP-33 protocols. The CP-33 monitoring program is a national survey effort which has been reviewed and adopted by Southeast Quail Study Group (SEQSG) and Southeast Partners In Flight (SEPIF) research committees. When survey objectives were not compatible, the survey needs of the CURE program trumped those of other national monitoring efforts.

Useable Habitat Surveys

Quail can serve as an indicator species for early-succession adapted birds. A critical determinant of quail populations' health is the amount of useable habitat in the landscape (Guthery 1997). In order to track the impacts of CURE and other land management actions on the quantity of quail habitat, we established a methodology to track useable habitat within each CURE area. Useable habitat was defined as any area with sufficient cover for quail to carry out life functions (breed, forage, roost, etc).

Note that this definition is slightly different from "suitable habitat". "Suitable habitat" is based on quantitative vegetation measurements, while "useable habitat" is a qualitative, eyeball assessment. To capture landscape habitat changes, quantitative measurements of all stands were not feasible. Surveys like these were potentially subject to the observer bias. Assessments were made by biologists, land management supervisors, or foresters with the aid of ArcMap and personal experience. Most sites retained the same observers to standardize assessments of "usability" thru time. Annual private cooperative landscape assessments included all properties with active CURE contracts within a given year.

Useable habitat determinations were made at the scale of the stand (i.e. a contiguous and distinct field, forest stand, or field border, called a "management unit"). At least 50% of the management unit must have consisted of useable habitat for the entire unit to be designated as "useable". To track habitat availability during both the breeding and non-breeding season, we classified useable habitat as breeding season only, non-breeding season only, or most-of-year (containing useable habitat for a sufficient portion of both the breeding and non-breeding seasons). The breeding season is defined as May through September and the non-breeding season October through April.

A stand was classified as useable for "non-breeding only" if it was available in five of the seven months of the non-breeding season and was available for less than two months of the breeding period (e.g. regenerating woodland with thick woody cover but no herbaceous cover). A stand was useable for "breeding only" if it was useable in at least two of the five months of the breeding period and was not useable for more than two months of the non-breeding period (e.g. crop fields and seasonally flooded impoundments). "Most of the year" habitat was habitat available to quail during both breeding and non-breeding seasons, meeting the criteria for each above (e.g. fallow areas, open canopy woodlands). "Not useable" habitat was all areas without suitable cover for quail (e.g. closed canopy woodlands, residential areas).

Useable habitat: Private Cooperatives

In the fall of 2007, useable quail habitat during the breeding and non-breeding seasons declined on the private CURE cooperatives due to an overall decline in CURE acreage (Table 1 and Fig. 1 & 2). During the CURE II transition, 3 landowners on Benthall (1778 acres) and 2 landowners on Rowland (628 acres) did not renew their CURE contracts. However in 2007, useable habitat assessments did include 1 new Benthall cooperator (575 acres) who was neighboring the original cooperative. Even though total acreage was lost, the percentage of useable habitat was generally unchanged, just redistributed across the landscape.

Control areas for both cooperatives were also assessed for quail habitat in 2007. Control areas provided some quantitative insight into quail/useable habitat associations specific to each focal area. Rowland control area maintained similar percentages of useable habitat to that seen on the Rowland CURE area prior to habitat enhancement efforts. Benthall control (Caledonia State Prison) had lower percentages of non-breeding habitat than seen on the pre-CURE Benthall area due to the intensive farming practices conducted by inmates at the prison.

All cooperatives and controls maintained more useable habitat during the breeding season than found during the non-breeding season. Breeding season habitats primarily consisted of agricultural fields, however surveys did not account for the potential impacts of crop type. Non-breeding season habitats primarily consisted of fallow fields/field borders and actively managed timber stands. CURE cooperatives had more useable habitat than control areas due primarily to their 6 year CURE management history.

Since the initiation of CURE efforts on private lands, greatest gains of useable quail habitat have been seen for the non-breeding season. CURE habitat improvements have been successful converting "breeding-only" cropland into "most of year" fallow habitat. Fallow conversions comprised ~4% of each cooperative (~200 acres). The success of other management techniques (i.e. prescribed burning, Farm Bill Conservation and Forest Initiative programs) accounted for many of the other net gain differences found between CURE cooperatives (Table 5).

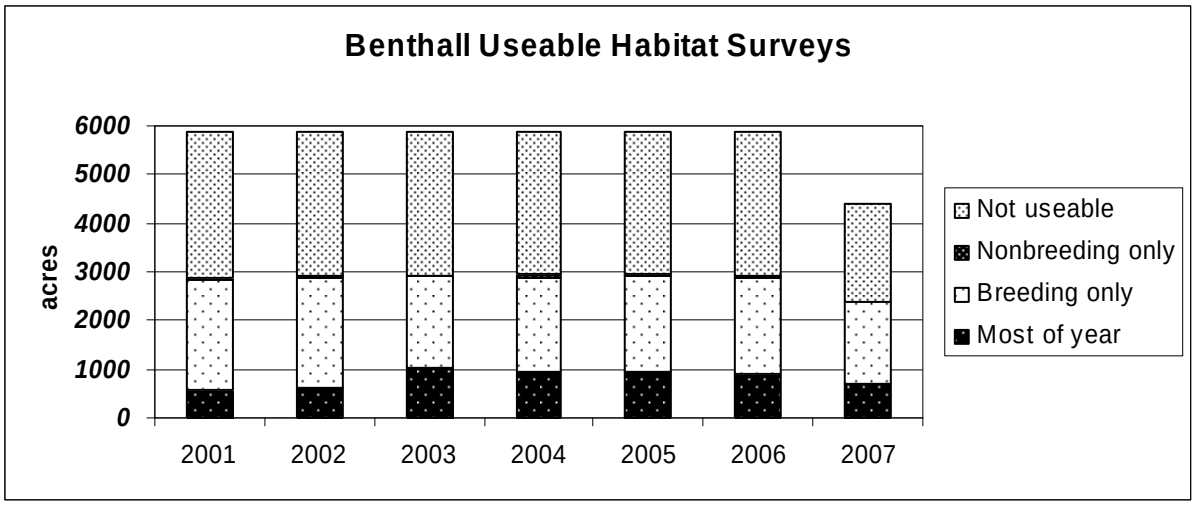
Benthall Plantation established the greatest acreage enrolled in the CURE program. 369 acres of field (6.3%) and 618 acres of forested habitat (10.5%) had at least one CURE treatment since CURE initiation. Habitat gains from these efforts were primarily credited to the conversion of "breeding season only" cropland habitat to "most of year" useable fallow habitat. Most of the habitat improvements were realized early, with the establishment of fallow areas by 2003. Almost all of Benthall Plantation's CURE fallow habitats were successful (92.3%) within both linear field borders (205 acres) and block fallow habitats (164 acres). However, Benthall's overall useable habitat percentage gains were the lowest compared with the other CURE cooperatives. Total useable habitat (habitat available during at least part of the year) increased by only 95 acres during the first five years of the CURE program. Reduced habitat potential within CURE buffers was related to practice of discing and planting wheat in the fall to maintain early successional conditions. Areas disked in the fall did not maintain adequate habitat for the following winter. Despite prescribed burning efforts, forested areas enrolled in the CURE program were also less successful (78%) in producing useable habitat compared to cropland conversions. Prescribing burning of mature, unthinned stands often did induce an adequate response of understory vegetation. When prescribed fire improved habitat conditions within unthinned forest stands, suitability was only short term. Since the initial gains of useable forest habitat within pre-commercial pine thinning/herbicide treatments (60 acres), only small amounts of additional useable habitat have been added.

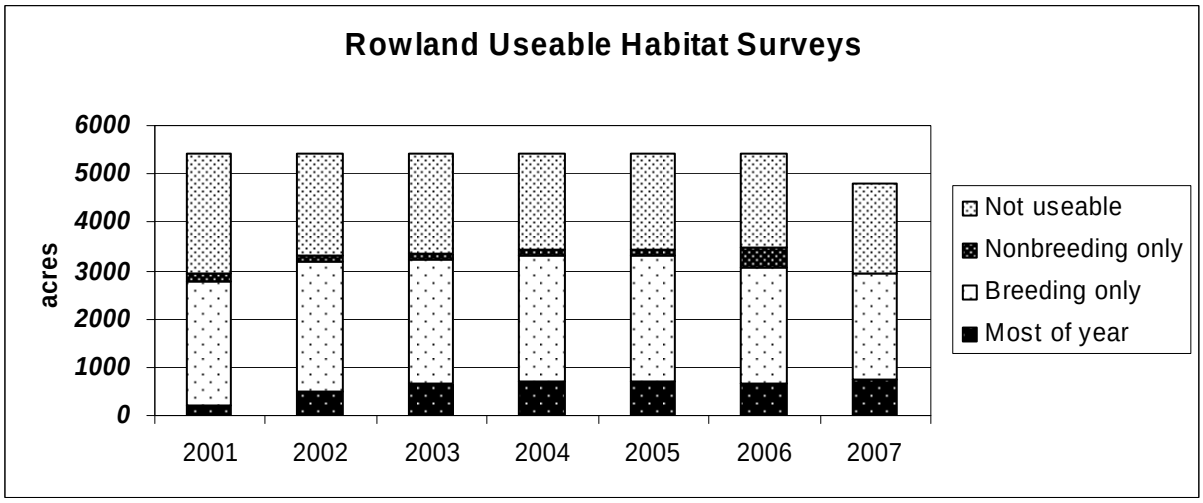
Rowland private cooperative maintained comparable overall percentages of habitat available during the breeding (~55%) and non-breeding seasons (~15%). Before CURE, useable habitat consisted mostly of "breeding only" row-crop fields with some "most of year" longleaf CRP stands. Mature, closed-canopy pine and hardwood stands comprised most of the "unuseable" habitat which contained little understory herbaceous cover. CURE treatments were conducted on 206 acres of field (3.8%) and 218 acres of forested habitat (4.0%). Rowland's overall useable habitat gains were the largest seen within the private cooperatives. After the first growing season in 2002, Rowland saw its highest annual gains in useable breeding (7.7%) and non-breeding (4.1%) habitat primarily within CURE fallow field blocks/borders and prescribed burned, thinned pine stands. The percentage of useable habitat has continued to increase due to new CRP longleaf pine plantings (304 acres), non-CURE pine thinnings, and prescribed burning by individual landowners.

For the Piedmont focal CURE program, approximately half (65 acres) of the newly established warm season grass fields (117 acres) maintained "breeding only" habitat, similar to baseline habitat conditions previously found within the forage crop fields. The remaining portion (52 acres) was currently in establishment phase during 2007 and classified as "not useable". "Most of year" useable habitat gains are expected to be modest until WSG fields mature and altered landowner management techniques take effect. Conversion of fescue can often take several years depending on grass species, establishment rates, growing conditions, and landowner compliance. Warm season grass fields (20 acres) and a thinned, prescribed burn area (38 acres) previously established during CURE I phase, maintained "most of year" habitat in 2007.

Table 1.--Acres of habitat useable for bobwhite quail on private CURE II cooperative and control areas, fall of 2001-2007.

		Breeding Habitat Only	Non-breeding Only	Most of Year Habitat *(Breeding and Non-Breeding)*	Not Useable Habitat	Total Acres	Total Breeding Area (%)	Total Non-breeding Area (%)
Benthall	2001	2233	48	585	3021	5887	47.9	10.8
	2002	2264	48	614	2961	5887	48.9	11.2
	2003	1874	22	1041	2950	5887	49.5	18.1
	2004	1923	57	965	2942	5887	49.1	17.4
	2005	1959	56	946	2926	5887	49.3	17.0
	2006	1998	25	887	2977	5887	49.0	15.5
	2007	1672	25	698	2004	4399	53.9	16.4
Benthall Control	2007	5506	0	110	1432	7048	79.7	1.6
Rowland	2001	2553	165	218	2491	5427	51.1	7.1
	2002	2716	133	477	2101	5427	58.8	11.2
	2003	2579	133	650	2065	5427	59.5	14.4
	2004	2579	133	716	1999	5427	60.7	15.6
	2005	2579	133	716	1999	5427	60.7	15.6
	2006	2387	428	670	1942	5427	56.3	20.2
	2007	2190	11	747	1868	4816	61.0	15.7
Rowland Control	2007	4072	0	440	2861	7373	61.2	6.0





Figures 1 & 2.--Acres of useable habitat for bobwhite quail on CURE II private cooperative areas, 2001-2007.

Useable Habitat: Game Lands

In the fall of 2007, useable quail habitat on CURE Game Lands continued to increase over 2006 levels (Table 2 and Figs. 3-6). Regenerating and thinned timber stands provided the majority of useable habitat by providing adequate cover during the breeding and non-breeding months. Overall percentages of breeding habitat across CURE landscapes were much smaller in forest dominated Game Lands compared to the private cooperative landscapes which are dominated by agriculture crop fields. Useable habitat on CURE game lands during the winter was approximately equal to that found on the private cooperatives.

Before CURE, closed canopy forests comprised the majority of game land stands and were classified as "not useable" for quail because of the lack of understory cover and herbaceous growth. Greatest strides for CURE Game Lands in recent years have been the development of habitat during the breeding season. Originally, breeding season habitat made up a very small

percentage of the CURE landscapes. Most of the "useable" stands were originally classified as "non-breeding only habitat" which contained adequate cover for quail, but lacked the necessary herbaceous understories required for nesting and brood rearing.

At Caswell, CURE-managed stands continued to be transformed from "not useable" closed canopy stands to "most of year" and "breeding only" useable habitat. Management included thinning and prescribed burning of upland loblolly/shortleaf pine stands, and clearcutting Virginia pine stands and replanting with loblolly pine. In 2007, Caswell continued to make net gains of breeding (4.8%) and non-breeding (4.9%) season habitat. Most gains (251 acres) were seen in the second and third CURE management units which were harvested (thinnings and clearcuts) 2-3 years previously. However, the majority of the non-useable habitat (71.8%) was a mixture of mature pine/hardwood stands and recently cut stands which have not yet responded with adequate groundcover. 2007 marked the 5th year of timber cutting in the 7 year management plan. Caswell's CURE goal is to establish and maintain ~51% of the area in early successional habitat by 2012.

At Sandhills Game Land, useable habitat also continued increasing with annual gains within both the breeding (15.5%) and non-breeding (10.4%) seasons. Management included prescribed burning and thinning 40% of the forested area to a basal area less than 40 ft^2/acre, and 60% of the area (areas assigned to federally endangered red-cockaded woodpecker foraging partitions) to a basal area of 40-50 ft^2/ac. In 2007, large net gains (252 acres) in useable habitat were primarily created by thinning and planting Atlantic Coastal Panic (ACP) grass in plantation pine stands which had been previously raked for pine straw. ACP stand establishment often created both breeding and non-breeding season quail useable habitat within 2 years after planting. Other natural upland stands also added "most of year" habitat as a result of the timing of prescribed burning rotations. The majority of the non-useable habitat remained in mature longleaf/loblolly pine forest (52.1%) with inadequate understory. 2007 marked the last year of the initial timber cutting within the CURE management plan. However, full habitat establishment will take another few years. Sandhills' CURE goal is to maintain 74.7% of the area in early successional habitat by 2008.

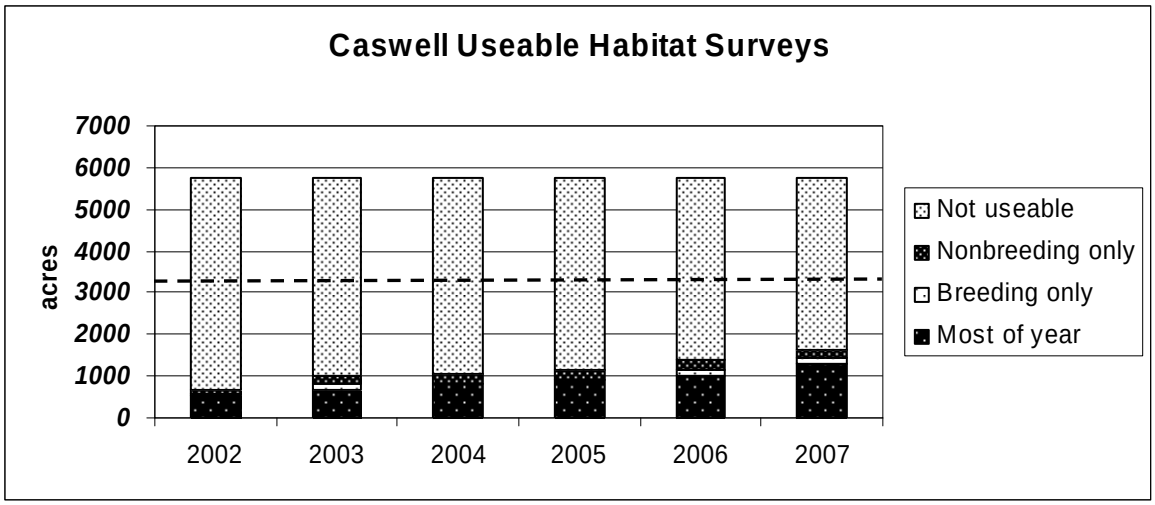
At South Mountains, useable habitat continued increasing with modest annual gains within both the breeding (0.5%) and non-breeding (4.5%) seasons. In 2007, net gains (100 acres) in useable habitat were primarily created by the roller chopping and burning of Virginia pine stands in 2006. Useable habitat was maintained within the 8-year old clearcuts (Potts Branch and Golden Valley) and small fields from continued prescribed burning and roller chopping efforts. The remainder of the non-useable habitat (81.1%) consisted of closed canopy mature pine and hardwood stands, and stands which have not yet responded to prescribed burning. Net gains of useable habitat has been comparably slower because of more extreme topography, greater manpower requirements, lower timber values, and small number of available burning days. South Mountain's CURE goal is to establish and maintain ~61% of the area in early successional habitat by 2014.

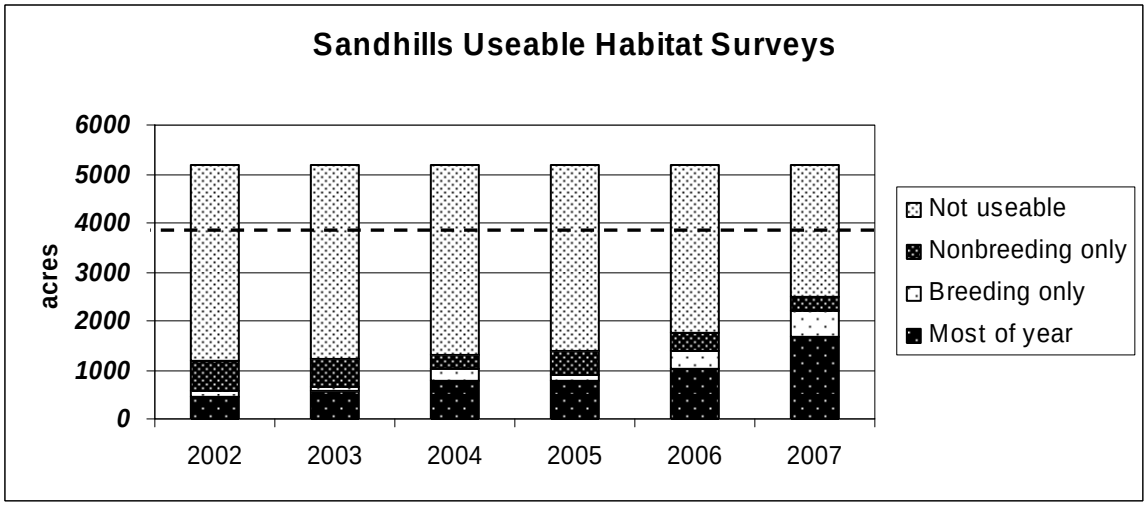
At Suggs Mill Pond, useable habitat continued to make gains within both the breeding (0.8%) and non-breeding (7.0%) seasons during 2007. Net gains (190 acres) in useable habitat were primarily created within loblolly pine stands thinned in 2006. Large increases in habitat during

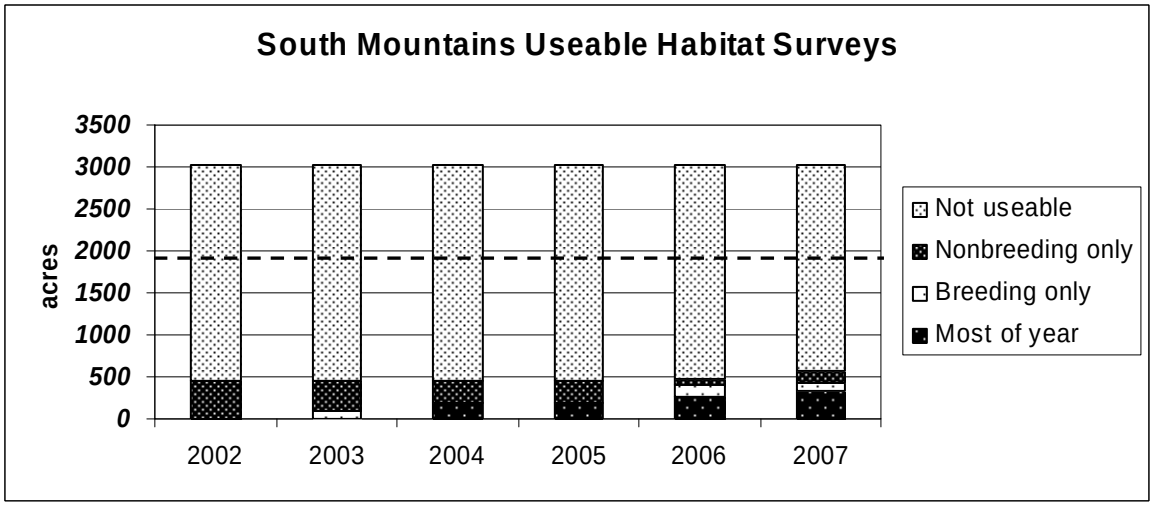
the non-breeding season could be attributed to additional "most of year" stands previously classified as "breeding only". Successive burning and time allowed these thinned stands to mature and develop adequate understories over the past 2-4 years. In 2007, 1717 acres of useable stands (18.5%) existed within Suggs Game Land. The majority of the non-useable habitat remained in mature loblolly/pond pine forest and pocosin with inadequate herbaceous understory. However, only 2,800 upland acres (30.2%) out of the total 9,280 Suggs Mill Pond Game Land's acres has potential for early successional habitat management. The remainder of the CURE Game Lands consists of wet pocosin and bay habitats (69.8%). Suggs Mill Pond's CURE goal is to establish and maintain 2,492 acres (~26% of the game land; ~89% of the upland area) in early successional habitat by 2014.

Table 2.--Acres of habitat useable for bobwhite quail on CURE Game Lands, fall 2002 - 2007.

		Breeding Only	Non-breeding Only	Most of Year (Breeding and Non-Breeding)	Not Useable	Total Acres	Percent Total Breeding	Percent Total Non-breeding
Caswell	2002	20	114	548	5084	5766	9.9	11.5
	2003	123	188	680	4775	5766	13.9	15.1
	2004	30	210	800	4726	5766	14.4	17.5
	2005	19	197	912	4638	5766	16.1	19.2
	2006	186	200	985	4395	5766	20.3	20.6
	2007	151	176	1296	4143	5766	25.1	25.5
Sandhills	2002	118	604	451	4023	5196	11.0	20.3
	2003	54	579	581	3982	5196	12.2	22.3
	2004	251	300	756	3889	5196	19.4	20.3
	2005	136	494	764	3802	5196	17.3	24.2
	2006	367	341	1039	3449	5196	27.1	26.6
	2007	558	268	1653	2709	5196	42.6	37.0
S. Mtns.	2002	0	455	0	2578	3033	0.0	15.0
	2003	100	355	0	2578	3033	3.3	11.7
	2004	9	260	192	2572	3033	6.6	14.9
	2005	0	264	200	2569	3033	6.6	15.3
	2006	138	64	272	2559	3033	13.5	11.1
	2007	100	147	325	2461	3033	14.0	15.6
Suggs Mill	2002	154	0	211	8915	9280	3.9	2.3
	2003	622	1185	1	7472	9280	6.7	12.8
	2004	376	417	125	8362	9280	5.4	5.8
	2005	294	476	701	7809	9280	10.7	12.7
	2006	630	510	395	7760	9280	11.0	9.8
	2007	162	627	936	7570	9280	11.8	16.8







Figures 3, 4, & 5.--Acres of useable habitat for bobwhite quail on Caswell, Sandhills, and South Mountains CURE Game Land areas, 2002-2007. (Note: Dashed line indicates early successional acreage goal as stated in CURE area management plan.)

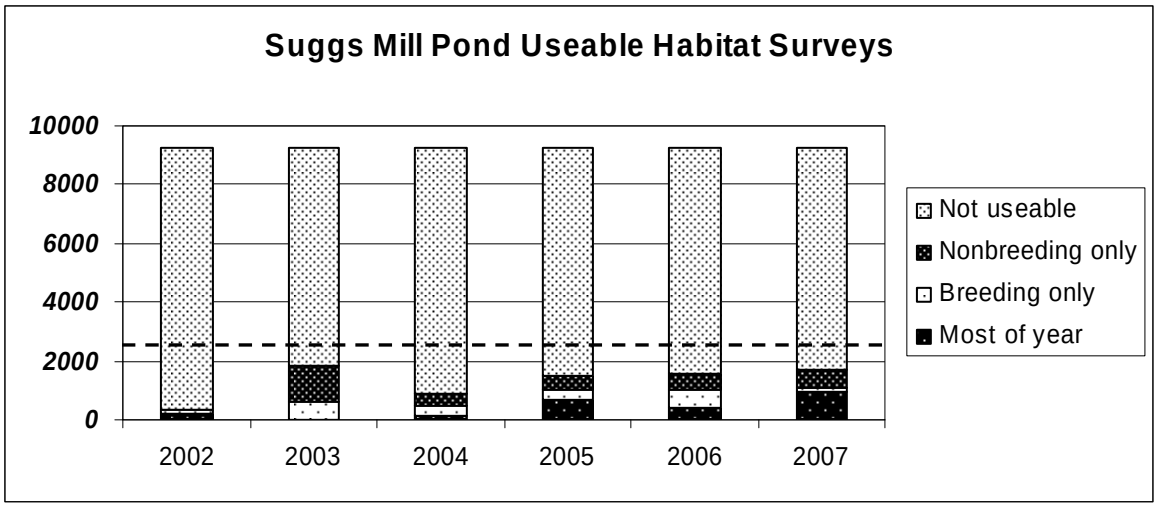


Figure 6.--Acres of useable habitat for bobwhite quail on Suggs Mill Pond Game Land CURE area, 2002-2007. (Note: Dashed line indicates early successional acreage goal as stated in CURE area management plan.)

Useable Habitat: Corporate Cooperative

Murphy Brown Corporate CURE cooperative contained a similar amount of useable habitat as the coastal private CURE cooperatives (Fig. 7, Table 3). Stands were dominated by agricultural row crops fields with some surrounding pine forest/pocosin and pastureland. Crop fields were located within a 3000 acre, ditched Carolina bay.

Useable habitat surveys were initiated in 2005 marking baseline habitat conditions. Useable habitat consisted primarily of "breeding-only" habitat in the form of row crops (~50%). Forested stands maintained heavy cover and comprised the majority of "non-breeding only" habitat (28%). The remainder of the non-useable habitat (18%) consisted of pasture, roads, and commercial areas (hog barns).

Murphy Brown CURE goals include the conversion of 250 acres primarily to improve water quality while concurrently enhancing early successional habitat conditions. Delineation of CURE field edge buffers around drainage ditches began in the fall of 2005. Management thru 2006 included the additional conversion of 150 acres of cropland to fallow areas and warm season grass plantings. In 2007, Murphy Brown made positive habitat gains within the non-breeding season due to the initial 47 acres (1.4%) of ditch buffer and warm season grass block conversions.

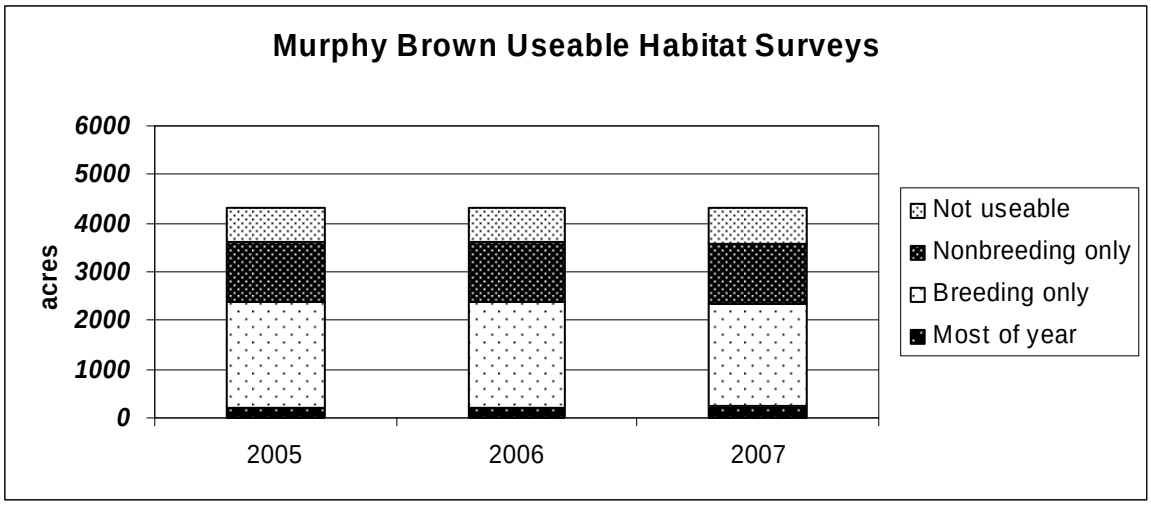


Figure 7.--Acres of useable habitat for bobwhite quail on Murphy Brown - Ammon CURE area, 2005-2007.

Table 3.--Acres of habitat useable for bobwhite quail on the Corporate CURE area, fall of 2005-2007.

		Breeding Only	Nonbreeding Only	Most of Year (Breeding and Non-Breeding)	Not Useable	Total Acres	Total Breeding (%)	Total Non-breeding (%)
Murphy Brown	2005	2182	1215	211	724	4333	55.2	32.9
	2006	2182	1234	211	705	4333	55.2	33.3
	2007	2087	1243	243	759	4333	53.8	34.3

Spring Breeding Songbird Surveys

An index of spring breeding songbird abundance at the scale of the CURE area was tracked using 3 minute point count surveys (Hamel et al. 1996, Freemark and Rogers 1995). Point count survey routes were initiated during the year of CURE habitat establishment. Each CURE survey route consisted of 21-47 survey points and was run on 3 mornings throughout the month of June. Points were located approximately 0.5 mile apart using a modified grid system to provide maximum coverage of each CURE area. Reference routes for each CURE area were developed to provide insight into regional annual population changes. All CURE surveys were run on the same mornings as the reference routes to reduce daily count variation.

To provide some insight into short term count patterns, simple linear regression was used to determine significant relative abundance changes thru time. Trend slope comparisons were used to determine songbird abundance responses to CURE habitat improvements. Regression models utilized a baseline year of 2002 for the private cooperatives. 2007 represented the first treatment

year for the Murphy Brown corporate cooperative. Trends were determined if the regression model slopes were significantly different from zero at the alpha level of 0.05.

1. CURE II Private Cooperatives - Spring Songbird Surveys

In 2007, several modifications were made to the breeding songbird surveys on private lands for CURE II. Some spring songbird point listening station locations were slightly shifted within each CURE area to become standardized with other quail surveys. The focal songbird count was also combined with the spring breeding quail counts to provide for more survey repetitions of grassland/shrubland dependent species. The spring sampling time frame was widened to include the whole month of June, instead of the first 2 weeks of June to encompass more of the focal CURE breeding songbird calling peaks. The 2007 summaries provide only preliminary insights into songbirds and quail responses to CURE II.

The focal CURE breeding bird species list was refined in 2007 (Table 4) based on the following considerations: 1) Species of conservation concern identified by NC PIF and CP33 monitoring program, 2) Early successional habitat specialists (grassland and shrubland), 3) Consistent long term BBS trend data in North Carolina, 4) Moderate abundance within CURE I private cooperative surveys, 5) Easily identifiable and detectable by sight or sound in the field, and 6) Lower flocking tendencies to reduce count variability. With the development of this focal breeding bird list, we hope to achieve more precision and accuracy in our counts.

Additional modifications in 2007 also included the delineation of control areas located within 3-5 miles of the Benthall and Rowland CURE cooperatives. Control areas were developed on Caledonia State Prison (Tillery, NC) for the Benthall cooperative, and on adjacent farming landscape (Fairmont, NC) for the Rowland cooperative. Despite efforts to delineate control sites with comparable cropping types and histories, biases such as the proportion of stand types may still exist which influence songbird abundances. Previously, Breeding Bird Survey (BBS) routes were used as reference data for CURE surveys. The addition of control areas is anticipated to improve comparisons of CURE areas to untreated areas.

For the Piedmont Focal area, breeding songbird surveys were redesigned from a cooperative approach (formerly Turnersburg cooperative), to a field level scale approach as a result of CURE II management changes. Survey design utilized a paired, treatment/control comparison. Surveys were conducted on 9 CURE contracted warm season grass establishment fields which were paired with 9 neighboring non-CURE fescue pastures located 1-3 kilometers away. All suitable contracts which were signed and initiated in 2007 were selected for monitoring. Historical Turnersburg cooperative data was not comparable to 2007 Piedmont focal area data to provide for any long-term trend comparison.

Table 4.—Focal CURE II early-successional bird species.

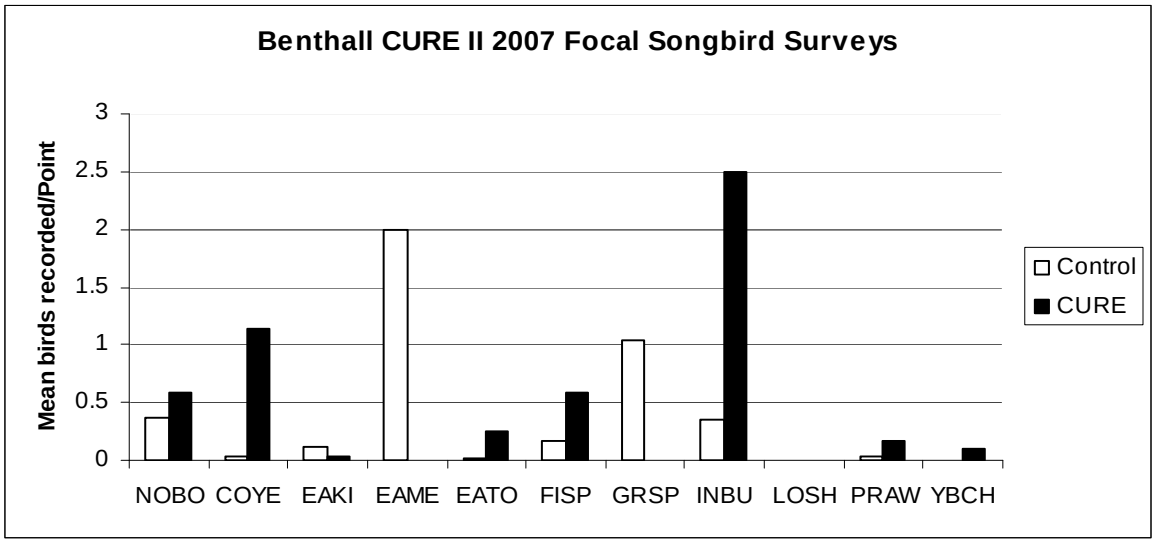
CURE II Focal Songbird Species

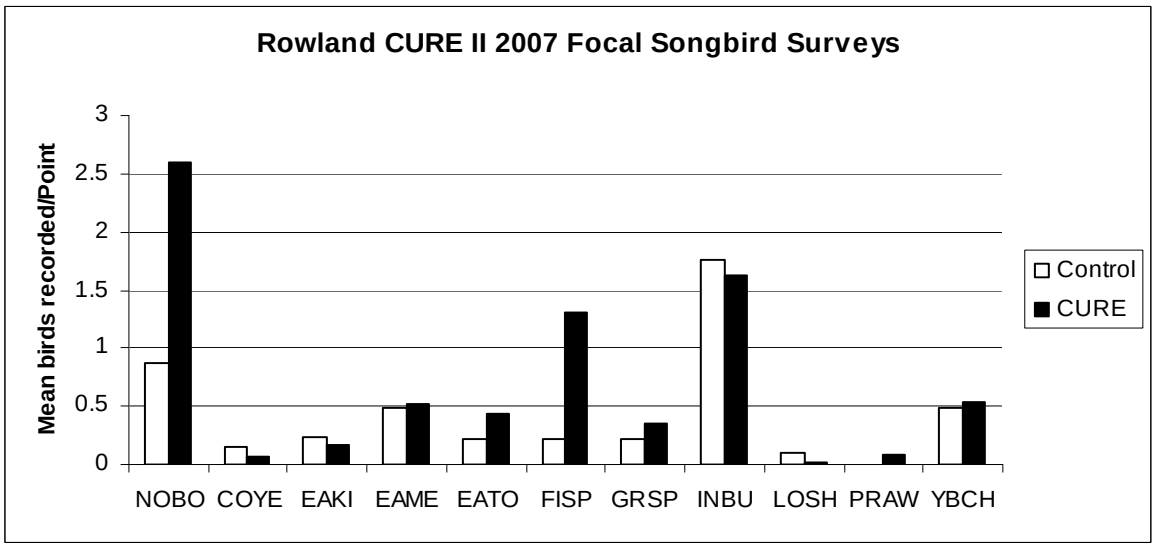
Northern Bobwhite (NOBO) *Colinus virginianus*
Common Yellowthroat (COYE) *Geothlypis trichas*
Eastern Kingbird (EAKI) *Tyrannus tyrannus*
Eastern Meadowlark (EAME) *Sturnella magna*
Eastern Towhee (EATO) *Pipilo erythrophthalmus*
Field Sparrow (FISP) *Spizella pusilla*
Grasshopper Sparrow (GRSP) *Ammodramus savannarum*
Indigo Bunting (INBU) *Passerina cyanea*
Loggerhead Shrike (LOSH) *Lanius ludovicianus*
Prairie Warbler (PRAW) *Dendroica discolor*
Yellow-breasted Chat (YBCH) *Icteria virens*

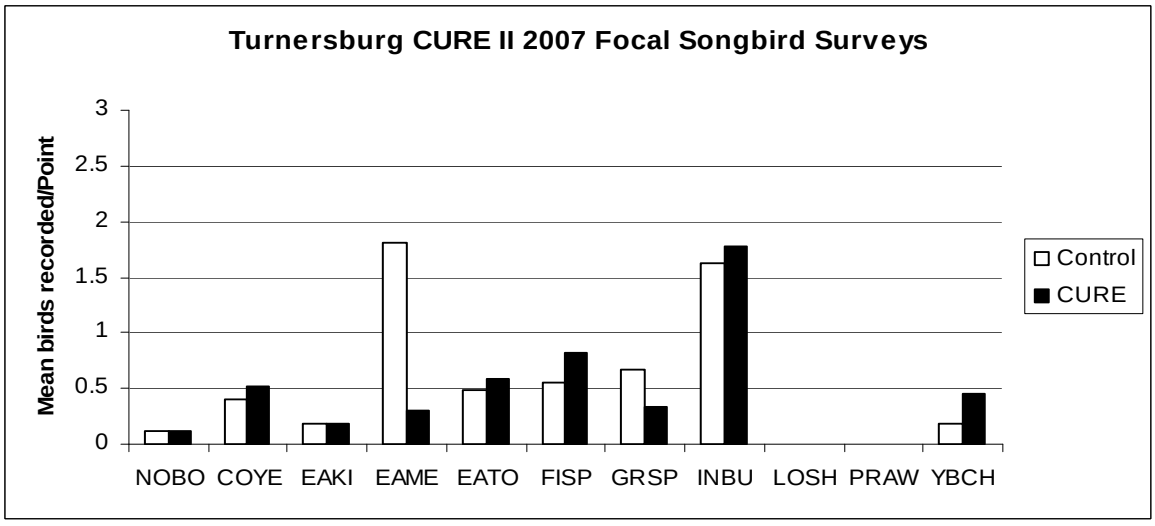
In 2007, some focal songbird count averages were higher on CURE areas than control areas (Fig. 8-10). Indigo Bunting (INBU) was the most prevalent focal songbird species recorded on the private cooperatives and was more abundant on the CURE sites than controls. Some of the largest differences in abundance between treatment and control sites existed for Field Sparrow (FISP). These observations were consistent with previous CURE I songbird analyses which suggested that both INBU and FISP positively responded the most to CURE habitat enhancements. CURE sites also included higher abundances of Common Yellowthroat (COYE), Eastern Towhee (EATO), and Yellow-breasted Chat (YBCH).

Other focal songbird averages were higher on control sites rather than the CURE sites. Eastern Meadowlark (EAME) was the most prevalent focal songbird species recorded on control areas. These songbirds appeared to be more closely associated with open pastureland which was more common on both Piedmont control fields and Benthall control sites. Grasshopper Sparrow (GRSP) and Eastern Kingbird (EAKI) abundances were also higher on these control sites. All of these species are grassland nesters and foragers.

However, some species abundance comparisons could not be made at this time because of extremely low abundances or inconsistent patterns between focal areas. Loggerhead shrike (LOSH) was the least recorded focal songbird species. Because of their specific scrub shrub/grassland habitat requirements, low abundance and continuing downward trends, LOSH remain a top priority for conservation efforts. Prairie Warbler (PRAW) was also recorded less often than most focal species. Low abundances were potentially related to landscape preferences. PRAW are more often associated with regenerating woods stands (clearcuts) within forested landscapes, instead of the herbaceous fallow enhancements created on the CURE private cooperative agricultural landscapes.







Figures 8, 9, & 10.--Relative abundance of focal songbird species on CURE II private cooperatives, based on unlimited distance, five minute counts.

2. CURE Game Lands - Spring Songbird Surveys

An index of songbird abundance at the scale of the CURE area was tracked using point count surveys (Hamel et al. 1996, Freemark and Rogers 1995). In 2002, we established 21-47 permanent survey points on each CURE area. Control routes on Sandhills and Caswell Game Lands were initiated in 2004. Five minute, unlimited distance point count surveys were conducted once per year on each area between May 18th and June 14th.

To facilitate analyses, we grouped species together into guilds based on life history characteristics (Table 5). Grassland nesters are those birds that nest primarily in grassy or herbaceous cover. Shrubland nesters are birds that require low woody growth for nesting. Early succession foragers are birds that nest in other habitats, but utilize grass/shrub habitats for foraging or other activities. Habitat generalists that utilize early succession habitats (such as grackles, mockingbirds, cardinals and doves) were not included in these groupings.

Grouping by guild was necessary to increase sample size of detections for trend analyses, and also allows us to look for generalized benefits to bird communities with common habitat needs. However, there are some pitfalls to grouping species. Trends for the guild can be influenced by a very abundant individual species. Species within a guild do not have equal detectability, and they do not use, or respond to habitat in the same way. Several species (particularly migratory species) may experience influences on populations that are unrelated to CURE breeding habitats. Species in the same guild with opposite population trends can "cancel each other out", and mask underlying population dynamics.

Based on 1980 - 2006 statewide BBS trends, some grassland and early-successional songbird species in North Carolina have displayed significant declines in annual counts, including: loggerhead shrike (-9.5%), northern bobwhite (-5.7%), eastern meadowlark (-3.9%), yellow-shafted flicker (-3.4%), field sparrow (-2.1%), indigo bunting (-1.3%), and common yellowthroat (-1.0%). Conversely, other early successional species over the same timeframe have appeared to increase, including American goldfinch (3.3%), chipping sparrow (2.6%), purple martin (1.6%), eastern bluebird (1.9%), blue grosbeak (1.5%), eastern towhee (0.9%), and grasshopper sparrow (0.9%).

Regional Breeding Bird Survey (BBS) routes were selected from nearby counties to serve as a reference for each CURE cooperative and Game Land (USGS 2007). Direct comparisons of abundance should not be made between CURE and BBS routes due to differences in survey designs. We assume that the trend in bird counts should be comparable between the two surveys.

Because of limited pre-treatment data, simple linear regression was used to compare and evaluate trends, utilizing 2003 as a baseline year for trend analyses. 2007 represents the third year since habitat enhancements began on CURE Game Lands. Point counts can vary markedly from year to year and require many years to develop biologically and statistically significant trends. As more years of surveys are completed, trends should become clearer.

Data from unlimited distance, five minute counts were analyzed. Counts were standardized on the number of birds heard per 10 listening stations. Significant differences were determined at the alpha level of 0.05.

Table 5.--Songbird species groupings for analysis of spring point count data.

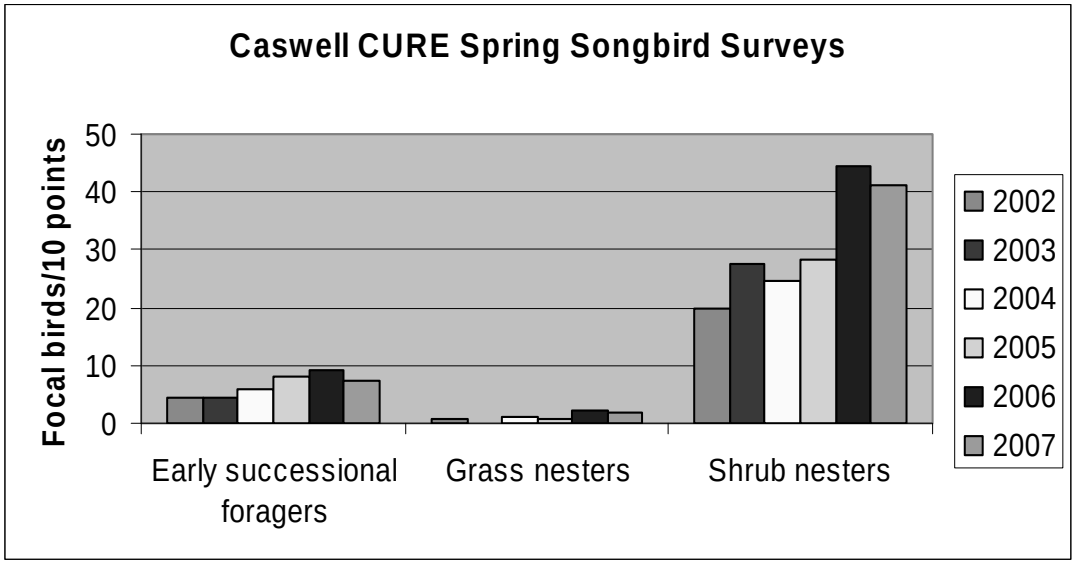
Grassland Nesters	**Shrubland Nesters**	• ***Early Succession Foragers***
Bachman's Sparrow	American Goldfinch	Barn Swallow
Aimophila aestivalis	*Carduelis tristis*	*Hirundo rustica*
Eastern Meadowlark	Blue Grosbeak	Brown-headed Cowbird
Sturnella magna	*Guiraca caerulea*	*Molothrus ater*
Grasshopper Sparrow	Brown Thrasher	Chipping Sparrow
Ammodramus savannarum	*Toxostoma rufum*	*Spizella passerina*
Northern Bobwhite	Common Yellowthroat	Eastern Bluebird
Colinus virginianus	*Geothlypis trichas*	*Sialia sialis*
Red-winged Blackbird	Eastern Towhee	Eastern Kingbird
Agelaius phoeniceus	*Pipilo erythrophthalmus*	*Tyrannus tyrannus*
	Field Sparrow	Eastern Phoebe
	Spizella pusilla	*Sayornis phoebe*
	Gray Catbird	Eastern Wood-Pewee
	Dumetella carolinensis	*Contopus sordidulus*
	Hooded warbler	Loggerhead Shrike
	Wilsonia citrine	*Lanius ludovicianus*
	Indigo Bunting	Orchard Oriole
	Passerina cyanea	*Icterus spurius*
	Prairie Warbler	Purple Martin
	Dendroica discolor	*Progne subis*
	Song Sparrow	Red-headed Woodpecker
	Melospiza melodia	*Melanerpes erythrocephalus*
	White-eyed Vireo	Wild Turkey
	Vireo griseus	*Meleagris gallopavo*
	Yellow-breasted Chat	Yellow-shafted Flicker
	Icteria virens	*Colaptes auratus*

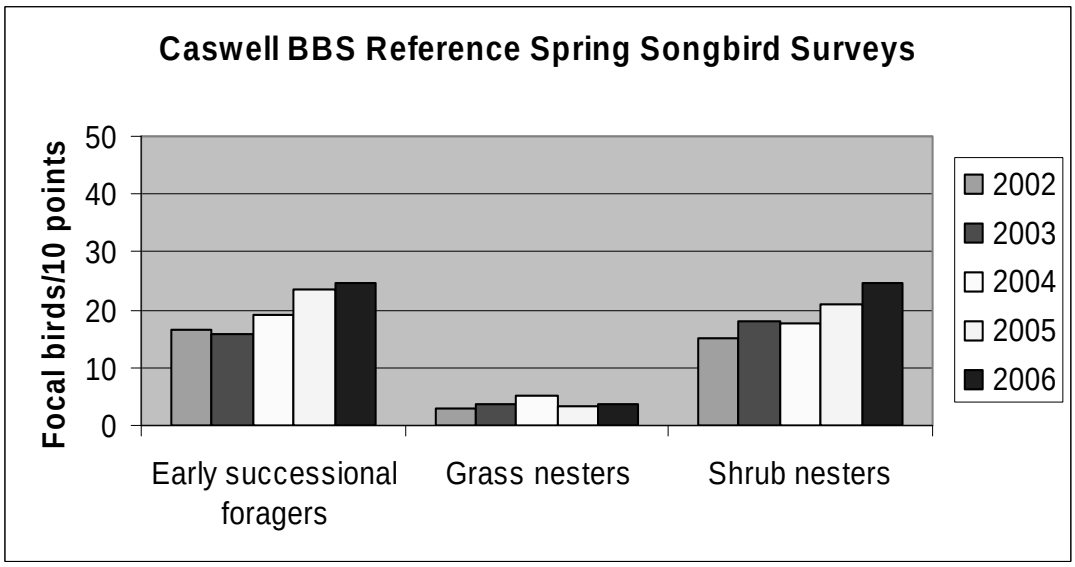
Relative abundance summaries will be based on the average number songbirds heard across all survey days under suitable weather conditions. Within each of the focal songbird guilds, CURE Game Lands contained similar dominant species as those seen on the private cooperatives. The early successional forager group was dominated by chipping sparrows, eastern bluebirds, and eastern wood peewees. The grassland nester group was entirely represented by northern bobwhite, except for Bachman's sparrows which were found on Sandhills and Suggs Mill Pond Game Lands. The shrub nester group consisted primarily of indigo bunting, eastern towhee and common yellowthroat.

All three early successional songbird group trends have been significantly increasing ($P = 0.02$) across all sites on both CURE and BBS since 2003 (Table 6, Fig. 11-19). Shrub nesting species have been increasing at a higher rate than other early successional groupings. Grass nesters maintained significantly lower trend rates than either shrub or early successional foragers, but count trends appeared to be relatively stable.

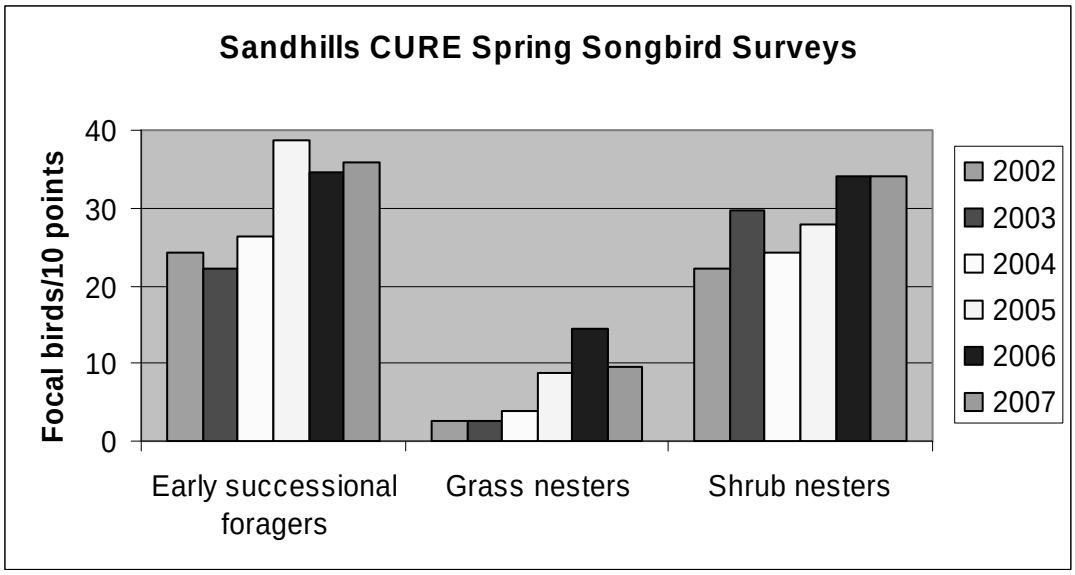
Some CURE game lands showed significant evidence that CURE efforts have increased focal early successional songbird abundance. Sandhills Game Land was the only CURE area to significantly increase ($P \leq 0.01$) overall focal songbird groupings, after accounting for year and grouping effects ($F_{4, 26} = 62.47$, $P \leq 0.01$). Sandhills habitat management plans were the first to be completed which may account for more rapid responses than those seen on the other CURE game lands. Shrub nesters seemed to show the greatest positive response ($F_{5,35} = 12.74$, $P \leq 0.01$) across all CURE game lands.

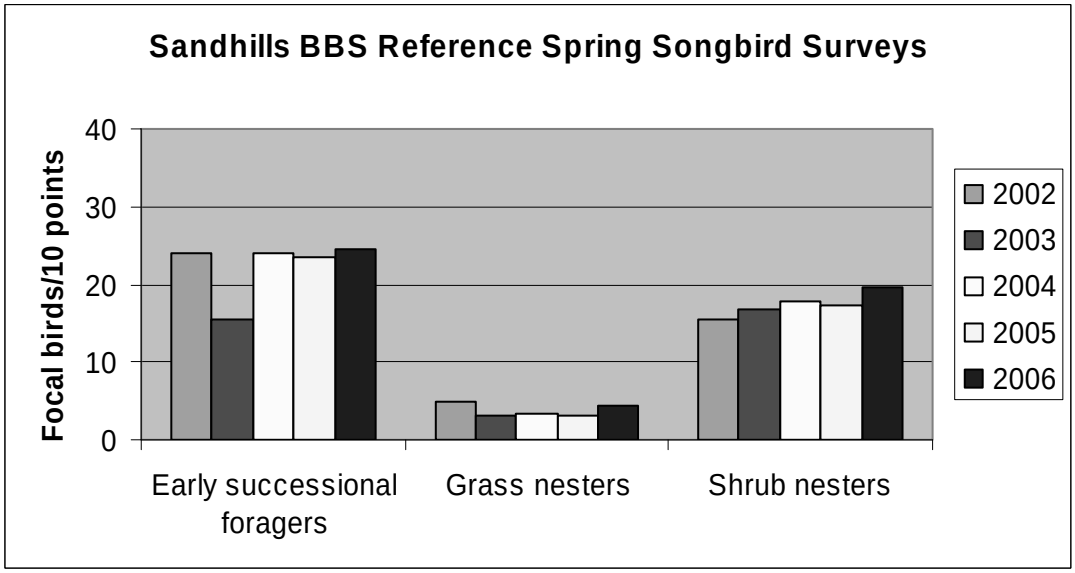
Early successional foragers on regional BBS had significantly higher trends ($P \leq 0.01$) than CURE game lands ($F_{5,35} = 4.85$, $P \leq 0.01$). The species that seem to be driving this trend include chipping sparrow, eastern bluebird, orchard oriole, red-headed woodpecker, and purple martin. Except for Bachman's sparrows on the Sandhills CURE area, grass nesters on CURE game lands also have a lower count trend ($P = 0.01$) than regional reference routes. This was primarily due to regional increasing counts of eastern meadowlark, which were not found on any of our game land CURE areas. .



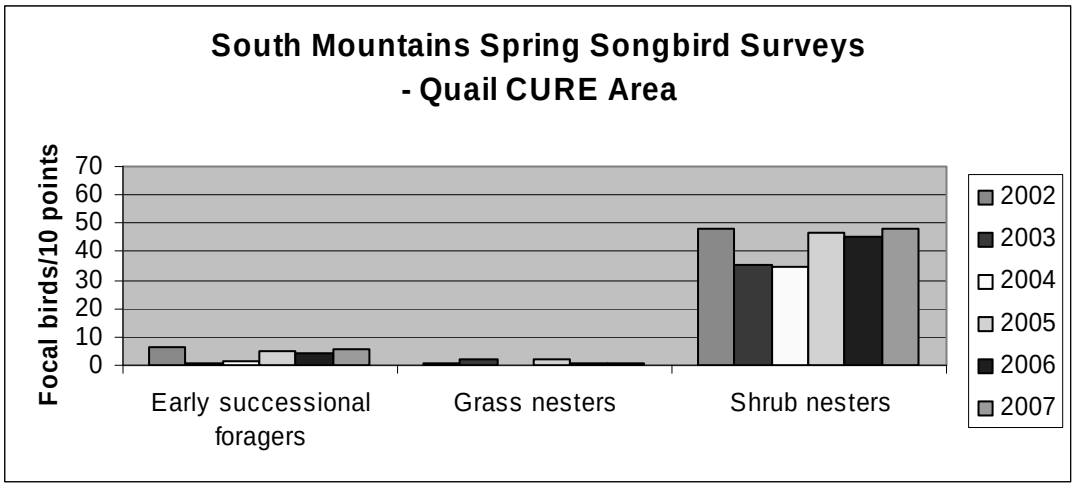


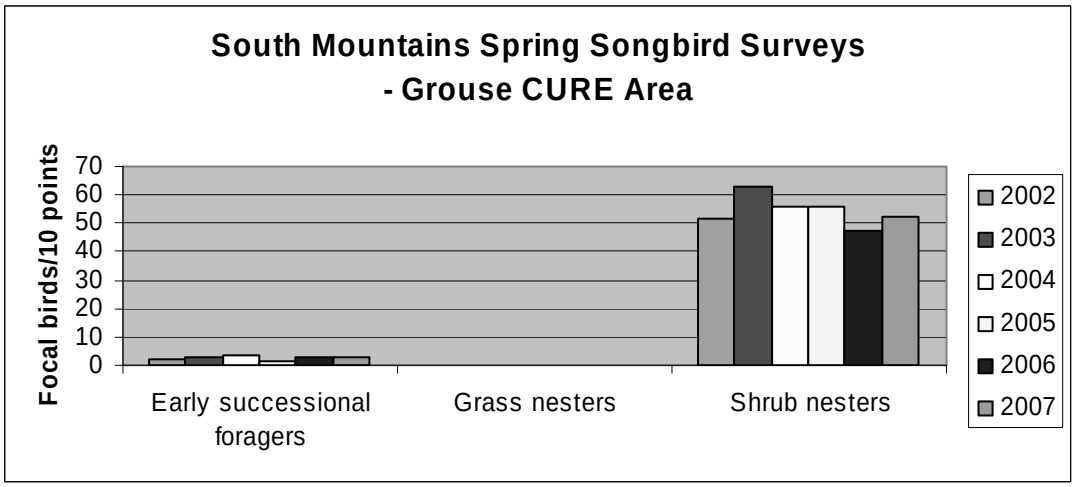
Figures 11 & 12.--Relative abundance (# focal birds detected per 10 survey points) of early succession habitat songbird guilds on Caswell Game Land CURE area, based on unlimited distance, five minute counts. Habitat enhancements were initiated in the summer of 2003. Comparisons between BBS and CURE should be made only for count trends, not relative abundance. BBS data for 2007 was not available as of the writing of this report.

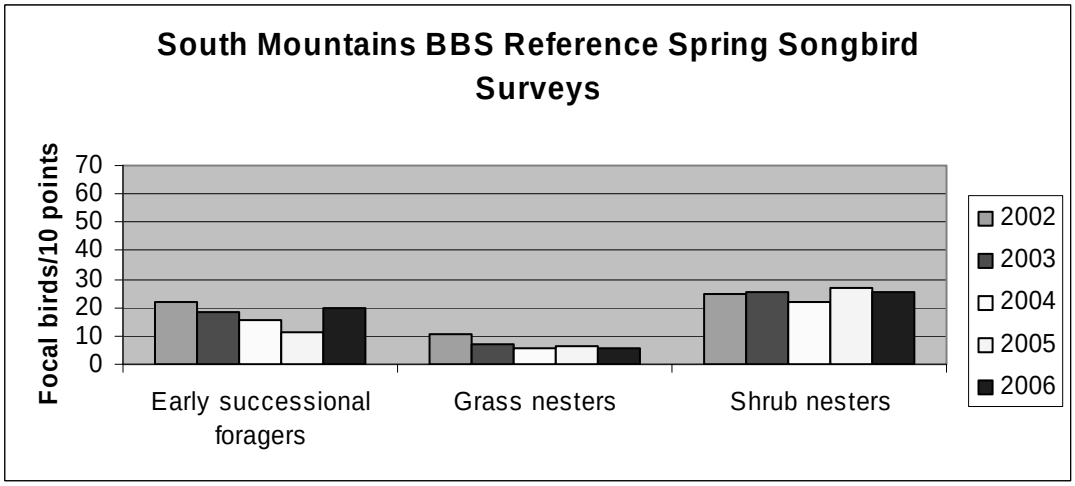




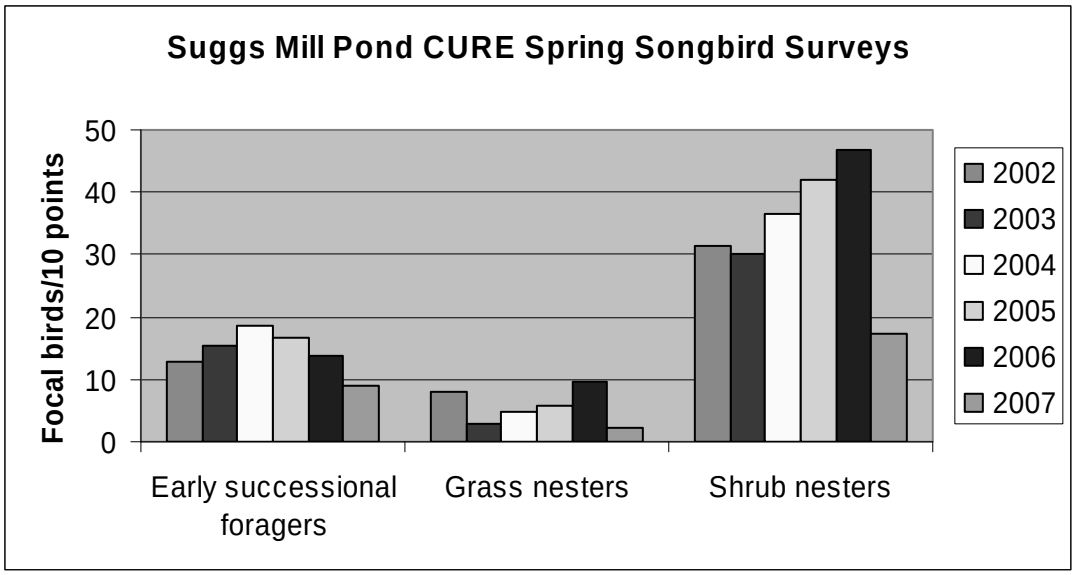
Figures 13 & 14.--Relative abundance (# focal birds detected per 10 survey points) of early succession habitat songbird guilds on Sandhills Game Land CURE area, based on unlimited distance, five minute counts. Habitat enhancements were initiated in the summer of 2003. Comparisons between BBS and CURE should be made only for count trends, not relative abundance. BBS data for 2007 was not available as of the writing of this report.

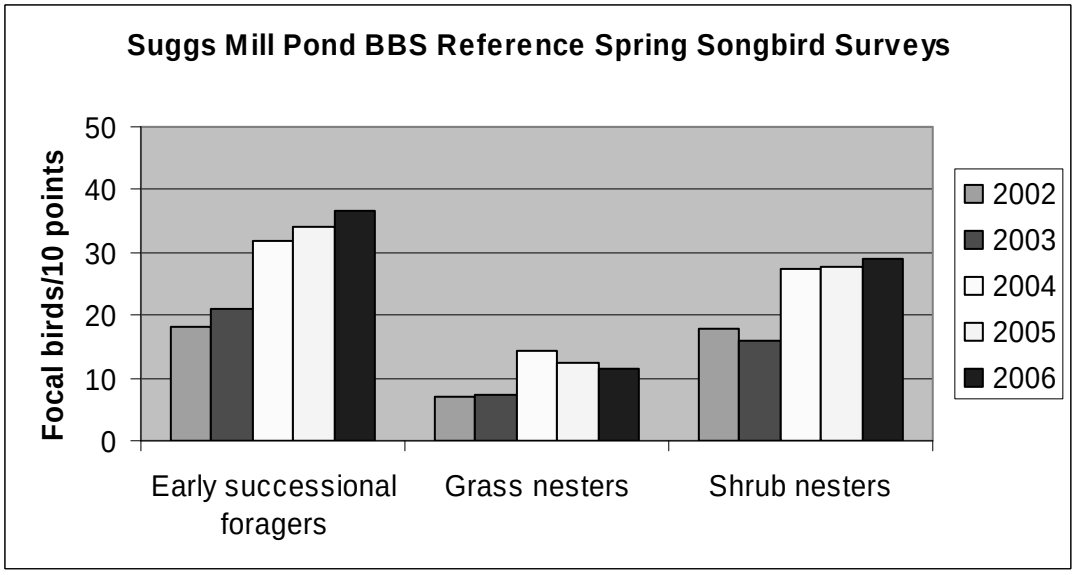






Figures 15, 16 & 17.--Relative abundance (# focal birds detected per 10 survey points) of early succession habitat songbird guilds on South Mountains Game Land CURE area (Quail and Grouse areas separated), based on unlimited distance, five minute counts. Habitat enhancements were initiated in the summer of 2003. Comparisons between BBS and CURE should be made only for count trends, not relative abundance. BBS data for 2007 was not available as of the writing of this report.





Figures 18 & 19.--Relative abundance (# focal birds detected per 10 survey points) of early succession habitat songbird guilds on Suggs Mill Pond Game Land CURE area, based on unlimited distance, five minute counts. Habitat enhancements were initiated in the summer of 2003. Comparisons between BBS and CURE should be made only for count trends, not relative abundance. BBS data for 2007 was not available as of the writing of this report.

Table 6.--Estimated annual spring CURE focal songbird trends on CURE Game Lands and regional reference BBS routes. Coefficient *(slope)* refers to the annual difference in number of birds heard per 10 points. P-value is the probability that the slope is different from zero. A positive coefficient (slope) indicates an increasing trend over the years, while a negative coefficient indicates a decreasing trend. Trends estimated with baseline year of 2003.

Group	site	*Coefficient (slope)*	*SE*	*P value*
Early foragers	CURE	1.00	0.64	0.13
	BBS	2.68	0.83	< 0.01
Grass nesters	CURE	0.77	0.43	0.09
	BBS	0.26	0.36	0.48
Shrub nesters	CURE	2.21	1.22	0.09
	BBS	1.89	0.66	0.02

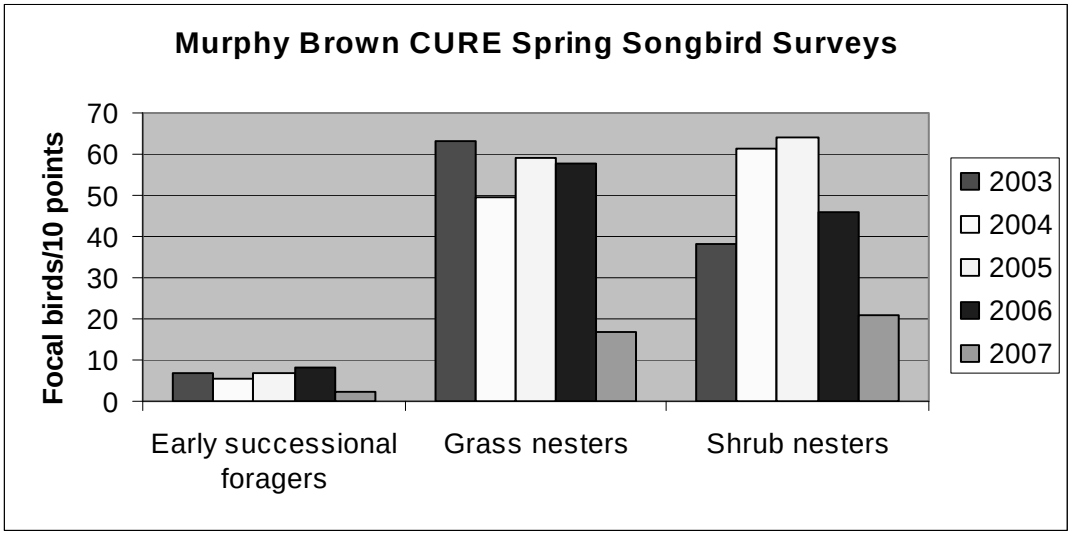
On each CURE area we identified two songbird species of conservation concern for which we saw the most opportunity for beneficial management (Table 7). Low baseline numbers have made it difficult to track these populations with point count surveys. Most notable in 2007 was first Bachman's sparrow observation recorded at Suggs Mill Pond Game Lands. Other species observations have appeared to remain relatively consistent since 2002.

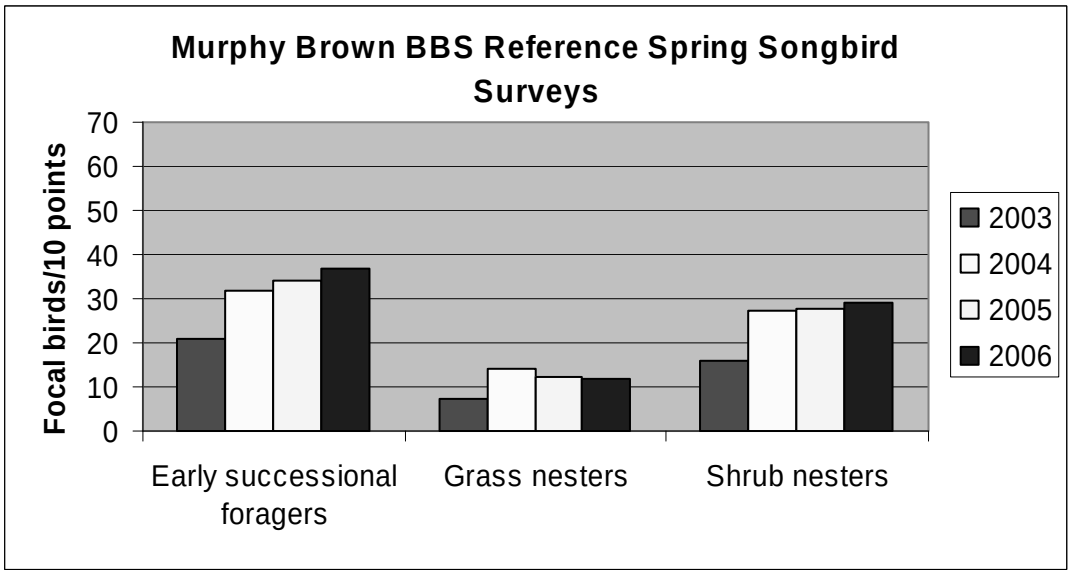
Table 7.--Songbirds of higher conservation concern found on CURE Game Land areas. Conservation concern was determined by Partners in Flight. These are species for which there are particularly good opportunities for management on a given area. Values are number of birds heard per 10 listening stations during spring point counts.

CURE area	**Species**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Caswell	Field sparrow	1.2	0.8	1.5	1.5	2.5	2.8
	Prairie warbler	2.3	5.4	1.1	3.1	4.2	4.8
Sandhills	Bachman's sparrow	0.0	0.8	0.4	2.1	5.0	3.8
	Brown-headed nuthatch	5.0	3.8	5.0	4.6	7.5	5.4
South Mountains	Field sparrow	1.0	1.0	0.0	2.6	0.0	6.3
-Quail area	Prairie warbler	7.4	7.9	5.8	6.3	8.9	8.4
Suggs Mill Pond	Brown-headed nuthatch	1.4	1.9	1.0	1.9	3.8	1.4
	Prairie warbler	6.7	8.1	5.2	11.9	3.8	2.4

3. CURE Corporate Cooperative - Spring Songbird Surveys

An index of spring songbird abundance at the scale of the CURE area was tracked using point count survey methodologies similar to the CURE Game Lands spring songbird surveys (see previous section) (Fig. 20 & 21). Baseline surveys for the Murphy Brown CURE area were initiated in 2003 utilizing 21 listening points. Five minute point count surveys were conducted once on each area between May 18th and June 14th. Since habitat enhancements were not initiated until spring 2006, trends relating to CURE improvements could not yet be determined.





Figures 20 & 21.--Relative abundance (# focal birds detected per 10 survey points) of early succession habitat songbird guilds on the Murphy Brown Ammon Farm, based on unlimited distance, five minute counts. Comparisons between BBS and CURE should be made only for count trends, not relative abundance. BBS data for 2007 was not available as of the writing of this report. Note: Habitat enhancements were initiated in 2006 on the CURE site.

Summer Vegetation Surveys: Game Lands

In the summer of 2007, we continued surveys of vegetative structure and composition in forested habitat improvement areas on CURE Game Lands. These surveys measured the amount of cover provided for quail, vegetative growth forms, and dominant plant genera in habitat areas, and tree basal area of wooded areas. The objectives of this survey were to determine if habitat improvement areas have adequate cover for quail, to compare management techniques, and to describe the vegetative composition of habitat areas.

The amount of overhead and ground cover available within the habitats was estimated using the cone and disc of vulnerability techniques (Kopp et al. 1998). The cone of vulnerability, an index of overhead cover for a quail, represents the volume of air space within which a raptor could attack a quail with no obstruction in the line of flight. The cone volume was estimated from the mean angle of a pole that, starting from a vertical position, was leaned over until it touched the first piece of vegetation. The disc of vulnerability, an index of ground-level cover, represents the area within which a terrestrial predator could see a northern bobwhite (0-15 cm above ground). The disc radius was estimated by measuring the distance at which a quail-sized object disappears from view at a height of 1 meter in 4 directions around each subsample. According to Kopp et al. (1998), quail selected against habitats with an average cone of vulnerability angle less than 45 degrees and a disc of vulnerability greater than 11.6 meters.

Vegetative composition and growth forms are other primary determinants of suitable bobwhite quail habitat (Kopp et al. 1998, Schroeder, 1985). For growth forms we measured the percent cover of woody, forb and grass vegetation >15cm and <2m within a $1m^2$ sampling frame. Dominant genera (those understory plant genera covering at least a third of at least 3 stands on the CURE area) coverage was also recorded within each subsample. Average percentage of dominant genera coverage was calculated for each year within each site.

Within each of the CURE Game Lands, summer vegetation surveys included randomly selected stands and stands selected for management interest. Each CURE Game Land contained management techniques unique for their geographic and management area. CURE Game Lands were dominated by forest stand types. Management prescriptions primarily involved timber cutting and prescribed burning and the vegetation surveys were intended to evaluate the effectiveness of these management actions.

Early successional habitats have been slower to develop on the predominantly forested CURE Game Lands compared to the predominately agricultural CURE private cooperatives. Habitat management on the private cooperatives directly impacted a smaller portion of the landscape (approx. 5-10%) while CURE Game Land management will impact a larger portion of the landscape (Caswell, 51%; South Mountains, 60%; Sandhills, 100%; Suggs Mill Pond, 100% of available uplands). Thus, we expect to see a more dramatic vegetation change at the landscape scale over the long term on game lands.

Surveys were performed on managed stands both pre-treatment and for several years post-treatment. However, sample size remained relatively low for some statistical tests to be made relating to some game land management techniques. To date, sample sizes are adequate for

wooded stand types up to 4-5 growing seasons since initial treatments on game lands. We applied our model of minimum quail habitat requirements (based on minimum cover and herbaceous vegetation needs) to allow for comparisons of quail suitability across the different game land treatments. For an entire stand to be considered "suitable habitat" for bobwhite quail, at least half of the subsamples within the stand must have fulfilled all the following criteria: cone of vulnerability average angle >45 degrees, disc of vulnerability average radius <11.6m, *and* herbaceous cover (grasses + forbs higher than 15cm) >10%.

A full and detailed report of the vegetation survey results can be found in the 2007-2008 annual Wildlife Resources Commission CURE report. Copies of this report can be requested through the Division of Wildlife Management office, 919-707-0050. Full details for this section will include specific vegetation cover, composition, and quail suitability assessments for each of the CURE game lands.

Winter Songbird and Vegetation Surveys

Early succession habitats may be as limiting for wintering birds as for breeding birds in North Carolina. By providing wintering habitat, CURE cooperatives have the potential to benefit a largely different group of migratory songbird species that stage during the winter in North Carolina (Marcus et al. 2000).

Densities of focal wintering birds (Table 8) were measured using a strip transect technique with two to four, 20m x 100m transects (0.2 hectare per transect) surveyed within each management unit by 2 observers. Strip transect surveys were initiated the winter before habitat establishment, in January 2002 for the private cooperatives and 2003 for Suggs, Sandhills, and South Mountains Game Lands. Baseline surveys for the Murphy Brown CURE area and surveys on Caswell CURE and control areas and the Sandhills control area were initiated in 2004. Control sites were added on Sandhills and Caswell Game Lands to serve as a reference for local bird trends while meeting other Wildlife Diversity survey objectives.

In 2008, 241 stands were surveyed within the 4 CURE Game Lands, 2 control areas, and 1 CURE Corporate area. Survey results were not available in time for the writing of this report. Winter songbird density estimates will be determined for each stand type. Stands were stratified based on overstory tree type and management regime, and will be analyzed by stand type. Caswell stands were stratified into field, hardwood, and pine stands. Sandhills stands were stratified by drain, field, hedgerow, natural pine, and plantation pine stands. South Mountain stands were stratified by woods height (3-4 meters, 5-7 meters, and >7 meter tall median canopy height). Suggs Mill Pond stands were stratified into fields, linear openings and mature pine woods (>7 meters). Murphy Brown stands were stratified by cropped agricultural fields (fields), fallow fields (fallow), field borders along drainage ditches (field borders), grazed pasture (pasture), and unmanaged woods of various ages (woods).

Table 8.--Focal species for CURE winter bird surveys.

American Goldfinch	*Carduelis tristis*
Bachman's Sparrow	*Aimophila aestivalis*
Brown-headed Nuthatch	*Sitta pusilla*
Carolina Wren	*Thryothorus ludovicianus*
Chipping Sparrow	*Spizella passerine*
Dark-eyed Junco	*Junco hyemalis*
Eastern Bluebird	*Sialia sialis*
Eastern Meadowlark	*Sturnella magna*
Eastern Towhee	*Pipilo erythrophthalmus*
Field Sparrow	*Spizella pusilla*
Fox Sparrow	*Passerella iliaca*
Loggerhead Shrike	*Lanius ludovicianus*
Northern Bobwhite	*Colinus virginianus*
Northern Cardinal	*Cardinalis cardinalis*
Northern Harrier	*Circus cyaneus*
Savannah Sparrow	*Passerculus sandwichensis*
Song Sparrow	*Melospiza melodia*
Swamp Sparrow	*Melospiza georgiana*
White-throated Sparrow	*Zonotrichia albicollis*
Winter Wren	*Troglodytes troglodytes*
Yellow-rumped Warbler	*Dendroica coronata*

Photoplots

A qualitative assessment of habitat improvements is being done with the use of photoplots (Fig. 22). Six to eight permanent photo stations were established on Caswell, Sandhills, Suggs, Murphy Brown, and each of the 3 CURE private cooperatives.

Digital photos were taken prior to habitat management, immediately after management action, and at regular intervals (winter and late summer) thereafter. These photos will help to visually assess habitat work and help communicate our habitat improvements to various stakeholders. To date 323 photos have been taken at 51 photoplot stations.

Figure 22.--Photoplot examples: Pine thinning on Sandhills Game Land CURE area (left column) and fallow field on Benthall CURE area (right column).

Bachman's Sparrow Response to Sandhills CURE Management

The Bachman's sparrow (*Aimophila aestivalis*) is a pine savanna specialist, and a species that has been in sharp decline in recent years due to habitat loss, fire exclusion, and habitat fragmentation (Dunning and Watts 1990). The Breeding Bird Survey shows an 18.9% decrease in Bachman's sparrow populations since the late 1990's. The Bachman's Sparrow is a Wildlife Action Plan priority species, is listed as a Federal Species of Special Concern, and is recognized as a Tier 1 species of conservation concern by Partners In Flight (PIF) in North Carolina, second only the Federally Endangered Red-cockaded woodpecker as one of the top priority at-risk birds in the Sandhills region.

Like the northern bobwhite quail, the Bachman's sparrow spends much of its time on the ground, including nesting and foraging. Both birds prefer low basal-area forests where ground cover consists of grasses and some forbs. Both quail and the Bachman's sparrow are known to benefit from frequent use of growing-season prescribed fire which maintains appropriate plant communities and arthropod diversity for high bird-productivity (Tucker 2006). The Bachman's sparrow and bobwhite quail have been observed using overlapping areas during their respective breeding seasons.

Infrequent sightings of the Bachman's sparrow have limited our understanding of the current status of the species. Observations have been limited due to the low abundance of the bird, lack of skilled observers, lack of vocalizations in the non-breeding season, and their habit of running on the ground instead of flying when flushed.

Habitats used by Bachman's sparrow include open pine woods, old fields, and clearcuts with grass and forb understories. Bachman's sparrows are also associated with wiregrass/longleaf pine ecosystems which have frequent (2-3 year) fire regimes. The longleaf pine savanna and early successional habitats that the Bachman's sparrow and northern bobwhite quail depend on have been greatly reduced in scope across the coastal plain and piedmont regions by human development, conversion of habitat to closed canopy woodlands, and reduced fire regimes (Tucker 2004). Fragmentation of habitat also prevents these ground-dwelling birds from finding suitable habitat, even when it is available (Dunning et al. 1995).

At the inception of the CURE program on Sandhills Game Land in 2003, very few Bachman's sparrows were observed on the CURE area. Over time, sparrows were observed colonizing recently managed areas and populations seemed to be increasing (Figure 23). In particular, we observed the colonization of plantation pine stands which had been heavily thinned and the understory planted to Atlantic coastal panic grass (see NCWRC Piedmont Game Land Songbird Surveys annual report for State Wildlife Grants for more details). We wished to learn more about how a Sandhills grassland specialist would respond to this grass which is not native to the Sandhills (it naturally occurs on coastal dunes).

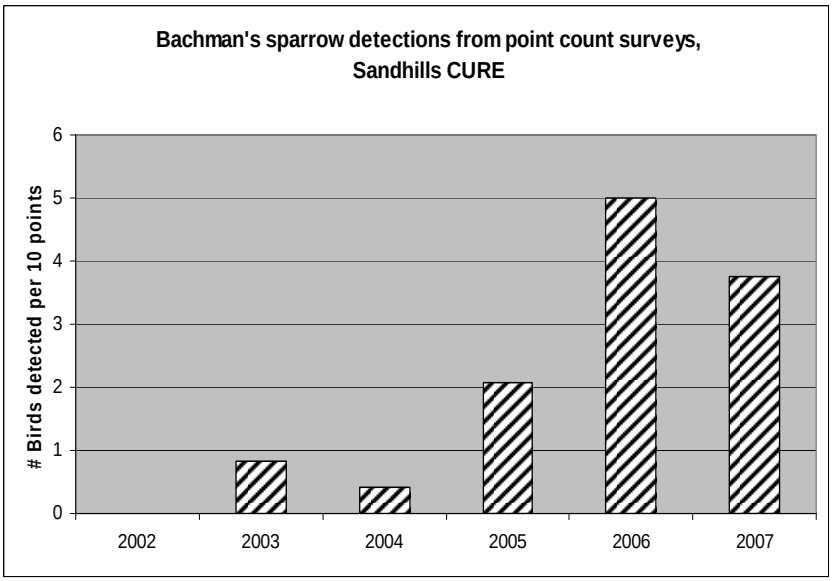


Figure 23. Counts of Bachman's sparrows from CURE area songbird point count survey, 2002-2007. Management was initiated on the CURE area in 2003, and habitat establishment was nearly complete across the CURE landscape by 2007.

Further, with bobwhite quail as the flagship species for CURE, we wished to better understand the overlap and divergence of habitat use between quail and sparrows, to help inform future land management for Sandhills Game Land. Managers are challenged by simultaneously managing for federally endangered red-cockaded woodpecker on the Sandhills CURE area, and this study will help to elucidate the effects of management decisions on target species competing for resources and using the same landscape.

The objectives of the study include:
1. Track relative abundance of Bachman's sparrows over time on CURE and control areas.
2. Determine distribution and habitat use responses to CURE management.
3. Characterize Bachman's sparrow territory establishment rates and territory size.
4. Describe reproductive effort of Bachman's sparrows.
5. Describe vegetative structure and composition of sparrow territories and compare these measurements between habitat types, between occupied and unoccupied stands, between CURE and control areas, and between Bachman's sparrow and quail locations.

Methods

This study was conducted on the 5196 acre Sandhills CURE acre, and a similar-sized area in the southeast corner of Block B which did not receive the same intensive management as the CURE area. The control area received typical Sandhills Game Land management of burning on a 2-4 year rotation, and managing small fields for fallow habitat or annual food plots. The control area contains similar proportions of drains, fields, and uplands as the CURE area, but has less acreage of plantation pine (~200 acres vs. ~700 acres).

Plantations on the control area supported a high basal area of longleaf pine and were raked annually for pine straw, leaving little understory vegetation, similar to the pre-treatment condition of plantations on the CURE area. Plantation stands on the CURE area were thinned to a basal area of 20-30 ft^2/ac and planted to Atlantic Coastal Panic grass (ACP). This habitat will be referred to as ACP plantation or simply ACP. Upland longleaf stands with understories dominated by wiregrass and other native plants will be referred to as "natural upland pine". Drains are streamhead pocosin habitats, areas of dense vegetation along headwater creeks. Fire was excluded from drains on Sandhills Game Land for many years, and most drains are characterized by a closed-canopy pine and hardwood overstory, and a dense evergreen shrub understory (referred to as "woody drains"). As part of the CURE program some drains had overstory trees mechanically removed and more frequent fire introduced, producing a more herbaceous, cane-dominated understory (referred to as "herbaceous drain").

Repeated point count surveys with song playback were employed to develop a relative abundance estimate for Bachman's sparrow, spot mapping was used to determine territory establishment rates, territory size and reproductive effort, and vegetation surveys were used to determine microhabitat characteristics for Bachman's sparrows and quail.

Point Counts

Survey points were located $\geq$0.2 miles (322 meters) apart using a modified gird system. In 2006, 226 points were established on the CURE area and no surveys were conducted on the control area. In 2007, every other point on the CURE area was dropped, and 103 points were established $\geq$ 0.4 miles apart on the control area. Point locations were determined by establishing a grid on the CURE area in ArcMap, and were adjusted slightly for logistical considerations. Points were not placed in unsuitable habitats (i.e. lakes and the center of large woody drains).

The survey began at first light and ended ~5 hours after sunrise. Counts were conducted by four observers on days with little wind and no precipitation. Observers recorded the estimated location of each bird on aerial photos.

We used playback of Bachman's sparrow song recordings to determine their effect on calling rates during the breeding season. From 0-3 minutes the observer listened passively with no playback stimulation. From 4-6 minutes, the observer played recorded Bachman's sparrow vocalizations using a MP3 wildlife caller facing four cardinal directions. Observers also recorded singing quail during the 6 minute listening period to provide an index of quail abundance and to evaluate the correlation between Bachman's sparrow distribution and quail distribution on the landscape.

In 2006, the survey was conducted in April, May, and July to determine seasonal variation in Bachman's sparrow call rates. Survey routes were run once in mid April and early July and 3 times in mid May to determine daily variation in call rates. That is, in 2006, all 226 points were surveyed 5 times. In 2007, the survey was run three times in late April/early May, which was determined to be the peak calling time from the previous year's survey.

Landscape Useable Habitat Survey

Useable habitat surveys were designed to track changes in habitat availability to Bachman's sparrows. These surveys were used to determine: 1) the quantity of useable habitat that is available to Bachman's sparrows in the breeding season and 2) the distribution of useable and non-useable habitats between stand types and across the landscape.

Determinations were conducted for the entire CURE and control area during each point count survey. Determinations of useable habitat were made at the scale of the stand (e.g. one contiguous field or timber stand that receives uniform management). Useable habitat was defined based on literature reviews of life history requirements. Stands were classified as useable for Bachman's sparrows if the majority of the stand had a minimum of 40% herbaceous ground cover > 15 cm. Herbaceous vegetation included wiregrass (*Aristida stricta*), Atlantic coastal panicgrass (*Panicum amarum,* ACP), broomstraw (*Andropogon virginicus*), and other grasses and forbs. Row crops did not count as useable habitat.

Spot mapping and nest searching

Spot mapping was used to determine territory establishment rates and sizes (Robbins 1970, Engstrom 1988, and Ralph et al. 1993). Territory abundance and size was compared between different stand types and management histories.

Territory mapping in 2007 was conducted at 45 randomly selected Bachman's sparrow sighting locations (from the point counts). Bird locations were visited at least once every 10 days on mornings without heavy precipitation or strong winds, and spot-mapped for a minimum of 15 minutes. If the target bird was not detected within ~10 minutes the MP3 caller was used to stimulate a response. Observers recorded age (adult vs. juvenile), behavior, location, and movement of each bird observed. Locations and behaviors of all neighboring Bachman's sparrows and bobwhite quail were also recorded.

At the end of the field season, all observations were transferred to one map. A territory was designated if the target bird was observed at least 3 times within a 21-45 day period. Territory size was determined using the least convex polygon method in ARC GIS. Each territory was given a Vickery score (Vickery 1992), a reproductive index based on observed behaviors.

In 2006 we attempted to find Bachman's sparrow and quail nests during and after spot map surveys. Very few nests were found and this effort was abandoned in 2007.

Vegetation Surveys

The objective of the vegetation survey in 2006 was to describe the habitat structure of established Bachman's sparrow territories and to compare it to locations where Bachman's sparrow were detected but did not establish territories, to unoccupied stands that were potentially useable for Bachman's, and to nest sites within territories. In 2007 the primary objective was to compare the structure of Bachman's sparrow locations to quail locations. Vegetation surveys were conducted from mid-July through early August.

We conducted vegetation surveys for all of the sparrows that were randomly selected for spot mapping after the April point count survey. In 2006 we also conducted surveys in stands that contained useable habitat, but were not occupied by Bachman's sparrows. For each stand that was classified as "useable" in April 2006, we overlaid the point count observations and classified stands as "occupied" if at least one sparrow observation occurred in the stand, and "unoccupied" if there were no sparrow observations in the stand. We then selected a stratified random sample of the unoccupied stands, stratified by habitat type (field, ACP, natural longleaf). In 2007, we also conducted surveys at bobwhite quail locations. We compiled observations of 121 quail on the CURE and control areas from the Bachman's sparrow point counts, song bird point counts, quail point counts, and spot mapping surveys and randomly selected 42 quail for vegetation sampling.

For each bird or stand, 9 vegetation measurement points, or vegetation subsamples, were taken. One subsample was taken at the center point and 2 were taken in each of the 4 cardinal directions, 30 and 60m from the center point.

For quail and sparrow locations, we located the center of each vegetation survey plot at the weighted center of all the observations for the bird. If a bird was only detected once, the center of the vegetation plot was located at that point. These center points were located in the field using a GPS unit. In stands we located the center of the vegetation plot at a random location in the interior of the stand. After reaching the point, a meter stick was tossed backwards over the observer's shoulder to establish the initial (center) vegetation measurement point.

In 2006, if we had irregular-shaped stands the 9 measurement points were re-arranged to fit within the stand while still being independent. In 2007, we maintained the same "+" shaped subsample layout for each bird, even if a location straddled 2 stands or habitat types (e.g. a forest stand next to a field) and measurements were taken in more than one habitat. We think this helped to describe the habitats selected by the birds, since several birds were found near habitat edges.

Vegetation surveys were conducted in August of 2006 and 2007, after spot mapping was completed. Note that the timing presents some opportunity for bias, since the habitat structure at the time of Bachman's sparrow habitat establishment in April may have changed by the time vegetation was surveyed in August. However, if these vegetation changes occur at similar rates throughout the study area, then comparisons between birds and habitats should still be valid.

Vegetation Measurements:

Ground Obstruction

Bachman's sparrow and quail spend much of their time walking and foraging on the ground. When the ground level vegetation and duff gets too rank or dense for them to walk through, the habitat becomes less suitable. We estimated the percentage of ground surface where a Bachman's sparrow would be obstructed from free movement with a line intercept technique. Using a meter stick, we measured the cumulative length of the stick that had vegetation or other material between 3 cm to 9 cm height, imposing an obstruction to a theoretical Bachman's

sparrow. For instance, if there are overhanging grasses between 3-9 cm tall touching the stick for a 5 cm length at one end, another 15 cm in the middle, and an additional 10 cm length at the other end of the meter stick, then we would record a total of 30 cm, or 30% ground obstruction.

Litter Depth

When excessive litter builds up, habitat becomes less suitable for Bachman's sparrow, perhaps because of reduced ability to find seeds and other food on the ground. We measured the litter depth at the front of the meter stick at the 0, 50, and 100cm marks using a cm ruler. Vegetation was determined to be "litter" if the observer thought that a Bachman's sparrow would have to scratch or move the vegetation out of the way in order to reach bare mineral soil.

Composition of Growth Forms

Bachman's sparrows require dense herbaceous cover for breeding and other life functions. We measured the horizontal cover of growth forms using a 1 m^2 sampling frame (Daubenmire 1959). The observer visually estimated the percent cover of woody vegetation, herbaceous vegetation (grasses and forbs), forbs (broad-leaved, non-woody plants), grasses, Atlantic coastal panicgrass, and wiregrass between 9-150cm, and open ground (vegetation <9cm, shorter than a Bachman's sparrow). Each category was measured independent of the others and the categories do not sum to 100%.

Density of Mid-Story Trees

Dense coverage of mid-story trees can shade the ground level and impact understory habitat conditions. We counted all mid-story trees within a 10m radius of the center of the 1m^2 sampling frame. Midstory trees are those trees >2.5m tall and shorter than the lowest live branch of the average canopy pine trees (approximately 8m maximum height). Pines and hardwoods were tallied separately.

Canopy Tree Basal Area

Canopy tree basal area also impacts understory habitat conditions, and is one of the variables that wildlife managers can manipulate with timber management. We measured canopy tree basal area for all trees >4 in. diameter at breast height using a 10-factor prism. Pines and hardwoods were tallied separately.

Cone of Vulnerability

This measurement was added in 2007 to determine the amount of overhead cover that would hide a bird on the ground from an aerial predator. The cone of vulnerability, which was developed for quail (Kopp et al. 1998), represents the volume of air space within which a raptor could attack a quail with no obstruction in the line of flight. The cone volume was estimated from the mean angle of a pole that, starting from a vertical position, was leaned over until it touched the first piece of vegetation.

Presence of Woody Material

This measurement was also added in 2007 after it was observed that Bachman's sparrows tend to use downed woody material to hide in and forage around. Presence of woody material may also indicate good snake and meso-predator (e.g. squirrel, fox, raccoon, and opossum) habitat, and may correlate negatively to nest success of both quail and sparrows (Jim Cox, pers. comm.). Downed woody material was defined as any piece of woody debris at least one meter long and at least 6 inches in diameter within 10 meters of the vegetation subsample point.

Results

Point count surveys

In 2006 we detected an average of 0.48 Bachman's sparrows per point on the CURE area during the April survey on the 103 points that were also surveyed in 2007. In 2007 we detected an average of 0.46 sparrows per point on the CURE area and 0.67 per point on the control area.

Sparrows were detected as far as 477m from the survey point, with a median detection distance of about 100m and 90% of the observations less than 227m.

The use of song playback increased detections of Bachman's sparrows by 26% in April 2006 and 35% in 2007 over passive listening counts. In 2006 the song playback was equally effective in May (25% increase over passive counts) as in April, but was not at all effective in July (no increase in detections), when the breeding season is starting to wind down.

Usable Habitat

In late April/early May 2007, a similar proportion of the acreage of natural longleaf stands and fields were classified as useable habitat for Bachman's sparrows on the CURE area and control area (Figures 24 & 25). However, 82% of plantation stands on the CURE area were classified as useable because of CURE management, while only 5% of the unmanaged plantation stands on the control area were classified as useable habitat. In addition 16% of the acreage of drains on the CURE area provided useable habitat after thinning and burning created a more herbaceous understory, while only 2% of the closed-canopy, woody drains on the control area provided useable habitat for sparrows. On the CURE area, 51% of the acreage of natural pine uplands was classified useable, while 62% of natural pine acres on the control area were useable.

Overall in 2007, 2630 acres of useable habitat were available on the CURE area (out of 5190 acres total) while 2839 acres were available on the control area (out of 5124 acres total). There was little change in the total acreage of useable habitat in late April on the CURE area between 2006 and 2007 (2654 vs. 2630 acres), though the location of useable stands shifted with the controlled burn rotation.

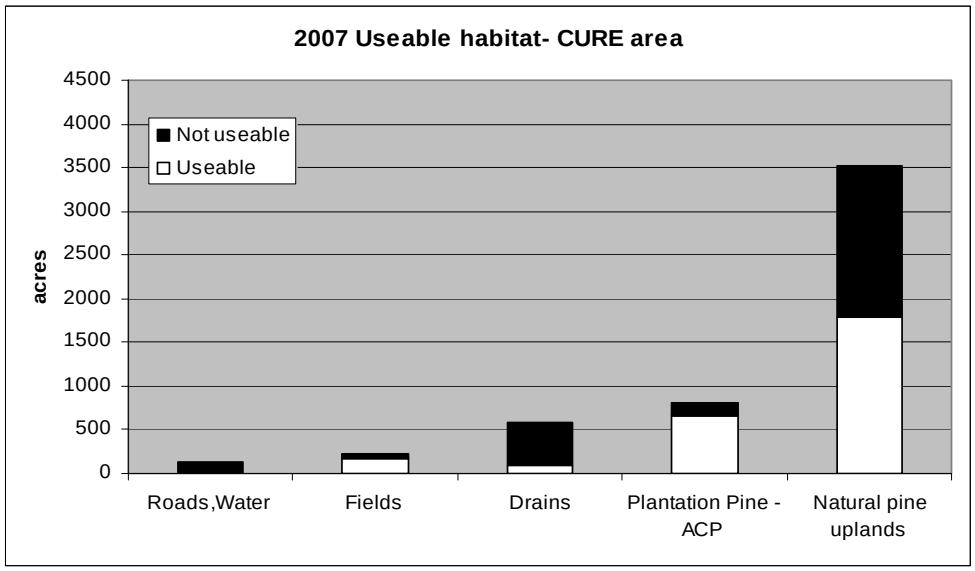


Figure 24. Acreage of stands in Sandhills CURE area classified as containing useable habitat for Bachman's sparrows (majority of the stand with >40% herbaceous groundcover) in early May 2007.

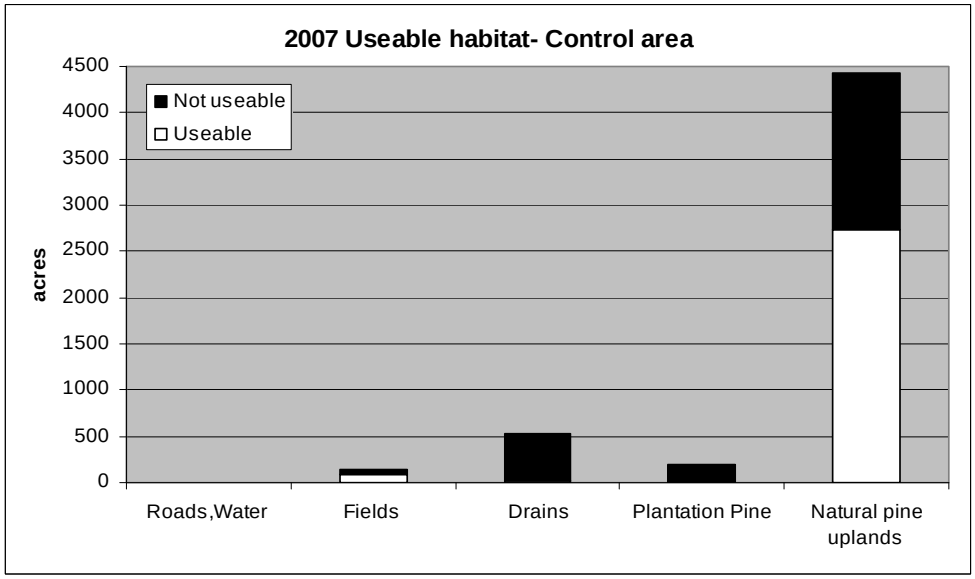


Figure 25. Acreage of stands in Sandhills control area classified as containing useable habitat for Bachman's sparrows (majority of the stand with >40% herbaceous groundcover) in early May 2007.

Bachman's sparrow and quail habitat selection

Bachman's sparrows were found primarily in upland habitats. In 2007 on the CURE area, about half of the area of managed plantation stands and natural pine stands were occupied by Bachman's sparrows, while about a quarter of the acreage of drains were occupied (Figure 26)

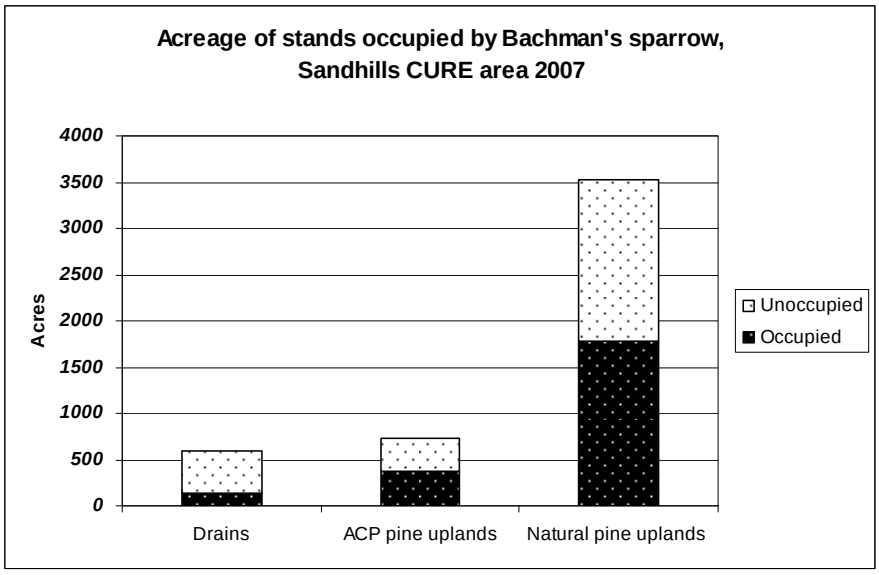


Figure 26. Acreage of stands occupied by Bachman's sparrows, Sandhills CURE area 2007. An occupied stand had at least one observation of a sparrow during the late April/early May point count.

The vegetation surveys provide a more detailed look at habitat selection for both Bachman's sparrows and quail. Each subsample location was characterized by habitat type. Since the birds selected were a random subset of all those observed across the landscape, the proportions of habitats observed at bird locations should roughly reflect the proportion of habitats selected across the landscape.

On both the CURE and control areas, Bachman's sparrows used natural upland pine habitats in proportion to their availability (Figure 27 A & D vs. C & F). 28 % of Bachman's sparrow locations were in managed plantations planted to ACP, while this habitat made up only 15% of the CURE landscape, suggesting that they may be selecting for this habitat type. No Bachman's sparrows were found in unmanaged pine plantations on the CURE area. Very few Bachman's sparrow vegetation survey points were in drains.

On the CURE area, quail appeared to select natural upland pine and woody drains less than their availability, while they were found in herbaceous drains, fields and ACP plantations in greater proportion to the availability of these habitats (Figure 27, B vs. C). In contrast, on the control area, quail appeared to use natural upland pine and woody drains approximately in proportion to their availability, while they used fields in greater proportion than available (Figure 27, E vs. F).

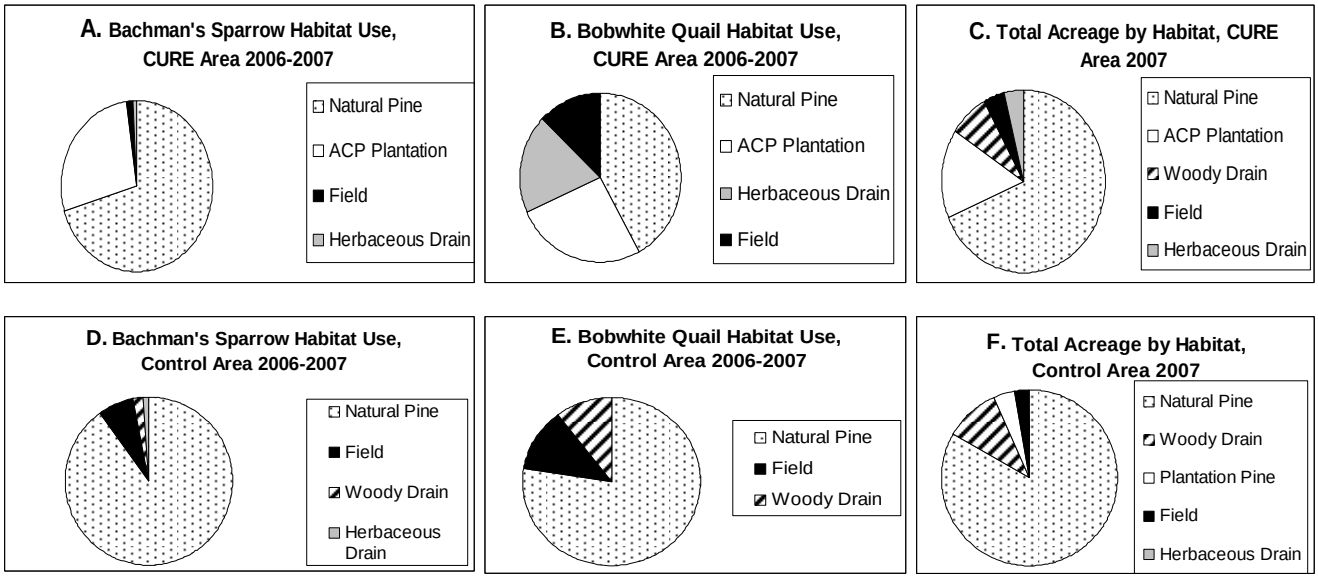


Figure 27. Proportion of habitats at bird locations (first 2 columns of pie charts), classified during vegetation surveys, and the proportion of habitats available on the CURE and control areas (last column). Look across rows to compare bird habitat use within a treatment, and look down columns to compare between treatments.

On the control area, which represents typical habitat conditions on Sandhills Game Land, quail and sparrows demonstrated similar habitat selection (Figure 27, D vs. E), with quail found slightly more frequently in fields and woody drains. On the CURE area, both species seemed to take advantage of thinned plantations planted to ACP, with similar proportions of birds found in this habitat (Figure 27, A vs. B). However, quail were found more often in herbaceous drains and fields and less often in natural upland pine.

These data suggest that Bachman's sparrows are primarily keying in on upland areas with sufficient herbaceous cover, and that ACP seems to be at least as suitable as native wiregrass dominated stands. Quail seem to prefer areas of dense groundcover, and this habitat may be limited on the control area. The 2 habitats that were most intensely managed and changed from baseline conditions to create dense groundcover, plantations and drains, were heavily used by quail. Fields seem to also be preferred by quail on both landscapes.

Territory Establishment, Size, and vegetative composition

Overall, 62 of 109 (57%) Bachman's sparrow locations became established territories, and the rest were abandoned. There were no statistically significant differences in territory establishment rates between years ($Z = 1.45$, $P = 0.15$), CURE vs. control ($Z = 1.48$, $P = 0.15$), or ACP vs. natural pine uplands ($Z = 0.51$, $P > 0.5$).

Overall, 36% of established territories either included parts of a field, or were located immediately adjacent to a field. This rate did not differ between ACP and natural pine habitats ($Z = 1.08$, $P = 0.28$). In 2007, 56% of Bachman's sparrow territories had at least one neighboring

Bachman's sparrow territory within 162m, and 56% of sparrow territories had at least one calling quail within 162m. Established territories were more likely to be associated with a quail than Bachman's locations that were abandoned (Table 23).

Across both years and all habitats, established territories averaged 3.62 acres. In ACP stands territories averaged 4.51 acres (n=12 territories) and in natural stands territories averaged 3.47 acres (n=35), though these means were not statistically different ($P = 0.21$). More territories were established (28 out of 54) in stands that had been burned the previous year, and territory sizes appeared to be slightly smaller in these stands, perhaps suggesting that stands one-year post burn may provide better habitat (Figure 28).

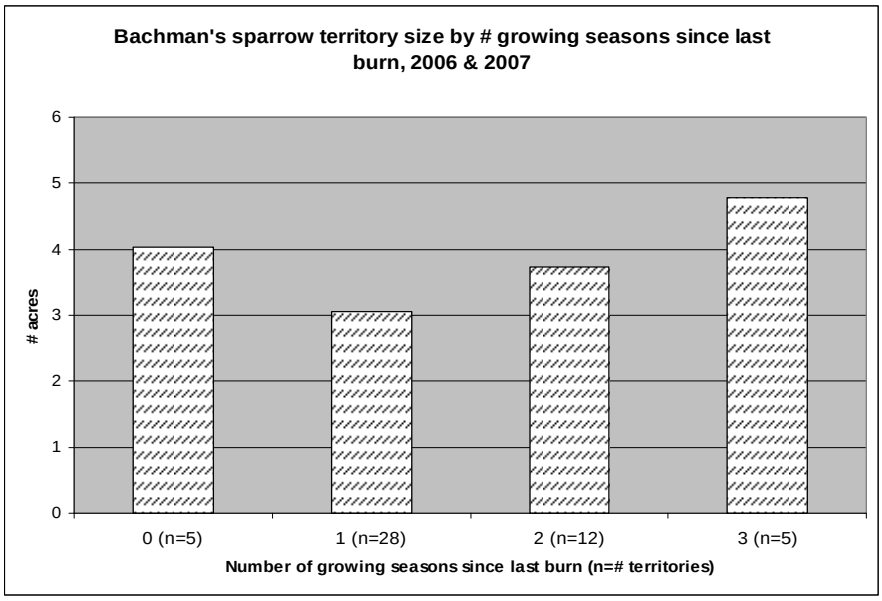


Figure 28. Bachman's sparrow territory size by # growing seasons since last burn. 0 growing seasons means that the territory was established later in the same year that the burn was conducted.

Habitat parameters within established Bachman's sparrow territories were similar to locations where Bachman's sparrows were initially observed but did not establish a territory (Table 9). Not only were the means similar, but so was the distribution of the data (skewness and kurtosis). Failure to breed therefore might not depend on sub-optimal habitat choices by birds, but may have something to do with habitat shocks, like burns conducted during the nesting period, or "confounding factors" we were not able to measure, such as predators in the area, or individual fitness of the birds. One factor that emerged as having high predictive power for determining the success of a territory was number of growing seasons since last burn (Figure 29).

Table 9. Bachman's Sparrow Habitat Measurements according to territory-establishment success, 2006-2007. Averages of each parameter measured are shown.

Measurement	Territory Birds	Non-Territory Birds	Unoccupied, useable stands (2006 only)
Cone of Vulnerability (degrees)	73.9	69.8	Not recorded
Ground Obstruction (%)	26.3	24.5	26.5
Litter Depth (cm)	1.7	1.8	1.5
Percent Open (% cover)	48.2	51.5	34.9
Percent Woody (% cover)	19.4	21.1	14.6
Percent Herbaceous (% cover)	34.9	30.4	52.9
Percent Forbs (% cover)	7.3	7.5	15.3
Percent Grass (% cover)	29.1	24.1	38.8
Percent ACP (% cover)	7.8	5.5	25.8
Percent Wiregrass (% cover)	14.9	13.4	5.9
Pine Basal Area (ft^2/ac)	29.8	30.8	17.7
Hardwood Basal Area (ft^2/ac)	2.4	3.8	2.8
Total Basal Area (ft^2/ac)	32.2	34.6	20.5
Pine Midstory Trees (stems/ac)	50.3	67.0	17.9
Hardwood Midstory Trees (stems/ac)	46.4	58.0	38.0
Total Midstory Trees (stems/ac)	96.7	125.0	55.9
Woody Debris (% of subsamples with)	46.2	43.4	Not recorded
Co-occurrence with Quail (%)	60.0	25.0	N/A
Growing Seasons since Last Burn	1.28	0.81	

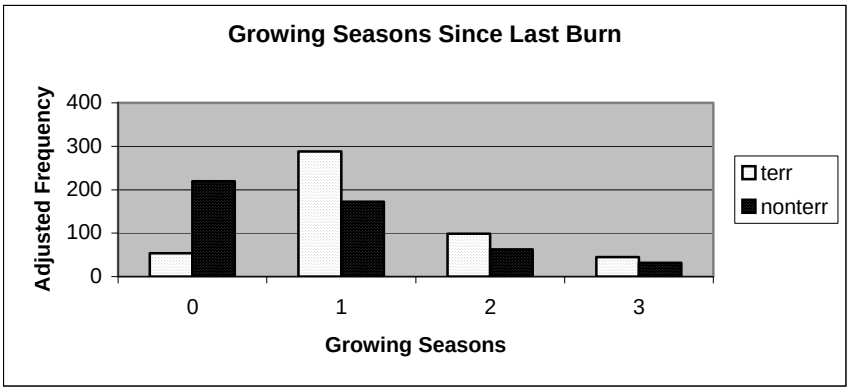


Figure 29. Number of growing seasons since last controlled burn at Bachman's sparrow locations that became established territories ("terr") and locations where sparrow were initially seen but territories were not established ("nonterr"), Sandhills CURE and control areas 2007.

Future Analysis

Ultimately, we would like to see what the shared habitat needs of Bachman's sparrows and northern bobwhite quail are, and where their needs differ, so we can suggest a management plan that may optimally benefit both birds. One form of analysis we will try is Akaike's Information

Criterion **(**AIC) modeling. In this type of analysis, we will try to predict to co-occurrence of birds, to see what factors determine when Bachman's sparrows and bobwhite quail are able to share habitat.

Another avenue of analysis we will pursue is the multivariate logit function to predict territory establishment of Bachman's sparrow. We are currently performing non-parametric tests on the data. Preliminary steps have been completed, and final analysis is in process.

B. Target Dates for Achievement and Accomplishment

All activities on schedule and according to plans.

C. Significant Deviations

None

D. Remarks

See above.

E. Recommendations

This project should be continued in the next fiscal year to document continuing impacts of CURE habitat manipulations on songbird populations and habitats.

F. Estimated Cost

$78,406

G. References

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Prepared by: Ryan Myers, CURE Survey Biologist
Wildlife Diversity Program
Division of Wildlife Management

Annual Performance Report

State: North Carolina

Period Covered: July 1, 2007 - June 30, 2008

Grant Title: State Wildlife Grants T-8 (Implementation)

Project Title: Coastal Region Waterbird Management

Objectives:

1. Protect waterbird nesting sites to reduce human disturbance and increase the probability of reproductive success.
2. Provide technical guidance to other agencies and individuals to stabilize declining populations of breeding and non-breeding colonial waterbirds and shorebirds.

A. Activity

Posting

Prior to the 2008 nesting season, Wildlife Diversity staff posted a total of 21 state-owned estuarine islands to protect nesting colonial waterbirds and shorebirds from human disturbance during this critical stage. The following islands were posted: D, E, F, G, H, I, MN, L, Parnell and Wells located near Oregon Inlet; UNI Hatteras Ferry Channel 1, Cora June and DOT near Hatteras Inlet; Bigfoot near Ocracoke Inlet; Stumpy Point Bay along the western shore of the Pamlico Sound; New Dump and Sandbag in Core Sound; Bogue Inlet Shoal at Bogue Inlet; and UNI New River Channel 1, 2 and 3 near New River Inlet. In addition, we were able to gain permission from landowners to post six important sites on private lands. These included five sites along the barrier islands (North Topsail, South Topsail, west end Bogue Banks, west end Holden Beach, east end Ocean Isle and Sunset Beach) as well as a section of one estuarine island (Dump Island). This represents the greatest number of sites we have protected in a single year and undoubtedly enhanced nesting habitat for thousands of colonial waterbirds and shorebirds. Lastly, we assisted Division of Coastal Management staff with posting portions of the NC Estuarine Research Reserve and provided signs to other agencies and organizations with the ability to post nesting areas.

Technical Guidance

During the last fiscal year, we continued to provide technical guidance to other agencies, organizations and individuals in an effort to minimize impacts of human activities on colonial waterbirds and shorebirds and their habitats. Beach nesting birds and migrating and wintering shorebirds can be impacted by efforts to stabilize beaches and inlets. We worked closely with beach towns and the US Army Corps of Engineers on various beach stabilization and disposal projects including projects on North Topsail Beach, Topsail Beach, Figure Eight Island, Bear Island, Bald Head Island and Brunswick County beaches to minimize impacts. We also provided

technical guidance on activities related to the replacement of Bonner Bridge over Oregon Inlet. Lastly, we responded to many questions from the public regarding waterbirds.

B. Target Dates for Achievement and Accomplishment

All planned activities are on schedule.

C. Significant Deviation

There were no significant deviations.

D. Remarks

None

E. Recommendations

We made significant strides this year in protecting additional habitat for nesting waterbirds, but there are additional areas that are in need of protection in the future. One such area is Shark Tooth Island: a privately owned dredged material island in Bogue Sound. This year Shark Tooth Island hosted a large colony of least terns along with a few other beach nesting birds. Unfortunately the colony was vandalized as evidence by a pile of least tern and Wilson's plover eggs that had apparently been collected. We have spoken with the land owner and plan to post the site next year.

F. Estimated Cost

$9,843 (including in-kind contributions)

Prepared By: Susan Cameron
Waterbird Biologist
Wildlife Diversity Program

Annual Performance Report

State:	North Carolina
Period Covered:	July 1, 2007 - June 30, 2008
Grant Title:	State Wildlife Grants T-7 (planning)
Project Title:	Piedmont Cooperative Land Conservation Project (PCLCP)

Objectives:

The primary objective of the PCLCP is to implement the goals of the NC Wildlife Action Plan by participating in conservation partnerships, particularly the Greater Uwharrie Conservation Partnership and the Sandhills Conservation Partnership to accomplish the following:

1. Coordinate and focus land protection efforts (including acquisition and easements) between land trusts, state agencies, federal agencies, and local conservation entities.
2. Work with county and municipal governments and industry representatives to develop land use plans that will protect important natural resources while promoting sustainable economic growth.
3. Leverage grant funding in support of these activities.
4. Communicate the need for, and benefits of, conservation coupled with sustainable development to decision makers.

A second objective of this project is to continually assess wildlife conservation priorities by creating and updating a map indicating the location of the highest priority ecological conservation targets in the region.

A. Activity

In this past year WRC staff has improved effectiveness of habitat conservation in the southern piedmont by cooperating with and supporting conservation efforts of the Greater Uwharrie Conservation Partnership (GUCP). The GUCP steering committee and working groups met, communicated, and collaborated regularly over the past year. The Piedmont Land Conservation Biologist (PLC biologist) lead a consensus process as her Natural Resources Leadership Institute practicum to create and adopt what came to be the Greater Uwharrie Conservation Planning Map (GUCP Map). This tool will help the GUCP partners to leverage partner resources and pursue funding for various strategic conservation projects in the Greater Uwharries. Throughout this year we have also continued to conserve land and participate in the Sandhills Conservation Partnership. We have formed relationships with key leaders, county planners, and landowners in the region. These efforts have resulted in several cooperative projects and land use policy initiatives that seek to conserve priority habitats.

GUCP Coordination

The GUCP held 3 steering committee meetings and 9 work group meetings in the past year. The steering committee agreed upon and adopted a Charter, which included a communications plan to more formally guide the workings of the group. The PLC biologist created a private wikispace website for the GUCP where partners can disseminate shared documents such as minutes, the charter, GIS maps and files, aerial photos, information on conservation funding and incentives, presentations and other shared materials. The PLC biologist served as chair of the GUCP steering committee.

Conservation Priorities Assessment and Surveys

The first working version of the Greater Uwharrie Conservation Planning Map was completed and adopted by the GUCP after the consensus process led by the PLC biologist. The map, map layers and a map project are available for download on the GUCP wikispace. The PLC biologist led 5 workshops to build consensus and understanding of the map and map layers. During the workshops, the GUCP adjusted the definitions of 3 single attribute priority ranks for over 140 target species and habitats and agreed on the multi-attribute priority ranks and representation of multiple features that contained conservation targets across the landscape, such as watersheds and Significant Natural Heritage Areas. The conservation targets are the priority species, habitats, and natural communities that are either unique to the region or important to conserve within the region. The map methodology follows the decision tool framework of multi-attribute utility theory, which allows assessment of complex alternative decisions by a group of decision makers. The map will receive scientific expert review.

We coordinated with the NC Natural Heritage Program to complete mapping of the landscape habitat indicator guilds in the Uwharries (for those guilds for which there are sufficient data) leveraging partner resources for this project. We also partnered with the Environmental Defense Fund to focus a graduate student project on mapping piedmont prairie suitability for the region. This map is being used by 8 of 12 GUCP partner organizations currently as the basis for focusing conservation strategies and projects (see below). These projects include: reintroduction of an endangered mussel in the Uwharries, piedmont longleaf pine and prairie enhancement and restoration on private lands, land trust conservation priorities assessment, use by the Piedmont Triad Council of Governments to prioritize stream surveys, and NC Zoo conservation priorities assessment. We have also coordinated with the Land Trust for Central North Carolina (LTCNC) and the NC Zoo to incorporate their identified priorities into the GUCP Map. The GUCP Map has been used to assist a private landowner to identify lands to purchase as a conservation buyer. We have begun work to incorporate the GUCP Map into the State Strategic Conservation Planning Tool so that regional priorities can be considered in Natural Heritage Trust Fund applications.

During the consensus process to form the GUCP Map, we used various map layers and worked through the Partnership's steering committee and the 3 regional work groups to collaborate and focus limited resources on the following 5 strategies: land acquisition, conservation easements, farm bill and other habitat incentives programs, county planning, and habitat restoration. The GUCP and the PCLCP biologists have implemented these strategies by working with local

natural resources agencies from the Division of Forest Resources (DFR) and the Soil and Water Conservation Service to identify over 70 key landowners of priority conservation areas. Seven of these landowners were contacted and have agreed to consider conservation of key areas. Two of these landowners are undertaking conservation due to efforts by the NC DFR District Rangers for Rowan and Montgomery Counties made since working with the GUCP.

To date 350,858 acres have been identified as known conservation priorities of some level out of a total of 1,640,956 acres comprising the focus region. Lands identified as the highest priority for a land acquisition and easement strategy total 44,348 acres. We are assisting 2 county governments and one Council of Governments to identify key natural areas and resources and policies to conserve them.

Surveys were conducted on the Diggs Tract and Eagle Point Preserve (LTFCNC property) for target species and at locations throughout the region for early successional habitats and hardwood forest landscape habitat indicator guild presence. Bats were surveyed by the southeastern bat conservation director on the Diggs Tract as part of a Wildlife Society Training. A southeastern myotis (*Myotis austroriparius*) was captured and is the first record of this species in the Uwharries. Pilot surveys for moth indicator species and loggerhead shrike breeding habitats were conducted on open grasslands to document the presence of any semi-natural grasslands habitat guilds. Reptile and amphibian surveys were also targeted in the Uwharries by the Piedmont Herpetologist (See Piedmont Reptile and Amphibian Survey Annual Report). The PLC biologist conducted an inland heronry survey for the southern Yadkin Basin as part of the coastal waterbird project and 43 great blue heron nesting colonies were documented and will be used to inform land use planning.

Land Protection

In the past year the PCLCP has pursued and assisted with 4 land acquisition projects in the region in collaboration with GUCP partners and WRC Land Management staff and has assisted partners with 2 non-WRC led projects. WRC worked with the LTCNC to submit grants for acquisition of the Tuckertown Game Lands (2420 ac.) in Davidson County along the Yadkin River, a site with a high density of priority habitats in several Significant Heritage Areas. This site is two times the average conservation priority value in the Greater Uwharries as calculated using the GUCP Map. WRC will also cooperate with the LTCNC to pursue purchase of the Upper High Rock Alcoa lands (2200 ac.) in the coming year.

The Diggs Tract (1659 ac.) in southern Richmond County was purchased in the past year by the Conservation Fund on behalf of WRC. WRC is pursuing grant funding to buy the tract from the Conservation Fund. This project leveraged funding from non-traditional sources and received 1 million dollars in funding from the North American Wetlands Conservation Act, a highly competitive grant. Collaboration with the Richmond County and funding from the Cole Foundation has been sought for the Diggs project.

WRC worked in cooperation with the Sandhills Area Land Trust to begin WRC purchase of the Rankin-Diggs Tract (963 ac.) which connects both the Diggs and the Buchannan Tracts. The

Buchannan Tracts (1340 ac.) is the subject of current conservation negotiations. WRC is also seeking funding for The Gulledge Tract (329 ac.) directly south of Diggs.

WRC assisted the LTCNC with acquisition activities and to harness matching funds to purchase the King Mountain (Triple H, 362 ac.) tract in Randolph County. WRC and USFWS assisted the LTCNC to purchase a key 55 ac. tract along the Uwharrie River adjoining the Uwharrie National Forest.

A landowner relationship built over the last 2 years by the PLC biologist has led to an opportunity to begin to evaluate the purchase of, or other conservation options for, over 1,400 ac. in Anson County, which includes 1,000 ac. of contiguous hardwood forest. In addition, we have consulted with Alcoa and Progress Energy through the Federal Energy Regulatory Commission re-licensing agreement in principle regarding forest conservation measures on lands that will be donated and/or sold to WRC. These efforts are helping to contribute to a connected network of conservation lands along the Yadkin-Pee Dee River and throughout the Uwharries (Figure 1). This network would conserve land along a large section of the Pee Dee River, offering significant protection of WAP priority terrestrial and aquatic habitat.

Private Lands Habitat Enhancement and Restoration

The GUCP map and the PCLCP has helped a USFWS – Environmental Defense Fund partnership enter into and carry out Partners for Fish and Wildlife contracts with private land owners focusing on piedmont longleaf pine and prairie enhancement and restoration. To date 388 ac., comprised of 6 tracts (including one 240 ac. tract) has been enrolled into this cost-share effort focused on these priority WAP habitats. We are working on landowner relationships to secure 300 additional acres for this program and we are working to inspire other conservation organizations to pursue acquisition and easements in priority areas with large tracts and conservation-minded landowners.

The PCLCP has assisted GUCP partners to build relationships and provide technical guidance to 7 key landowners during the year. The GUCP has also invited landowners to participate in field trips and workshops. One of these landowners has stated he has donated his land (approx. 800 ac.) to GUCP organizations in his will. The other landowners are evaluating or are enrolled in wildlife habitat cost share programs.

The GUCP Pee Dee Work Group organized a workshop on private forestry practices and conservation opportunities hosted by the Jordan Lumber Company. Seven local forestry professionals from NC DFR, WRC and private industry attended and were given a tour of Jordan Lumber Company's Operation followed by a discussion of habitat conservation issues.

Land Use Planning and Policies

The PLC biologist assisted planning for, and presented technical guidance to a conservation-based development workshop held in Stanly County. The PCLCP partnered in this project with the LandTrust and Stanly County Friends of the Land, which includes a county commissioner, the economic development director, and Albemarle city leaders. The workshop was presented

by Randall Arendt, one of the leading experts in conservation-based development and ordinances. The PLC biologist worked with Mr. Arendt to incorporate a "hands-on" planning exercise that dealt with wildlife habitat conservation in open-space subdivisions into a section of the workshop. The event was attended by over 100 county and city leaders, planners, and also by developers and surveyors. The PLC biologist has built 5 new working relationships with major developers, surveyors and the NC Home Builders Association in the region and also has laid the ground work to implement the Green Growth Toolbox (see the Urban Wildlife Project annual report) in Stanly County as a result of this event.

In collaboration with partners, the PCLCP has been working with officials from the Anson and Montgomery County governments to implement the Green Growth Toolbox (GGT). The GGT provides data and recommendations for local governments to improve land use plans and ordinances to minimize negative impacts of development on wildlife habitats. A regional Geographic Information System (GIS) for the Uwharries was developed for the GGT. The GIS is based on the GUCP Map and includes detailed maps of priority WAP habitat. Both counties received a Green Growth Toolbox tailored to their county and have since used the toolbox for their land use plans.

The PLC biologist assisted the Anson County Planner to present information on the benefits of planning to the Anson Board of Commissioners and to the Land Use Plan Committee. Anson County Commissioners graded the importance of wildlife habitat conservation through planning as a 4.56 out of a top score of 5 after the planner's presentation. Additionally the Land Use Plan Committee voted to adopt goals and objectives that follow 95% of WRC recommendations. The Anson County Planner has requested that the PLC biologist assist her to create an Environmental Protection Overlay District to conserve most wildlife habitats through ordinances. We have also been requested to assist further in the county's efforts to create a zoning ordinance that incorporates wildlife and natural resources conservation. The PLC biologist facilitated a partnership between the LTCNC and Anson County whereby the land trust will provide interns to assist the planning director and seek more formal support of their farm conservation initiatives from the county.

We have assisted the Montgomery County Planner to incorporate recommendations from the GGT into the Montgomery County Land Development Plan, but to date none have been written into the proposed plan. We have coordinated with the Sandhills Conservation Partnership to present holistic conservation-based planning tools to the county.

The Piedmont Triad Council of Governments is using the GGT and the GUCP Map to prioritize stream surveys for a watershed restoration project in Davidson County. Additionally the PLC biologist has interviewed local leaders and former commissioners from Davidson and Rowan Counties about the best way to encourage county governments to implement the GGT. The PCLCP is evaluating a contract with UNCC to produce development growth pattern maps under a conservation scenario and more accurate maps of predicted sprawl through 2030. These will be used to encourage county leaders to create land use policies that are more likely to conserve wildlife habitat.

General technical guidance and outreach

WRC staff provided technical guidance recommendations that have helped to enable Progress Energy to avoid sensitive habitats in the area of a proposed transmission line that would span the Pee Dee River between Anson and Richmond Counties. The GUCP map draft was provided to show areas of sensitive habitat. The proposed transmission line follows 80% of recommendations and will follow a path that does not bisect most priority WAP habitats. The PLC biologist has made 2 general presentations about the benefits of wildlife conservation to over 120 students, teachers, Rotary Club and civic organization members in the region.

Summary Measures of Success

- 100% of projects involved partner coordination from 16 partner and stakeholder organizations
- 8 of 12 partners that use the Greater Uwharrie Conservation Planning Map and or map layers as a conservation tool (4: LTCNC, USFWS, USFS, EDF, NC Zoo, NHP, State Plan, PTCOG)
- 2 new GUCP potential partner relationships formed
- 2,076 acres of habitat conserved
- 7 landowner relationships formed
- 12 local government officials have received technical guidance
- 24 presentations, meetings and other information exchanges with local decision-makers
- 140 local leaders received technical guidance through workshops and presentations
- 2 project partnerships established with local governments
- 4 plans (2 land use) and permits (2 sets of comments) commented on
- 87.5% of recommendations implemented, not including Montgomery County which has yet to come to a decision.
- 330 data exchanges = the number of original map layers created for the GUCP map (i.e. not existing GIS layers) multiplied by 8 users plus additional data exchange = 330
- 8 additional data users
- 50 additional records added to regional conservation planning databases
- 4 new surveys implemented
- Related measures: importance of wildlife conservation graded 4.56 out of 5 by Anson County Commissioners

B. Target Dates for Achievement and Accomplishment

We have requested a no-cost extension of the project through 6-30-2009 to be able to continue project efforts. This was due to delays with hiring PCLCP staff at the beginning of the grant. Within the next year we will update and analyze conservation priorities to continue to facilitate the coordination of the GUCP to focus limited time and funding on high priority areas. There will be an ongoing need for coordination and communication to keep the Partnership working

effectively. In the next year WRC staff will work to improve conservation based planning tools, information and outreach to local governments. In the next year we will shift to implementation of collaborative conservation actions using the completed GUCP map. Activities will include land acquisition, developing relationships with private landowners to pursue conservation easements and improved land management, and providing technical guidance to local governments on land use planning issues and development ordinances. We aim to include more conservation partners and stakeholders including additional private land owners, industries and local government staff in the GUCP.

C. Significant Deviations

None

D. Remarks

None

E. Recommendations

This project should be continued.

F. Estimated Cost

$111,231 (including in-kind contributions)

Prepared By:

Kacy Cook
Piedmont Land Conservation Biologist
Wildlife Diversity Program, Division of Wildlife Management
NC Wildlife Resources Commission

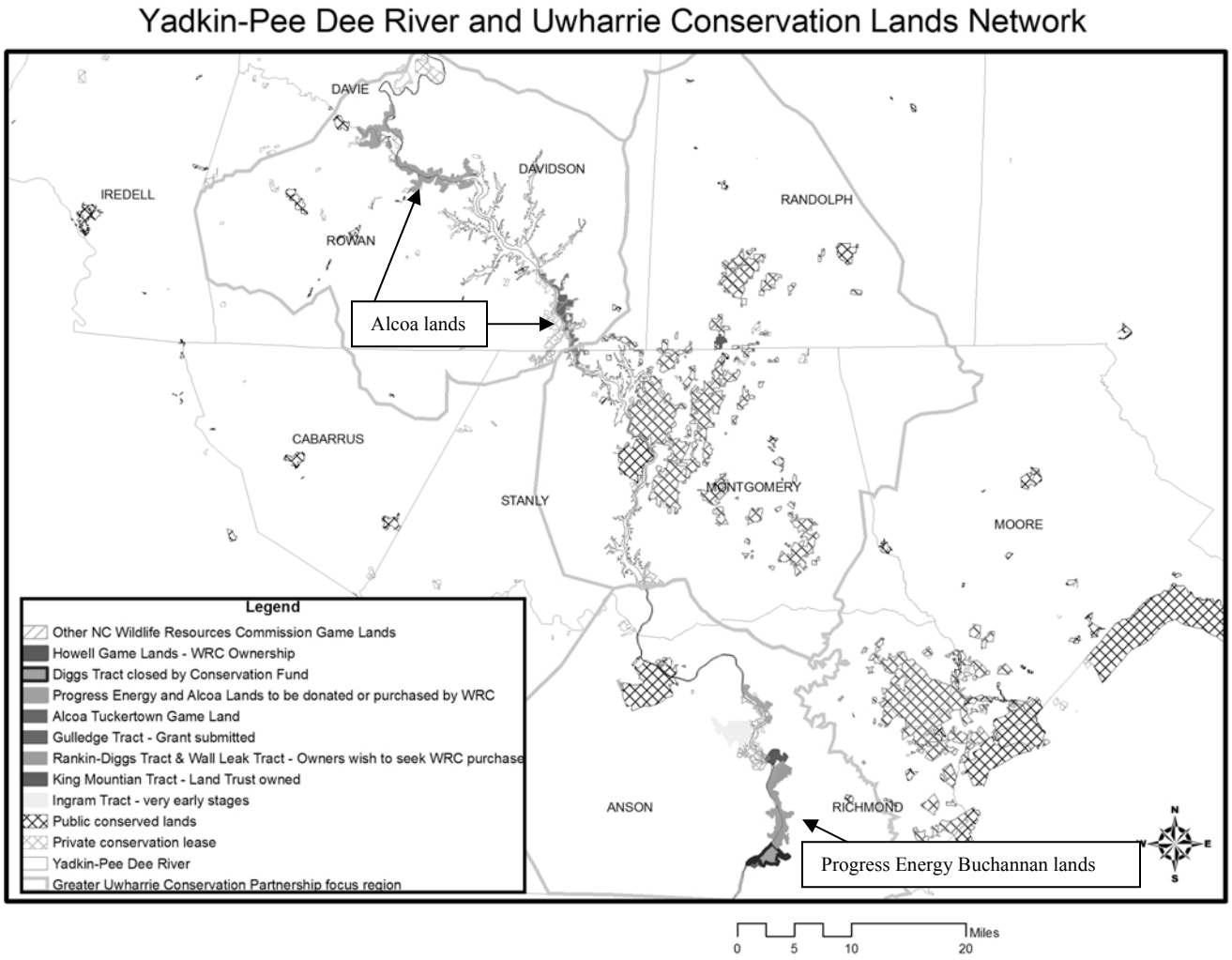


Figure 1. A) Focus Area (in green) for the Greater Uwharries Conservation Partnership in south-central NC. The green lines indicate the boundaries of the 3 regional working groups (Pee Dee, Uwharries, and Lower Yadkin). B) Existing and potential conservation lands forming a network along the Yadkin-Pee Dee River in southern NC. WRC has received most of the funding for the Diggs tract. We have submitted grants for the Alcoa lands in the region. We will be pursuing funding for the Rankin-Diggs Tract, and we have begun to evaluate potential purchase of the Ingram Tract with some interest from a family member in WRC purchase.

Annual Performance Report

State: North Carolina **Project Number:** E-16
Segment Number: 1

Period Covered: July 1, 2007 - June 30, 2008

Grant Title: North Carolina Terrestrial Endangered Species 2007

Project Title: Sea Turtle Nest Surveys, Status, Management and Protection in North Carolina

Objectives:

To conduct sea turtle nesting surveys and to carry out sea turtle and nest protection measures in compliance with the Endangered Species Act.

A. Activity

Coordination

The Coastal Wildlife Diversity Supervisor for the North Carolina Wildlife Resources Commission supervises and assists the Sea Turtle Project Biologist in overseeing the State's Sea Turtle Protection Program. The Biologist supervises the Assistant Sea Turtle Biologist, employed by the NCWRC. The Biologist and Assistant Biologist are responsible for overseeing statewide sea turtle nest monitoring projects, training agency staff and volunteers on nest management techniques, coordinating rehabilitation and release of sick or injured sea turtles in North Carolina, collecting nesting data from beach project coordinators, and serving as Coordinators for the North Carolina Sea Turtle Stranding and Salvage Network (NCSTSSN). Coordination of activities associated with nesting is directed toward standardizing management techniques and data collection (including training in field-based techniques), compiling nesting data and reporting results. Additionally, activities associated with beach management and reconstruction activities during and outside the nesting season require coordination with sea turtle volunteers, beachfront property owners, town officials, NC Division of Coastal Management, NC Division of Parks and Recreation, US Army Corps of Engineers, US National Park Service and US Fish and Wildlife Service to ensure that these activities do not result in the take of viable nests or hatchlings. The Sea Turtle Project Biologist spends a considerable amount of time addressing environmental concerns as they relate to sea turtles, including reviewing Endangered Species Permit applications and a growing number of environmental impact documents.

Nest Surveys and Protection

In 2007, 22 sea turtle nest monitoring and protection projects were active in North Carolina (Table 1). These projects varied in intensity from simply counting crawls to full-scale night-time monitoring and management.

B. Target Dates for Achievement and Accomplishment

All planned activities are on schedule.

C. Significant Deviations

There were no significant deviations.

D. Remarks

Coordination

The Wildlife Resources Commission is responsible for issuing Endangered Species Permits to other agencies and volunteers involved with the State Sea Turtle Protection Program. In 2007, 87 permits were issued to volunteers, agency cooperators and researchers for the collection of sea turtle nesting and stranding data, as well as for obtaining or receiving biological samples for research purposes. Furthermore, more than 500 additional individuals who operated under umbrella beach project permits contributed significantly to sea turtle management efforts.

Nest Surveys and Protection

During the 2007 nesting season, there were 1023 sea turtle crawls observed on ocean-facing beaches in North Carolina. Of these, there were 566 sea turtle nests (535 loggerhead, 21 green turtle, 9 leatherback, and 1 unknown species) and 457 non-nesting or false crawls (Table 1). The observed nesting total of 535 loggerhead nests is lower than the state average based on the previous 15 years, but annual fluctuation in reproductive activity of sea turtles is common (Figure 1). Note that Brown's Island in Camp Lejeune Marine Corps Base and the southern half of Masonboro Island were not regularly monitored for nesting activity, although the total beach length of these areas is <10 miles.

A primary objective of the Sea Turtle Project is to allow as many nests as possible to incubate *in situ*. On occasion it is necessary to relocate nests that are laid in areas prone to erosion or threatened by heavy human impact. In 2007, 119 loggerhead nests (22.2%) and 3 green turtle nests (14.3%) were judged to have been laid in a threatened area and were relocated to a more secure location on the same beach. No leatherback nests were relocated in 2007. Relocation rates that are <30% are considered acceptable for best management practices. For loggerheads, the mean hatchling emergence success rates of relocated nests (78.1% ±27.1SD, n=119) and *in situ* nests (69.5% ±37.3SD, n=393) were not significantly different (p=0.13, Mann Whitney test). The lack of tropical storm activity during the 2007 sea turtle season contributed to relatively high hatchling production rates. Egg and hatchling loss due to fox predation continued to occur on beaches in the southern part of the state; 102 loggerhead nests suffered some level of predation, ranging in severity from the loss of a few eggs to complete clutch destruction. For green turtles, hatchling emergence success was 58.9% (±37.1SD, n=21), and for leatherbacks was 45.5% (±34.7SD, n=9). Mean clutch size for each species was as follows: loggerhead = 111 eggs (range: 56-187, n=453), green = 115 eggs (range: 74-148, n=17), leatherback = 83 eggs (range: 44-100, n=9).

On Bald Head Island, four post-nesting females were fitted with Platform Terminal Transmitters (satellite tags) in July 2007, in order to follow their migration away from the nesting grounds in North Carolina. One turtle moved north to the waters off the Delmarva Peninsula, and three moved south, including one that settled in coastal waters of South Carolina, one that remained near Cape Canaveral, Florida, and one that swam to the Florida Keys. Updated maps are available at: http://www.seaturtle.org/tracking/?project_id=227.

E. Recommendations

Monitoring and protection of sea turtle nests in North Carolina is vital to sea turtle conservation efforts in the southeast USA. It is recommended that these activities continue indefinitely in North Carolina. In 2007, great efforts were made to meet the challenge of ensuring standardized management techniques are used by the diverse number of volunteers and participants in the Sea Turtle Project. The relatively low rate of nest relocation is an indication of consistency of management approach across the state. A major concern continues to be the ongoing human development of the coast. As more coastline is developed, the amount of suitable sea turtle nesting habitat concomitantly decreases. As such, it is imperative that coastal communities take a greater role in ameliorating the impacts beach nourishment, lighting, sand fencing, beach bull-dozing and other human activities commonly associated with developed beaches may have on sea turtle reproductive success. In order to achieve this goal, the Sea Turtle Project Biologist and Assistant Biologist must be able to work year round with the communities, as well as with state and federal regulatory agencies, to facilitate the protection of turtle nests and nesting habitat on all ocean beaches.

F. Estimated Cost

Nest Surveys and Protection (including in-kind contributions)	$ 194,002

Prepared By: Matthew H. Godfrey - Sea Turtle Project Biologist
Wendy M. Cluse – Sea Turtle Project Assistant Biologist

Table 1. Observed loggerhead turtle nests laid on beaches in North Carolina, May-September 2007. Nests laid by other species are noted at the bottom of the table.

PROJECT	LOGGERHEAD TURTLE NESTS
VA STATELINE TO SOUTH NAGS HEAD	8
PEA ISLAND NWR	13[a]
CAPE HATTERAS NATIONAL SEASHORE	73[b]
CAPE LOOKOUT NATIONAL SEASHORE	71[c]
FORT MACON STATE PARK	4
BOGUE BANKS	23
HAMMOCKS BEACH STATE PARK	17
CAMP LEJEUNE MARINE CORPS BASE	27[d]
TOPSAIL ISLAND	62
LEA-HUTAFF ISLANDS	0
FIGURE 8 ISLAND	5
WRIGHTSVILLE BEACH	4
MASONBORO ISLAND	22
CAROLINA BEACH	8
KURE BEACH	3
FORT FISHER STATE PARK	14
BALD HEAD ISLAND	50
CASWELL BEACH	39
OAK ISLAND	56[a]
HOLDEN BEACH	18
OCEAN ISLE BEACH	8[a]
SUNSET BEACH and BIRD ISLAND	10
TOTAL	**535**

[a]One green turtle also nested on this beach.

[b]Eight green turtle and one leatherback nests were observed on this beach

[c]Seven green turtle and eight leatherback nests were observed on this beach

[d]Three green turtle nests were observed on this beach

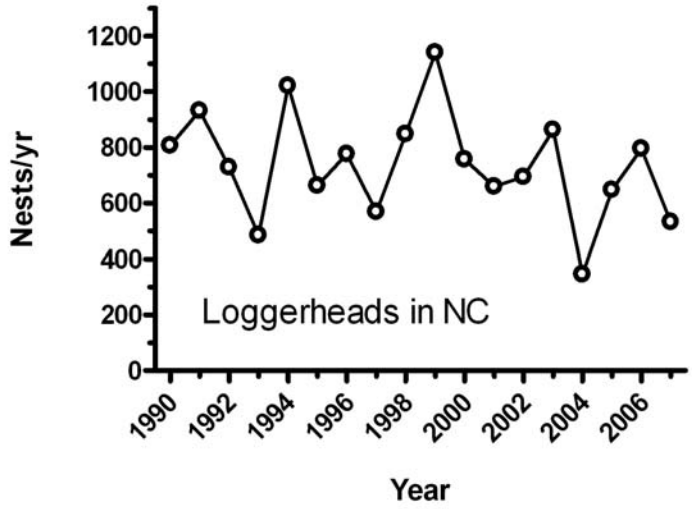


Figure 1: Annual numbers of loggerhead nests laid on ocean-facing beaches in North Carolina, 1990-2007.

Annual Performance Report

State: North Carolina **Project Number:** E-16
Segment Number: 1

Period Covered: July 1, 2007 - June 30, 2008

Grant Title: North Carolina Terrestrial Endangered Species

Project Title: Northern Flying Squirrel Habitat Management and Use Study

Objectives:

The overarching goal of this project is to address conservation concerns of an isolated population of endangered Carolina northern flying squirrels in the Unicoi Mountains that is threatened by loss of conifers and by fragmentation of its habitat by a road that serves as a barrier to dispersal. Objectives to accomplish this goal may include:

Conifer Habitat

- Work with the U.S. Forest Service (USFS) to engage appropriate management to stave-off complete loss of hemlocks from the Unicoi Geographic Recovery Area
- Plant suitable conifers to replace the existing hemlocks which are expected to die-off
- Create small clearings in hardwood stands for conifer plantings and to slow hardwood succession and under-plant with conifers in existing forested stands.

Dispersal Study

- Determine northern flying squirrel preferred den and foraging habitat and movements (through telemetry) along the Skyway to determine potential crossing corridors
- Facilitate dispersal across the Cherohala Skyway by erecting jump poles, rope bridges, or rope passages through culverts in areas determined (from telemetry data) to be potential crossing corridors for the northern flying squirrel

A. Activity

Introduction

Studies have shown that optimal habitat for the endangered Carolina northern flying squirrel (*Glaucomys sabrinus coloratus*; NFSQ) consists of the transition zone between red spruce-Fraser fir forest and northern hardwood forest (Weigl et al. 1992, McGrath 1999, McGrath 2002, McGrath and Patch 2003). NFSQ populations tend to persist in these mixed forests, while populations inhabiting pure northern hardwood forest or high elevation red oak forest (Schafale and Weakley 1990) are less stable and vulnerable to encroachment by the competing southern flying squirrel (*Glaucomys volans*; SFSQ) (Weigl et al. 1992). In areas where past land use has altered forest composition resulting in marginal habitat for the NFSQ, it may be possible to improve conditions for the NFSQ by planting patches of red spruce trees adjacent to or within northern hardwood forest.

Within its range in North Carolina, its habitat has been impacted by massive Fraser fir tree mortality due to the balsam woolly adelgid (*Adelges piceae*). Eight geographic recovery areas (GRAs) were identified for NFSQ in North Carolina. These include the Unicoi Mountains, Great Smoky Mountains, Plott Balsams, Great Balsams, Black and Craggy Mountains, Grandfather Mountain, Roan Mountain, and Long Hope Valley (Figure 1). The North Carolina Wildlife Resources Commission has surveyed seven of the eight GRAs through nest boxes and trapping. Each of these GRAs hosts small, isolated NFSQ populations within a limited range of suitable habitat.

The Unicoi Mountains GRA area (Figure 2) is perhaps the most threatened in western NC due to (1) absence of remnant spruce-fir stands, (2) impending loss of the existing dominant conifer, eastern hemlock, to hemlock woolly adelgid (*Adelges tsugae*), (3) greatest isolation from other NFSQ populations, and (4) further isolation within the mountain massif as a result of the Cherohala Skyway road corridor bisecting the population, preventing dispersal and genetic mixing. The existing conditions in the Unicoi Mountains, with eastern hemlock as the dominant conifer, may be the result of a climate warming period (hypsithermal) that occurred approximately 5000 years ago, although this is based on information for other nearby areas; red spruce and Fraser fir cover was greatly reduced in the Great Craggy Mountains. However, the NFSQ has persisted in the Unicois, despite what appears to be a very small remnant population occurring in marginal habitat that has been altered by natural processes and extensive recent land use practices (e.g., logging and silviculture, road construction, pasture and home sites). The habitat consists predominantly of typical northern hardwoods (Schafale and Weakley 1990) with a hemlock component in Whigg Cove. The barrier to dispersal created by the Skyway was documented in a radio telemetry study that tracked nocturnal movements and diurnal denning (Weigl et al. 2002). Trapping and nest box surveys in the Unicoi Mountains have documented presence of both NFSQ and SFSQ (McGrath 2003, Weigl et al. 2002). Studies in other GRAs suggest that the SFSQ is the superior competitor, especially in low quality NFSQ habitat. As SFSQs encroach into marginal NFSQ habitat, NFSQ populations become increasingly at risk for local extinction.

Figure 1. Carolina northern flying squirrel Geographic Recovery Areas in North Carolina, shown in black.

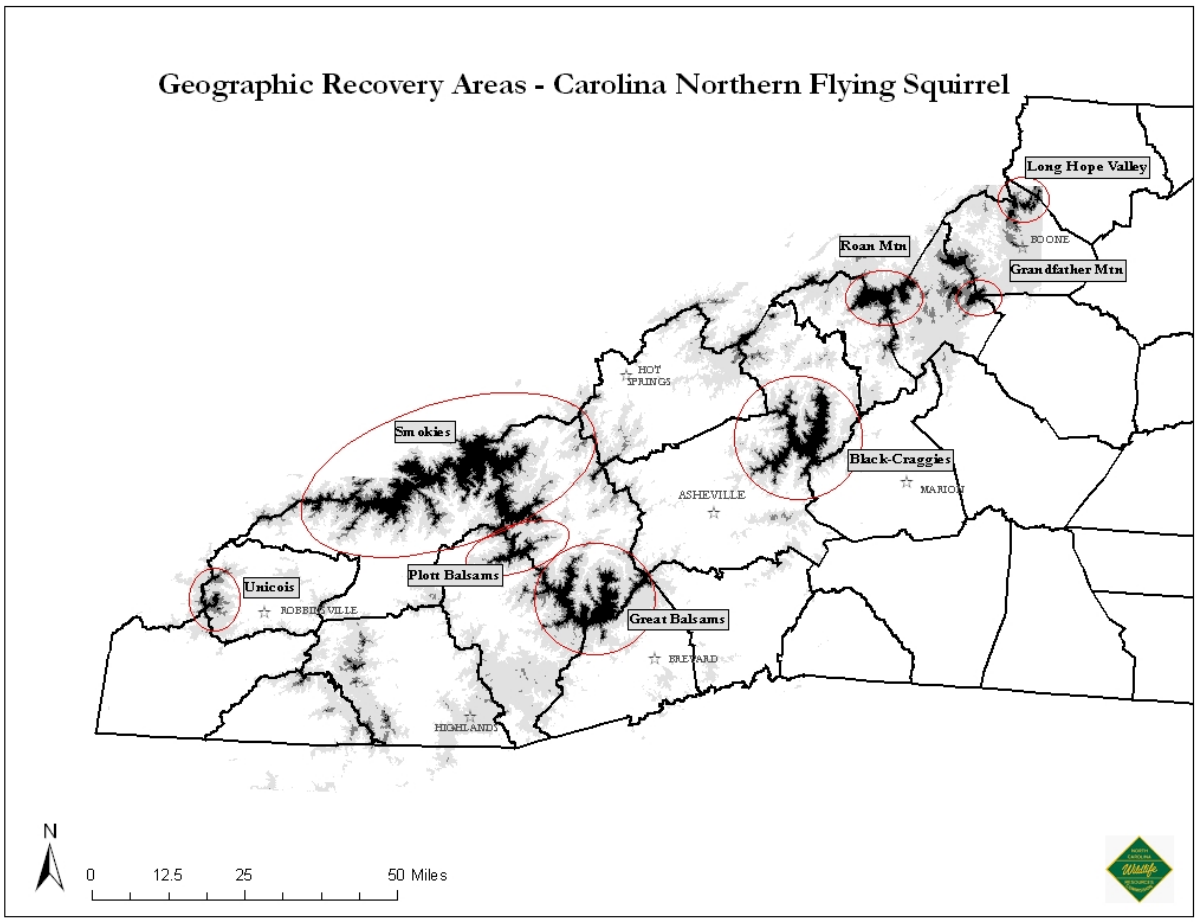


Figure 2. Carolina northern flying squirrel range (indicated by rectangle) in the Unicoi Mountains Geographic Recovery Area, showing Cherohala Skyway.

Conifer Habitat

Existing conifer habitat in the Unicoi Mountains may be protected and retained by treating eastern hemlocks for hemlock woolly adelgid. The U.S. Forest Service prepared an Environmental Assessment for treating hemlocks across the Pisgah and Nantahala National Forests and included provisions for prioritizing treatment of areas that harbored sensitive species. Unfortunately, despite hosting a federally endangered species, the Unicoi Mountains were not included in this site-specific analysis (U.S. Forest Service 2005). Furthermore, the importance of hemlock to the NFSQ was dismissed despite a lack of research to support or refute this contention. As a result, there has been massive hemlock die-off at elevations below 4,000 feet in the Unicois, and hemlocks above 4,000 feet are now infested. NCWRC met with the USFS district ranger and forester to address this oversight and to develop a treatment plan. In March, 2007, the USFS released the predatory beetle (*Pseudoscymnus tsugae*) on hemlocks in the Whigg Cove area. Follow-up treatments are needed. However, the trees in these areas have lost the ladder greenery that is needed for beetle release. The alternative option of using chemical treatment (imidacloprid) is under consideration, but may not be a viable option in occupied habitat.

Anticipating loss of hemlocks, habitat for the endangered NFSQ in the Unicoi Mountains GRA may be improved by enhancing the conifer component with a suitable conifer such as red spruce (*Picea rubens*). The USFWS Recovery Plan for the NFSQ and the North Carolina Wildlife Action Plan identify spruce restoration as an appropriate and desirable management measure (USFWS 1990, NCWRC 2005). Elsewhere in the range of Appalachian northern flying squirrels, efforts are underway on National Forests and National Wildlife Refuges to restore red spruce forest for the benefit of the squirrel and other high elevation species.

The habitat improvement project will take place over the next few years and includes the following steps: (1) identifying locations for spruce plantings, (2) site preparation in the Unicois, (3) harvest of seeds or seedlings, (4) transplanting seedlings to a nursery bed for one to two years, (5) transplanting to the project site, (6) maintenance, and (7) monitoring seedling survival. Preliminary consultation with foresters, literature review, and field trials were undertaken on site preparation, seed propagation, and transplant of seedlings. Local expertise on spruce forestry is limited and there is no source of local seed stock in tree nurseries. Furthermore, forestry methods used at more northerly latitudes may not apply well in the Southern Appalachians. Therefore, it may be necessary to employ a variety of methods, such as direct transplanting of seedlings, propagation from seed, and planting in openings, hardwood understories, or artificial canopy gaps. Site preparation and NFSQ activity and dispersal needs will determine locations selected for spruce plantings. In collaboration with the USFS, NCWRC continued to develop plans for establishing spruce seedlings in small (<1 acre) artificial forest canopy gaps and natural tree fall gaps located during routine field work. Unfortunately, there have been delays in starting the seeds collected from Great Smoky Mountains National Park in autumn 2006 at the NC Forestry facility.

Dispersal Study

Compounding the threat of conifer loss is the possibility that the Cherohala Skyway effectively fragments the limited amount of habitat and isolates NFSQ populations. A previous study demonstrated that, upon completion, the Skyway itself presented an insurmountable barrier to dispersal as NFSQs did not attempt to cross the road at night (Weigl et al. 2002). At no time during that 18 month study were any radio-collared NFSQs observed crossing the Skyway. A majority of the flying squirrels were found moving, foraging, and denning close to the right of way, but none attempted to cross it. Extensive clearing of trees and subsequent blasting resulted in treeless shoulders and slow regeneration of woody vegetation. Mature trees, needed for squirrels to launch into a glide in order to cross the roadway, are absent. The width of the Skyway exceeds the gliding ability of NFSQs. This artificial barrier further isolates the population by creating two distinct populations on either side of the Skyway. The creation of these smaller populations also increases the risk of genetic isolation, exposing these NFSQs to additional threats. In time, spruce and other seedlings planted along the shoulder of the Skyway may help bridge the gap between populations isolated on either side of the road. Plantings will not supply appropriate crossings until trees become tall enough to allow NFSQs the ability to glide across the road. Therefore, plans were initiated to erect artificial crossing structures to facilitate road crossing at this time. NCWRC met with the USFS and North Carolina Department of Transportation (NCDOT) to discuss design and locations for crossing structures and safety concerns. One option, using rope bridges, was ruled out due to concerns that heavy ice accumulation on the ropes could cause them to collapse. Another option considered the use of wood poles as artificial trees. Researchers studying a homologous marsupial squirrel glider (*Petaurus norfolcenses*) in Australia have successfully enhanced landscape connectivity by installing wood poles at intervals to facilitate dispersal between habitat remnants in a fragmented landscape (Ball and Goldingay 2006, Ball and Goldingay 2008). This option was selected and developed in 2007 and implemented in 2008. In order to better target those areas most important to NFSQs, we continued the telemetry study which commenced in February, 2007 to determine potential crossing locations (i.e., where NFSQs spend the most time near the roadway). Initially diurnal den sites were documented; nocturnal movements may be documented in the future.

The second phase of the telemetry study, which commenced in June 2007, continued from July 2007 through June 2008 and incorporated an ecological study by a graduate student from Western Carolina University (WCU). The WCU study will analyze scats to determine the diet of northern flying squirrels in this atypical habitat using DNA extraction techniques and traditional visual assessment, and it will include an assessment of foraging habitat (availability and connectivity) within the Unicois (Allman 2007). The goal was to obtain scats during the summer months to determine diet during the growing season. Continuing upon the trapping effort that began in June 2007, trapping was expanded to other areas through early October (Table 1). Nest boxes were also checked periodically in an effort to augment summer captures. Traps were baited with peanut butter, oats, and apple and fitted with a small plastic shelter and polyester fill for bedding material. Traps were checked in the mornings and reset in the evenings. Extremely low captures during the growing season made it necessary to attempt to capture squirrels from boxes during the winter months when squirrels den more readily in boxes.

Table 1. Summary of modified #201 Tomahawk trap nights beginning June 2007 through fall 2007 in three study areas, both above and below the Skyway.

	Whigg Branch[2]		Big Junction	Hooper Bald		Total
June[1]	180	194	**0**	0	0	**374**
	374			**0**		
July	44	135	**48**	0	314	**541**
	179			**314**		
August	0	0	**126**	72	345	**543**
	0			**417**		
September	0	42	**104**	0	200	**346**
	42			**200**		
October	0	6	**33**	0	0	**39**
	6			**0**		
Total	224	377	**311**	72	859	**1,843**
	601			**931**		

[1] This depicts trap nights from June 2007 in the previous grant cycle for the sake of a complete summary.
[2] Split cells show trap nights for areas up-slope of Skyway (top left cell), down-slope of Skyway (top right cell), and for the total area (bottom center cell).

up-slope	down-slope
total area	

Results- Conifer Habitat

The USFS's site-specific Environmental Assessment for treating hemlocks delayed treatment in the Unicoi Mountains, since the Unicois were omitted from the original Environmental Assessment. NCWRC requested that the USFS follow up the March 2007 treatment with a second beetle release. However, the trees in these areas have lost the ladder greenery that is needed for beetle release. The alternative option of using chemical treatment (imidacloprid) is under consideration, but may not be a viable option in occupied habitat.

Red spruce seedlings harvested from the Great Balsam Mountains and transplanted along the shoulder of the Skyway in March 2007 fared poorly during the prolonged drought, suffering 50% mortality. Some of the smaller seedlings persist. The USFS recently developed preliminary actions for the greater Upper Santeetlah watershed, including conifer planting along the shoulder of the Skyway. NCWRC is working with the USFS to expand conifer planting into the surrounding forest and to address concerns with proposed timber harvest and stand improvement units in this area.

Results- Dispersal Study

Between July 2007 and March 2008, 11 NFSQs were captured and eight which met minimum body mass requirements were fitted with radio collars and tracked to den sites (Table 2). Captures were the result of low yield trapping during the summer and fall and higher yield nest box surveys during the winter. All captures were from the north side of the Skyway. Live

trapping during this grant cycle continued upon the work that started in June 2007, and ended in October 2007. In 1,843 total trap nights, just two Carolina northern flying squirrels were captured in traps. This amounted to 311 trap nights in the area of capture, Big Junction. The two NFSQs were captured on August 16 and September 6, 2007 from the same trap in the Big Junction area. In addition, two red squirrels (*Tamiasciurus hudsonicus*) and one southern flying squirrel were captured in the Whigg Branch area. Nine additional squirrels were captured from boxes, mostly during the period from January 2008 to March 2008, in the Hooper Bald and Whigg Branch areas.

Table 2. Summary of northern flying squirrel captures in nest boxes and den locations beginning winter 2007 through spring 2008 in the Unicoi Mountains GRA.

Date	Location	Trap/ Box #	Squirrel ID (Ear Tag-Transmitter)	Sex	Radio Collar Placed	# Dens[1]	# Times Located after release	Disposition
2/6/07	Hooper Bald	Box 20	1856-351	M	Y	4	6	Suspect dropped collar or battery died
2/6/07	Hooper Bald	Box 20	1872-370	M	Y	4	6	Shed collar
2/7/07	Big Junction	Box 4	1857-319	M	Y	3	3	Shed collar
7/7/07	Hooper Bald	Box 5	1874-none	F	N	1	0	Released- too small to radiocollar
8/16/07	Big Junction	Trap J13	1826-279	F	Y	1	1	Suspect transmitter failure
9/6/07	Big Junction	Trap J13	1825-301	M	Y	7	27	Transmitter expired after seven months
1/11/08	Lower Whigg	Box 11	2024-160	M	Y	2	1	Shed collar
1/11/08	Lower Whigg	Box 11	2020-199	M	Y	5	4	Shed collar
1/11/08	Lower Whigg	Box 11	2023-none	M	N	1	0	Released- too small to radiocollar
1/12/08	Lower Whigg	Box 9	2022-100	F	Y	5	25	Still tracking
1/29/08	Hooper Bald	Box 13	2019-071	M	Y	5	22	Transmitter expired after seven months
1/29/08	Hooper Bald	Box 13	2021-130	F	Y	1	0	Shed collar
1/29/08	Hooper Bald	Box 21	2017-none	F	N	1	0	Released- too small to radiocollar
3/3/08	Hooper Bald	Box 25	2025-181	F	Y	2	3	Shed collar

[1] Includes box squirrel was captured in and any additional boxes it used.

Diurnal den sites were located at approximately weekly intervals until collars were dropped. Thirty-one diurnal dens of four different types were used: squirrel boxes, natural cavities in trees, a natural cavity in a log, and subterranean dens (Figure 3). Over 60% of dens were in trees, situated in hollow trunks, natural cavities, and woodpecker holes. The twenty-five natural dens (excluding traps and boxes) were found in seven different tree species (Figure 4). The majority

of dens were in American beech and yellow birch trees which typically have abundant cavities. In attempting to evaluate the role of eastern hemlock in the squirrel's ecology, we did document one den in a hemlock in Whigg Branch used by a male NFSQ. It is unknown if this den site was a cavity or a dray because it was high in the tree and obscured from view. Other knot holes and natural cavities were visible lower on the trunk of the same tree. Other northern flying squirrels tracked in the hemlock-northern hardwood stand at Whigg Branch were found denning in an area dominated by a mix of mature hemlock, rhododendron, and northern hardwoods (yellow birch, fire cherry, sugar maple, and buckeye). Also of note were two varieties of ground dens. Squirrel 2022-100 moved 20m from a log den to a den beneath a large hemlock and boulder, and was subsequently tracked to this den 18 times between March and July 2008. Nest material was found spilling out of a hole in the log. At least two burrows were found at the base of the hemlock and more at the base of the boulder. During a nighttime emergence survey, this squirrel was out moving in the vicinity of the den but, upon hearing our approach, retreated to the underground den. Given the time of year and the tendency of female flying squirrels to move less when nursing (Villa et al. 1999), we suspect this female may have been caring for young. A male NFSQ used a den in winter 2007 in the Hooper Bald area; this den was also a combination of a tree and boulder. It is not clear how prevalent subterranean denning is in western North Carolina. Underground denning has also been documented in this subspecies in southwestern Virginia, but only in males (Hackett and Pagels 2003). Though this behavior may provide easier access to food, it makes them more vulnerable to terrestrial predators. They hypothesized that subterranean denning may reflect competition with southern flying squirrels or red squirrels for tree dens or a shortage of suitable den trees. Whether or not this is the case in Whigg Branch (where the three species are sympatric) is unclear, though there appears to be an abundance of den trees. The log and subterranean den used by female 2022-100 was in a seep area adjacent to Whigg Branch that supports a particularly rich fungal community, with fungal blooms directly over the den location. The original telemetry work in the Unicois documented more female NFSQs in Whigg Branch, and they postulated that this area might provide better foraging habitat to support the nutritional needs of female squirrels (Weigl et al. 2002).

Figure 3. Types of dens used by Carolina northern flying squirrels in the Unicois Mountains based on 37 natural and artificial dens, 2007-2008.

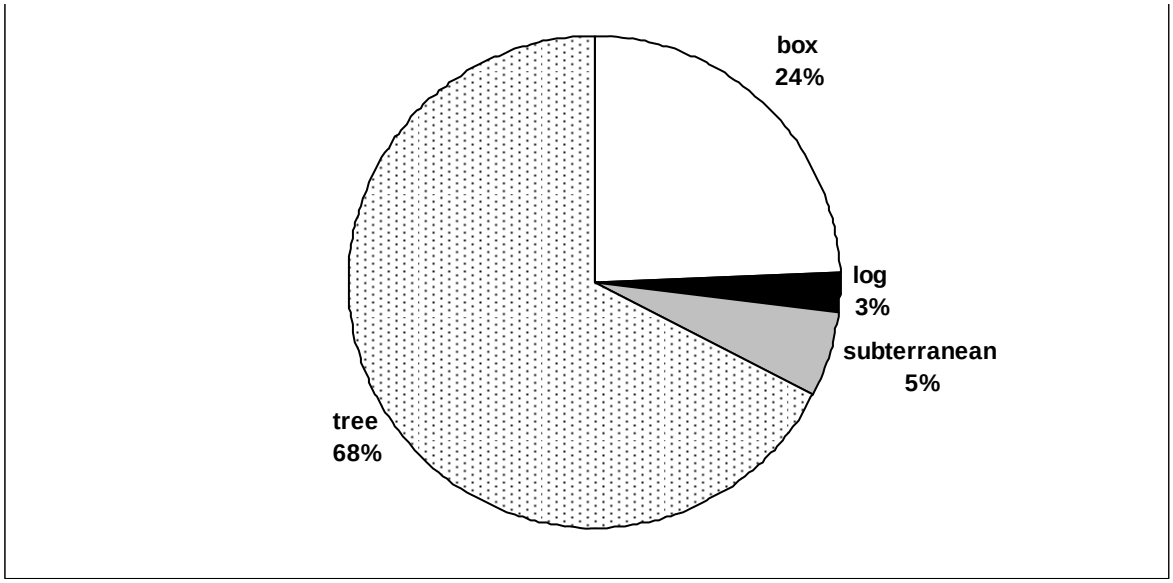
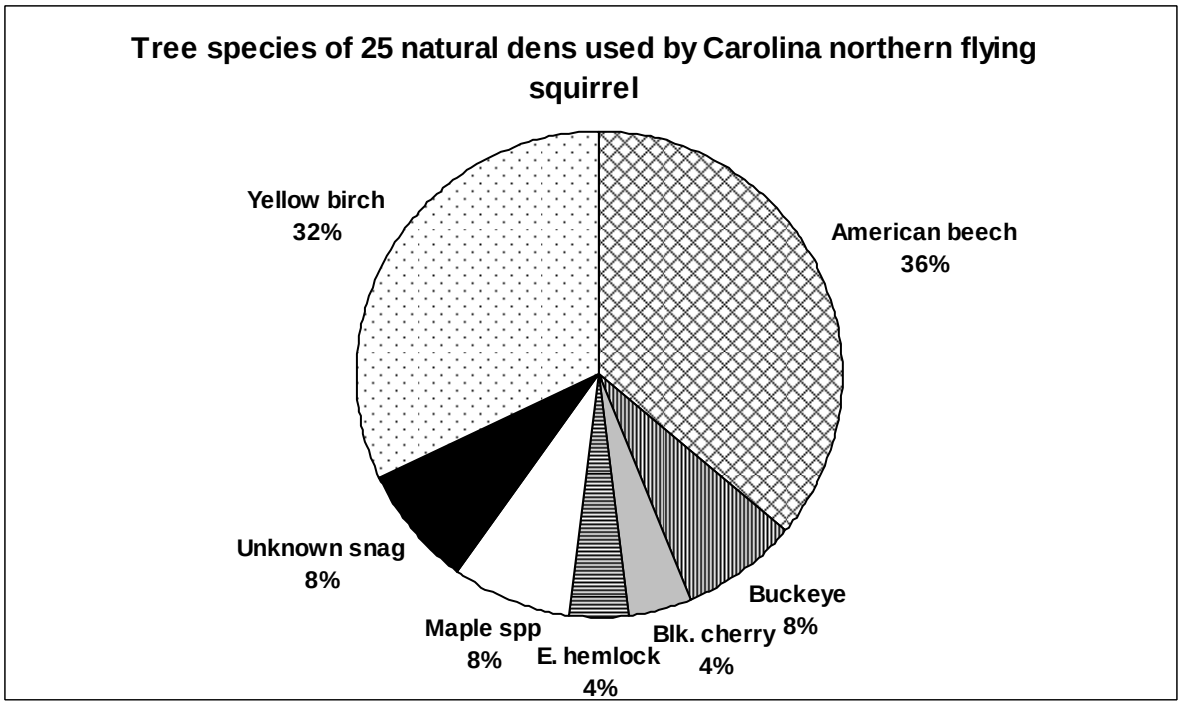


Figure 4. Tree species of 25 natural dens used by Carolina northern flying squirrel in the Unicoi Mountains, 2007-2008.



The locations of all of these dens, as well as other criteria, were used to guide placement of the crossing structures. *Therefore, den data from all squirrels, including three captured and tracked in winter 2007, is included in the summary that follows.* Dropped collars were a continuous problem and limited the amount of den data compiled for each squirrel, as did availability of

personnel to support extensive telemetry work in winter 2008. We relied on a volunteer to track winter captures to diurnal dens. However, three of the squirrels were located over 20 times each, and two were located on six occasions. More pertinent to the placement of crossing structures, four squirrels used dens within 50 meters of the Skyway, and two of those used dens within 15 meters of the Skyway. Male 2019-071 was found denning in a buckeye 53 meters from one of the crossing structures on the north side of the Skyway. These den locations were used to determine areas of heavy squirrel use.

The optimal placement of crossing structures was based on several considerations: (1) documented areas of concentrated squirrel activity, (2) sections of Skyway where the road is likely to continue to pose an insurmountable barrier for many more years, (3) habitat on both sides of the road is fair to good, (4) regenerating trees on the shoulder provide a natural corridor for funneling tree-gliding squirrels from the woods toward the poles and roadway, and (5) areas where our existing nest box network will allow us to capture additional squirrels in order to assess the use of the structures. Based on these criteria, two locations were selected in the area below Hooper Bald (milepost 8) and a third in Whigg Cove (milepost 4) as crossing sites. Structures were not initially planned for the Big Junction area due in part to mediocre habitat conditions on the south side of the Skyway, the location of the state line, and also safety concerns in this particularly windy section of road.

Once sufficient location data on squirrels were gathered, we proceeded with the mitigation project. On June 2, 2008, six crossing structures were assembled and installed in pairs at three locations along the Skyway by Duke Energy, under supervision by the project leader (Figures 5 and 6). The structures were placed on opposite sides of the roadway and consist of 34cm diameter wood (pine) utility poles buried 2m (7 ft) in the ground. Each pole stands approximately 14m (48 ft) above the ground and is set 1.5-3m (5-10 ft) from the road or behind a guardrail. A 3m (10 ft) long 10x10cm (4x4 in) wood cross beam was attached to the top with 2/3 the length aimed over the road facing the opposite pole. The function of this wood beam is to serve as a launch pad for a gliding squirrel. To address concerns about avian predators, three escape shelters made of four inch diameter PVC pipe were attached to the upper third of each pole. Holes were cut in the top and bottom of each shelter to allow squirrels access from above or below, and to drain water. One shelter on each pole is positioned so that the holes face the woods, in an effort to mimic a natural cavity.

Figure 5. Locations of three pairs of NCWRC road crossing structures, and locations of northern flying squirrel dens in the Unicoi Mountains recovery area, Graham County, NC.

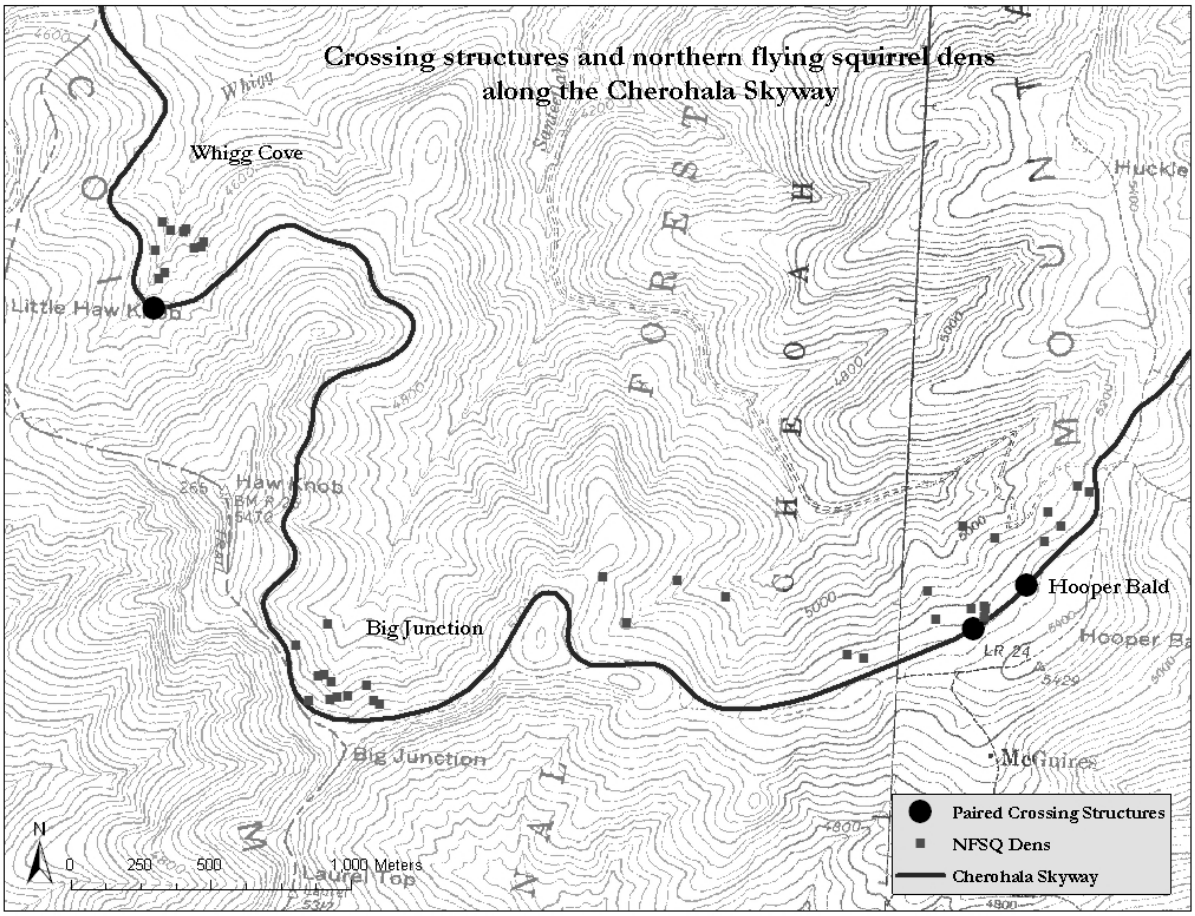
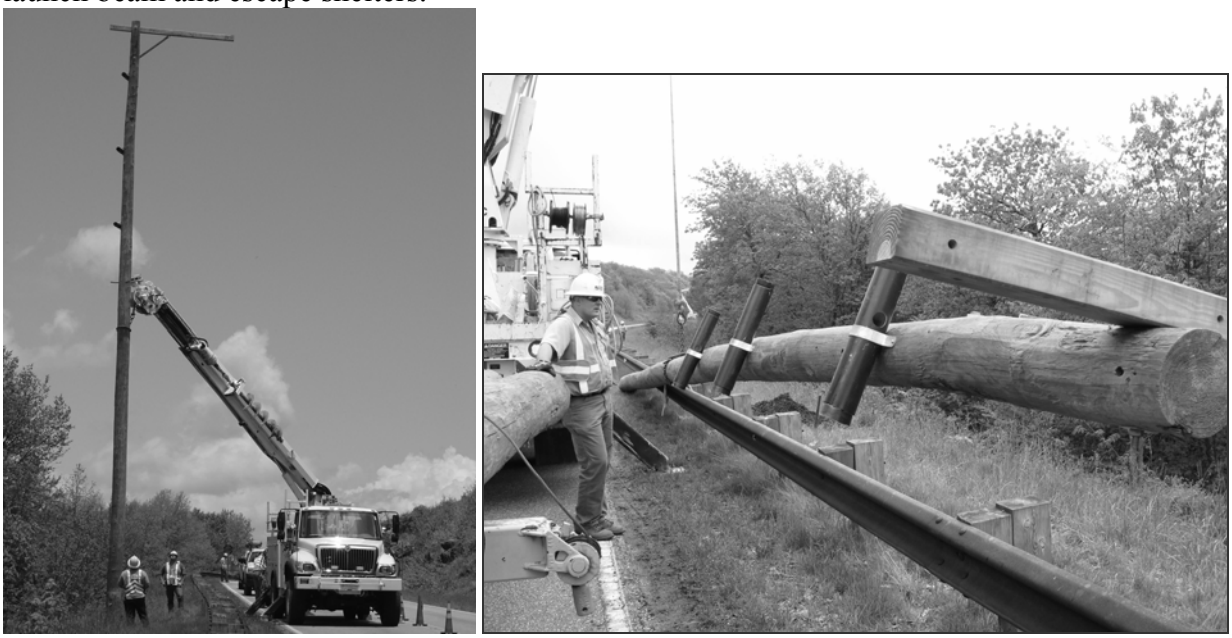


Figure 6. NCWRC wood crossing structures posted along the Cherohala Skyway, showing launch beam and escape shelters.



Following installation of the structures, measurements were taken around each pole to document some parameters that may be useful for determining use of the poles in the future (Ball and Goldingay 2008). This assessment included measures of distance from each pole to: (1) nearest possible "landing tree" (i.e., a tall, prominent tree), (2) nearest probable den tree, and (3) nearest replacement tree (i.e., a tree that will, upon maturing, replace the need for the pole). Vegetation along the shoulder was also noted. Also following installation of the structures NCWRC initiated outreach efforts to inform the public about the purpose of the poles. These efforts included development of a fact sheet intended for the USFS, NCDOT, and Duke Energy field staff to address inquiries from the public, design of a temporary interpretive sign to post at bulletin boards on the Skyway, and planning of a media alert to inform the surrounding communities and tourists about the poles.

B. Target Dates for Achievement and Accomplishment

On schedule.

C. Significant Deviations

None

D. Remarks

Dispersal Study

Through a collaborative effort, NCWRC successfully implemented a major step in the road barrier mitigation project. The six utility poles modified as crossing structures were built and

installed by Duke Energy at no cost to NCWRC under a special use permit with the USFS. The next step is to evaluate use of the structures by NFSQs. It is critical that this evaluation take place in a timely manner both from an ecological perspective and a socioeconomic perspective for several reasons: (1) this is the first attempt in the U.S. to use wood poles to help a gliding mammal cross a road barrier, (2) we need to avoid further delay in coming up with an alternative solution if they are not effective, and (3) the poles are situated on a scenic byway where view shed values are emphasized by the landowner (USFS) and the local tourism industry. This evaluation will take place over the next two years and will entail additional capture and telemetry work along with use of other methods to document squirrels' use of the structures (e.g., cameras, hair traps, acoustic monitoring). During initial planning efforts, 15 potential crossing sites were identified. Our planned assessment of the current three pairs of structures will help us determine if they are effective and if additional poles are warranted. To effectively accomplish this, there is a need for significantly greater funding due to the intensive nature of this project (trapping, box surveys, and telemetry).

While the poles may narrow the gap for a gliding tree squirrel, it remains to be seen if they will use them. Past studies have shown that northern flying squirrels appear to avoid the road and are habitual in their nocturnal foraging habits following a circuit within their home range and using favorite den trees (Weigl et al. 2002). The reasons they avoid the road may be numerous and are unclear. Squirrels may be repelled by the physical barrier of right-of-way width, by the thick vegetation on the shoulder that is impassable on foot, by the increased noise of vehicle traffic, or by secondary effects of the canopy gap. It is thought that southern flying squirrels may avoid wide road corridors in Ontario due to the large gap in the canopy, in part in response to the increased vulnerability to roadside predators (especially raptors) and in part in response to the more attractive surrounding forested habitat (Bednarczuk and Judge 2003). Our initial assessment of the effectiveness of the crossing structures will inform necessary modifications to the poles or other mitigation measures that would counter the isolating effect of this bisected population.

An overview of low success using traps was presented in the 2006-2007 report. Due to low captures during summer 2007, the WCU assessment of foraging habitat was, by necessity, extended to the 2008 growing season following the successful capture of nine squirrels and subsequent documentation of den locations in winter and spring 2008. Most of the funding had been invested in the summer-fall 2007 trapping effort. By winter 2008, when we were able to capture squirrels from boxes, there was little funding remaining to support frequent tracking of squirrel locations and movements. A volunteer intern located squirrel dens at approximately two week intervals between January and July 2008, though there were occasional lapses in coverage due to the voluntary nature of this enormous effort.

E. Recommendations

Conifer Habitat

In the interest of retaining as much of the existing conifer component as possible, NCWRC will continue to encourage the USFS to treat priority hemlock areas for the adelgid. Additional

adelgid treatments are needed in the Whigg Branch drainage and may require alternative methods for accessing the foliage in order to release the predatory beetles. Delays in propagating spruce from seed indicate a need for a larger range-wide multi-agency effort to develop a seed source and/or a need to try the direct transplant approach.

Dispersal Study

In an effort to assess the crossing structures and in response to two major habitat-altering projects proposed by the USFS in the Unicois, more information should be gathered regarding the lower elevation limits of NFSQs and use of habitat in this unusual recovery area. Alternative techniques should be tested, both for capturing squirrels and for documenting presence without captures. These may include off-season squirrel box surveys, acoustic monitoring, nets placed around a feeding station, hair traps, track plates, cameras, or other methods. NCWRC should continue to provide technical guidance to the USFS regarding land management proposals.

F. Estimated Cost

$32,327 (including in-kind contributions)

G. References

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Prepared By: Chris Kelly
Division of Wildlife Management

Annual Performance Report

State: North Carolina **Project Number:** E-16
Segment Number: 1

Period Covered: July 1, 2007 - June 30, 2008

Grant Title: North Carolina Terrestrial Endangered Species

Project Title: Rafinesque's big-eared bat artificial roost construction and monitoring

Objectives:

1. Construct and monitor artificial roost structures
2. Collect microclimate data within structures
3. Collect habitat characteristics at structures

A. Activity

The Rafinesque's big-eared bat is considered a federal species of special concern and classified as threatened in North Carolina. Populations of this particular species are known or suspected to be declining in some portions of its range. Researchers most frequently cite potential causes to be loss of habitat and disturbance, particularly at roosts and/or foraging areas.

In forest stands where available roosts are limited or lost, researchers and conservationists have erected various types of bat houses/structures in an effort to provide alternative roost sites. To date, very few of these structures have been successful in attracting big-eared bats. A permanent, effective, and cost efficient artificial roost structure could potentially facilitate future monitoring of Rafinesque's big-eared bat populations throughout its range.

During this project, Wildlife Diversity staff constructed two artificial roost structures in an effort to provide permanent summer roosting habitat for Rafinesque's big-eared bats. Structures were erected on Pisgah National Forest land in Haywood County near a recently destroyed abandoned house which previously contained a maternity colony of big-eared bats.

To increase the probability that big-eared bats would occupy an artificial structure we constructed a cinderblock tower designed by Bat Conservational International which has had limited success attracting big-eared bats in other parts of its range (Figure 1). The USFS provided funds for materials needed to construct the cinderblock structure. The total height of the structure is 3.6 m with an inside diameter of 1x1 m. The bat entry window is 10x41cm and the lower entry is 51x43 cm. We used plywood and metal roofing for the roof and no door was used on the lower entry. Contact Bat Conservation International www.batcon.org for a detailed material list, instructions, and cost estimate.

Current limiting factors of cinderblock structures are cost of materials, labor, and difficulty of construction in remote areas. Development of a less prohibitive alternate artificial roost structure is needed to make this approach more applicable and practical to general landowners and managers. Therefore, a new culvert structure was designed to more accurately simulate a natural

roost (hollow tree) that is relatively easy to transport, inexpensive, easy to erect without extensive manpower and/or skill level, and not permanently fixed to one location (Figure 1).

Figure 1. Experiment culvert structure and Bat Conservation International designed cinderblock structure in Haywood County in western North Carolina.

The culvert structure consisted of a 6.1 m section of 61 cm diameter heavy duty polyethylene (HDPE) corrugated culvert which was wrapped with insulation and inserted into a capped 6.1 m section of 76 cm diameter 16 gauge galvanized steel culvert. The roosting camber inside the HDPE culvert was lined with inverted carpet to provide further insulation and allow bats to shift positions within the structure to more suitable microclimates (Figure 2). The bat entry window is 35.6x40.6 cm and two 7.6 cm diameter vents were added to adjust the roost microclimate if necessary. Contact Scott Bosworth bosworthsc@earthlink.net in the Wildlife Diversity program of NCWRC for a detailed material list, construction instruction, and cost estimate.

Figure 2. Roosting chamber of the culvert (left) and cinderblock (right) structures in Haywood County in western North Carolina.

The cinderblock and culvert structures were erected in July and September of 2007. For comparison, the structures were placed adjacent to each other on a southeast facing slope approximately 5 m from the forest edge to ensure adequate sun exposure. Hobo data loggers were installed in both structures to collect temperature and relative humidity over time. In 2008, the structures were visited once in April, May, and June to document use or presence. No bats or bat sign was observed in either structure.

In addition to the construction and monitoring of the artificial roost structures, radio telemetry surveys were conducted to collect natural roost data for comparison to the artificial roosts. On July 9, 2007, mist nets placed across road corridors and road ruts near the old maternity site captured two lactating female Rafinesque's big-eared bats. The mist nets were closed after the second big-eared bat was captured due to the likelihood that bats at that site are a part of the same maternity colony. The bats were fitted with 0.35 gram transmitters and tracked to two roost trees before the signals were lost. A colony of approximately 30 big-eared bats was observed roosting in an 81 cm dbh northern red oak (*Quercus rubra*) snag with a large (604x100 cm at base tapering to 5 cm) basal opening with an open top or chimney. The second roost tree was a 78 cm dbh partially hollow live chestnut oak (*Quercus montana*) with a moderately sized (55x46 at base tapering to 14 cm) basal opening with no other cavity openings. Both roosts trees were in closed canopy mixed deciduous forest and within 40 m of a large regenerating clear cut forest edge. Data loggers were placed in the tree cavities as close to the roosting height of the big-eared bats as possible.

Data loggers will be retrieved from artificial and natural roosts in September 2008 at which time temperature and humidity data will be analyzed and compared to other roosts throughout the big-eared bat range. Appropriate adjustments will then be made to the artificial structures to increase the probability of use or occupancy.

B. Target Dates for Achievement and Accomplishment

On schedule.

C. Significant Deviations

None

D. Remarks

Although the artificial structures have been unsuccessful to date, they have only been available for roosting for a short period of time. If necessary the artificial structures will be modified to emulate the microclimate within natural roosts. Location of the culvert structure may also be adjusted to an area that better represents vegetative characteristics around natural roosts.

Artificial structures should be used as tool to gain a better understanding of target species biology and provide a means for long term population monitoring. Creation and management of natural habitat will ultimately provide adequate roost availability for the continued existence of Rafinesque's big-eared bats.

E. Recommendations

Threatened and endangered species surveys provide much needed information when creating management strategies, long-term monitoring programs, providing technical assistance, prioritizing land acquisitions, and assessing recovery efforts and status on a state and national level. We must continue to cooperate with other agencies and conservation groups in an ongoing effort to better understand threatened and endangered bat species to ensure proper conservation strategies and their continued existence.

G. Estimated Cost

$6,289

Prepared By: Scott Bosworth
Division of Wildlife Management

Annual Performance Report

State: North Carolina **Project Number:** **E-16**
Segment Number: **1**

Period Covered: July 1, 2007 - June 30, 2008

Grant Title: North Carolina Terrestrial Endangered Species

Project Title: Bog Restoration and Management in Western North Carolina

Objectives:

The primary goal of this project is to restore and maintain important habitat to bog turtles. Objectives to accomplish this goal include:

1. Removal of manmade drainage devices
2. Removal of trees and stalling succession
3. Maintenance of wetland hydrology through use of berms and other necessary structures

A. Activity

Habitat management continues to be a vital part of bog turtle conservation. In 2007-2008, we provided technical guidance for habitat management activities at several different sites to improve bog turtle habitat and restore hydrology. Activities included cutting trees, removing shrubs and brush, and taking measures to discourage trees from resprouting.

Habitat management work was conducted at the Pisgah Hatchery site in Transylvania County again in November 2007, with the help of seven volunteers from Western Carolina University. Additional shrubs and trees were cut, brush was removed, and propane torches were used to retard future growth of stumps. The bog area is much more open and appears to be holding moisture better since the hydrology restoration work was completed. Photos were taken before and after the work was done to document the changes (see Figures 1 & 2).

Figure 1. Pisgah Hatchery site in July 2007 before habitat management work was conducted (in November 2007).

Figure 2. Pisgah Hatchery site in November 2007 after habitat management work was conducted. Note that Figure 1 was taken during the summer growing season and Figure 2 was taken in the winter season. Nevertheless, differences in vegetation, especially woody shrubs, are apparent in the photos.

In March 2008, a major habitat management project was undertaken at Franklin Bog in Henderson County to set back succession at the lower section of the bog. Partners in this project included NC Department of Transportation (NCDOT), NC Wildlife Resources Commission, and Haywood Community College. As this area had many medium sized trees and was almost completely shaded, it took a great deal of effort to complete this project. We had 18 volunteers from Haywood Community College, two Wildlife Resources Commission staff, and three NCDOT biologists helping with cutting and removing trees and shrubs and applying herbicide to the stumps to retard future growth. NCDOT also provided a large chipper and a prison crew to chip the enormous piles of cut trees and shrubs. Photos were taken before and after the work began (see Figures 3 and 4) to document accomplishments. The site will require additional management efforts to keep tree stumps from re-sprouting and to monitor the long-term effects on the habitat and the bog turtle population.

Figure 3. Franklin bog on March 11, 2008 before habitat management work began that day. Poor image quality because photo had to be taken directly into the sun to show the area we would be working.

Figure 4. Franklin bog on March 12, 2008 after habitat management work was completed. This photo is taken at a slightly different angle from Figure 3, but still demonstrates the habitat changes.

Bog habitat management work was also conducted at Lewis Creek Bog in Henderson County in March and April 2008. A total of eight people assisted with this project, including a wildlife biologist from the NC Wildlife Resources Commission, four staff at Carolina Mountain Land Conservancy, and three dedicated volunteers. Woody trees and shrubs were thinned out of a central portion of the bog, focusing on removal of maples and crowded alders, while leaving a few scattered clumps of other tree and shrubs species, such as willow, in the bog. Turtles have not been detected at this site yet, but the habitat looks excellent and bog turtles have been documented in the watershed, so it is possible that they are using or will use this area at some point. Photos were taken before and after to show the improvements made during this project (see Figures 5 and 6).

Figure 5. Lewis Creek Bog (Henderson Co) in March 2008 before habitat management work was conducted.

Figure 6. Lewis Creek Bog in March 2008 after habitat management work was completed.

In partnership with The Nature Conservancy, a new management plan was created for McClure's Bog in Henderson County. Objectives were clearly outlined and different sections of the bog have been assigned specific management schemes as deemed necessary by all involved in the project. Several work days took place in spring 2008 to remove trees and shrubs from certain parts of the bog. In addition, goats are being grazed in several parts of the property in an effort to reduce encroachment of exotic and invasive plants into the bog. Partners in this project include The Nature Conservancy, the Atlanta Botanical Garden, US Fish and Wildlife Service, the Wildlife Resources Commission, and various volunteers. In May and June 2008, we searched for turtles visually, conducted probing surveys, and set up a 10-day trapping session in an attempt to detect bog turtles at this site. However, no bog turtles were found during these surveys. More surveys will occur in the future to see if habitat management has encouraged turtles to move back into the site. The Nature Conservancy's Asheville office has photos on file of this site.

Often, private landowners want to know what type of wetland they have so that they can best manage it. On several occasions in the past year we provided technical guidance to landowners regarding habitat management options for bog turtles on their property. These personal interactions and connections with private landowners can be beneficial over the long term for conservation, even if it is not a bog or if the wetland turns out to be marginal in quality.

As part of outreach and collaboration efforts with other agencies, and Habitat Conservation staff within our own agency, we have increased our participation in commenting on 401/404 permits for development, if proposed developments will impact or destroy potential bog turtle sites. We conduct site visits to assess habitat potential and/or sample for turtles and make comments accordingly for the permitting process. We also communicate and advise consultants working on these development projects with regards to bog turtle issues and potential habitat impacts. Several consultants have requested an official, in-depth bog turtle workshop so they may feel better trained to look for turtles and potential habitat as they work with developers. We may pursue this idea in the near future.

Working with local land trusts is another way we outreach and collaborate with the public and other entities. Not only have we participated in wetland conservation planning meetings with land trusts this past year, but we also conducted site visits to properties either under easement or proposed for easement to assess bog turtle habitat potential. We are also frequently asked to review and offer text for conservation easements related to bog turtle habitat, including access to the property for future management and monitoring efforts.

B. Target Dates for Achievement and Accomplishment

On schedule

C. Significant Deviations

None

D. Remarks

None

E. Recommendations

Ecological succession occurring at many known sites has become a serious threat to the longevity of bog turtle populations. We must continue to work diligently with volunteers, non-governmental organizations, other agencies, and private landowners to manage succession and bog turtle habitats throughout the western region of the state. Research needs to more directly address management techniques that can be implemented in the field. Cooperative and collaborative projects need to be pursued with landowners, universities, and state and federal agencies to determine efficiency, impacts, and practicality of various techniques (e.g., site burns, grazing, clearing and restoring hydrology with the use of heavy equipment). It is important to determine both short term and long term impacts of these techniques on the ecosystem as a whole.

F. Estimated Cost

$ 6,550

Prepared by: Gabrielle J. Graeter
Wildlife Biologist
NC Wildlife Resources Commission
Division of Wildlife Management

Semi-Annual Progress Report
North Carolina Sea Turtle Stranding and Salvage Network
1 July 2007 – 31 December 2007

A.	Grant Number:	NA03NMF4720207
B.	Amount of Grant:	$50,000.00
C.	Project Title:	North Carolina Sea Turtle Stranding and Salvage Network (STSSN)
D.	Grantee:	North Carolina Wildlife Resources Commission (NCWRC)
E.	Award Period:	1 July 2007 – 30 June 2008
F.	Summary of Progress:	

Job 1 Title: STSSN Recruitment, Training, and Improved Data Collection and Coverage

1. To enhance and strengthen the overall stranding network, the Coordinator and Assistant Coordinator worked towards recruiting participants and building capacity with respect to post-mortem examinations and sample collection. New recruits in the North Carolina STSSN include commercial and recreational fishermen, employees of various state and federal agencies, local town employees, and members of the public.

2. During this reporting period, identification/stranding workshops for volunteers were held in Morehead City, Bald Head Island, Manteo, and Wilmington. Additionally, the new on-line reporting function for stranded turtles was streamlined and volunteers were encouraged to use it to upload data and photos to the centralized state database. In the reporting period, there were 130 on-line reports of observed stranded turtles.

3. During this reporting period, calipers, GPS units, digital cameras and PIT tag scanners were distributed to permitted volunteer members of the North Carolina STSSN.

Job 2 Title: Stranding Data Reporting

1. The North Carolina stranding database was updated regularly throughout this reporting period and originals of completed stranding reports were proofed, photocopied and forwarded to the NMFS Southeast Fisheries Science Center

every two to three months. Additionally, copies of stranding reports for turtles found with tags and tagging reports for live stranded turtles that were tagged prior to release were mailed to the Cooperative Marine Turtle Tagging Program office at the ACCSTR of the University of Florida. Lastly, stranding reports of turtles from which biological samples were collected were photocopied for submission to recipients of the samples.

2. Weekly stranding reports for statistical zones 33 – 36 were submitted electronically to the National STSSN Coordinator, NMFS Southeast Regional Office (SERO), NMFS Beaufort Laboratory, NMFS Law Enforcement, NCDMF and North Carolina Fisheries Association.

3. There was no take of sea turtles by employees or agents of the NCWRC during this period

4. There were no mass-stranding events recorded along the NC estuarine or oceanic coastline during this period.

Job 3 Title: Post-Mortem Examinations and Collection of Biological Samples

1. There were 240 strandings reported by the STSSN during this period: 102 loggerheads, 111 green turtles, 18 Kemp's ridleys, 4 leatherbacks, and 5 unidentified species. Of these, 37 loggerheads, 45 green turtles, and 3 Kemp's ridleys were necropsied by NCWRC staff and permitted volunteers. These examinations revealed 42 females, 21 males, and 22 turtles with unclassifiable gonads. Nine of the examinations showed signs of illness and infection, including low muscle and fat loads, high parasite counts, and paleness. Three examinations (2 greens and 1 loggerhead) revealed numerous plastic pieces in the gut. All other specimens appeared healthy or were otherwise inconclusive. Many had seagrasses (greens) or crab parts (loggerheads and Kemp's ridleys) in their digestive tracts.

2. Several necropsy workshops in different parts of the state were held during this reporting period (see above), and one-on-one training of volunteers was conducted when the opportunity arose.

3. Necropsy supplies were issued to the STSSN on an as-needed basis throughout this reporting period.

4. During this reporting period a variety of samples were collected for research purposes. Humeri and/or eyes were collected from loggerheads, green turtles, and leatherbacks. Muscle tissue was collected on an opportunistic basis from green turtles for DNA analysis. All four flippers were collected from Kemp's ridleys that stranded dead. These specimens are in storage at NOAA-Beaufort Laboratory for later use.

Job 4 Title: Facilitate the Recovery and Release of Live Stranded Sea Turtles

1. The STSSN recovered 34 live-stranded sea turtles during the reporting period: 20 loggerheads, 13 green turtles, and 1 Kemp's ridleys. Three loggerheads and 4 greens were brought to the NEST facility at the NC Aquarium on Roanoke Island. Two of the loggerheads and one green were found lethargic but have since been released. The remaining loggerhead and 3 greens are still recovering from cold stunning. Three greens were sent to the NC Aquarium at Pine Knoll Shores to be rehabilitated for cold stunning. Two remain at the aquarium, and the third was transferred to the Aquarium on Roanoke Island. Fourteen loggerheads and 5 green turtles were sent to the Topsail Turtle Hospital. Of the loggerheads, 8 were emaciated, lethargic, and covered with epibiota. Six of these turtles died shortly after arrival, and the other two loggerheads continue to recover at the Topsail Turtle Hospital. The remaining 6 loggerheads are recovering from boat injuries (3), floatation problems (1), shark bites (1), and unknown causes (1) at the Topsail Turtle Hospital. One green is recovering from boat injuries, and 4 greens are currently undergoing treatment for cold stunning. In addition, two live-stranded loggerheads and one green died before arrival at the rehabilitation center; they were lethargic, emaciated, and covered with epibiota. One loggerhead (post-hatchling size) and one Kemp's ridley were released shortly after stranding.

2. Three releases of rehabilitated turtles occurred during the reporting period. One emaciated loggerhead from the NEST facility was released off of Coquina Beach. Three greens were released in the Gulf Stream after recovering at the NEST facility from complications from gill net entanglements. Two loggerheads and one cold stunned green turtle were released off of Topsail Beach.

3. During this reporting period, the Topsail Sea Turtle Hospital and the sea turtle rehabilitation facility at the North Carolina Aquarium on Roanoke Island were issued medical, transport, and husbandry supplies as needed.

Semi-Annual Progress Report
North Carolina Sea Turtle Stranding and Salvage Network
1 January 2008 – 30 June 2008

A.	Grant Number:	NA03NMF4720207
B.	Amount of Grant:	$50,000.00
C.	Project Title:	North Carolina Sea Turtle Stranding and Salvage Network (STSSN)
D.	Grantee:	North Carolina Wildlife Resources Commission (NCWRC)
E.	Award Period:	1 July 2007 – 30 June 2008
F.	Summary of Progress:	

Job 1 Title: STSSN Recruitment, Training, and Improved Data Collection and Coverage

1. To enhance and strengthen the overall stranding network, the Coordinator and Assistant Coordinator worked towards recruiting more participants and building capacity with respect to post-mortem examinations and sample collection. New recruits in the North Carolina STSSN include employees of various state and federal agencies, local town employees, and members of the public.

2. During this reporting period, identification/stranding workshops for volunteers were held in Hatteras and Swansboro. Additionally, on 28 March a statewide Permit Holder's meeting was held in Onslow County. The Coordinator and Assistant Coordinator presented information on stranding and nesting trends and coordinated discussions on live stranding responses and other issues of concern. During this meeting, Todd Menke (USDA) presented information on methods to control fox predation on beaches where there is predation on sea turtle nests. There were also necropsy demonstrations representing three different species of sea turtle.

3. During this reporting period, calipers, GPS units, digital cameras and PIT tag scanners were distributed to permitted volunteer members of the North Carolina STSSN.

Job 2 Title: Stranding Data Reporting

1. The North Carolina stranding database was updated regularly throughout this reporting period and originals of completed stranding reports were proofed, photocopied and forwarded to the NMFS Southeast Fisheries Science Center.

Additionally, copies of stranding reports for turtles found with tags and tagging reports for live stranded turtles that were tagged prior to release were mailed to the Cooperative Marine Turtle Tagging Program office at the ACCSTR of the University of Florida. Lastly, stranding reports of turtles from which biological samples were collected were photocopied for submission to recipients of the samples.

2. Weekly stranding reports for statistical zones 33 – 36 were submitted electronically to the National STSSN Coordinator, NMFS Southeast Regional Office (SERO), NMFS Beaufort Laboratory, NMFS Law Enforcement, NCDMF and North Carolina Fisheries Association.

3. There was no take of sea turtles by employees or agents of the NCWRC during this period

4. There was one mass stranding event that was reported to state/federal agencies and state/federal law enforcement during the reporting period. On 7 January 2008, 2 loggerhead and 36 green turtles stranded in a 0.6 mile section of inshore coastline along South Core Banks, Cape Lookout National Seashore. Seven addition stranded green turtles were observed in this same location on 14 January. Necropsies were performed on approximately one-third of the carcasses; nothing remarkable was determined. One green turtle was still alive but lethargic; it was taken to a rehabilitation center and has since been released. A few of the stranded turtles did exhibit signs of net entanglement (constriction marks around front flippers) but the majority showed no sign of human interaction. Gill nets had been set in this area one day prior to the first stranding day (photos of the fishing boats and gear were submitted to enforcement officers).

Job 3 Title: Post-Mortem Examinations and Collection of Biological Samples

1. There were 241 strandings reported by the STSSN during this period: 74 loggerheads, 144 green turtles, 19 Kemp's ridleys, 1 leatherback, and 3 unidentified species. Of these, 28 loggerheads, 41 green turtles, 12 Kemp's ridleys and 1 leatherback were necropsied by NCWRC staff and permitted volunteers. These examinations revealed 45 females, 26 males, and 11 turtles with unclassifiable gonads. The majority of the turtles necropsied had no remarkable findings. One loggerhead was found to have a fish hook in its stomach; 7 loggerheads and 1 green were found to be in poor body condition; these turtles were emaciated, anemic, and one had severe liver damage. Two greens had small bits of plastic in their gut, although these objects were most likely not the cause of death.

2. Several necropsy workshops in different parts of the state were held during this reporting period (see above), and one-on-one training of volunteers was conducted when the opportunity arose.

3. Necropsy supplies were issued to the STSSN on an as-needed basis throughout this reporting period.

4. During this reporting period a variety of samples were collected for research purposes. Humeri and/or eyes were collected from 13 loggerheads and 47 green turtles. Muscle tissue was collected on an opportunistic basis from green turtles for DNA analysis. All four flippers were collected from Kemp's ridleys that stranded dead. These specimens are in storage at NOAA-Beaufort Laboratory for later use. Carapaces and skulls from 2 loggerheads and 1 unidentified species were collected and prepared as teaching aids. Fifteen green turtle carcasses, 4 loggerhead carcasses and 1 Kemp's ridley carcass were collected and frozen for necropsy workshops with students and/or volunteers. Additional samples taken from strandings include epibiota, fat, liver, heart, lung, kidney, feces, and brain tissue.

Job 4 Title: Facilitate the Recovery and Release of Live Stranded Sea Turtles

1. The STSSN recovered 22 live-stranded sea turtles during the reporting period. These included 6 loggerheads and 16 green turtles. One loggerhead was entangled in a nylon rope and was released immediately after disentanglement. Four loggerheads and 3 greens died en route to a rehabilitation center; these turtles were lethargic and suffered from emaciation or cold stunning. One loggerhead and 3 green turtles were brought to the NEST facility at the NC State Aquarium on Roanoke Island. The loggerhead had suffered shark bite wounds. The green turtles were cold-stunned. All 4 turtles have been released. Two cold stunned/lethargic greens were sent to the NC Aquarium at Pine Knoll Shores, and have been released. Eight green turtles were sent to the Topsail Turtle Hospital. Three suffered prop wounds, one was cold stunned, and four were emaciated. All remain at the Turtle Hospital at this time.

2. Five releases of rehabilitated turtles occurred during the reporting period. Eight green turtles from the NC Aquarium on Roanoke Island were released into the Gulf Stream in February. Two greens from the NC Aquarium at Pine Knoll Shores were released in March. One loggerhead that was transported from New Jersey for rehabilitation at the Topsail Turtle Hospital was also released in March. In June, three Kemp's ridley turtles, 9 loggerheads, and 4 greens from the Topsail Turtle Hospital were released off of Topsail Beach, and one loggerhead in rehab at the NC Aquarium on Roanoke Island was released off of Cape Hatteras National Seashore.

3. During this reporting period, the Topsail Sea Turtle Hospital and the sea turtle rehabilitation facility at the North Carolina Aquarium on Roanoke Island were issued medical, transport, and husbandry supplies as needed.

ANNUAL PERFORMANCE REPORT

State: North Carolina **Grant Number: I-5**

Period Covered: July 1, 2007 – June 30, 2008

Grant Title: Landowner Incentive Program Tier 1

Project Title: Statewide Red-cockaded Woodpecker Safe Harbor Program for North Carolina

Objectives:

1. To coordinate with U.S. Fish and Wildlife Service (USFWS) personnel to complete the Statewide Red-cockaded Woodpecker (RCW) Safe Harbor application process and receive an Enhancement of Survival permit.
2. To prepare Safe Harbor Management Agreements (SHMA) for landowners who meet the program criteria. Landowners will be issued a Certificate of Inclusion for their participation in the program.
3. To attend meetings of appropriate professional and community groups to promote Safe Harbor, RCW conservation, and beneficial habitat management either through presentations, dissemination of program literature, or networking.
4. To prepare and/or update Safe Harbor program literature and to create a website for dissemination of information about the program, RCWs, and coastal pine ecosystems.
5. To conduct surveys for presence of RCW cavity trees, RCW reproductive activity, habitat condition, and completion of habitat management. Other species-at-risk observed on a property will also be recorded.

A. Activity

The Statewide RCW Safe Harbor Agreement was completed for North Carolina and an Enhancement of Survival Permit received from the regional USFWS office in December, 2006. During the reporting period, North Carolina Wildlife Resources Commission (NCWRC) signed two SHMAs for properties in Johnston County and Bladen/Cumberland Counties. These properties encompass a total of approximately 2,278 acres, will provide suitable RCW habitat on approximately 956 acres, and will maintain habitat for one inactive cluster. The RCW Biologist met or spoke with several additional potential applicants, conducted seven site visits, and has completed draft SHMAs for three of those applicants. Three additional applicants are interested in participating in Safe Harbor and have requested draft SHMAs. During the reporting period, the RCW Biologist met with staff of the Girl Scouts – NC Coastal Pines to discuss and review a draft SHMA for Camp Pretty Pond in Brunswick County. Once signed, this property will provide baseline habitat for portions of three RCW clusters and will contribute to a larger population of RCWs in Brunswick County. An annual report summarizing Safe Harbor activities was submitted to the USFWS Ecological Services Raleigh Field Office in accordance with the Statewide RCW Safe Harbor Agreement.

In support of the NC Statewide Safe Harbor Program, the RCW Biologist gave a presentation to the NC Association of Consulting Foresters and prepared a newspaper item highlighting the RCW Safe Harbor program. The RCW Biologist also designed and presented an educational RCW poster to the NC Girl Scouts to display at Camp Pretty Pond in their communal areas.

Another important component of the NC Statewide RCW Safe Harbor Program is to provide technical guidance, participate in professional meetings, and conduct RCW surveys and monitoring on private lands to facilitate and direct participation in the Safe Harbor Program. This also encourages and ensures proper management of RCWs and habitat on private properties. During the reporting period, a helicopter cavity tree survey was completed on The Nature Conservancy's Shaken Creek Preserve in Pender County and baseline surveys were conducted on six enrolled or potential Safe Harbor properties. The RCW Biologist participated in a variety of professional meetings in support of the objectives of the RCW Safe Harbor Program. The Onslow Bight Conservation Forum discusses conservation issues and planning in the central coastal plain of North Carolina, including RCW population recovery and management. The RCW Biologist attended six regular meeting of the Forum, chaired four RCW Subcommittee meetings, and attended a workshop of the Onslow Bight Fire Learning Network. Similarly, the Cape Fear Arch Conservation Collaborative (CFA) represents the southern coastal plain of North Carolina. The RCW Biologist attended four regular meetings of the CFA and participated in conservation planning meetings for the CFA and the Boiling Spring Preserve. The RCW Biologist also participated in planning workshops hosted by the Southeast Regional Partnership for Planning and Sustainability.

B. Target Dates for Achievement and Accomplishment

All planned activities were either completed or are continuing.

C. Significant Deviation

There were no significant deviations.

D. Remarks

No Remarks.

E. Recommendations

No recommendations.

F. Estimated Cost

Year	Job	Cost
2007-2008	Implement RCW Safe Harbor Program	$45,529

Prepared By: Jennifer Begier, Red-cockaded Woodpecker Biologist
Wildlife Diversity Program

ANNUAL PERFORMANCE REPORT

State: North Carolina **Grant Number: I-1**

Period Covered: July 1, 2007 - June 30, 2008

Grant Title: Landowner Incentive Program Tier II

Project Title: Red-cockaded Woodpecker Habitat Management (Tier II)

Objectives:

1. To enhance and/or maintain habitat for red-cockaded woodpeckers (RCW) on 2,000 acres of properly managed sites through long-term management commitments by private landowners in North Carolina.
2. To provide financial assistance to private landowners for implementation of habitat management techniques that will benefit RCWs.
3. To provide benefits to other native plant and animal species of longleaf pine savannahs through a shift toward management that enhances, restores, and maintains the longleaf pine ecosystem.

A. Activity

During the reporting period, North Carolina Wildlife Resources Commission (NCWRC) provided financial assistance to two private landowners to conduct habitat management that promotes and/or maintains suitable RCW habitat. NCWRC provided reimbursement of up to 75% of the total cost to complete the work.

The Ricks Property is located in Northampton County and is comprised of approximately 700 acres divided among three tracts. During the reporting period, NCWRC completed payments for prescribed burning and fire line construction on approximately 180 acres of 26-year-old pines and on an additional 83 acres of 27-year-old pines on another tract.

The Shaken Creek property is owned and managed by The Nature Conservancy and is located in Pender County. It is situated within the Onslow Bight region of the coastal plain and is adjacent to Holly Shelter game lands; a part of the Coastal North Carolina Primary Core recovery population of RCWs. This property encompasses 5,000 acres of longleaf pine, pond pine, and pocosin communities and RCWs have been observed on the property. During the reporting period, NCWRC financially assisted the cooperator with prescribed burning on approximately 80 acres of longleaf pine savanna. This property will be managed long-term for restoration of the natural communities.

B. Target Dates for Achievement and Accomplishment

All management activities were either completed or are continuing.

C. Significant Deviation

North Carolina was under a burn ban for a large portion of the reporting period. Prescribed burning is a primary management tool in the coastal pine communities of North Carolina and therefore, opportunities for habitat management with prescribed fire were limited during the reporting period.

D. Remarks

No Remarks.

E. Recommendations

The North Carolina Safe Harbor Program is currently dependent on the Landowner Incentive Program to financially assist landowners with their agreed upon habitat improvements. Therefore, continued funding of the Landowner Incentive Program or other comparable program will ensure that NCWRC can continue to provide this assistance.

F. Estimated Cost

$9,136 (including landowner costs)

Prepared By: Jennifer Begier, Red-cockaded Woodpecker Biologist
Wildlife Diversity Program

Annual Report

USFWS Grant Agreement # 40181-03-G202

State: North Carolina

Period Covered: July 1, 2007 - June 30, 2008

Project Title: Partners for Fish and Wildlife Grant: Forest Landbird Legacy Program

Introduction/Overview:

On January 30, 2003 a meeting was held at the U.S. Fish & Wildlife Service office in Raleigh, N.C. related to the potential for a program addressing the conservation of forest landbirds with private landowners. The purpose of the meeting was to begin to think up ideas for a new program that would initially be funded at $25K by the Service's Partners for Fish and Wildlife Program in cooperation with the N.C. Wildlife Resources Commission. The money would be used to develop and implement stronger partnerships with state agencies and other partners. More specifically the funding would be used for on-the-ground restoration practices on private lands. The Partners for Fish and Wildlife staff wanted to use the money for practices that would benefit forest-dependent migratory birds, particularly species or suites of species that are of a high conservation priority. Although the money was not yet in hand, since Congress had not passed a federal budget, Partners for Fish and Wildlife staff felt the money would eventually come and wanted to be prepared to use it when it came. Initial partners present at this meeting included representatives of the U.S. Fish & Wildlife Service, N.C. Wildlife Resources Commission and National Resources Conservation Service.

At this preliminary meeting, the group was supportive of launching a new program with the goal of conservation of biodiversity in mature forests for the benefit of forest-dependent landbirds. The group discussed at length the conditions of certain existing habitat types and how those habitats might best be improved. In particular, the group felt that mature forests were top priority for forest-dependent land birds. Though, as discussed, it is not necessarily the age of the trees that is so important in mature forests, but rather the structure that is present (midstory, vine diversity, dead wood (downed and standing), and gaps). The group also decided that perhaps this complex structure could be achieved in younger forests through a variety of management actions. Riparian zones were another priority habitat that the group felt should be targeted, and acknowledged the lack of understory and midstory vegetation in many forest stands. As a component of the program it was suggested this partnership create a Program Certification. This would educate and recognize the landowners that participated. Signs could designate the certification process and the group decided to develop a sign certification program.

Initially, it was agreed to work this new forest landbird program under the framework of NC Partners, an already established and successful program that reimburses landowners for restoration expenses when developing moist soil habitat. Even though NC Partners has had a

focus on waterfowl and shorebirds, it can have a branch or new component for forest-dependent land birds. Administratively it has been successful. Money comes from partners through the Commission and back to the Service. The Service handles reimbursing landowners and ensuring that cooperative agreements with landowners are signed.

The Partners for Fish and Wildlife program hoped to contribute $25K each year for 5 years. The Wildlife Commission representatives were not in a position to commit funding, but expressed support and interest in accepting, promoting, and carrying out the program.

Based on the thinking that mature forests and riparian areas should be a priority focus, the partners decided after discussion on several practices that might be funded to benefit forest landbirds. Those included: developing a harvest management strategy, creating gaps, burning, thinning, exotic plant control, use exclusion, understory planting, reforestation, offsetting the cost of planting hardwoods vs. pines, removing timber of no commercial value to reforest. Other programs address some of these practices, but not necessarily from a mature forest or forest landbird perspective. In some cases the recommended practices may be those in existing Forest Stewardship Plans or they may be modifying or taking a Forest Stewardship Plan to the next level. It was agreed that the program would likely be opportunity driven and that there are no 'cookbook formulas' for achieving these goals and each project would have to be handled on a case by case basis.

It was decided that those eligible for participation in the program would be any landowner including private landowners, land trusts, universities, etc. Partners agreed that they could or should provide only technical assistance for backyard-type or small-scale management and focus funding on larger tracts. For now, there was no definition of small vs. large. It was discussed that there may be an audience to target that is currently not targeted by existing programs and the partners discussed the possibility of: non-agricultural landowners, land trust members and easement holders, birders, land trusts, universities, and local governments. It was agreed that the partners would target the audience that will buy into the program.

It was decided that it would be best to wait to advertise or publicize this program until partners handpicked several projects and tested them. Those projects would be carefully reviewed and ranked and serve as examples to then launch a program that would be advertised more generally later. The representatives present already meet with landowners regularly to help them meet objectives for their land with existing programs. All present agreed that they could offer this program as another 'tool in the box' to help further better bird conservation. Partners for Fish and Wildlife Biologists and Commission Stewardship Biologists are in particularly good positions to promote and carry out this program in the future. NRCS District Conservationists could also promote and carry out the program. Some Wildlife Commission staff should have opportunities and so might those working with Safe Harbor to develop contacts. This diverse group that committed to the concept of a program to benefit forest landbirds should also follow the successful pattern of the NC Partners Program in which partners from the Service, the Commission, NRCS, and Ducks Unlimited all bring projects forward to benefit waterfowl and shorebirds on private lands.

Partners present agreed that other potential partners who were discussed (NC Forest Service, Audubon Society, Southern Environmental Law Center, The Nature Conservancy, Natural Heritage, NC Museum, US Forest Service, NCSU Extension, etc.) could serve a technical assistance role, especially related to forest management, either locally or on an as needed basis. The partners present at the initial meeting, the Service, Wildlife Commission, and NRCS would likely be the only financial contributors and would be the decision-makers. It was decided that several issues related to this type of program intended to benefit forest landbirds on private lands would require additional planning meetings to determine organization and focus of this initiative.

Prior to visiting potential landowner sites in 2003 the partners decided to name the program the Forest Landbird Legacy Program (FLLP), and developed a program logo for use on signs (Certified Forest Landbird Habitat) to denote certification and participation in FLLP. It was decided that the Wildlife Resources Commission would use the grant funds from the Service to reimburse landowners. A cooperative agreement between the landowner and Wildlife Resources Commission was signed. Brad Gunn of the Wildlife Resources Commission is Project Administrator and disperses requested funds plus handles grant financial reporting. Mark Johns of the Wildlife Commission is the Project Officer and handles grant reports, with assistance from other partners as needed.

Previous annual reports (2004-2007) detail FLLP activities in those years.

Project Activities 2007-2008 (June 2007 – May 2008)

Seven site visits by members of the FLLP working group to potential FLLP sites were made between June 2007 and May 2008.

Stewart Tract (Davidson County): A site visit was made by Danny Ray and Jon Shaw of NCWRC and personnel from NC Forest Service (NCFS) in July of 2007 to discuss possibilities for a Forest Stewardship Plan and a FLLP project with the landowners.

Boy Scout Camp (Caswell County): A site visit was made by Mark Johns and Danny Ray of NCWRC in August of 2007 to meet with forestry consultant David Halley about this property and potential for FLLP. This site has been visited once already in 2006 by FLLP working team members and this was a final follow-up site visit to fine tune ideas for the FLLP plan proposal.

Longleaf Pine Farms (Scotland County): A site visit was made by Susan Miller, John Ann Shearer and Laura Fogo of USFWS and Jeff Marcus of NCWRC in August of 2007 to meet with landowners and their consulting forester about FLLP.

Waynesborough Historical Village (Wayne County): A site visit was made by Joe Folta and Danny Ray of NCWRC, Don Barker representing NRCS and Kendall Smith of USFWS in September of 2007 to discuss possibilities for a FLLP project.

Stewart Tract (Davidson County): This was a follow-up site visit in September of 2007 to this tract by Danny Ray and Mark Johns of NCWRC, John Isenhour representing NRCS, Laura Fogo of USFWS and NCFS personnel. This site was first visited in July of 2007 by FLLP.

Sigmon Tract (Granville County): A site visit was made by Danny Ray of NCWRC and John Isenhour representing NRCS in March of 2008 to meet with the landowner and discuss possibilities for a FLLP project.

Ricks Tract (Northampton County): A site visit was made in April of 2008 by Mark Johns, Danny Ray and Joe Folta of NCWRC and Kendall Smith of USFWS to meet with the landowner to discuss possibilities for a FLLP contract.

FLLP Baseline Bird Inventory Work:

Baseline inventories will be preformed on potential FLLP sites to document existing birds present whenever possible, and also to compare baseline bird communities present prior to FLLP management activities with bird guilds that are present after FLLP management activities over time. Additional monitoring will be performed by FLLP as opportunities allow, or by other partners involved in/managing the property.

River Oaks Tract (Cumberland County)

Candace Williams, Program Coordinator for Land Protection of the Sandhills Area Land Trust continues to conduct bird survey work (point counts) as time allows at the River Oaks site in Cumberland County. She has also conducted extensive bird inventory work toward developing a site bird list and wants to survey at other times of the year in the future. This was a tract originally visited by several members of FLLP in early 2006 to determine suitability for FLLP and the final FLLP contract was signed in Feb. of 2008.

Boy Scout Camp (Caswell County): A site visit was made by Mark Johns and Danny Ray of NCWRC in August of 2007 and all birds heard/seen during the visit were documented.

Stewart Tract (Davidson County): During a site visit in September of 2007 bird inventory work was performed by Mark Johns.

Ricks Tract (Northampton County): During a site visit in April of 2008 bird inventory work was performed by Mark Johns.

Jenkins Tract (Granville County): During a site visit in late May of 2008 bird inventory work was performed by Mark Johns of NCWRC and Laura Fogo of USFWS.

Landowner Agreement and FLLP Management Plan Activities

Bragg FLLP Contract: Laura Fogo of USFWS drafted a FLLP Plan and cost-share agreement for the 300 acre Bragg Tract in Mecklenburg County in July of 2006, assisted by Danny Ray of the NCWRC. This plan was reviewed by several other members of FLLP. The total of all planned management activities is $18,095.00, of which $13,571.00 is eligible for FLLP cost share. This contract with a FLLP management plan was signed by the landowner. *Mr. Bragg invoiced the NCWRC for $3750.00 for treatment of non-natives in a demo area in August of 2007. After the*

work was inspected by FLLP members Danny Ray and Laura Fogo, the landowner was reimbursed.

Waynesborough Historical Village FLLP Contract: Joe Folta of NCWRC drafted a FLLP Plan and cost-share agreement for the 68 acre tract owned by the Waynesborough Historical Village in Wayne County. This draft was reviewed by several other FLLP members. The total of all planned management activities was $5,304.00, of which $3,978.00 was eligible for FLLP cost share. This contract was finalized by all parties in Jan. of 2008.

Dupont Tract FLLP Contract: A modification was made and paperwork signed in Feb. of 2008 relating to the Dupont tract in Bladen County of the NC Coastal Land Trust to allow an extension for trying to get FLLP funded prescribed burning done. Drought conditions have delayed the ability to burn at this site.

Stewart Tract FLLP Contract: Danny Ray drafted a FLLP Plan and cost-share agreement for the 68 acre Stewart tract in Davidson County. The draft was reviewed by several FLLP members. The total of all planned management activities was $2,795.00, of which $2,096.00 was eligible for FLLP cost share. This agreement has not yet been signed as of May 30, 2008 by the landowner and returned to the NCWRC.

Riley Horne FLLP Contract: Kendall Smith of USFWS drafted a FLLP Plan and cost-share agreement for the 55 acre Horne tract in Halifax County. This draft was reviewed by several FLL members. The total of all planned management activities was $10,929.00, of which $8,197.00 was eligible for FLLP cost share. This contract was finalized by all parties in Feb. of 2008.

Longleaf Pine Farms –Snowden FLLP Contract: Susan Miller drafted a FLLP Plan and cost-share agreement for this 90 acre tract in Scotland County. This draft was reviewed by several FLLP members. The total of all planned management activities was $5,500.00, of which $4,125.00 was eligible for FLLP cost share. This contract was finalized by all parties in Feb. of 2008.

River Oaks FLLP Contract: John Ann Shearer of USFWS drafted a FLLP Plan and cost-share agreement for the 142 acre River Oaks Preserve tract owned by the Sandhills Area Land Trust in Cumberland County along the Cape Fear River. This draft was also reviewed by several other FLLP working group members. The total of all planned management activities was $11,630.00, of which $8,722.00 was eligible for FLLP cost share. This contract was finalized by all parties in April of 2008.

Boy Scout Camp FLLP Contract: Danny Ray drafted a FLLP Plan and cost-share agreement covering 76 acres of the Boy Scouts of America Camp in Caswell County. This draft was reviewed by several FLLP members. The total of all planned management activities was $10,856.00, of which $8,142.00 was eligible for FLLP cost share. This contract was finalized by all parties in April of 2008.

Jenkins FLLP Plan: Danny Ray of NCWRC drafted a FLLP Plan and cost-share agreement for the 117 acre Jenkins Tract in Granville County in September of 2006 that was also reviewed by

several FLLP working group members. The total of all planned management activities is $5,078.00, of which $3,808.00 is eligible for FLLP cost share. This contract with a FLLP management plan was signed by the landowner in 2006. On May 30, 2008 several FLLP members visited the site to inspect management work done by the landowner and his consulting forester over the past 2 years. A FLLP certification sign and certificate were presented to the site landowners by the FLLP group. This site is also now in a conservation easement with the Tar River Land Conservancy.

Program Organizational Activities:

FLLP Annual Meeting

The FLLP working group met on Dec. 6th for the 3rd annual FLLP working group meeting in Wake County at the Raleigh USFWS office to discuss ongoing projects and plan future program developments. Twelve FLLP working group members attended and all funded and several potential FLLP projects were discussed. The official process for use by FLLP for a instigating and processing a FLLP project was outlined, including the initial landowner site visit to final contract signing. In addition, attendees also discussed the continued evolution of the landowner recognition process, and John Ann Shearer of USFWS requested that FLLP working group members review and update a chart she developed for all past and present FLLP landowner projects. This chart was updated with final changes in April of 2008. Minutes from the FLLP annual meeting were distributed electronically to all FLLP working group members by Mark Johns in Dec. of 2007.

FLLP Recognition

Kelly Hughes of NCWRC developed the FLLP certificate of recognition in 2007, and presented the first to a FLLP landowner (Hosley) in 2007 when that landowner also received the FLLP certification sign for their property. These certificates will also be used to honor FLLP landowners or others that are already conducting management on their lands that benefit forest songbirds.

A certificate of recognition and a FLLP sign were presented to Frank Bragg (a FLLP participating landowner from 2007) for his work done through the FLLP program at the annual meeting of the NC Chapter of The Wildlife Society in Feb. of 2008.

Danny Ray of NCWRC drafted a FLLP Plan and cost-share agreement for the 117 acre Jenkins Tract in Granville County in September of 2006. On May 30, 2008 several FLLP members visited the Jenkins Tract to inspect management work done by the landowner and his consulting forester over the past 2 years. A FLLP certification sign and certificate were presented to the site landowners by the FLLP group. This site is also now in a conservation easement with the Tar River Land Conservancy. This contract with a FLLP management plan was signed by the landowner in 2006.

In addition, feature articles were included in the fall 2007 NC Partners in Flight newsletter and the winter 2008 Upland Gazette newsletter of the NC Wildlife Resources Commission on the

successful Hosley FLLP project. Inquires on the FLLP program and its practice have been received as far away as Pennsylvania.

FLLP Fact Sheet

The FLLP Fact Sheet was updated in Feb. of 2008 and is posted at:
http://www.fws.gov/nc-es/es/partners/factsheetlbl.pdf

FLLP Training Workshop for 2007

A 2nd FLLP training workshop was held in Johnston County on October 3, 2007 conducted by Mark Johns and Danny Ray of NCWRC, FLLP certified consulting forester David Halley, and Chris Moorman of NC State University to promote FLLP to natural resource managers, consulting foresters and land trusts, and to train consulting foresters. This workshop was a partnership with the NC State University Forestry Education and Outreach Program and the FLLP working group. It is important to note that many of the consulting foresters involved in developing signed FLLP landowner agreements, or that were involved in potential FLLP site visits have already been through FLLP training. FLLP wants to continue to add to the number of FLLP certified consulting foresters in North Carolina by offering these types of training workshops whenever possible.

Annual Report

USFWS Grant Agreement # 401814J011

State: North Carolina

Period Covered: July 1, 2007 - June 30, 2008

Project Title: Bog Turtle Habitat Restoration and Enhancement in Western North Carolina

Objectives:

Identify sites and restore, enhance, and protect wetland/bog habitats in western North Carolina.

A: Summary

This grant has funded restoration and management at 3 privately owned bog sites in Western North Carolina. Habitat management, removal of woody vegetation, occurred at the Nature Conservancy's McClure's bog. Restoration and management of riparian and bog habitat occurred at 2 sites in Ashe County, North Carolina. Both of those (Peak Creek and Bowlin) sites currently support bog turtle populations, but neither site was being managed to provide optimal bog turtle habitat. A comprehensive enhancement and management plan was developed with the NC Wildlife Resources Commission, the landowners, and the USFWS Project Officer. A landowner agreement was also developed and signed by the landowners. The management plan was implemented in 2007 and 2008.

B: Project Implementation

McClure's Bog

At a former bog turtle site in Henderson County North Carolina, owned by the Nature Conservancy, funds from this grant were used by the North Carolina Wildlife Resources Commission to assist the Nature Conservancy and several partner organizations in a planned vegetation manipulation to restore bog turtle habitat. Years of unchecked succession had rendered the site unsuitable for bog turtles and had compromised conditions for many of the rare wetland plants found at the site. The Nature Conservancy developed a plan in cooperation with the US Fish and Wildlife Service, the North Carolina Wildlife Resources Commission, and the Atlanta Botanical Garden to restore the wetland vegetation to conditions more favorable to bog turtles and rare plants. As part of this effort the Wildlife Resources Commission provided management expertise and labor to help remove woody vegetation from portions of the site. The restoration activities at the site have not yet been concluded, however on significant portions of the site vegetation management has restored suitable conditions for bog turtles, and the partnership is continuing the efforts. Significant "in-kind" contributions to this restoration

project have been accumulated thus far in the form of volunteer and non-federally funded personnel time.

Peak Creek and Bowlin Bogs

Fencing was installed around both bogs during October and November of 2007 and photos of the sites were taken in December 2007 to document the final product (see Figures 1 – 5). A total of 3.5 acres of bog were protected with fencing in this project, with 1.5 fenced acres at Bowlin Bog and 2.0 fenced acres at Peak Creek Bog. Partners in the project include the North Carolina Wildlife Resources Commission's (NCWRC) Habitat Conservation and Wildlife Diversity Programs, the landowners Dympse and Harold Bowlin, and the USFWS.

There were a few minor deviations from the original fencing plan. The landowners offered to install more fencing than was shown in the plan for Peak Creek Bog. The Bowlins hired someone to fence the portion along the road on the western side of the Peak Creek Bog, whereas originally this was going to be fenced from Partners in Fish and Wildlife funds. Another minor difference was that the landowners requested that the small, separate wetland area at the Bowlin site not be fenced. Further assessment of the area and discussion with the USFWS Project Officer, Anita Goetz, showed that it was not a priority to fence this small area, in particular due to the small size and the fact that the spring at that particular spot had been dry for several years. The Bowlin family has communicated that they plan to finish fencing around the field at the Bowlin Bog in winter 2008 and spring 2009. Until they are able to fence around the perimeter of the field, cattle can be released into Bowlin Bog for grazing since the bog is fully fenced and gated. Therefore, the agreement to seasonally graze the bogs is satisfied despite the delay in fencing around the field at this bog.

Figure 1. Fence around Bowlin Bog looking south from northeastern side of bog. Photo taken December 2007. Note the tall trees in the bog.

Figure 2. Fence around Bowlin Bog looking north from southeastern corner of bog. Photo taken December 2007.

Figure 3. Fence around Bowlin Bog looking east from northwestern corner of bog. Photo taken December 2007. This is the side of the bog that was already relatively open.

Figure 4. Fence around Peak Creek Bog looking west from eastern side of bog. Photo taken December 2007. Shows most of the fenced bog area at this site.

Figure 5. Fence around Peak Creek Bog looking east from southwestern corner of bog. Photo taken December 2007. Fencing along Peak Creek (actual creek) can be seen in the distance on far end of field near large brush pile.

The NC Wildlife Resources Commission's Wildlife Diversity program conducted habitat management with the help of several volunteers at Bowlin Bog for three days in April 2008. Hand tools, including hand-held clippers, a brush cutter, and chainsaws, were used to cut and remove shrubs from the most overgrown portion of the bog. A portable propane torch was used to retard re-growth from the stumps of cut trees and shrubs. Photos were taken before the management work began, immediately after work was completed, and one month after work was completed (see Figures 6-8). Approximately half an acre of the Bowlin Bog site was cleared of large trees and shrubs, leaving a matrix of open areas and areas with short shrubs in the bog.

Costs for the entire project were slightly higher than expected, so we had to prioritize the use of remaining funds for the habitat management portion of the project. With the funds remaining, we conducted habitat management at Bowlin Bog as there was consensus among biologists that this site had the greatest need for management. The Peak Creek Bog remains relatively open and was not in as immediate need of management. For Peak Creek bog, the most essential activity to accomplish was the fencing of the bog area.

Figure 6. Western side of Bowlin Bog on April 8, 2008. Before habitat management work began at this site. Note dense brush and multiple tall trees in bog area. Photo taken from gate into bog on the southernmost corner of the bog.

Figure 7. Western side of Bowlin Bog on April 10, 2008. Immediately after habitat management work was completed at this site. Photo taken from gate into bog on the southernmost corner of the bog.

Figure 8. Western side of Bowlin Bog on May 7, 2008. One month after habitat management work was completed. Photo taken from gate into bog on the southernmost corner of the bog.

A seasonal grazing regime has been established with the landowners. The cattle will be allowed to graze in the bogs from mid-October to mid-April of each year. Fall of 2008 and Spring of 2009 will be the first time the controlled grazing is implemented. Monitoring of this grazing regime will occur in 2009 to assess the effectiveness of this grazing regime. Adjustments will be made as deemed necessary to meet the overall objective of maintaining the open habitat of the bog while also providing sufficient protection for the bog turtles and rare plants.

In May 2008, members of Project Bog Turtle and Wildlife Resources Commission staff surveyed for bog turtles at both sites. An adult female bog turtle that was previously captured and marked was found at Peak Creek Bog and a new adult female bog turtle was captured at Bowlin Bog during this visit. Surveys for bog turtles and rare plants at these two sites will continue to occur on a regular basis.

C. Project Expenses

The partners in this project included the USFWS Partners in Fish and Wildlife Program, the NC Wildlife Resources Commission (NCWRC) Habitat Conservation Program and Wildlife Diversity Program, volunteers from the Atlanta Botanical Garden and other volunteers, and the landowners (the Nature Conservancy and the Bowlins). A financial summary (as of 6/30/08)is outlined in Table 1 (below). The NCWRC Habitat Conservation Program contributed a larger portion due to a slightly longer fence line than anticipated and slightly higher costs of materials for the fencing. Once the landowners complete the fencing around the field at Bowlin Bog, their contribution will have been much higher than seen in the table. Between the landowners, volunteers and NCWRC's Habitat Conservation Program contributions, we have secured an excellent match (56%) to the Partners in Fish and Wildlife grant.

Table 1.

WRC Wildlife Diversity Expenses (staff and fencing)		$17,175.84
WRC Habitat Conservation (fencing)		$8,790.00
In-Kind		
	Bowlins (fencing)	$5,994.30
	Volunteers (habitat mgmt.)	$2,182.60
Total Cost		$34,142.74

D. Conclusions

The fencing and habitat management activities conducted as part of this project were successful in several ways. The objectives of this project included reducing woody vegetation, installing fencing around the perimeter of 2 bogs to allow for control of grazing, and establishing a cattle grazing regime at those 2 sites. These objectives were successfully met on most accounts. The fencing around the bogs was completed, a cattle grazing regime was planned and established with the landowners, and woody vegetation was reduced at Bowlin bog and McClure's bog. The area along the perimeter of Peak Creek Bog that contains Gray's lily (*Lilium grayi*) plant, a state

threatened species, was included in the interior fenced bog area, thereby affording it more protection. Trees and shrubs were removed from the most overgrown part of Bowlin Bog, resulting in an open meadow wetland on the western side of the bog, with more scattered woody vegetation on the remaining portion. Trees and shrubs were also removed from McClure's bog on multiple occasions during this project, with a consensus of the project partners (USFWS, The Nature Conservancy, Atlanta Botanical Garden, and WRC) that those habitat management efforts have resulted in significant improvements in habitat condition for bog turtles and rare plant species of the bogs. The effect of the work done at these sites on the bog turtle populations is yet to be determined. The evidence at other bogs indicates that opening up the habitat by using controlled grazing and through habitat management efforts improves the habitat conditions for bog turtles as well as many of the rare plants. Visits were made to the sites after the fencing and habitat management work was completed and turtles were located on each visit at the Bowlin and Peak Creek sites, but it is too early to determine the overall and long-term effects of this work on the bog turtle populations. Future surveys will be conducted to monitor the response of the population.

Most habitat management projects need to be continually monitored over time. For that reason, these bogs will need to be monitored for the success of the established grazing regimes and additional work will need to be carried out periodically to manage re-growth of trees and shrubs within the bogs. Work that remains to be accomplished includes the completion of the fencing of the field at the Bowlin site, which is expected to occur in Winter 2008. At some future date, Bowlin Bog would benefit from having more habitat management work to thin the shrubs in the portion of the bog that was not thinned during the workdays in April 2008. Likewise, if an opportunity arises, the larger trees and shrubs could be thinned out of the small thicket in Peak Creek Bog. This would result in further improved ecological conditions at these two sites.

Prepared By: Gabrielle J. Graeter
North Carolina Wildlife Resources Commission

Annual Report
Bogue Inlet Waterbird Monitoring and Management
November 1, 2006 – October 31, 2007

Prepared for: Town of Emerald Isle, NC

Prepared by: Emily Rice, Assistant Waterbird Biologist
Susan Cameron, Waterbird Biologist
NC Wildlife Resources Commission

1. Introduction

Bogue Inlet is situated between Carteret and Onslow counties in eastern North Carolina. Since 1984, the channel through Bogue Inlet had migrated in an easterly direction, causing erosion and threatening infrastructure and development on the western end of Emerald Isle in the area known as The Point. The inlet channel was relocated to its new, more centrally located position in the spring of 2005. The purpose of the relocation was to move the channel away from The Point, hopefully resulting in the closing of the old channel and sand accretion along the west end of Emerald Isle.

The Bogue Inlet complex is extremely valuable to waterbirds. In 1998, the Bogue Inlet shoal system encompassed 250 acres and was classified as the eighth largest inlet shoal system in North Carolina in terms of habitat available to avifauna (USFWS 2002). The North Carolina Wildlife Resources Commission (NCWRC) has surveyed the inlet area for a number of years, including the west end of Emerald Isle, the east end of Bear Island and natural islands within the inlet, for breeding waterbirds and found significant numbers of nesting Least Terns (*Sterna antillarum*), Common Terns (*Sterna hirundo*) and Black Skimmers (*Rynchops niger*), all of which are species of special concern in North Carolina. Shorebirds, including Wilson's Plovers (*Charadrius wilsonia*) and American Oystercatchers (*Haematopus palliatus*), both state listed as significantly rare; also nest within the project area. In addition to its value to nesting birds, the inlet complex is extremely important to migrating and wintering colonial waterbirds and shorebirds including the federally listed Piping Plover (*Charadrius melodus*).

Along our coastline the dynamic barrier islands and associated inlets on which many waterbirds depend are being severely altered by attempts to stabilize beaches. If we are to retain habitat for migrating, wintering and breeding waterbirds, it is imperative that we manage remaining habitat in the face of these changes. Beaches along inlets are particularly valuable to waterbirds and as such should be afforded extra protection. According to the US Shorebird Conservation Plan (Brown et al. 2001), data from several shorebird inventory programs in North American in the past two decades strongly suggest that populations of the majority of species are declining, some at rates exceeding 5% per year. The Plan also states that coastal development and human activities in coastal zones have grown enormously and have reduced intertidal habitats and prey base and have usurped high tide resting areas used by shorebirds. Populations of many species of colonial waterbirds are also showing declines and coastal development, coastal protection, dredging and human disturbance are listed as actions that can significantly affect the ability of

coasts and intertidal waters to sustain waterbirds (Kushlan et al. 2002). There is a clear need to monitor and manage these habitats in the face of these changing conditions

The Bogue Inlet channel relocation project has the potential to negatively impact the quality and quantity of habitat available to breeding and non-breeding colonial waterbirds and shorebirds. As a result, NCWRC and the United States Fish and Wildlife Service (USFWS) have worked with the Town of Emerald Isle to develop a Waterbird Management Plan and a monitoring schedule for Bogue Inlet. Post-project monitoring began in the spring of 2005 following the completion of the project. This report summarizes work on the project from November 1, 2006 through October 31, 2007.

2. Objectives

NCWRC has been contracted to manage and survey important bird areas in Bogue Inlet. These areas include nesting, foraging and roosting habitats for colonial waterbirds and shorebirds. Given the known impacts of beach stabilization projects on waterbirds and the possibility of additional unforeseen impacts, it is important to monitor large scale beach stabilization projects and protect created and existing waterbird habitat. The overall objectives of the project are as follows:

1) Identify and protect nesting habitat for waterbirds.
2) Protect high quality foraging and roosting habitat for waterbirds.
3) Monitor/research breeding and non-breeding waterbirds after channel construction.
4) Prevent human and animal disturbance to waterbirds throughout the year.
5) Educate the public about waterbirds and the importance of the Bogue Inlet area for waterbirds.

3. Activities

3.1 Protection of breeding, foraging and roosting habitat

Management along Bogue Inlet continued through 2007 as described in the Bogue Inlet Waterbird Management Plan (Cameron 2004). Management of habitat on the west end of Bogue Banks included the posting of important foraging, roosting and nesting habitats. Posted areas were maintained with detailed signs explaining that the area is closed to pedestrians and pets to protect waterbirds. Areas posted included supratidal and intertidal habitats on the spit. Pedestrian corridors were left open to allow public access as described in the Waterbird Management Plan. Over the year, it was necessary to adjust posted areas in response to changing conditions on the spit. Attempts were made to enforce Emerald Isle's leash law. New "leash law" signs were created and posted to make people more aware of the Emerald Isle Town ordinance. In addition, NCWRC posted nesting habitat on state-owned Island #2 and Hammocks Beach State Park (HBSP) posted nesting areas on Bear Island.

3.2 Research and Monitoring

Weekly surveys were conducted along four transects as outlined by CZR, Inc. (2004). Transects were surveyed using a flat-bottomed boat and by walking throughout the designated areas. The transects include the west end of Emerald Isle (listed as Bogue), Dudley Island, the east end of Bear Island and a complex of small islands and shoals identified as the Inlet transect. Tide is a major factor influencing shorebird distribution, abundance and activity (Burger et al 1977, Connors et al. 1981) so surveys were conducted at both high and low tides to further understand habitat use. Observations were taken with a spotting scope and binoculars and included numbers and species of birds, habitat, bird activity and human disturbance. A concerted effort was also made to identify banded birds and record band combinations. Habitats surveyed included the surf, intertidal zone and beach. All data was entered into a Microsoft Access database.

Colonial waterbird and shorebird nesting activity was monitored from early April through the end of the nesting season. Intensive monitoring was conducted on Bogue Banks with less intensive monitoring at other sites including Bear Island, Dudley Island and Island #2. Monitoring on Bogue Banks consisted of counting nesting pairs and locating and monitoring nests every three to four days to estimate reproductive success. Efforts were also made to determine causes of nest and chick losses. Numbers of breeding birds were estimated on Dudley and Bear Island during weekly surveys and notes taken on reproductive success. Lastly, we surveyed appropriate habitat on Bogue Banks and within the inlet complex for breeding Piping Plovers during the annual coast-wide Piping Plover survey. Biologists with HBSP surveyed Bear Island for nesting Piping Plovers. This survey is conducted June 1st - June 9th throughout the Piping Plover's breeding range with the purpose of estimating population sizes and assessing recovery of the species.

3.3 Education

Public education is a key component in the management of beach-nesting birds. The Waterbird Management Plan outlines the importance of gaining community involvement to encourage waterbird conservation. Saturday bird walks continued during the months of July and August along Beaufort Inlet at Fort Macon State Park. Brochures detailing the bird walk were placed at visitor centers throughout the county. The recently created brochure entitled "Sharing the Shore with North Carolina's Beach-Nesting Birds" was also distributed to similar centers and to visitors to Bogue Banks. Important nesting areas within the inlet complex were patrolled by a NCWRC biologist on holidays and weekends during the summer season. Beach-goers were educated on the importance of providing breeding, foraging and roosting habitats for waterbirds and shorebirds. A spotting scope was provided to give the visitors a chance to observe the birds in their natural habitat without disturbing them.

Dropping Anchor, a free local magazine, published an article on North Carolina's beach-nesting birds in their August edition. This publication is distributed at various businesses, visitor centers and public buildings throughout Carteret and Onslow counties. The article described species that can be seen along Bogue Banks during the breeding season, the difficulties they face and the importance of protecting barrier island habitat.

4. Results and Discussion

The following section summarizes the results of monitoring efforts at Bogue Inlet during the past year. Because of the differing characteristics and habitat preferences of colonial waterbirds and shorebirds, these two groups were separated to summarize data and determine species richness and relative abundance. Data were standardized by transect lengths, which were obtained using a Trimble GeoXM GPS unit, with species richness reported as the number of species per km and relative abundance as the number of birds per km. Data on Piping Plovers, breeding activities and disturbances are also presented.

4.1 Non-breeding waterbirds

Table 1 lists all waterbird species observed from November 2006 through October 2007 from most to least abundant. As in 2006, Black Skimmer *(Rynchops niger)*, Royal Tern (*Sterna maxima)*, Double-crested Cormorant (*Phalacrocorax auritus*), Brown Pelican (*Pelecanus occidentalis*) and Laughing Gull (*Larus atricilla*) were the most common waterbird species observed along Bogue Inlet. Black Skimmers comprised 20% of all observations followed by Royal Terns with 14%, Double-crested Cormorants with 13%, Brown Pelicans with 10% and Laughing Gulls with 7%. Combined, these five species accounted for 64% of all waterbird observations. Most waterbirds were observed along the Bear Island and Inlet transects. Dudley Island continues to support the lowest numbers of waterbirds. The timing of peak counts varied considerably by species. Species composition and transect use was similar to observations made during last year's surveys, although total numbers were lower along all four transects.

Table 1. Total waterbird observations for each species per transect.

Species	Bear	Bogue	Dudley	Inlet	Grand Total	Peak Count (Month)
Black Skimmer	220	725	12	1168	2125	884 (October)
Royal Tern	500	136	13	866	1515	202 (October)
Double-crested Cormorant	279	65	9	982	1335	529 (November)
Brown Pelican	490	66	32	416	1004	301 (November)
Laughing Gull	194	107	120	333	754	62 (May)
Sandwich Tern	182	99	2	337	620	77 (August)
Herring Gull	258	84	23	198	563	105 (November)
Common Tern	108	8	12	384	512	100 (October)
Least Tern	178	19	39	276	512	99 (July)
Ring-billed Gull	131	132	32	170	465	59 (October)
Caspian Tern	68	213		144	425	104 (August)
Great Black-backed Gull	79	13	8	51	151	25 (November)
Bonaparte's Gull	20	13	1	94	128	35 (March)
Forster's Tern	3	4	7	93	107	44 (October)
Snowy Egret	39	3	2	37	81	12 (July)
Red-breasted Merganser	38	7	9	3	57	25 (February)
Great Egret	18	5	15	19	57	8 (May)
Northern Gannet	52	2			54	50 (April)
Canada Goose	7	2	17	2	28	11 (March)
White Ibis	6		17		23	6 (July)
Tricolored Heron	3		5	2	10	3 (July)
Glossy Ibis				9	9	9 (September)
Great Blue Heron		1	3		4	1 (Nov, Dec, March, June)
Black Tern	3				3	1 (July, August)
Common Loon		3			3	1 (Dec, May, July)
Gill-billed Tern	3				3	2 (September)
Hooded Merganser		2			2	2 (April)
Hooded Grebe			1		1	1 (March)
Sooty Tern	1				1	1 (March)
Total Individuals	**2880**	**1709**	**379**	**5584**	**10552**	
Total Species	**24**	**22**	**21**	**20**	**29**	

Figure 1 compares waterbird relative abundance by month during the time period of November 1, 2006 through October 31, 2007. The total length of all transects in 2007 was 4.65 km and abundance is expressed as the average number of birds per survey per km of shoreline. The highest waterbird abundance was observed during October 2007. Last year, waterbird numbers peaked slightly earlier in September. Perhaps the extension of warmer weather through October this year delayed peak fall migration. Relative abundance was lowest during the months of February and March. Waterbird species richness by month is depicted in Figure 2 and is also expressed as average number of species per survey per km of shoreline. April and August had the highest richness, during spring and fall migration. January supported the lowest richness due to the lack of diversity during the colder months as many species have moved further south.

Figure 1. Comparison of waterbird relative abundance by month.

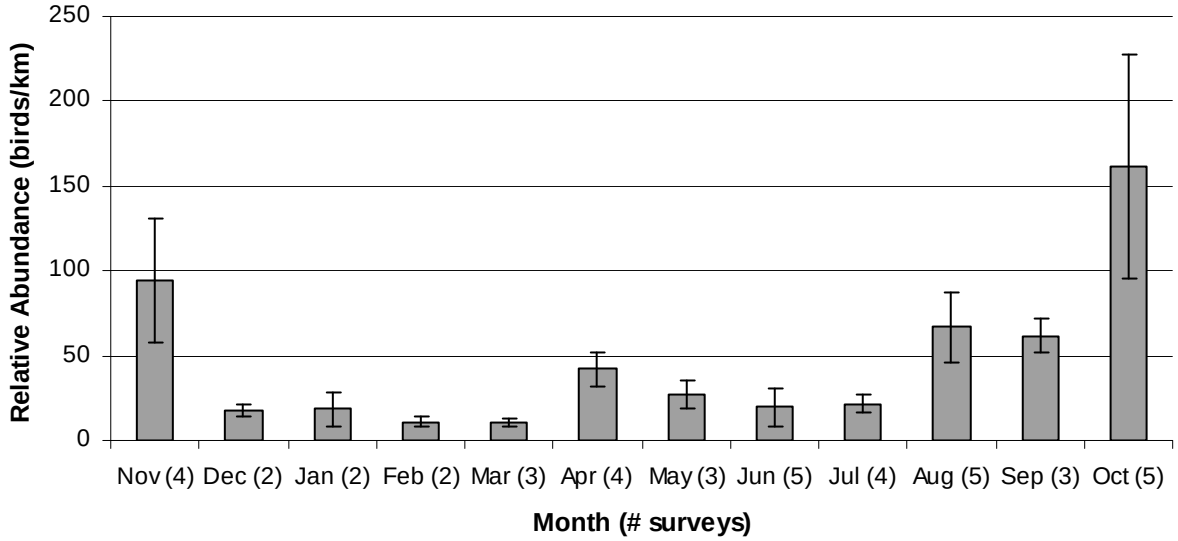

Figure 2. Comparison of waterbird richness by month.

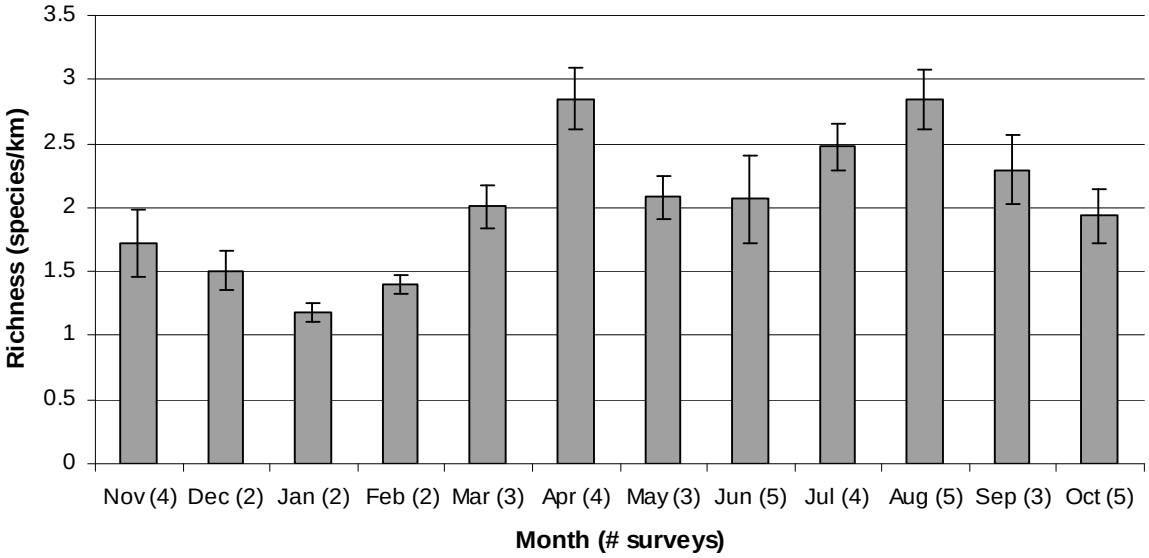

Table 2 summarizes waterbird activity within the different habitats surveyed. Activity along the Bear, Bogue and Inlet transects was very similar across all habitat types. Roosting was the most

common activity in the intertidal zone and on the beach in these transects. Waterbird activity along the beach of Dudley Island differed with only 33.3% waterbirds using the beach for roosting and 66.0% observed flying over. This is similar to results from last year's surveys and likely the result of the limited amount of dry beach habitat available on this island. In total, nearly 95.0% of waterbirds counted in the intertidal zone and 93.0% of those counted on the beach were observed roosting. Observed activities over the surf zone along most transects were flying and foraging. It appears birds spent less time foraging in the surf zone along Bear and Bogue transects than last year, but more time foraging in the surf zone along the inlet transect. Overall, 33.1% of all waterbirds counted over the surf were foraging and 52.1% were flying.

Table 2. Percentages of total waterbirds observed during surveys by activity within different habitats and transects.

Transect	Habitat	Roosting	Foraging	Flying
Bear	Intertidal	87.9	10.2	1.9
	Beach	88.6	0.1	11.3
	Surf	5.4	34.9	59.8
Bogue	Intertidal	94.7	4.3	1.0
	Beach	93.8	0.0	6.2
	Surf	13.8	13.0	73.2
Dudley	Intertidal	79.8	4.4	15.8
	Beach	33.3	0.7	66.0
	Surf	12.5	30.4	57.1
Inlet	Intertidal	97.9	0.8	1.3
	Beach	97.6	0.0	2.4
	Surf	34.1	43.6	22.3
Total	Intertidal	94.9	3.1	2.0
	Beach	92.8	0.1	7.1
	Surf	14.8	33.1	52.1

A summary of all waterbird data by transect is given in Table 3. The Inlet transect was used most often by waterbirds, with an average of 95.0 birds/km/survey observed. The accretion of sand on the inlet shoal along the relocated channel has provided a high tide roost site that is regularly used by waterbirds. This area connected with Bear Island in 2007. Even though this area is connected, it is still included in the Inlet transect for consistency. Bear Island and Bogue Banks transects saw similar numbers with 49.0 and 37.0 birds/km/survey respectively. As previously mentioned, Dudley Island hosted the lowest number of waterbirds, with just 6.4 birds/km/survey observed. On average, most waterbirds were seen roosting (76.4%) and most were found along the beach (61.4%). Similar results were found in 2006 with the majority of waterbirds observed roosting and using the beach habitat. Only Dudley Island differs from 2006 with the percentages of birds using intertidal, beach and surf habitats closely split on Dudley in 2007 but with the majority (71.7%) of birds using beach habitat in 2006.

Table 3. Summary of waterbird data by transect.

					Percentage of Birds					
Transect	Total Species	Total Individuals	Species/ km/survey	Birds/ km/survey	Habitat			Activity		
					Intertidal	Beach	Surf	Foraging	Roosting	Flying
Bear	24	2880	3.9	49.0	21.5	65.6	12.9	2.8	81.0	16.2
Bogue	22	1709	3.2	37.0	12.1	80.7	7.2	1.5	88.1	10.4
Dudley	21	379	2.1	6.4	30.1	40.4	29.5	10.5	41.2	48.3
Inlet	20	5584	4.6	95.0	37.3	59.1	3.6	1.9	95.4	2.7
Average	22	2638	3.5	46.9	25.3	61.4	13.3	4.2	76.4	19.4

4.2 Non-breeding shorebirds

Table 4 lists all shorebird species observed from November 2006 through October 2007 from most to least abundant. The five most abundant species encountered were Dunlin (*Calidris alpina*), Short-billed Dowitcher (*Limnodromus griseus*), Sanderling (*Calidris alba*), Black-bellied Plover (*Pluvialis squatarola*) and Semipalmated Plover (*Calidris pusilla*). Dunlin accounted for 31% of all shorebird observations along the four transects followed by Short-billed Dowitchers and Sanderlings both with 16%, Black-bellied Plovers with 10% and Semipalmated Plovers with 8%. These five species accounted for 81% of all shorebird observations and have been the most abundant species in previous year. As with the waterbirds, Bear Island and the inlet shoals supported the highest total numbers of shorebirds. Timing of peak counts varied considerably by species. The total number of shorebirds observed was slightly higher than last year. Use of most of the transects was similar although the inlet transect supported considerably higher numbers.

Table 4. Total shorebird observations for each species per transect.

Species	Bear	Bogue	Dudley	Inlet	Grand Total	Peak Count (Month)
Dunlin	1034	366	383	2016	3799	734 (February)
Short-billed Dowitcher	752	183	123	879	1937	290 (February)
Sanderling	517	319	106	977	1919	233 (September)
Black-bellied Plover	436	154	82	505	1177	127 (September)
Semipalmated Plover	343	318	103	235	999	249 (May)
Semipalmated Sandpiper	311	38	40	26	415	169 (May)
Wilson's Plover	256	42	33	37	368	72 (August)
Western Sandpiper	77	7	17	258	359	153 (January)
Willet	144	51	43	52	290	40 (August)
Piping Plover	85	10	14	66	175	18 (March)
Ruddy Turnstone	21	17	52	52	142	13 (May, August, September)
American Oystercatcher	61	18	27	33	139	26 (August)
Least Sandpiper	65		36	23	124	21 (September)
Red Knot	31			89	120	43 (February)
Whimbrel	47	5	2	14	68	15 (August)
Greater Yellowlegs	54	2		8	64	9 (July)
Spotted Sandpiper	10	1	18	1	30	7 (August)
Marbled Godwit	7				7	4 (August)
Killdeer	2	3	1		6	2 (August & December)
Unknown Peeps	5				5	5 (August)
Wilson's Phalarope	1				1	1 (August)
Buff-breasted Sandpiper				1	1	1 (September)
White-rumped Sandpiper			1		1	1 (April)
Total Individuals	**4259**	**1534**	**1081**	**5272**	**12146**	
Total Species	**20**	**16**	**17**	**18**	**22**	

Figures 3 and 4 display shorebird relative abundance and species richness per month along all transects. The total length of all transects in 2007 was 4.65 km. Abundance and richness data are expressed as mean number of shorebirds and species per survey per km of shoreline. In 2007, shorebird relative abundance was highest during the month of February (Figure 3). Last year, relative abundance was highest during the months of December and January, but was quite low in February. February is typically the coldest month of the year in North Carolina and a time when many birds move further south to escape extreme weather. A warm winter in 2006/2007 may have resulted in the higher numbers of shorebirds observed in February and lower numbers observed in December and January. Birds will often linger at more northern sites in response to mild weather. Large flocks of Dunlin and Short-billed Dowitchers were once again observed roosting and foraging throughout Bogue Inlet during the winter months. Again,

data indicates that Bogue Inlet is an important wintering site for these species. Shorebird numbers also peaked March through May and again in August, following the periods for spring and fall migration. The low abundance in June and July reflects the paucity of breeding shorebirds along the Bogue Inlet complex as most species of shorebirds breed in the Arctic. Shorebird species richness was greatest during peak spring and fall migration in April and August (Figure 4). The lowest species richness was in June, during the breeding season.

Figure 3. Comparison of shorebird relative abundance by month.

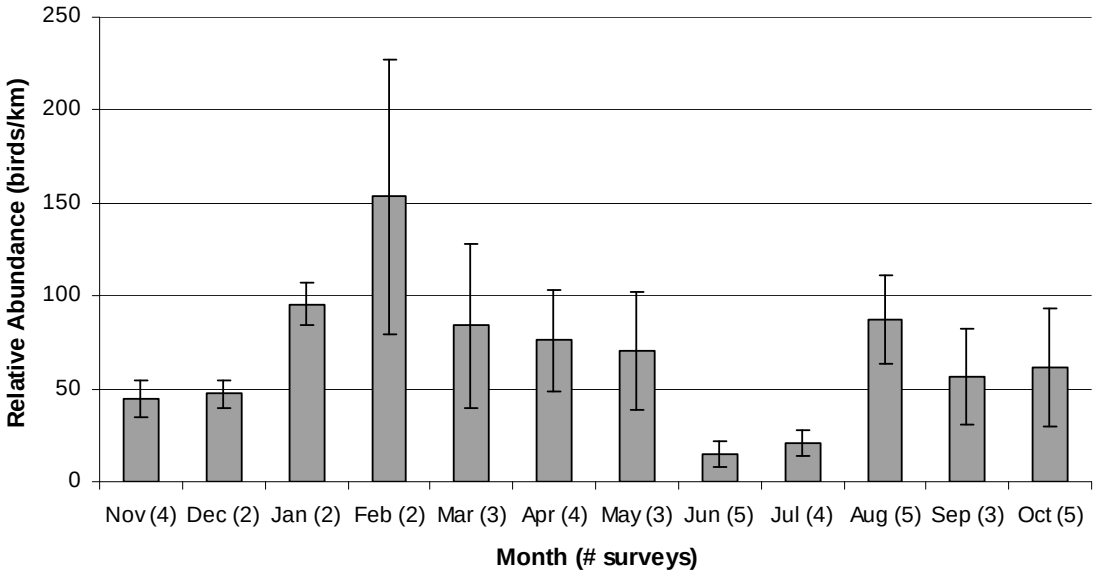

Figure 4. Comparison of shorebird richness by month.

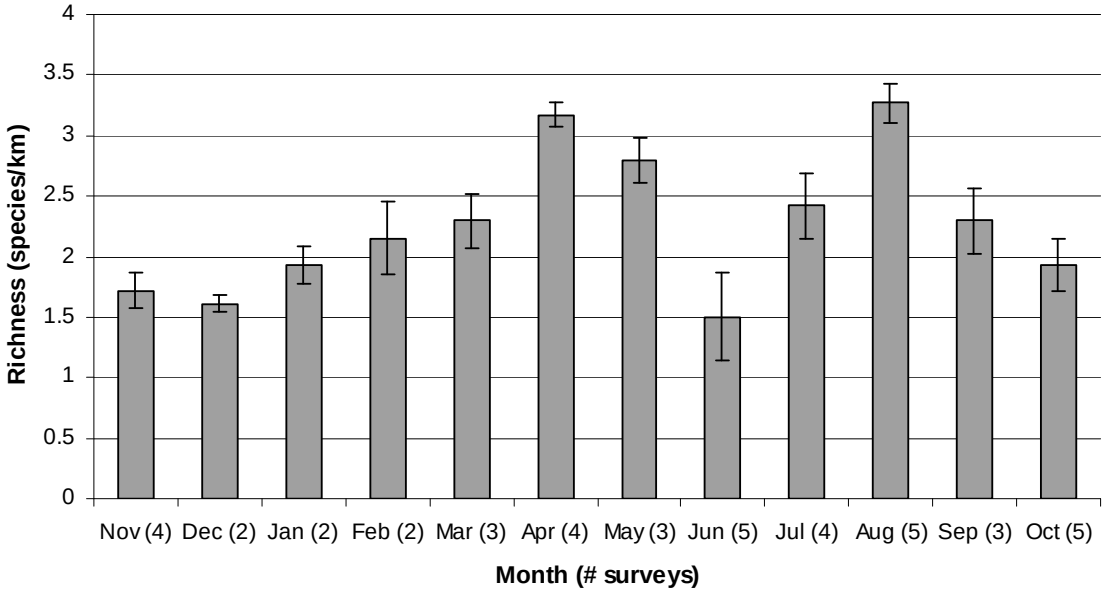

Table 5 summarizes shorebird activity within the different habitats surveyed along the Bogue Inlet complex. A similar pattern emerges for the beach and intertidal habitats along all transects with the beach used primarily for roosting and intertidal habitat used primarily for foraging. These observations are consistent with typical shorebird behavior with birds roosting along beaches at high tides and foraging on exposed shoals and along the water's edge during low tides. In total, 20.5% of shorebirds were found roosting and 78.2% foraging along the intertidal zone. In previous years shorebird activity in the intertidal zone had been more evenly split between roosting and foraging. Activity along the beach was similar to previous years with 89.7% of birds roosting and 8.7% foraging. The use of the surf habitat for roosting and foraging was primarily seen in a few of the long-legged shorebirds such as Willets (*Catoptrophorus semipalmatus*) and Greater Yellowlegs (*Tringa melancoleuca*), which were observed in deeper waters classified as surf.

Table 5. Percentages of total shorebirds observed during surveys by activity within different habitats and transects.

Transect	Habitat	Roosting	Foraging	Flying
Bear	Intertidal	29.9	70.0	0.1
	Beach	81.1	16.2	2.7
	Surf	0.0	50.0	50.0
Bogue	Intertidal	21.1	78.4	0.5
	Beach	96.6	1.5	1.9
	Surf	33.3	0.0	66.7
Dudley	Intertidal	7.4	91.8	0.8
	Beach	79.4	13.9	6.7
	Surf	0.0	0.0	100.0
Inlet	Intertidal	15.8	81.3	2.9
	Beach	94.6	5.1	0.3
	Surf	0.0	50.0	50.0
Total	Intertidal	20.5	78.2	1.3
	Beach	89.7	8.7	1.6
	Surf	3.0	15.2	81.8

A summary of shorebird data for each transect is presented in Table 6. As was the case with waterbirds, the inlet shoals supported the greatest relative abundance (89.7 birds/km/survey) followed closely by Bear Island (72.4 birds/km/survey). Dudley Island supported the lowest relative abundance (18.4 birds/km/survey). During low tides, an expansive intertidal shoal is exposed along the inlet, providing excellent foraging for shorebirds. Dudley Island also has an important foraging site in the form of a peat bank that is exposed at low tides although erosion appears to have decreased the size of the bank in recent years. On average, 70.8% of the birds were found in the intertidal zone and 28.6% were found on the beach. This varied a bit by transect with a higher percentage of birds using the intertidal zone than the beach on Dudley Island and the inlet shoals, but similar numbers using these two habitat types on Bear Island and Bogue Banks. On average, birds were observed foraging and roosting in fairly equal percentages. This was the trend along all transect except Dudley Island where 74.0% of the birds

were observed foraging. Overall, the percentage of shorebirds observed foraging has increased from previous years while the percentage observed roosting has decreased.

Table 6. Summary of shorebird data by transect.

					Percentage of Birds					
Transect	Total Species	Total Individuals	Species/ km/survey	Birds/ km/survey	Habitat			Activity		
					Intertidal	Beach	Surf	Foraging	Roosting	Flying
Bear	20	4259	4.8	72.4	59.3	40.6	0.1	48.1	50.7	1.2
Bogue	16	1534	3.3	33.2	51.9	47.9	0.2	41.4	57.3	1.3
Dudley	17	1081	3.1	18.4	77.5	20.6	1.9	74.0	22.1	3.9
Inlet	18	5272	4.2	89.7	94.4	5.5	0.1	46.3	52.0	1.7
Average	18	3037	3.9	53.4	70.8	28.6	0.6	52.5	45.5	2.0

Also of note is the continued use of Bogue Inlet by Red Knots (*Calidris canutus*). The Red Knot is a medium-sized shorebird that has shown alarming declines in recent years and is a candidate species for federal listing under the Endangered Species Act. During regular weekly surveys, a total of 120 Red Knots were observed along two of the four transects and a peak count of 43 birds was observed along the Inlet transect in February (Table 4). Counts are down from the 2005 and 2006 counts when 211 and 317 knots were counted respectively. Additionally, knots were only observed using the Inlet and Bear Island transects, while two years ago they were observed along all four transects.

Weekly surveys provide an opportunity to observe banded birds using Bogue Inlet. Banding efforts focusing on Red Knots and American Oystercatchers continue along the Atlantic Coast. In recent years, there has also been an increased effort to band Sanderlings in conjunction with Red Knots. Resightings of banded birds provides information on survivorship, migration patterns, and locations of stop-over sites for shorebird species. Appendix A lists all banded birds observed along the four transects. Most of the banded birds observed were shorebirds, although a single banded Caspian Tern (*Sterna caspia*) was seen. Two banded Red Knots were seen on the Inlet transect and two banded Sanderlings were observed along the Bogue transect in 2007. Lastly, two American Oystercatchers, originally banded in South Carolina, were seen roosting on Bear Island during fall migration this year. Banded Piping Plovers were also recorded during the surveys and these are briefly discussed in the following section.

4.3 Piping Plovers

The federally listed Piping Plover was observed along all four transects during 2007 (Table 7). The majority of Piping Plovers were observed along Bear Island, followed closely by the inlet shoals. Similar to previous years, birds on Bear Island used intertidal and beach habitats almost equally. Along the inlet shoals, Piping Plovers used the intertidal habitat almost exclusively. This is a change from earlier years when birds could be found roosting in addition to foraging and changes might be a result of the continued loss of supratidal habitat and an increase in intertidal habitat along this transect. The majority of birds were observed foraging along all four transects. Overall we are seeing similar numbers of Piping Plovers using the inlet complex when compared with earlier years, although their use of the different transects has changed. Observations of birds using the Inlet transect have increased considerably, while numbers using

the west end of Bogue Banks and Dudley Island has decreased slightly. Numbers using Bear Island are similar to earlier years. Numbers of wintering birds have fluctuated between seven and nine since surveys began. This year, eight plovers were found wintering at Bogue Inlet.

Table 7. Summary of total Piping Plover observations and percentage of observations by habitat and activity.

		Habitat Use (%)			Activity (%)			
Transect	Total Obs.	Intertidal	Beach	Surf	Roosting	Foraging	Flying	Peak Count (Month)
Bear	85	45.9	51.8	2.3	22.4	74.1	3.5	15 (October)
Bogue	10	90.0	10.0	0	10.0	90.0	0	4 (April)
Dudley	14	35.7	64.3	0	14.3	85.7	0	9 (April)
Inlet	66	92.2	7.8	0	4.7	95.3	0	18 (March)

Monitoring of banded Piping Plovers along the Bogue Inlet complex continued in 2007. Three banded plovers were observed this year and all were from the endangered Great Lakes population (Appendix A). One banded bird (X,R:O,-) was observed foraging on the Inlet transect February through April in early 2007. The same bird returned in the fall of 2007 and was again observed foraging along the inlet shoals.

4.4 Breeding waterbirds and shorebirds

Colonial waterbird and shorebird nesting activity was monitored from early April through July in 2007. The west end of Bogue Banks again supported two pairs of nesting Wilson's Plovers and one pair of American Oystercatchers. The two Wilson's Plover pairs each attempted to nest only once. One pair lost its nest prior to hatching most likely to predation as evidenced by raccoon tracks along portions of the transect. The second pair hatched three chicks with one chick surviving to fledge. Nest success (% of nests to hatch at least one chick) was 50% and fledging success (# of fledglings per breeding pair) was 0.5. The cause for chick loss is unknown, but human disturbance by beach-goers and extreme high tides after hatching may have contributed to losses. Wilson's plover productivity on Bogue Banks was the same during both the 2005 and 2006 breeding seasons.

A single American Oystercatcher nest was first documented on the west end of Bogue Banks during the May 12, 2007 survey. The eggs were abandoned by June 2nd, immediately following Memorial Day weekend. The cause of abandonment was undoubtedly human disturbance as the incubating adult was frequently seen running off the nest in response to people walking along the pedestrian corridor. In 2005 and 2006, nesting oystercatchers suffered similar fates. Due to the loss of supratidal habitat on the west end of Bogue Banks, there is not enough area to provide an adequate buffer for nesting oystercatchers while also allowing for a pedestrian corridor. Additional management in the form of closing a small section of beach to the public near future nests to provide a proper buffer is warranted given the consecutive years of failure as a result of human disturbance.

A pair of Piping Plovers was observed showing territorial and breeding behavior on the west end of Bogue Banks during late April 2007. A male was observed performing territorial flights and

attempting to attract a female foraging on the mudflats. Later, the male was observed scraping along the beach just above the high tide line. No nest attempts were made by the female and the six scrapes created by the male were overwashed during an extreme high tide event. The birds were not seen past May 12, 2007 and it was assumed they moved to Bear Island. While no eggs were laid, it was encouraging to see breeding activity at this site, but loss of beach habitat here remains a concern.

Three pairs of Wilson's Plovers and one pair of American Oystercatchers nested on Dudley Island this breeding season. All nest attempts failed and nest losses were most likely due to human disturbance, mammalian predation and the early-season tropical storms. Wilson's Plovers chicks were observed foraging along the beach, but none survived to fledge. The number of nesting Wilson's Plover pairs at this site has decreased from previous years. Also, no nest attempts were made by colonial waterbirds this year. The pair of oystercatchers nested very close to the 2006 nesting site. This nest was overwashed by Sub-tropical Storm Andrea.

Bear Island supported the greatest number of nesting Wilson's Plovers in the Bogue Inlet complex. Six pairs were observed nesting along the inlet spit. Nest success on Bear Island is unknown, but at least two fledglings were observed late in the season. Two pairs of Least Terns attempted nesting within the posted area, but failed due to unknown causes. Numbers of nesting colonial waterbirds on Bear Island have declined over the past four years. Mammalian predators including fox and raccoons have been a problem at this site in recent years and likely contributed to nest/chick losses this year and to the declines in the number of breeding pairs over the years. It is unknown if humans had a detrimental effect on the nests, but people were seen within the posted area on a couple of occasions and human tracks were often observed. Bear Island is a popular destination during the summer and people can be seen using both sound and ocean beaches of the island's east end.

Finally, Bear Island saw the return of a pair of Piping Plovers during the summer of 2007. Territorial and breeding behavior was observed though no eggs were ever found. The male was observed performing a courtship ritual on May 12th and scrapes were found in early June. It is unknown if eggs were laid and quickly lost to predation or if the pair never reached the egg-laying stage. A predator exclosure has been created as described in the Piping Plover Recovery Guidelines (USFWS 1996). The exclosure will be used if the pair returns and lays eggs in an effort to protect the nest from mammalian and avian predators.

4.5 Disturbances

Table 8 describes disturbances observed during surveys along each of the transects. Of note is the increase in the number of people recreating along the Inlet transect. In 2007 an average of 6.57 people were counted per survey compared to just 1.32 per survey in 2006. The accretion of sand along the inlet shoals has created a small stretch of beach that remains above high tide and is very popular with boaters. The west end of Bogue Banks also had high levels of human disturbance with an average of 3.31 people per survey observed. The number of people encountered during surveys on Bear Island was down with an average of 1.17 people per survey and Dudley Island saw the lowest number with 0.45 people counted per survey. The number of dogs encountered during surveys was similar to previous years with eleven dogs seen along three

of the four transects. With the human population and the number of people with boats increasing in Carteret County, we would expect the number of visitors to the inlet to increase in the future. This highlights the need to continue to protect certain areas for breeding and non-breeding waterbirds and to educate the public about coastal birds.

Table 8. Summary of recorded disturbances for each transect.

Type of Disturbance	Bear	Bogue	Dudley	Inlet
Humans (total individuals)	49	139	19	276
Pets (total individuals)	0	2	3	6
Average number of people per survey	1.17	3.31	0.45	6.57
Percent of surveys with a human/pet	19%	26%	12%	38%

As previously discussed, two storms struck the North Carolina coast early in the summer season and may have impacted nesting this year. Tropical Storms Andrea and Barry brought strong winds and heavy rains during May and June. While untimely storms can be a significant disturbance to beach-nesting birds, a much large issue is disturbance by mammalian predators. Mammalian tracks were documented along the west end of Bogue Banks, Bear Island and Dudley Island. Tracks included those of raccoon and fox, major predators on beach-nesting bird nests. Constant disturbance from predators during the breeding season can lead to low reproductive success and can cause birds to abandon a nesting site. Predator pressure is likely the reason for the deterioration of the Bear Island colony.

5. Conclusions and Recommendations

Bogue Inlet continues to provide important habitats for migrating and wintering waterbirds and shorebirds with thousands of observations of each made over the course of the year. Piping Plovers used the inlet complex during migration and during the winter and were recorded every month of the year. As noted in last year's report, anecdotal observations indicate that foraging habitat is still abundant and numbers of shorebirds and observations of piping plovers along the inlet complex are up from previous years. However, the number of potential roost sites has declined. Bear Island continued to accrete providing addition intertidal and supratidal habitat, but the west end of Bogue Banks, Dudley Island, Island #2 and Island #1 continued to erode. Island #2 has lost its dry sand beach and is now almost all intertidal habitat and Island #1 has disappeared completely. The loss of supratidal habitat is supported by observations of shorebird habitat use along the transects, with a greater use of intertidal habitat and lower use of beach habitat on all transects except the one that runs along Bear Island. Furthermore, during periods of extreme high tides, Bear Island provides the only roosting habitat within the inlet complex.

Nesting activity within the Bogue Inlet complex has declined from previous years. While breeding activity was observed by shorebirds on Bear Island, the west end of Bogue Banks and Dudley Island; very little nesting by colonial waterbirds was observed. In fact, the only nest attempts made by colonial waterbirds this year, were by two pairs of Least Terns on Bear Island. As recently as 2004, nearly 100 pairs of Least Terns could be found nesting along the inlet (NCWRC 2007). Least Terns did not return to nest on Island #2 where they nested in 2004 or Dudley Island where they nested for the previous three years. The return of a pair of breeding

Piping Plovers to Bear Island remains a significant observation. However, their inability to have a successful nesting season, for the second year in a row is a concern.

The decline in nesting along Bogue Inlet can likely be attributed to two factors. First, there has been a loss of supratidal habitat on the west end of Bogue Banks and on Island #2. Island #2 did not support any nesting this season, since most of the island is submerged during high tides. Second, while there has been an increase in the amount of nesting habitat on Bear Island, this increase has come at a time when mammal populations are increasing on the island. In the past couple of years, fox have found their way to the island. Fox are detrimental to beach-nesting birds and once present on an island, breeding birds quickly disappear. Raccoons also continue to be a problem. Historically, mammalian predators were absent or present only in very low numbers on barrier beaches. They have benefited greatly from human refuse and are now abundant on many barrier islands. The arrival of fox on Bear Island comes at a time when there are fewer options for nesting sites along Bogue Inlet.

The low nesting success along Bogue Inlet is likely a result of abundant mammalian predators and to a lesser extent human disturbance. There are options for improving both the quality and quantity of nesting habitat along Bogue Inlet. With the partnership formed between the Town of Emerald Isle and cooperating agencies, there is great opportunity to restore nesting habitat within the Bogue Inlet complex. For example, there may be occasions to protect newly created habitat, such as the spit that's forming near the sandbags on Emerald Isle. It might also be possible to create new habitat in the future through disposal of dredged material. Finally, the control of mammalian predators particularly on Bear Island, would greatly benefit nesting waterbirds in the area. These have all been effective management tools in other areas (Hunter et al. 2006). Finally education remains a valuable tool for protecting waterbirds. Biologists with NCWRC will continue to provide education by leading weekly bird walks during the summer, having a presence at important nesting areas during peak hours on summer weekends, and distributing the beach-nesting bird brochure.

This annual report provides a summary of waterbird and shorebird use of Bogue Inlet during the past year. We will continue to collect post-project data for one more year to assess the impacts of the project. At the conclusion in 2008, an in-depth analysis of all data will be complied to create the final report.

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Appendix A. Summary of all banded birds observed during surveys.

Species	Transect	Left Band	Right Band	Banding Location
American Oystercatcher	Bear	UL: yellow; LL: blue/metal	UR: black; LR: none	Cape Romain NWR, South Carolina on 10/16/2003
American Oystercatcher	Bear	Blue 70	Blue 70	Cape Romain NWR, South Carolina on 9/14/2006
Caspian Tern	Bogue	White w/ black alpha code APF	Metal	Unknown
Piping Plover	Dudley & Bear	None	UR: metal; LR: split color band light green/orange	Platte River area, MI, banded as chick 2005 or 2006
Piping Plover	Inlet	UL: metal; LL: yellow	UR: none; LR: orange/light blue	North Manitou Island, MI, banded as chick 2005
Piping Plover	Inlet	UL: metal; LL: red	UR: orange; LR: none	Grand Marias area, Great Lakes, MI, banded as chick 2005 or 2006
Red Knot	Inlet	UL: lime green flag w/ unknown alpha; LL: none	UR: lime green; LR: metal	DE, NJ or VA 2006
Red Knot	Inlet	UL: lime green flag w/ numeric code 05; LL: none	UR: dark green; LR: metal	Kimbles Beach, NJ banded on 5/19/03
Sanderling	Bogue	UL: lime green flag w/ alpha code NUO; LL: none	UR: none; LR: metal	Unknown
Sanderling	Bogue	UL: lime green flag w/ alpha LET; LL: none	UR: yellow; LR: metal	Unknown

ANNUAL PERFORMANCE REPORT

State: **North Carolina**

Period Covered: **July 1, 2007 - June 30, 2008**

Project Title: **Bald Eagle Monitoring**

Funded By: **National Fish and Wildlife Foundation Grant #2006-0176-002**

Objectives:

We attempted to locate and monitor known bald eagle nesting territories across North Carolina. Occupancy, activity status, and the number of chicks fledged are determined by field observations from each bald eagle nest on non-federal lands in the state. Potential new eagle nests were investigated when reported. Land use, ownership, and potential disturbances around nests are documented. Letters were sent to inform non-federal landowners with eagle nests about the status of the nests and their responsibilities as landowners to protect the nests as stated under the Bald and Golden Eagle Protection Act. Data on each eagle nesting territory was obtained through various survey techniques as well as information collected from biologists and the public.

A: Activity

Coordination

The Coastal Wildlife Diversity Supervisor is responsible for coordination of the bald eagle project. A technician was hired this year to monitor the nesting territories in the Coastal Region. The duties of the technician are to assist the Coastal Wildlife Diversity Supervisor in investigating reports of possible new bald eagle nests, conducting aerial and ground surveys of known nests and to assess activity and productivity. The supervisor will also review projects concerning their effects on eagles.

The Piedmont Wildlife Diversity Supervisor and the Mountain Wildlife Diversity Supervisor both coordinated efforts to monitor territories in their respective regions. These employees of the Wildlife Diversity Program collected data themselves and also from other observers including additional North Carolina Wildlife Resources Commission employees, biologists and employees from State Parks, the U.S. Fish and Wildlife Service, the U.S. Army Corps of Engineers, and other interested individuals.

Nest Monitoring

A total of 121 eagle nesting territories are now known within the state. The Coastal Region continues to have the majority of known nests. There are 72 known nests in the Coastal Region, which includes 8 new nesting territories that were found this year. The Piedmont Region added 3 new nesting territories this year, bringing the total number of known nesting territories to 42. The Mountain Region has 7 known nesting territories, which includes 1 new territory.

These nests were monitored by ground, water, and aerial surveys. Nesting season in North Carolina runs from the beginning of December to the middle of July. With the goal of monitoring both nesting activity and productivity, observers attempted to visit nest sites early in the nesting season (January – March) for activity estimates and again late in the nesting season (April – July) to determine productivity. A nest is considered occupied if at least one adult is

present during the breeding season. A nest is considered active if eggs are laid or an adult is seen in incubation posture during the breeding season. If any chicks fledge, the nest is considered successful. Chicks observed in the nest after mid April are considered to have fledged because of the low rate of chick loss late in the nesting cycle.

Across the state, at least 93 of the 121 known nesting territories were occupied this year. At least 90 of the territories were active. At least 69 nests were successful in 2008 and production totaled at least 123 fledglings. This total of fledglings is a new record high for North Carolina and exceeds the previous record set last year by 12. Productivity was down from 1.72 young fledged per active nest in 2007 to 1.37 young fledged per active nest in 2008. Of the successful nests, 1.78 young fledged per nest in 2008. There were at least 8 inactive nesting territories this year. Nests are considered inactive when there are no signs of nesting activities throughout the nesting season.

Table 1. Summary of regional nesting activities across the state

Region	Occupied	Active	Successful	Chicks Fledged	Chicks Fledged per active nests	Inactive
Coastal	52	50	41	66	1.32	4
Piedmont	34	33	22	43	1.30	4
Mountain	7	7	6	14	2.00	0
Totals	93	90	69	123	1.37	8

Twenty nesting territories did not have complete monitoring this year for various reasons. Seventeen of the nests were in the Coastal Region and three were in the Piedmont Region. Four of the nests were empty when observed late in the nesting season, the probability that chicks could have already fledged by this date lead to the insufficient data. Five of the nests were not located when flown over and two nests were not found when checked from the ground. Five of the nests were not checked due to restricted flight areas and lack of flight time towards the end of the nesting season. Three nesting territories on federal lands were not checked this year, and one last nesting territory was not checked due to time constraints.

New Nesting Activity

Statewide, 12 new bald eagle nesting territories were found this year. In the Coastal Region, 8 new nests were found. Beaufort County added a new territory this year and it was reported by an environmental consultant. New nests were found in Bertie and Pamlico Counties during our flights. NCWRC employees found nests in Craven and Pitt Counties. Gates County added their first known nesting territory at Merchants Millpond State Park and it was found by a park ranger. Two new nesting territories were added in Martin and Pitt Counties. These new nests were alternate nests locations from previously known territories. This year the known territories were active along with the alternate nests. Since all locations were active, two new territories split from their previously known territories.

In the Piedmont Region, three new nesting territories were found this year. Two new nesting territories were found in Edgecombe County. One was found by a NCWRC employee and the other by a retired NC forester. A new nesting territory was found in Guilford County at the High Point Lake.

In the Mountain Region, one new nesting territory was found at Riverbend State Park in Catawba County.

Prime eagle habitat was surveyed during eagle flights this season. New nest were looked for around major rivers, creeks, aquaculture facilities, woodlands and wetlands. Two new nests were discovered this year during the aerial surveys. One was found in Bertie County in the dense wetlands along the Roanoke River. The other new nesting territory was found in Pamlico County along the Neuse River.

B: Target Dates for Achievements and Accomplishments

All planned activities are on schedule.

C: Significant Deviations

No significant deviations.

D: Remarks

Nesting Activity

The majority of the nesting territories in North Carolina are located in the Coastal Region of the state. The counties with the highest concentrations of eagle nesting territories are Beaufort (11), Craven (9), Pitt (8), Chatham (6), Hyde (5), and Wake (5).

Prime habitats associated with bald eagle territories are generally located around major rivers, lakes, and sounds. The Tar/Pamlico River has the most known nesting territories in the state. This water body runs through 8 counties and has 15 known nesting territories. The Yadkin/Pee Dee River, Roanoke River, and Albemarle Sound all have 9 known nesting territories associated with them. Jordan Lake in Chatham County has 6 known nesting territories. The Neuse River has 5 known nesting territories and Falls Lake has 4 known territories.

Mortalities/Injuries

This year we had four reports of injuries and deaths of bald eagles in the Coastal Region. In Craven County, an adult bald eagle died when it collided phase to phase with overhead power lines near an aquaculture facility. The power lines are owned by Progress Energy and they took immediate action following this incident. They began to reconstruct the overhead lines at the facility utilizing longer cross arms to increase clearance between phases. These modifications are intended to make the lines near the aquaculture facility more avian safe.

In Currituck County at the Mackay Island Wildlife Refuge, an adult eagle was found injured. Staff found the injured eagle and believed that the eagle suffered its injuries fighting with another adult eagle. The injured adult was taken to a wildlife rehabilitator in Virginia and died shortly after arriving.

In Wilson County, a young eagle was found dead underneath its nesting tree after the tree had blown over. The young eagle apparently died upon impact.

A 6-month old bald eagle was found with injuries to both wings near Pea Island National Wildlife Refuge. It was taken to a Veterinary Clinic in Manteo where it got immediate

treatment. The eagle was then taken to a wildlife rehabilitator in Edenton and then transported to the Carolina Raptor Center. The eagle received several weeks of rehabilitation and was placed in a 100 ft. outdoor flight cage for exercise. After successful recovery, the young eagle was released at the Alligator River National Wildlife Refuge.

Technical Guidance

Technical guidance issues continue even though the bald eagle is no longer protected by the Endangered Species Act. The eagle is still protected under the Bald and Golden Eagle Protection Act that was enacted in 1940 with several amendments since then. Private landowners and logging companies have asked for and received guidance. The main question has pertained to the decreasing size of the primary and secondary protective zones surrounding the nesting tree. The primary zone decreased from 750 ft. to 330 ft. and the secondary zone decreased from 1500 ft. to 660 ft. surrounding the nesting tree. Several reported new eagle nests were investigated, and most were found to be osprey nests.

Letters to landowners are currently being composed, and addresses are being collected. We intend to send these landowner letters in September. All data will be presented to the US Fish and Wildlife Service and the North Carolina Natural Heritage Program in September as well.

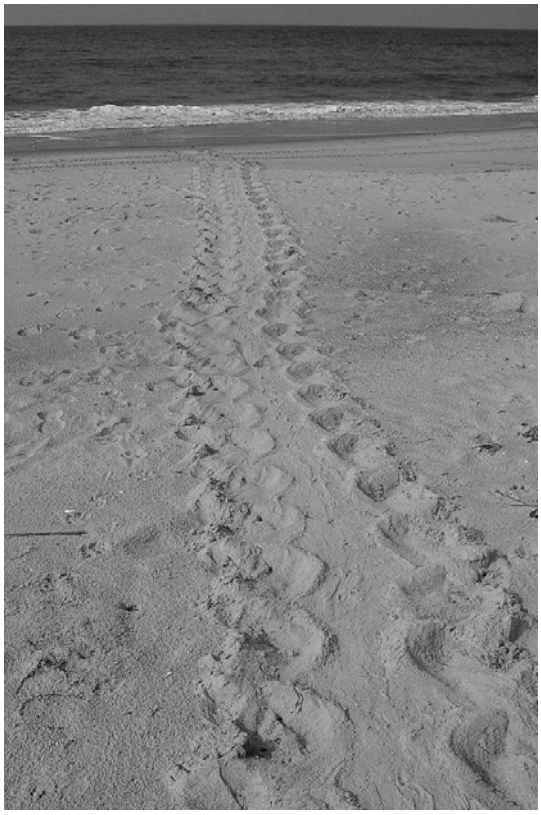
E: Recommendations

As the number of bald eagle territories in North Carolina continues to increase, monitoring all eagle territories in future will be difficult. It is recommended that all known eagle territories should continue to be monitored for at least one more year. After this time, a sub sample system should be considered.

F: Estimated Cost (FY-2007-08) **$ 32,733.38**

Prepared By: David H. Allen - Coastal Region Wildlife Diversity Supervisor
Fred Jarrett – Bald Eagle Technician

Sea Turtle Monitoring Project Report
Bogue Banks, North Carolina



Loggerhead turtle crawl on Atlantic Beach, NC

2002-2007 Final Report

Kristin T. Holloman & Matthew H. Godfrey
NC Wildlife Resources Commission
March 2008

Introduction

The study of the effects of beach renourishment on sea turtle nesting on Bogue Banks was initiated following concern that material placed on the beach may be different from what originally existed on the nesting beaches. Differences in sediment may have negative impacts on sea turtle reproduction. For instance, sand temperatures directly affect sea turtle nests: sex determination in hatchlings is dependent upon the temperature at which nests incubate, with higher temperatures yielding greater numbers of females while cooler temperatures result in more male hatchlings (Wibbels 2004). If nourished material is darker than natural material, then nourished beaches could result in warmer nests if turtles lay their eggs in darker nourished sand, as darker sand absorbs more solar radiation (Hays et al. 2001). This is of particular concern as North Carolina is roughly the northern boundary of sea turtle nesting in the SE USA. North Carolina sand temperatures are cooler than those of more southerly states, thereby producing relatively more male hatchlings than more southerly states (Mrosovsky et al. 1984; Mrosovsky & Provancha 1992; Hanson et al. 1998, Hawkes et al. 2007). Other potential impacts include the possibility that dark sediment could create nest temperatures that are too hot for successful embryonic development (Matsuzawa et al. 2002) or that the nourished material is too compact for successful nest construction by adult female sea turtles.

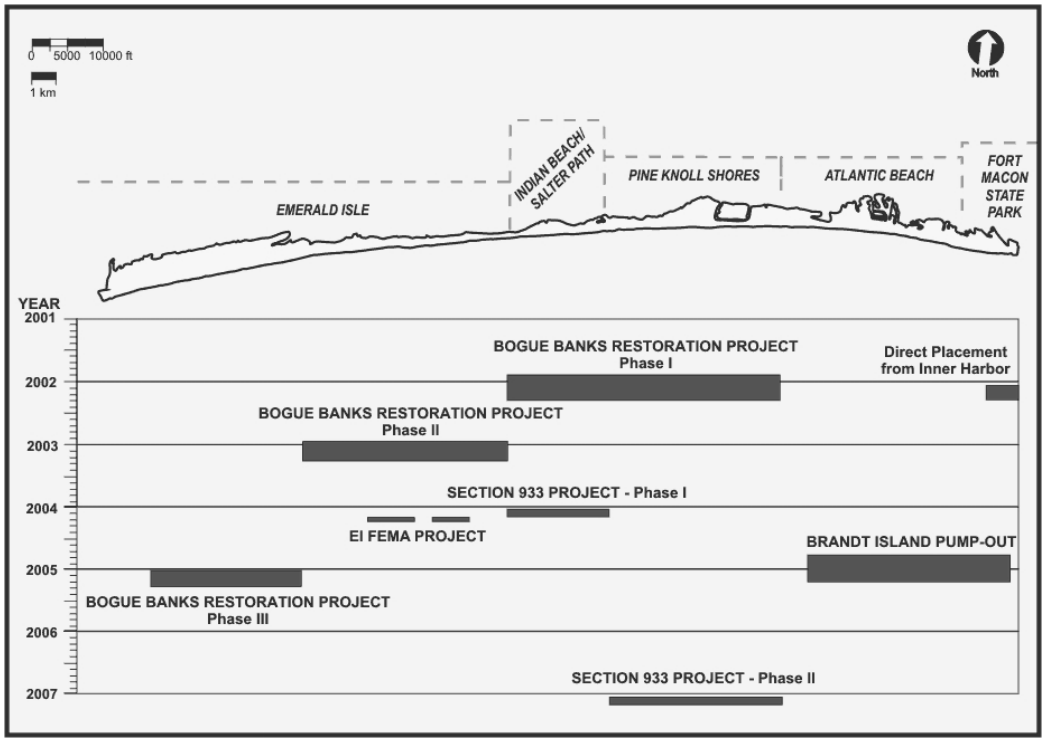


Figure 1. Schematic representation of Tier II nourishment projects on Bogue Banks since 2001. Figure reproduced from www.protectthebeach.com

Initially, Bogue Banks was to undergo three phases of nourishment, with placement of dredged material on roughly one third of the island per year, beginning in the winter of 2001/2002 in Pine Knoll Shores, continuing in the winter of 2002/2003 with material placed in eastern Emerald Isle, and finishing in the winter of 2003/2004 with placement of material in western Emerald Isle. Following the end of Phase III, there would be three years of post-project

monitoring. However, this initial schedule was changed for a variety of reasons, including the need for an emergency response to Hurricane Isabel that struck North Carolina in 2003, plus several other dredge disposal events on the island between 2002 and 2007 (see Figure 1). As a result, in the initial years of study, we aimed to compare nests and nest habitat of nourished vs. nonnourished areas of Bogue Banks. In the later years of the study, we used Bear Island, located just to the west of Bogue Banks, as a control site, as Bear Island is a state park and did not received dredge material except for a small section on the eastern end in May 2006.

Methods

Morning patrols for sea turtle activity were conducted daily along the beach by a contracted sea turtle monitor using an ATV from 1 May through 31 August of each year. Unless they were postponed due to lightening or other issues, the patrols began at dawn and were completed no later than 10:30 am. The monitored area extended roughly 18 miles westward from the Atlantic Beach/Pine Knoll Shores town boundary to Bogue Inlet in 2002; from 2003 onwards, monitored was extended from the Ft. Macon/Atlantic Beach boundary to Bogue Inlet (roughly 21 miles). Along the entire beach in Emerald Isle, Salter Path, Indian Beach and Emerald Isle, volunteers were assigned designated zones that they patrolled each morning to record crawl and nesting information. Specific details of each new turtle track were recorded, including whether it was a false crawl or nest, GPS coordinates, street location, date, etc. A crawl was defined as a nest only after carefully moving sand and confirming the presence of eggs. Nests were covered again, cordoned off and protected using four wooden stakes, construction tape and a sign. Nests were observed daily during incubation for evidence of overwash, predation, or human manipulation.

From 2002 through 2007, there was a moratorium on all relocations of nests, regardless of location or perceived threats. This helped to minimize the influence of extraneous variables in the assessment of effects of renourishment on sea turtle nests. Therefore, all nests were left in their original locations for the duration of incubation and emergence periods, except in a few cases when eggs from nests were exposed from erosion and were relocated midway through incubation. For all nests, as day 55 of incubation approached, volunteers fashioned a protective runway intended to aid hatchlings in their journey to the ocean. High edges discouraged hatchlings from crawling laterally along the shore and sand was cleared of debris and smoothed to facilitate the quick entrance of hatchlings into the sea. Staking off the runway created added protection for the hatchlings by keeping spectators at a distance. Many volunteers "sat" with the nests at night to be able to witness the hatching event. In doing so, they were able to provide estimates of the hatching time or number of turtles that emerged and also ensured that passersby on the beach did not interfere with the process. At least three days after the main emergence event, each nest was excavated in order to determine the hatching success rate, record any noticeable characteristics of the nest, and expedite the emergence of any live hatchlings remaining in the nest. Nest contents were segregated into the following groups: whole unhatched eggs (UE), empty eggshells (ES), broken or pipped eggs that contained a dead hatchling (PE), dead hatchlings free from any shell (DH) and live hatchlings (LH). The following equations were used to characterize the reproductive success of the nest.

$$\text{Total clutch size (CS)} = UE + ES + PE$$
$$\text{Hatching success} = (ES - DH) \div CS \times 100$$

Following nest excavation, any remaining live hatchlings were released to enter the ocean. Occasionally, injured or deformed hatchlings found alive in the nest were taken to the PKS Aquarium for rehabilitation and eventual release. The remaining nest material was then reburied into the original nest chamber. Early evening excavations provided valuable opportunities for public education, as people walking along the beach saw the action and quickly become a crowd of curious observers.

Temperatures were monitored during the nesting season using dataloggers, either Hobo H8, Hobo Pro, or Hobo Pendant (Onset Computer Corporation, USA). These small dataloggers (1.5 cm x 3cm x 1cm) were programmed to record temperatures every two hours (± 1.0°C accuracy, with 0.4 °C resolution). To measure nest temperatures, a datalogger was placed into the middle of each nest as soon as possible after laying, with care taken to avoid rotating the eggs temporarily removed from the nest. To measure sand temperatures, 8 transects were established along Bogue Banks: 2 in Atlantic Beach, 2 in Pine Knoll Shores, and 2 in Emerald Isle. Each transect consisted of 2 dataloggers that were buried at mid-nest depth (45cm), one at the toe of the dune, the second about halfway across the berm. The majority of loggerhead sea turtle nests are laid within the zone encompassed by these two sites.

Finally, a cone penetrometer was used to assess shear resistance of sand in nourished and non-nourished sand. When a turtle crawl was encountered, sand compaction measurements (in PSI) were immediately taken at depths of 6, 12, and 18 inches due North, East, South, and West within 2 feet of the nest or final apparent nesting attempt in the case of false crawls. Initially, only 3 replicate readings at each depth were taken, but starting mid-season 6 replicate measurements were taken to increase statistical accuracy. At sites where the sand was too compacted to get readings at all depths or in all directions, the compaction was recorded as "NA." In such cases, the minimal value of compaction was assumed to be the same as the readings recorded at preceding depths.

Results

2007 Season Data

In place of a separate annual report for 2007, we report here the specific data collected from May through November 2007. In 2007, the Sea Turtle Monitoring Project collected sea turtle nesting data for a sixth year on the island of Bogue Banks (Carteret County, North Carolina). The project collects and examines data relative to the effects of beach nourishment on sea turtle reproduction during the sea turtle nesting and hatching season (May 1 to November 15). The monitored area includes the ocean-facing beaches of Atlantic Beach, Pine Knoll Shores, Indian Beach/Salter Path, and Emerald Isle.

Table 1. Sea turtle activity on Bogue Banks in 2007

Beach area	False crawls	Nests	Hatchling emergence success
Atlantic Beach	4	1	0%
Pine Knoll Shores	2	3	61.8% ±53.6SD
Indian Beach/Salter Path	1	2	92.9% ±8.5SD
Emerald Isle	20	17	75.4% ±31.6SD
Bogue Banks	**27**	**23**	**71.8% ±33.1SD**

2007 Nesting

In the 2007 monitoring season, 23 nests were confirmed on the island of Bogue Banks (excluding Fort Macon). All nests were laid by loggerhead sea turtles. Of the 23 nests, 17 nests were laid in Emerald Isle, 2 nests were laid in Indian Beach/Salter Path, 3 nests were laid in Pine Knoll Shores, and one nest was located in Atlantic Beach (Table 1). See Appendix I for location data. The ratio of False Crawls to Nests was nearly 1:1.

2007 Sand Temperatures

The sand temperature dataloggers were retrieved from the beach on October 31, 2007 from each of the six transects along Bogue Banks. The two dataloggers used in the Emerald Isle West transect failed in mid June, so no sand temperature data were available from this area for the majority of the season. Tropical storm activity in September 2007 required most of the dataloggers to be removed from the beach for approximately two weeks. In general, sand temperatures were cooler than 29.2 °C, the NC loggerhead pivotal temperature (Mrosovsky 1988), except for late July and early August (Figure 2). The exception was the eastern end of Emerald Isle, where sand temperatures exceeded the pivotal temperature from late June through late August. The two locations on Bear Island were also relatively cool, with temperatures exceeding pivotal for only late July and/or early August (Figure 2).

2007 Nest Temperatures

Dataloggers were placed in 16 nests on Bogue Banks and three nests on Bear Island, to record incubation temperature during the 2007 nesting season. Data from three dataloggers from nests on Bogue Banks were unavailable, due to malfunction, and for the three nests laid on Bear Island, the dates of emergence were not recorded, making it impossible to compare Bear Island and Bogue Banks nest data. For the other nests, temperatures varied during incubation and according to when the nests were laid (Figure 3). Nest temperatures generally increased during the incubation period, due to increasing metabolic activity of embryonic development (Godfrey et al. 1997) and also due to the seasonal increase in sand temperatures (Figure 2).

The thermal influence on sexual differentiation in sea turtle development occurs in the middle third of egg incubation (Mrosovsky & Pieau 1991). Therefore, to better characterize the potential thermal impact of sea turtle nest incubation in nourished material, the nest temperatures of the middle third of incubation were analyzed (Figure 4). The majority of the nests were above the pivotal temperature during their thermosensitive period for sexual differentiation. However, to minimize the influence of seasonal changes in sand temperatures, it is ideal to compare temperatures of nests laid on or around the same day of the season. In the 2007 nesting season, only two sets of nests that were monitored for temperature were laid on the same day: three nests laid 6-7 June, and 2 nests laid on 16-18 June (Appendix I).

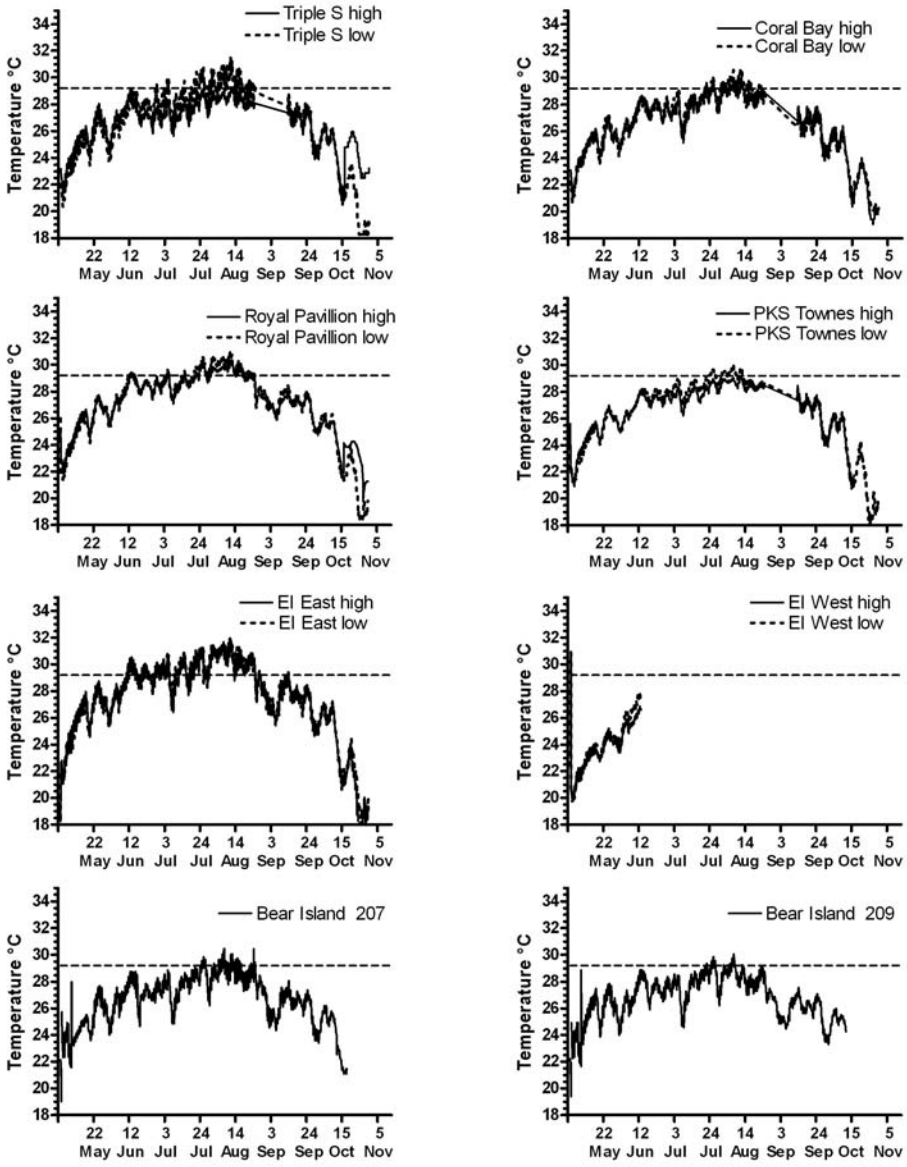


Figure 2. Sand temperatures collected at 6 different transects on Bogue Banks, 01 May through 31 October, with two sites from Bear Island (to the west of Bogue Banks). Dotted line = pivotal temperature (Mrosovsky 1988)

These groups of nests are indicated by the open triangles and open squares in Figure 3. Note that nests laid in the western end of Emerald Isle were cooler than nests laid at similar times but further east on Bogue Banks. This corresponds to the color of the material placed on the beaches of Bogue Banks: western Emerald Isle received lighter material during Phase III of the nourishment project while further east, darker material from other locations was placed on the beach. The mean temperature of nests EI 2 and EI 4 were significantly cooler than nests laid

around the same time but further east ($p<0.001$, Kruskal-Wallace nonparametric test, with Dunn's multiple comparison test correction factor).

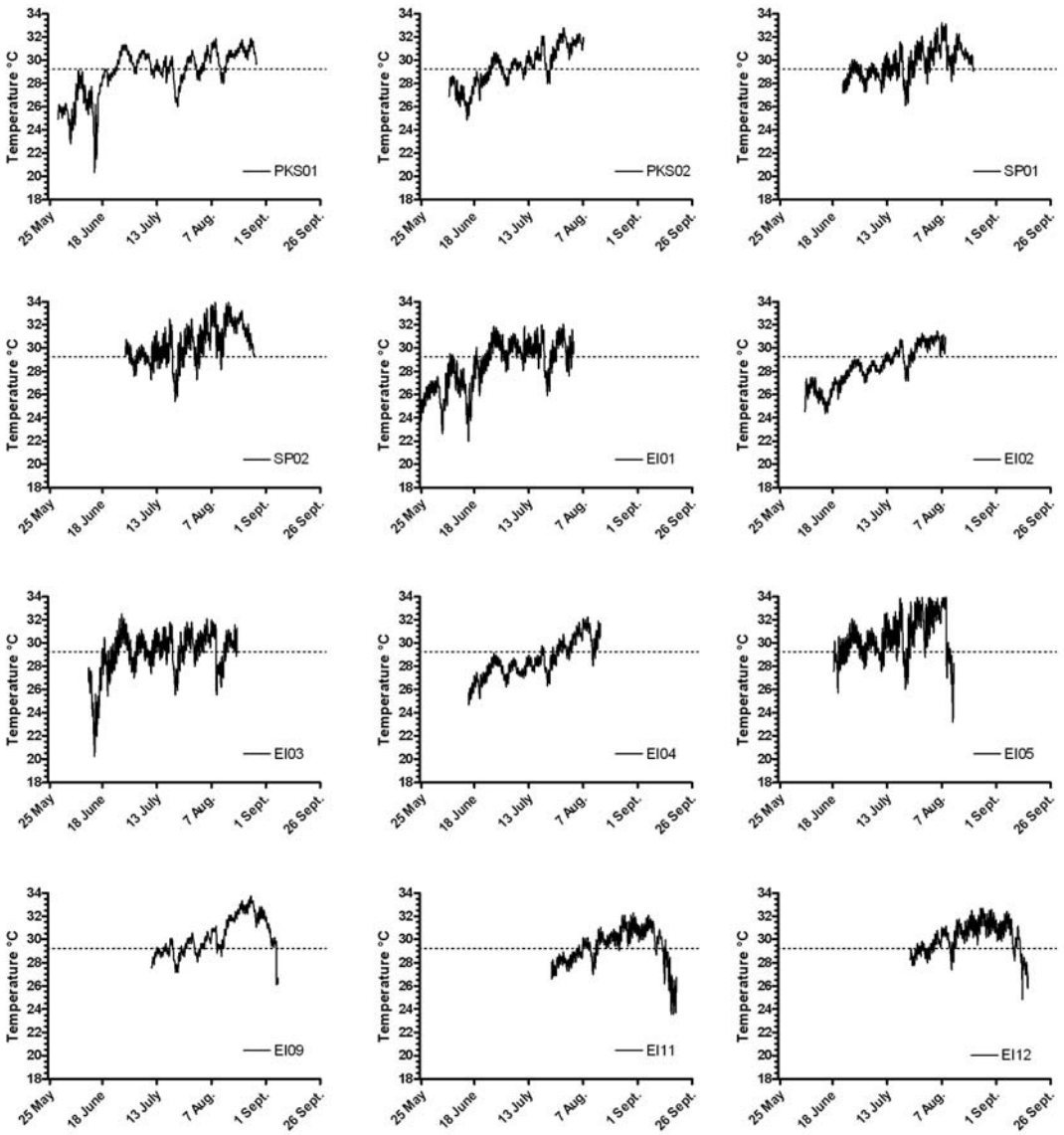


Figure 3. Loggerhead nest temperatures on Bogue Banks and Bear Island in 2006. Dotted line represents the pivotal temperature for NC loggerheads (Mrosovsky 1988)

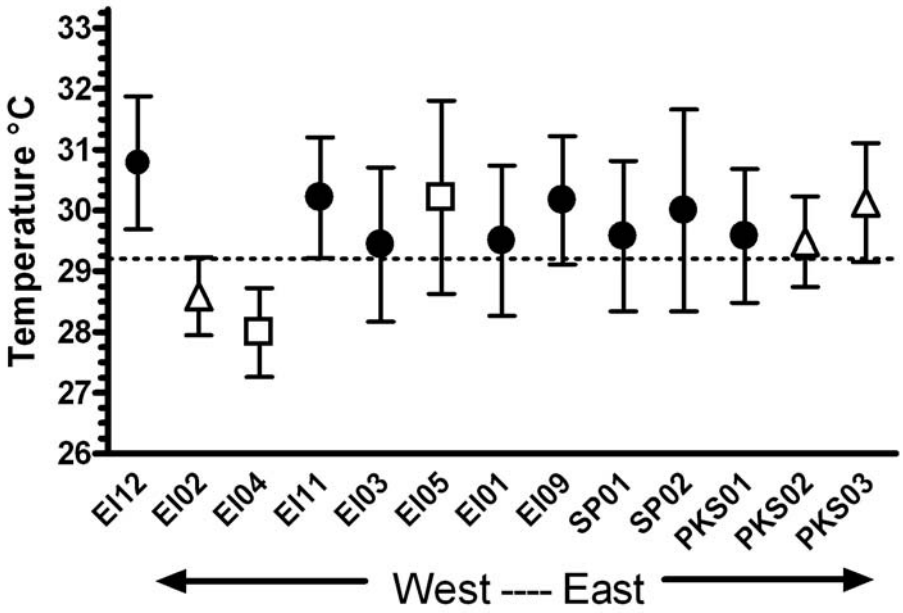


Figure 4. Mean(±SD) temperatures of monitored loggerhead nests during the thermosensitive period for sexual differentiation. Nests are plotted according to east-west placement along Bogue Banks. Similar open symbols indicate nests laid around the same date (see text). Dotted line represents the pivotal temperature for NC loggerheads (Mrosovsky 1988)

2007 conclusions:

There was not discernable impact of nourishment on nesting behavior or hatching success for loggerhead sea turtles in 2007. However, nourished material in Pine Knoll Shores, Indian Beach/Salter Path and eastern Emerald Isle continued to be warmer than western Emerald Isle (which had lighter colored sand). Ongoing monitoring in future years may shed light on how long the impacts of the darker material from the nourishment will impact sea turtle nest temperatures.

2002-2007 Summary Results

Here we provide a general overview the data collected from 2002-2007, for the different category of data: nests and nest success per year, ratio of false crawls to nests, sand temperatures, nest temperatures, and sand compaction. Detailed results from each individual sea turtle season from 2002 through 2006 can be found in the Annual Reports, and 2007 season data are presented above.

Nests and nest success:

The beaches of Bogue Banks provide suitable nesting habitat for all sea turtle species that nest in North Carolina. From 2002 to 2007, there were 349 nesting activities on Bogue Banks, the majority of which were made by loggerhead sea turtles (Table 2). There were a total of 167 nests, and all but three were laid by loggerhead sea turtles. In 2005, there were 2 leatherback nests and one green turtle nest observed on Bogue Banks. False crawl activity is not well understood, although it is known that loggerheads make many false crawls on different nesting beaches worldwide (Miller et al. 2003). Commonly, this species exhibits a ratio of 1:1 nesting events to false crawls (Dodd, 1988). The ratio of nests to false crawls across years varied, from equality in 2002 to more than double the false crawls vs. nests in 2003 to more than double the number of nests vs. false crawls in 2006. Overall, for the study period, the ratio of nest to false crawl was close to 1:1 (Table 2).

Table 2: Turtle nests and false crawls on Bogue Banks, NC

Season	Nests	False Crawls	Ratio
2002	19	19	1:1.0
2003	38	80	1:2.1
2004	21	20	1:0.9
2005	33	23	1:0.7
2006	33	13	1:0.4
2007	23	27	1:1.2
Total	167	182	1:1.1

Hatching success:

Hatching success, expressed as the percentage of eggs in a nest that produce viable turtle hatchlings, is dependent on a variety of parameters, including temperature, gas exchange, moisture, predation, as well as genetic or maternal factors (Carthy et al. 2003). On Bogue Banks, there was variation in annual hatching success of nests laid (Table 3). The primary cause of nest failure was nest inundation from high ocean swash associated with tropical storms or hurricanes, particularly in years 2003-2006. Tropical storm activity in the SE USA is thought to be a major determinant in hatching success for sea turtle nests laid in the region (Van Houtan and Bass 2007). There was no indication that nourished zones were less suitable for egg development in Emerald Isle, Salter Path, Indian Beach and Pine Knoll Shores. However, in one zone of Atlantic Beach, which received muddy silty material in 2004/2005 as part of the Brandt Island Pumpout (see Fig 1), egg incubation for a single nest laid there was not successful, likely due to impeded gas exchange.

Table 3: Annual hatching success for sea turtle nests on Bogue Banks

Year	Mean nest success	Maximum	Minimum
2002	89.8%	96.7%	70.2%
2003	59.4%	98.2%	0%
2004	56.3%	96.7%	0%
2005	49.6%	96.0%	0%
2006	57.4%	98.3%	0%
2007	71.8%	98.9%	0%

Sand Temperature:

Sand temperature was monitored at turtle nest depth in the middle of the beach and at the toe of the primary dune along 8 transects on Bogue Banks. The seasonal temperature profile was similar across years: sand temperatures increased from May 01 until reaching a peak in July and August, following which they declined again. In many cases, the sand temperature was warmer higher up the beach, likely related to the relative distance from the water table on the beach (see Figure 5 for an example).

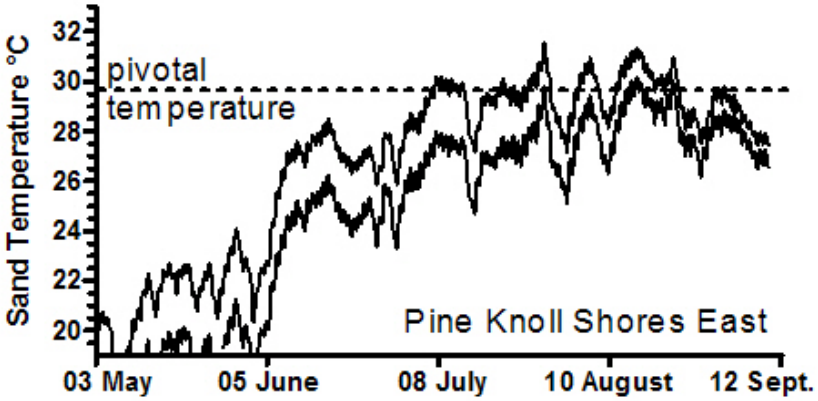


Figure 5. Seasonal sand temperature profile for eastern Pine Knoll Shores in 2005, lower line is middle of beach, upper line is close to toe of primary dune. Dotted line is the pivotal temperature for loggerhead sea turtles in North Carolina (Mrosovsky 1988).

In terms of the impacts of nourishment on sand temperature, there were slightly warmer temperatures in Pine Knoll Shores (nourished) vs. Emerald Isle (non nourished) in 2002, and both Pine Knoll Shores and eastern Emerald Isle (nourished) beaches were more often above pivotal temperature western Emerald Isle sand (nourished) in 2003. By the 2005 nesting season, all beach zones on Bogue Banks had been renourished, so we used Bear Island sand temperatures as a control for 2006 and 2007 (data from Bear Island in 2005 were lost due to datalogger failure). In 2006 and 2007, both sand temperature monitoring stations on Bear Island were cooler than those on Bogue Banks (e.g. see Figure 2 above).

Although sand temperatures are a rough guide of the thermal environment experienced by sea turtle eggs during incubation, the actual temperature regime of a nest is usually warmer than the surrounding sand, due primarily to metabolic warming generated by the developing sea turtle

embryos (Miller et al. 2003). Therefore, comparisons of temperatures within nests laid in nourished or nonnourished areas is a better means to uncovering potential impacts of nourishment on turtle eggs.

Nest temperature:

We deployed dataloggers into as many nests as possible during a nesting season on Bogue Banks, to collect data on daily temperature regimes experienced by incubating eggs. Because of the seasonal fluctuation of sand temperatures, we sought to compare temperatures of nests laid around the same date, to standardize seasonal influences on nest temperature. For nests laid near the same time of a particular season, we also sought to compare nests laid in nourished sand (placed in 2002 or later) vs. nests laid in nonnourished sand (either Pine Knoll Shores and Emerald Isle in 2002, western Emerald Isle in 2003 and 2004, or Bear Island in 2006 and 2007. Also, as the thermosensitive period for sexual differentiation in sea turtles occurs during the middle third of incubation (Mrosovsy and Pieau 1991), we restricted our comparisons to temperature data collected during the middle third of incubation for each nest. Despite a moratorium on nest relocation on Bogue Banks for the duration of the study, a few nests that were about to be washed away by the ocean were relocated in mid-incubation. We excluded temperature data (if any were collected) from nests that were relocated.

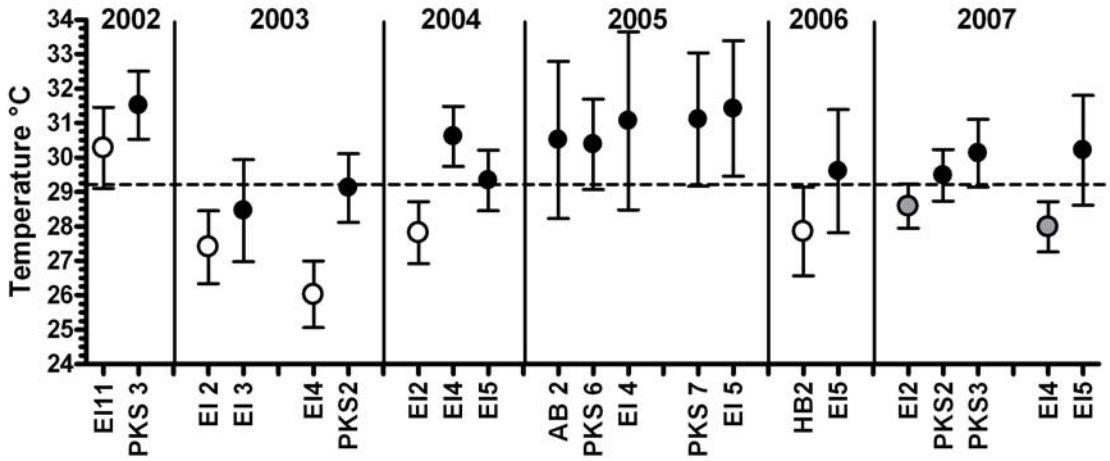


Figure 6. Comparisons of the mean temperatures during the middle third of incubation (the thermosensitive period for sexual determination) for groups of nests laid within 72 hours of each other. For years 2003, 2005, and 2007, two groups of nests (laid on different sets of days) are presented. White dot = nest laid in non-nourished area; black dot = nest laid in nourished area; grey dot = nest laid in nourished material in western end of Emerald Isle. All points are significantly different ($p<0.01$, Kruskal Wallace nonpaired parametric test with Dunn's posthoc test), except for the two groups in 2005, with the exception of PKS6 and EI4 ($p<0.05$). AB=Atlantic Beach, EI = Emerald Isle, HB = Hammocks Beach State Park (Bear Island), PKS = Pine Knoll Shores. Dotted line is the pivotal temperature for loggerhead sea turtles in North Carolina (Mrosovsky 1988).

Overall, we found a consistent pattern of mean nest temperatures during the middle third of incubation to be warmer for nests laid in nourished sand vs. nests laid in non-nourished sand (Figure 6). For 2005 and 2007, there were no data from nests laid in non-nourished areas. For 2005, the study nests were not significantly different in mean temperature, except for PKS6 vs. EI4 ($p<0.05$). For 2007, the two nests laid in eastern Emerald Isle (indicated by grey points in Figure 6) were significantly cooler (mean difference in temperature = 1.6 °C) than nests laid in Pine Knoll Shores or eastern Emerald Isle. The difference between these sites is that the western half of Emerald Isle received sand from Bogue Inlet as part of Nourishment Phase III; this material was not as dark as material placed in Pine Knoll Shores and eastern Emerald Isle during Phases I and II. Together, these data indicate the following:

a. Nests in nourished areas were on average 1.9 °C warmer than nests laid at the same time in nonnourished areas
b. Nourished sand in western Emerald Isle had less of an impact on sea turtle nest temperatures than nourished sand impacts, likely due to the more compatible sand placed on the beach in western Emerald Isle.

The impact of warmer nest temperatures due to nourishment on hatchling sex ratio is likely the production of more female hatchlings from nests. The overall sex ratio production for loggerheads in North Carolina is estimated to be about 55% female (Hawkes et al. 2007). The additional 1.9 °C on the sex ratio of specific nest is related to overall seasonal temperatures; for instance, 2003 was a cooler year in general, and thus nests laid in nourished sand had more but likely not >50% female hatchling production, relative to the nests laid in non-nourished sand (see Figure 6). In 2002, sand temperatures were warmer in general, so there was likely already >50% female hatchling production from nest EI11, laid in a non-nourished area (Figure 6). Therefore, the additional 1.9°C to the nest in the nourished area likely would have made the nest produce 100% females. Unfortunately, we were not able to sample any hatchlings to assess sex ratio directly, so these calculations are based on estimates from previously published studies relating temperature to hatchling sex ratio in loggerheads (e.g. Mrosovsky 1988; Mrosovsky and Provancha 1992). Regardless, increased nest temperatures in nourished sand will result in higher female hatchling production, altering the natural sex ratio.

Sand compaction:

Sand compaction varied greatly both among nests and among crawls in all years (note that no compaction data were collected in 2007), ranging from <150psi to >850psi. There was no specific pattern in compaction readings collected from nourished areas vs nonnourished areas (see Figure 7 for example). A cone penetrometer is not an exact reflection of the same resistance that turtles encounter because of the manner in which a female turtle digs her nest cavity (Davis et al. 1999); moreover, the readings generated by a cone penetrometer are influenced by the mass and technique of the person collecting the measurements. (Ferrell et al., 2003). Other difficulties in collecting compaction data included: not being able to reach all depths because of shell fragments encountered in many sections of nourished areas; not being able to record compaction for nests laid on the dune, for fear of disturbing the sensitive dune habitat or because it appeared that sand would heavily shift and accrete on the nest.

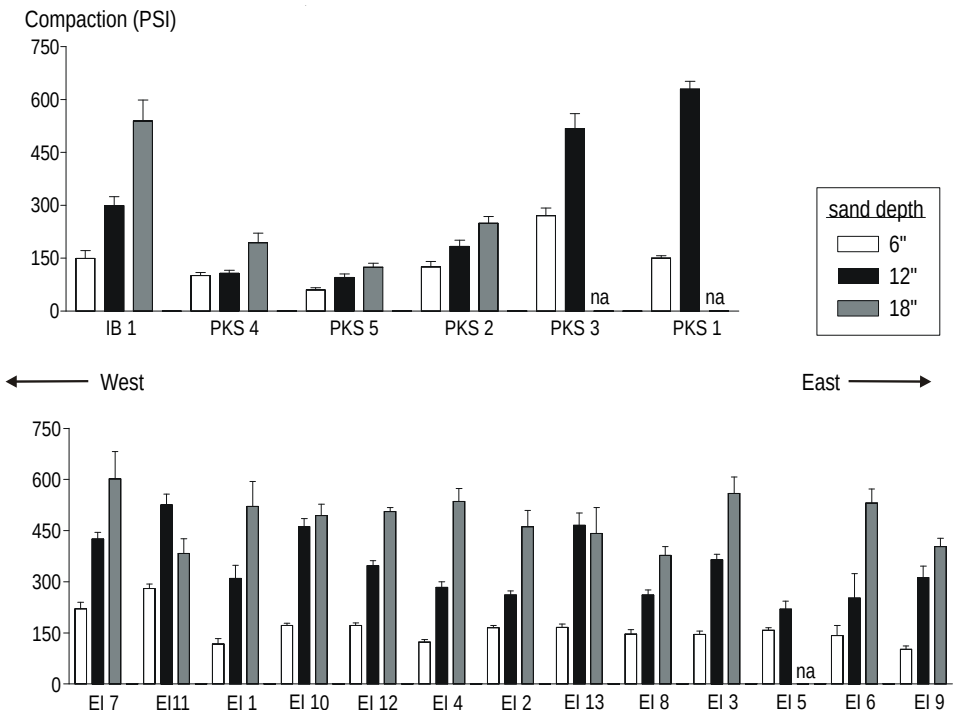


Figure 7. Average sand compaction measurements at nest sites in Indian Beach/Pine Knoll Shores (nourished) and Emerald Isle (non-nourished) in 2002. IB = Indian Beach, PKS = Pine Knoll Shores, EI = Emerald Isle. "Na" refers to where it was not possible to record compaction.

Overall, the cone penetrometer compaction data do not provide a clear index of suitability of nesting habitat for sea turtles, for the following reasons: a. the ambiguity associated with cone penetrative compaction as an index of resistance encountered by nesting female turtles; b. the imprecision associated with data collected from cone penetrometers; c. nesting success and hatching success were not significantly different between nourished and nonnourished zones (see above).

General Conclusions:

The Sea Turtle Monitoring Project on Bogue Banks compared a suite of parameters related to sea turtle reproduction as related to nourishment activities. The overall findings were as follows:

No significant impact:

Nesting success (nest/false crawl ratio)

Hatching success (proportion of eggs that produced viable turtles)

Sand compaction (in psi)

Significant impact:

Sand temperatures: sand temperatures in nourished areas were warmer than nonnourished areas

Nest temperatures: nest temperatures were on average 1.9 °C warmer for nests laid in nourished sand from Phases I and II (Pine Knoll Shores, Indian Beach & Salter Path, and eastern Emerald Isle). This likely increased the number of female hatchlings produced by nests laid in nourished sand.

Recommendations:

A major challenge in this study was having a suitable area or zone to act as a control (or unnourished) area, to compare with nourished areas. As the entire island experienced nourishment activities by 2005, it was necessary to use Bear Island as a control site for the subsequent years. There were logistical challenges to collecting data from Bear Island. Another challenge in the study was the lack of sufficient equipment: we were not able to put dataloggers in all nests, so that our sample size for study (comparing nests laid around the same date in different zones) was limited. A third challenge was the ongoing nourishment/dredge placement activities that continued on the island during and after Phases I, II and III of the study nourishment project (see Figure 1 above). This made it difficult to monitor post-project impacts during the final three years of the study, as was initially intended. Finally, we lacked pre-project data that could have been used as a baseline to compare impacts during and after the project. Therefore, we recommend ongoing monitoring of sand and nest temperatures, as a means to both continue assessing post-project impacts of nourishment on sea turtle reproduction, and constitute a baseline against which to assess impacts of future projects.

***Acknowledgements*:** Thanks to Nicole Minhovets for working on this project in 2002 and 2003, and to all of the incredibly passionate, dedicated volunteers and volunteer coordinators on Bogue Banks. We are indebted to Mr. Marc Schulze and the Atlantic Beach Public Works department for generously allowing storage of the ATV in the Public Works lot. Wendy Cluse graciously contributed to monitoring via ATV on many different days, and helped with analyses. Kelly Stewart also helped fill in with monitoring in 2007. Thanks to Carteret County and US Fish and Wildlife Service (Raleigh Office) for their financial support.

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APPENDIX I
SEA TURTLE ACTIVITY DATA FROM BOGUE BANKS IN 2007

Nests		Activity				Hatch						Emergence	Incubation
Atlantic Beach		date	Lat.	Long	datalogger	Date	ES	UH	PE	DH	LH	Success	Period
AB 1	301 Ocean Ridge	8/4/2007	34.69724	76.74946	~~~~	N/A	75	3	0	75	0	0.00	n/a
Pine Knoll Shores													
PKS 1*	Ocean Terrace	5/29/2007	34.69360	76.81966	992539	N/A	0	108	0	0	0	0.00	n/a
PKS 2	W of Ocean Park	6/7/2007	34.69473	76.81112	992541	8/8/2007	141	7	0	7	2	90.54	62
PKS 3	W of Coral Bay West	6/7/2007	34.69605	76.79311	995171	8/3/2007	94	5	0	0	4	94.95	57
Indian Beach / Salter Path													
SP 1	1809 Salter Path Rd.	6/23/2007	34.68339	76.90381	868197	8/19/2007	87	1	0	0	0	98.86	57
SP 2	Summerwinds	6/29/2007	34.68495	76.89345	868196	8/24/2007	86	13	0	0	0	86.87	56
Emerald Isle													
EI 1	607 Ocean Ridge	5/25/2007	34.68084	76.92029	992538	7/30/2007	4	128	2	0	0	2.99	66
EI 2	Land's End	6/6/2007	34.64718	77.08460	995137	8/6/2007	116	9	3	0	15	90.63	61
EI 3	Tammy St.	6/12/2007	34.67339	76.96815	995139	N/A	0	80	0	0	0	0.00	n/a
EI 4	Spinnakers	6/16/2007	34.65035	77.07451	995142	8/13/2007	103	1	5	14	34	81.65	58
EI 5	Ocean Reef	6/18/2007	34.67563	76.95396	868198	8/9/2007	110	10	0	0	3	91.67	52
EI 6	Holiday Trav-L-Park	6/22/2007	34.65501	77.05711	~~~~	8/21/2007	100	3	0	0	0	97.09	60
EI 7	8615 Ocean Ridge	6/29/2007	34.65859	77.04266	~~~~	8/25/2007	105	4	0	0	0	96.33	57
EI 8	E of Channel Drive	7/3/2007	34.64459	77.09315	~~~~	9/2/2007	45	62	2	1	44	40.37	61
EI 9	100 Ocean Ridge	7/11/2007	34.68232	76.91108	995170	9/2/2007	85	7	0	1	0	91.30	53
EI 10	201 Ocean Ridge	7/14/2007	34.68209	76.91240	~~~~	9/3/2007	73	3	2	1	1	92.31	51
EI 11	9801 Ocean Ridge	7/24/2007	34.65080	77.07286	995138	9/16/2007	90	1	0	0	0	98.90	54
EI 12	Emerald Pointe Villas	7/24/2007	34.64424	77.09125	995148	9/13/2007	77	5	2	3	0	88.10	51
EI 13*	Dolphin Ridge	8/5/2007	34.65033	77.07363	~~~~	9/28/2007	90	6	1	2	2	90.72	54
EI 14*	1st Street	8/5/2007	34.68226	76.91021	~~~~	9/26/2007	89	6	0	2	0	91.58	52
EI 14.5	9505 Ocean Ridge	8/15/2007	34.39104	77.04169	~~~~	########	101	6	0	0	3	94.39	67
EI 15	501 Ocean Ridge	8/17/2007	34.40876	76.55073	~~~~	########	62	15	5	1	3	74.39	57
EI 16*	1100 Ocean Ridge	8/30/2007	34.67963	76.92880	~~~~	11/1/2007	50	34	1	0	1	58.82	63

False Crawls		Activity		
Atlantic Beach		date	Lat.	Long
AB1	Landing	6/8/2007	34.69480	76.70215
AB2	Avenue	7/3/2007	34.69698	76.73296
AB3	of mm 2.9	7/17/2007	34.69726	76.75206
AB4	Beach &	7/27/2007	34.69698	76.77691
Pine Knoll Shores				
PKS1	Knoll	6/18/2007	34.69391	76.81658
PKS2	Inn	7/27/2007	34.69333	76.82464
Indian Beach / Salter Path				
IB1	Summerw	7/14/2007	34.68487	76.89269

False Crawls		Activity		
Emerald Isle		date	Lat.	Long
EI1	12th St.	6/12/2007	34.67976	76.92902
EI2	End	6/16/2007	34.64717	77.08440
EI3	End	6/16/2007	34.64691	77.08509
EI4	Drive, EI	6/16/2007	34.64480	77.09344
EI5	End	6/16/2007	34.64824	77.08108
EI6	Ocean	06/22/07	n/a	n/a
EI7	Ocean	6/28/2007	34.65320	77.06362
EI8	Myrtle	6/29/2007	34.65903	77.03938
EI9	the Sea	7/2/2007	34.65639	77.05057
EI10	Ocean	7/10/2007	34.66481	77.01538
EI11	block	7/11/2007	34.65381	77.06212
EI12	Ocean	7/12/2007	34.66466	77.01534
EI13	Motel	7/23/2007	34.39317	77.03325
EI14	Emerald	8/4/2007	34.64742	77.08378
EI15	Emerald	8/4/2007	34.64699	77.08499
EI16	Emerald	8/4/2007	34.64584	77.08756
EI17	Street	8/5/2007	34.68037	76.92526
EI18	End	8/5/2007	34.64838	77.08148
EI19	the Sea	8/16/2007	34.39395	77.03000
EI20	Ocean	8/17/2007	34.40838	76.53305

Annual Performance Report

State: North Carolina

Period Covered: July 1, 2007 - June 30, 2008

Project Title: Monitoring Avian Productivity and Survivorship

Introduction

In 1989, The Institute for Bird Populations initiated the Monitoring Avian Productivity and Survivorship (MAPS) program, a cooperative effort among federal, state and private agencies and organizations, as well as individual bird banders in North America to operate a continent-wide network of constant-effort mist-netting stations to capture and band landbirds during the breeding season. The MAPS methodology provides annual regional indices of adult population size and post-fledging productivity from data on the numbers and proportions of young and adult birds captured. Annual regional estimates of adult population size, adult survivorship, and recruitment into the adult population are collected from capture-recapture data on adult birds. MAPS provides these population and demographic data for about 100 target species.

Objectives

The objectives of the MAPS program are to identify and describe the temporal and spatial patterns in the demographic indices and estimates provided by MAPS and to explore relationships between those patterns and ecological characteristics, population trends, habitat characteristics, and climatic data. The MAPS program also has the following management objectives: (1) to determine the proximate demographic cause(s) of population declines, (2) to identify and formulate landscape-level management actions and conservation strategies to reverse population declines and maintain stable or increasing populations, and (3) to evaluate, through the adaptive management practice, the effectiveness of those management actions and conservation strategies. The goals of our particular MAPS station are to catch, band, and collect data from as many landbirds as possible within the guidelines of the MAPS program.

A. Activity

Wildlife Diversity staff operated the MAPS station on the Hanes Farm near Croatan National Forest in 2008. This station was established in 1996 and was operated annually through 2000. The station was not operated during 2001 or 2002, and therefore, this was the 11th year of data collection. The breeding season is divided into 10-day periods beginning on May 1 and continuing through August 8. A series of 10 mist nets, each 12 meters long and 3 meters high, are operated one day out of each 10-day period for six continuous hours beginning at sunrise. A total of eight banding days were conducted this year. All birds captured were banded, unless already banded, and data were collected to determine age, sex, and breeding status. One exception is for Ruby-throated Hummingbirds that are released unbanded. However, sex and age were determined, if possible, before release. All data is entered into MAPS-specific software and submitted to the Institute for Bird Populations for analysis at a regional and

national level. For further information go to http://www.birdpop.org or see the Bird Populations Journal for MAPS data summaries and other technical documents on avian demography and biogeography.

A total of 86 birds were captured this year representing 19 different species (Table 1). This included 55 birds that were newly banded, 23 recaptures, and 8 unbanded birds. A total of 55 species were seen or heard on the study site and 37 of those species were believed to breed in the study area, but several of these were not prone to capture by netting techniques. A couple of first-time migrants were banded May 14, 2008, on the site, and they were Tennessee Warbler and Swainson's Thrush. Raptors that have been regularly detected on or near the site include Barred Owl, Red-Shouldered Hawk, and Red-Tailed Hawk. Twelve of the recaptured individuals were banded in previous years (2006 & 2007) and they include 3 Carolina Wrens, 2 Acadian Flycatchers, 2 Eastern Towhees, 2 Ovenbirds, 1 Tufted Titmouse, 1 White-eyed Vireo, and 1 Summer Tanager. Many recaptured birds are caught during the same breeding season or are only caught the following year, then not seen again. However, a review of the recapture data for the entire eleven years of operation revealed 29 individuals that have been recaptured 3 or more subsequent years, including 6 Northern Cardinals, 6 Acadian Flycatchers, 6 Carolina Wrens, 5 Ovenbirds, 3 Tufted Titmice, 2 Summer Tanagers, and 1 each of Wood Thrush, Northern Parula, Great-crested Flycatcher, Eastern Towhee, and Downy Woodpecker. Table 2 lists some of the more interesting recaptures.

Table 1. Species and Number of Birds Captured During MAPS Station Operation on the Hanes Farm in 2008.

Species	# Captures	Species	# Captures
Ruby-throated Hummingbird	7	Swainson's Thrush	1
Red-bellied Woodpecker	1	Wood Thrush	5
Downy Woodpecker	2	American Robin	1
Acadian Flycatcher	8	Brown Thrasher	1
Great-crested Flycatcher	3	Tennessee Warbler	2
White-eyed Vireo	2	Ovenbird	6
Carolina Chickadee	1	Summer Tanager	1
Tufted Titmouse	7	Eastern Towhee	3
Carolina Wren	9	Northern Cardinal	13
Blue-gray Gnatcatcher	1		

Table 2. A Summary of Notable Recaptures during the eleven years of operation of the Hanes Farm MAPS station.

Species	Age at Banding[1]	Year Banded	Year Last Recapture	Estimated Age (years)[2]
Downy Woodpecker	HY	2004	2007	3
Acadian Flycatcher	SY	1998	2006	9
Great-crested Flycatcher	AHY	1999	2004	6
Tufted Titmouse	AHY	1997	2004	8
Carolina Wren	SY	1999	2003	5
Wood Thrush	ASY	2004	2006	4
Northern Parula	SY	1996	1999	4
Northern Cardinal	HY	1999	2005	6

[1] HY=hatching year, born that year; ; SY= 1-year-old; AHY=after hatching year, at least 1-year-old; ASY=after second year, at least 2 years old.
[2] Birds banded as AHY or ASY are at least the estimated age but could be older.

B. Target Dates for Achievements and Accomplishments

Data were not collected for period 6 due to conflicts with other work-related commitments.

C. Significant Deviations

No Significant Deviations.

D. Remarks

No remarks.

E. Recommendations

Long-term, annual operation of MAPS stations is imperative to achieve the objectives of the program. MAPS guidelines state that "Standardization from year to year and continuation of the study for at least five consecutive years at each station are necessary in order to provide reliable productivity indices and survivorship estimates. Continuation of the study for ten to twenty consecutive years at most stations will likely be necessary to obtain reliable trend information on these critical vital rates." Operation of MAPS stations is an identified conservation action of the North Carolina Wildlife Action Plan.

Prepared By:

Jennifer Begier, Red-cockaded Woodpecker Biologist
Wildlife Diversity Program

Annual Performance Report

State: North Carolina

Period Covered: 1 July 2007 – 30 June 2008

Project Title: North Carolina Birding Trail

Objectives: The mission of the NC Birding Trail is to conserve and enhance North Carolina's bird habitat by promoting sustainable bird-watching activities, economic opportunities and conservation education. We aim to meet this mission through the following objectives:

A. Increased economic development within North Carolina resulting from birding related revenues.

B. Increased recreational opportunities within North Carolina.

C. Increased awareness of the value of natural resources and the need to conserve them as assets for the future.

A. Activity

Coordination - The North Carolina Birding Trail (NCBT) initiative came into existence in 2003 and was coordinated on a volunteer basis until October 2005, when a full-time coordinator was hired, with position support by the NC Wildlife Resources Commission. A Steering Committee oversees the effort, with representation by the NC Wildlife Resources Commission, Audubon NC, NC Sea Grant, NC Cooperative Extension, NC State Parks, and the US Fish & Wildlife Service. Monthly Steering Committee meetings ensure regular communication between the coordinator and the committee. A formal Memorandum of Understanding was signed by all six NCBT steering Committee partners in May, 2008.

Regional Trails - The NCBT is being implemented in three regional components, beginning at the coastal plain in 2006 and moving westward in subsequent years. The NCBT website (http://www.ncbirdingtrail.org/) provides a location map and site descriptions of all the approved sites, under Trails.

- Coastal Plain: The coastal plain region was the first region to be completed. A total 102 sites were approved for the Trail in the region. The Coastal Plain Trail Guide was published and unveiled at a Grand Opening Celebration held at Hammocks Beach State Park on June 19, 2007.

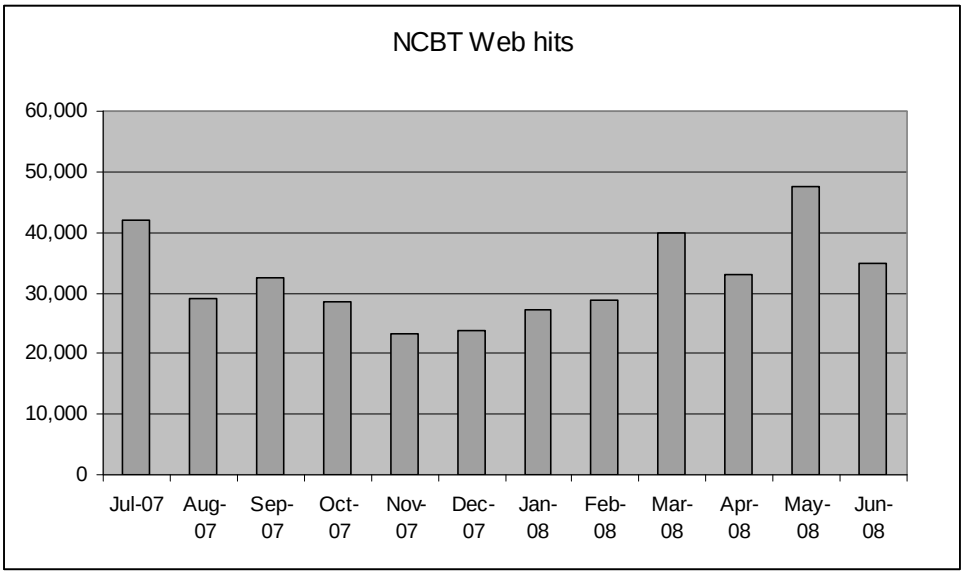
- Piedmont: A total of 103 sites were approved for the piedmont region. The Piedmont Trail Guide was published and unveiled at a Grand Opening Celebration held at Durant Nature Park on May 15, 2008.

- Mountains: A total of 106 sites have been approved for the mountain region. Site description development is currently underway. It is expected that on-line information will be available by early 2009. The Mountain Trail Guide is projected to be published by Summer 2009, signifying the completion of the NCBT, state-wide.

Trail Guide Series - The regional trail guides are being sold (retail) via the NC Wildlife Resources Commission's *Wild Store.* UNC Press is the wholesale/resale distributor for the guides, per Distribution Agreements signed in December 2007 and March 2008 between the NCWRC and UNC press.

- Coastal Plain - Retail sales as of May 1, 2008 totaled $7.436.13 (919 guides); an additional 5010 guides were sold to UNC Press for $19,109.27 through the distribution agreement. Total sales as tracked by the NCWRC *Wild Store*, through May 2008, totaled $26,545.40.
- Piedmont – Due to a printing error, the Piedmont Trail Guides will not be available for sale until July 1, 2008.

Website – The NCBT Website is the primary source for information on the NCBT. Website hits per month for the past fiscal year were as follows:



Grant Support - The NCBT relies on grant support to cover all aspects of the initiative beyond position support for the coordinator. In the past fiscal year, the NCBT was successful in receiving two new grants, totaling $32,455.70:

- A $25,000 grant from the Progress Energy Foundation, to support the publication of the Piedmont Trail Guide.
- A $7,455.70 grant from the Carolina Bird Club and Mecklenburg Audubon Society, to support the publication of the Piedmont Trail Guide.

These grants, along with $13,000 in in-kind contributions by Steering Committee members, were used as match for a Golden LEAF Foundation grant received in the previous fiscal year ($76,592).

Coordination and Communication - Coordination among supporters is a critical component of success for any partnership-based initiative. To that end, communication is a key responsibility of the NCBT coordinator. During the past fiscal year, the coordinator continued to publish *Trail Mail*, a quarterly electronic newsletter that keeps supporters up to date on the goings-on of the NCBT. This publication is now sent to more than 800 individuals and the distribution continues to increase as the initiative progresses across the state. PDF versions of the newsletter are posted to the NCBT Website, under Current News.

Meetings and Presentations - Four information meetings were held in the mountain region in the Fall of 2007 (Boone, Asheville, Bryson City, and Conover), to increase awareness and support for the NCBT across the region. The NCBT Coordinator also met with or gave presentations to the following groups throughout the year:

Mountain Region NCBT Supporters (Boone, NC); Carteret County Tourism Development Authority (Morehead City, NC); 2007 Watchable Wildlife Conference (Tucson, AZ); Nongame Wildlife Advisory Committee (Raleigh, NC); Southeastern NC Agritourism Conference (Kenansville, NC); International Partners in Flight Conference (McAllen, TX); NC Chapter of The Wildlife Society (Browns Summit, NC); Carteret County Tourism Summit (Pine Knoll Shores, NC).

Media - Over the past year, the NCBT received media coverage in more than 28 news or radio articles across the state.

Birder Friendly Business & Community Training Program (BFB/C) – The BFB/C training program, initiated at the start of the 2006-2007 fiscal year, and supported by funds from the Golden LEAF Foundation, continues to be a success. Lena Gallitano (Audubon NC) and Stacy Tomas (NC Cooperative Extension) oversee the Birder Friendly program. This 6 hour training, which is brought to communities at the request of a local contact, supplies participants with a binder full of guidance materials, a copy of *The Sibley Field Guide to the Birds of Eastern North America*, and extensive training on marketing, hospitality, birding as a travel hobby, and birders as a niche market. A total of 250 individuals attended trainings that took place at the following locations in the past fiscal year:

- August 16, 2007, Cape Fear Botanical Garden, Fayetteville
- Sept. 13, 2007, Sylvan Heights Waterfowl Park, Scotland Neck
- October 18, 2007, Dare County Municipal Building, Kitty Hawk
- February 7, 2008, Wilkesboro Town Hall, Wilkesboro

- March 11, 2008, Cleveland County Arts Council, Shelby
- April 2, 2008, Stecoah Valley Cultural Arts Center, Robbinsville
- May 6, 2008, Rockingham County Cooperative Extension, Reidsville
- June 3, 2008, W. Kerr Scott Reservoir, Wilkesboro

Four more trainings are planned through November 2008. The future of the Birder Friendly training programs beyond 2008 will depend on additional funding opportunities, which are currently being sought by Cooperative Extension.

B. Target Dates for Achievement and Accomplishment

- Fall 2007 – begin mountain region site nomination process
- Winter 2008 – post on-line piedmont trail information
- Spring 2008 – finalize mountain region site selection; finalize piedmont trail guide design
- Summer 2008 – publish piedmont trail guide; host piedmont grand opening

C. Significant Deviations

There have been no significant deviations during this annual performance report cycle.

D. Remarks

Work on the NCBT is progressing as planned. Regular Steering Committee meetings ensure communication and coordination among participating agencies.

E. Recommendations

Benchmark metrics we have identified to track the progress and success of the NC Birding Trail (by Objective) include:

- National Survey of Fishing, Hunting, and Wildlife-associated Recreation[1] results (Objectives A, B). This study is conducted every 5 years and will allow us to compare 2001, 2006 and eventually 2011 data and trends regarding the number of people in the United States and North Carolina who consider themselves birders, the number of people in the United States and North Carolina who travel away from home to view birds, and trip-related expenditures.
- Birder Friendly Business and Community Programs (Objective A)– Evaluation components of the training program include:
    - Pre- and post-training evaluations to assess participants' knowledge of the birder market and to gauge participant intent to incorporate ideas learned at the training.
    - Development of success stories and lessons learned.
- NCBT Website hits tracked over time (Objectives A, B).
- NCBT Trail Guide sales over time (Objectives A)
- An economic benchmark study, conducted in partnership with university researchers, will provide baseline data from which to compare future economic impacts of the NCBT (Objective A). *(This recommendation has not yet been implemented).*
- On-site surveys carried out at manned NCBT sites (e.g., state parks) will allow us to quantify use by NCBT visitors and gather qualitative information about their experiences (Objective C). *(This recommendation has not yet been implemented).*

F. Estimated Cost

$51, 597.20

G. References

[1]U.S. Department of the Interior, Fish and Wildlife Service and U.S. Department of Commerce, U.S. Census Bureau. *2006 National Survey of Fishing, Hunting, and Wildlife-associated Recreation.*

Prepared by:

Salinda Daley Bacheler, NC Birding Trail Coordinator
Division of Wildlife Management

Annual Performance Report

State: **North Carolina**

Period Covered: **July 1, 2007 - June 30, 2008**

Project Title: **Piping Plover Monitoring and Management in North Carolina**

Objectives:

Coordinate piping plover (*Charadrius melodus*) activities for North Carolina.

A. Activity

This report summarizes the 2007 breeding season for piping plovers and provides an early assessment of the 2008 season. The coast of North Carolina was surveyed for breeding piping plovers during the June 1st through June 9th census window in 2007 and 2008. Visual surveys were made in suitable habitat on ocean and inlet beaches on all but one of the barrier islands. The only site with suitable habitat that was not surveyed was Browns Island; an approximately four mile long barrier island that lies within a live-fire training range on Marine Corps Base Camp Lejeune. Biologists with NC Wildlife Resources Commission (NCWRC) coordinated the census and conducted surveys at beaches not covered by other agencies/individuals. We also compiled data on reproductive success. Most piping plover nests are found on federal land and as a result, federal agencies conduct much of the monitoring and management. Activities taken to protect nesting birds include posting nesting areas, erecting predator exclosures and controlling ORV use adjacent to nesting sites.

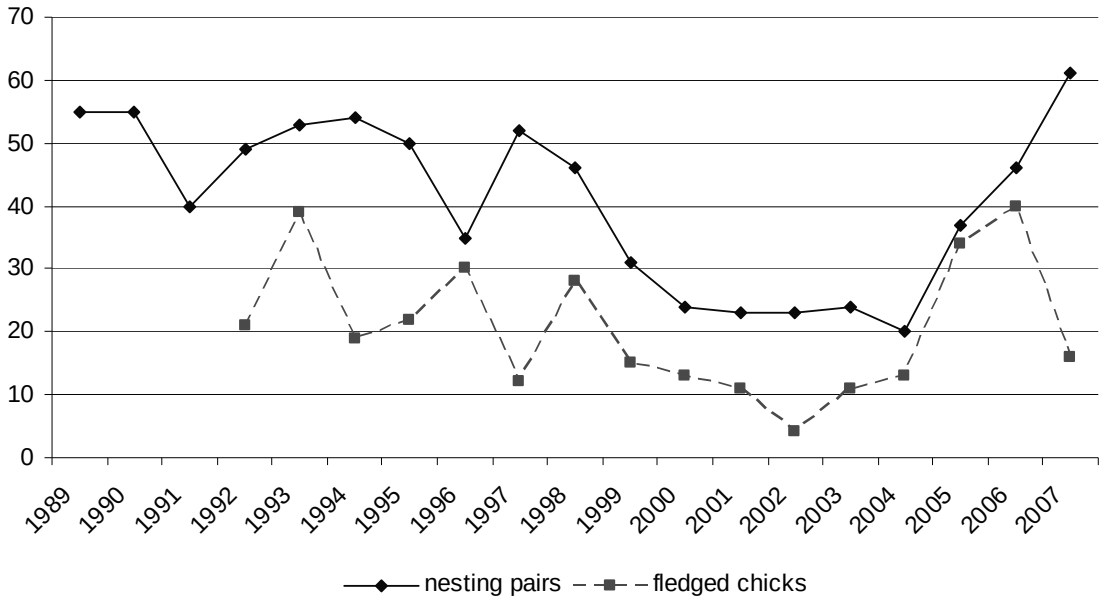
Fifty-nine pairs of piping plovers were counted during the 2007 census window and the best estimate at the end of the season was 61 pairs (Table 1). This is our highest count since surveys began in NC and represents an increase of 33% from the 2006 count of 46 pairs (Figure 1). Statewide distribution was similar to previous years with the majority of nesting pairs (74%) found at Cape Lookout National Seashore (CLNS). Plovers occupied two new sites in the state in 2007; one on the east end of Ocean Isle adjacent to Shallotte Inlet and the second on Dump Island located in Core Sound behind Middle Core Banks.

Unfortunately, 2007 was one of the worst years in terms of productivity with only sixteen chicks surviving to fledge from the 61 pairs (0.26 chicks per pair). This is below NC's average of 0.50 chicks fledged per pair and comes after three years of above average productivity. Productivity was highest on Cape Hatteras National Seashore (CHNS) where six pairs fledged four chicks (0.67 chicks per pair). Eleven chicks fledged from 45 pairs (0.24 chicks per pair) on CLNS and one chick fledged from five pairs (0.20 chicks per pair) on Lea/Hutaff Island. Birds nesting on Bear Island and South Topsail failed to produce any chicks. While we were not able to monitor the two new sites on Ocean Isle and Dump Island closely, we are certain that birds were unsuccessful at both sites.

Table 1. Total number of piping plover pairs and fledglings by site in North Carolina, 2007

Site Name	Piper pairs (individuals) Window Census	Piper pairs (individuals) Best Estimate	Young Fledged	Productivity
Sunset Beach/Bird Is.	0	0	--	--
Ocean Isle	1 pr.	1 pr.	0	0.00
Holden Beach	0	0	--	--
Oak Is.	0	0	--	--
Bald Head Is.	0	0	--	--
Ft. Fisher	(1 ind.)	(1 ind.)	--	--
Masonboro Is.	0	0	--	--
Wrightsville Beach	0	0	--	--
Figure Eight Is.	0	0	--	--
Lea/Hutaff Is.	5 pr. (1 ind.)	5 pr. (1 ind.)	1	0.20
S. Topsail	2 pr. (1 ind.)	2 pr. (1 ind.)	0	0.00
N. Topsail	0	0	--	--
Onslow Beach	(1 ind.)	(1 ind.)	--	--
Bear Is. (Hammocks Beach S.P.)	1 pr.	1 pr.	0	0.00
Bogue Banks	0	0	--	--
Bird Shoals	0	0	--	--
Cape Lookout NS	44 pr.	45 pr.	11	0.24
Dump Island	1 pr. (1 ind.)	1 pr. (1 ind.)	0	0.00
Cape Hatteras NS	5 pr.	6 pr.	4	0.67
Pea Is. NWR	0	0	--	--
Corolla North to State line	0	0	--	--
TOTAL	**59 pr. (5 ind.)**	**61 pr. (5 ind.)**	**16**	**0.26**

Figure 1. Number of piping plover nesting pairs and fledglings in NC, 1989-2007.



Several factors or combination of factors likely contributed to the below average productivity observed in 2007. Sub-tropical storm Andrea hit the coast in early May and Tropical Storm Barry struck in mid-June causing high tide flooding and high winds that impacted nesting.

Additionally, the later part of the season saw little rain and this may have reduced the quality of foraging in some areas. Predation also continues to be an issue along the NC coast. Predation of nests and/or chicks by ghost crabs and raccoons was documented. Gull-billed terns, boat-tailed grackles, mink and fox were also suspected predators in certain areas. Lastly, the deterioration of habitat created by Hurricane Isabel, which hit the coast in Sept. of 2003, is a growing concern. This storm renewed habitat on portions of CLNS and to a lesser extent, CHNS and likely knocked back predator populations. In the years immediately following the storm, piping plover numbers and productivity increased in response to the changes. There have been no significant storms since that time and much of the created habitat is now re-vegetating and eliminating prime foraging sites for chicks.

The census window was conducted again in 2008. Sixty pairs of piping plovers and four unpaired birds were counted along our barrier islands during the 2008 census window (Table 2). In addition to coordinating coast-wide surveys, we monitored four pairs of plovers on private property and state lands; two pairs on South Topsail Beach, one pair on Bear Island and one pair on Dump Island. We exclosed one nest on South Topsail and one nest on Bear Island and assisted Audubon staff with exclosing a nest on Lea/Hutaff Island. A complete summary of the 2008 nesting season including a best estimate of the number of breeding pairs will be provided at the end of the season. The best estimate will likely be slightly higher than the census window count, as it is based on observations collected over the course of the nesting season.

Table 2. 2008 breeding season census window count for piping plovers in North Carolina.

Site Name	**Piper pairs (individuals)**
Sunset Beach/Bird Is.	0
Ocean Isle	0
Holden Beach	(1 ind.)
Oak Is.	0
Bald Head Is.	0
Ft. Fisher	0
Masonboro Is.	0
Wrightsville Beach	0
Figure Eight Is.	0
Lea/Hutaff Is.	3 pr. (1 ind.)
S. Topsail	2 pr.
N. Topsail	0
Onslow Beach	1 pr.
Bear Is. (Hammocks Beach S.P.)	1 pr (1 ind.)
Bogue Banks	0
Bird Shoals	0
Cape Lookout NS	44 pr.
Dump Island	1 pr.
Cape Hatteras NS	8 pr.
Pea Is. NWR	(1 ind.)
Corolla North to State line	0
TOTAL	**60 pr. (4 ind.)**

Lastly we continue to update NCWRCs shorebird database with sightings of non-breeding piping plovers. Much of this data is collected from other agencies and organizations although we also conduct surveys as time permits. This data has proven invaluable in review of permits for beach stabilization projects and other activities that have the potential to negatively impact piping plovers.

B. Target Dates for Achievement and Accomplishment

All planned activities are on schedule.

C. Significant Deviation

There were no significant deviations.

D. Remarks

None

E. Recommendations

Human disturbance and dogs off leash were again an issue at some nesting areas across the state. Of note, is the abandonment of an exclosed nest on South Topsail after three dogs apparently tried to dig under the exclosure. While the town has a leash law, enforcement is lacking. We must continue to work with the Town of Topsail Beach and other towns to ensure that leash laws are enforced. Additionally, we should target dog owners for education.

Mammalian predators continue to plague several sites that support nesting piping plovers. Evidence of several different mammalian predators including fox and raccoon were prevalent on Bear Island and South Topsail. Plovers that attempted to nest at these sites were once again unsuccessful. We should continue to work with State Parks and explore actions on private properties to minimize predation by introduced and overabundant mammals.

F. Estimated Cost:

$1,677.74

Prepared By: Susan Cameron
Waterbird Biologist
Wildlife Diversity Program

Annual Performance Report

State: **North Carolina**

Period Covered: **July 1, 2007 - June 30, 2008**

Project Title: **Coast-wide Colonial Waterbird Survey**

Objectives:

The objective of coast-wide colonial waterbird surveys is to provide updated information on the status of waterbird nesting colonies along North Carolina's barrier islands and within estuaries. As part of this objective, survey efforts are aimed towards locating all nesting colonies, determining the number of nests of colonial nesting waterbirds, and updating the statewide colonial waterbird database. This information is necessary to achieve the goals of North Carolina's Waterbird Program, which are as follows: to maintain breeding populations at or near 1977-1983 levels, to discourage problem species, to encourage a dispersed breeding population over that portion of the coastal area traditionally occupied by each species, to provide special attention to state and federally listed species, and to develop management techniques to help meet these goals. The state's population goals for species of nesting colonial waterbirds are:

Table 1. Goals for colonial nesting waterbirds in North Carolina.

Species*	Scientific Name	# Of Nests	# Of Sites
White Ibis	*Eudocimus albus*	8000	6
Glossy Ibis	*Plegadis falcinellus*	500	7
Brown Pelican	*Pelecanus occidentalis*	4000	5
Black-crowned Night Heron	*Nycticorax nycticorax*	250	10
Great Egret	*Ardea alba*	2500	30
Cattle Egret	*Bulbucus ibis*	No management need; No goal set; State will continue to monitor	
Snowy Egret	*Egretta thula*	800	15
Tricolored Heron	*Egretta tricolor*	1500	15
Little Blue Heron	*Egretta caerulea*	1200	15
Least Tern	*Sterna antillarum*	2000	25
Forster's Tern	*Sterna forsteri*	1100	15
Royal Tern	*Sterna maxima*	15000	6
Sandwich Tern	*Sterna sandvicensis*	2700	6
Caspian Tern	*Sterna caspia*	25	1
Common Tern	*Sterna hirundo*	2500	20
Gull-billed Tern	*Sterna nilotica*	300	6
Black Skimmer	*Rynchops niger*	1000	15
Laughing Gull	*Larus atricilla*	No management need, but no < 10000	
Herring Gull	*Larus argentatus*	No management need, but no > 1000	
Great Black-backed Gull	*Larus marinus*	No management need, but no > 200	

*Since we do not have good census numbers for those species that nest primarily inland, we have not included them since goals could not be established

A. Activity

Twenty-five species of colonial waterbirds breed in North Carolina, including species of terns, gulls and skimmers (order Charadriiformes); herons, egrets and ibis (order Ciconiiformes); and pelicans, cormorants and anhingas (order Pelicaniformes). These species rely on different habitats for nesting. Herons and their allies and pelican typically nest in grasses, shrubs and

trees. Terns and skimmers are ground nesters with many species requiring bare sand/shell with little or no vegetation for nesting. Anhingas, double-crested cormorants and great blue herons nest almost exclusively in swamp forests and other inland wetlands and will not be considered further in this report. Yellow-crowned night herons, cattle egrets and green herons, which do nest at estuarine sites, can also be found nesting in significant numbers at inland sites. All other species nest primarily along the coast. This report will focus on species that can be found nesting in North Carolina's estuaries and along its' beaches.

Censusing of colonial waterbirds in the state began in 1977 when Dr. James Parnell of the University of North Carolina at Wilmington conducted the first coast-wide breeding survey in an effort to determine breeding population levels in the state (Parnell and Soots 1979). This was followed by a second coast-wide survey conducted by Dr. Parnell in 1983 (Parnell and McCrimmon 1984). Through these surveys and other research (Parnell and Soots 1975, Soots and Parnell 1975), the importance of dredged material islands to nesting colonial waterbirds in North Carolina has been recognized. Monitoring of North Carolina's colonial nesting waterbirds is listed as a priority in the North Carolina Wildlife Action Plan (NCWRC 2005) and with funding from the U.S. Army Corps of Engineers (USACOE) and help from other agencies, organizations and individuals, North Carolina Wildlife Resources Commission (NCWRC) continues coast-wide surveys today.

NCWRC's efforts to manage the state's colonial waterbird resources began in the early 1980s when a contract to develop a management plan was awarded to Dr. Parnell. The first draft of the plan was presented at the first annual Colonial Waterbird Management Workshop in May 1985. The culmination of this effort came in 1990 when *Management of North Carolina's Colonial Waterbirds* by Parnell and Shields was published. This publication now serves as the basis for management efforts in the state, as well as a model for other states. Actual management for colonial waterbirds began in 1989 with the formation of a Cooperative Agreement signed by eleven agencies with the purpose of implementing a program for the protection and management of colonial waterbirds nesting in North Carolina. The agreement includes virtually all agencies that have land management or permit review responsibilities in the coastal zone. Today, additional agencies have signed the Cooperative Agreement and annual Colonial Waterbird Committee meetings are held to update individuals on research and management issues in the state and to facilitate coordination among the different agencies. NCWRC works closely with USACOE and other agencies to direct the placement of dredged material on nesting islands and to ensure that projects along the coast are done in a way that minimizes impacts to colonial nesting waterbirds. In addition, NCWRC and partnering agencies post known nesting sites prior to the start of the breeding season.

Census data going back to 1972 is housed in The North Carolina Colonial Waterbird Database, developed by Dr. Parnell and now held and maintained by NCWRC's Wildlife Diversity Program. It contains a history of all known nesting sites of colonial waterbirds in North Carolina. This database has been continually updated with the help of USACOE funding since 1989. Information can be compiled and extracted easily and quickly in table or report form by year, site, or species. Reports or tables can be converted to Word or Excel files to be printed or manipulated. Additional information available includes site descriptions, specific nesting habitat characteristics, survey history, landowner information, and managing agency.

Need:

The need to monitor and manage colonial waterbirds was acknowledged in the *Management of North Carolina's Colonial Waterbirds* by Parnell and Shields (1990). The *North American Waterbird Conservation Plan* (Kushlan et al. 2002) was developed to provide a continental-scale framework for the conservation and management of waterbirds and points to the importance of regular monitoring to help determine conservation status, detect population trends and indicate whether environmental changes and management prescriptions are affecting waterbirds. More recently, waterbird conservation was put into a regional context with the publication of the *Southeast United States Regional Waterbird Conservation Plan* (Hunter et al. 2006). NCWRC utilizes all of these plans as a basis for the Waterbird Program and coast-wide nesting surveys are conducted as part of this program. In addition to tracking population trends, locations of nesting colonies and condition of habitat; survey information is critical in making management and conservation decisions and prioritizing research. NCWRC, USACOE and other agencies also use coast-wide nesting survey data when planning and reviewing coastal projects.

Coast-wide survey also allows for regular monitoring of colonial waterbirds on dredged material islands, which are becoming increasingly important to nesting waterbirds. Development along our barrier islands has usurped much of the habitat traditionally used by nesting colonial waterbirds. With coastal development comes an increase in human disturbance to nesting colonies and predation by mammals that benefit from human refuse; such as raccoons, fox and feral cats. Dredged material islands provide nesting sites that are relatively free of human disturbance and predators. USACOE has been very involved in colonial waterbird management in North Carolina and works with NCWRC and Audubon North Carolina to direct the placement of dredged material on waterbird islands to benefit nesting birds.

Methods:

Coast-wide surveys are currently conducted every three years. The last complete survey was done in 2004, and from early May through mid-June of 2007, NCWRC updated data on nesting waterbirds by coordinating another survey covering the entire coastline. Surveys were conducted along the state's barrier and estuarine islands and all known nesting sites along with potential nesting sites were visited over the course of the breeding season. Information was collected on the number of nests, stage of development, nest substrate, colony vegetation and site disturbance factors. Surveys were coordinated by the NCWRC Waterbird Biologist and conducted with the help of other agency staff including biologists with National Park Service, Audubon North Carolina, Camp Lejeune Marine Corps Base, U.S. Fish and Wildlife Service, North Carolina Division of Coastal Management, North Carolina Division of State Parks and University of North Carolina at Wilmington; additional NCWRC staff; and volunteers.

Surveys were conducted in a similar fashion to years past so that they remain comparable and allow for the detection of population changes. Nests were counted by one to fifteen people (depending on colony size), spaced approximately three to fifteen meters apart. Counters walked transects through the colonies and identified and tallied active nests (those with at least one egg or chick). Ground counts are the preferred method of surveying, but depending on the stage of

nesting, it was occasionally necessary to count from the perimeter of the colony or to estimate the number of breeding pairs from adult counts. A conversion factor of 0.5 was used to estimate the number of nesting pairs from adult counts for most species. As with years past, a conversion factor of 1.0 was used for laughing gulls. The 0.5 conversion factor can result in conservative counts given that some adults can be away from the nest site during surveys, but it is consistent with methods used in past surveys so results between years are comparable. We visited all colonies during peak incubation. Since we are only able to visit most sites once, counts of active nests likely underestimate the breeding population, but they provide index of the number of nesting pairs that is comparable from year to year. All data collected has been entered into the North Carolina Colonial Waterbird Database.

Results and Discussion:

Abundance

A total of 64,961 waterbird nests were either directly counted or estimated from adult counts along the coast during the 2007 census. One hundred and ten active colonies were found and 22 species of colonial waterbirds were observed nesting during the surveys. The most abundant species were laughing gulls, white ibis, royal terns, and brown pelicans. Results on number of nests and sites along with comparisons to earlier surveys can be found in Tables 2 and 3. Overall, populations of most colonial nesting waterbirds appear relatively stable, but we continue to be concerned about several species of early successional nesting birds.

While many species' totals fluctuate from year to year, several have shown marked downward trends over the 30 years since surveys began. Common terns, gull-billed terns and black skimmers have shown the greatest declines. All are early successional nesters requiring bare sand/shell with little or no vegetation for nesting. Historically, these species nested primarily on barrier island beach and have suffered declines because of habitat loss and degradation. Common terns and black skimmers are state listed as species of special concern and gull-billed terns are state listed as threatened. Both gull-billed terns and black skimmers are listed as species of high conservation concern in the *North American Waterbird Conservation Plan* (Kushlan et al 2002).

The downward trend continued for all three species in 2007. Common terns, gull-billed terns and black skimmers were down 13%, 9% and 11% respectively from 2004 counts and 68%, 50% and 25% from long term averages. The number of nests counted for all three species was the lowest in the history of waterbird surveys in North Carolina. Overall these birds are nesting in far fewer numbers and at fewer sites than historically. The majority of nests were found at just a handful of sites. For example, over half of the black skimmer population was found nesting at just two sites and two thirds of the gull-billed tern population was located at just one site. Common terns nested at 26 sites, but 18 of these sites supported fewer than six nesting pairs. Small colonies typically do not do well as they lack the predator protection provided by larger colonies. Middle Core Banks on Cape Lookout National Seashore supported the largest mixed tern/skimmer colony in the state this year. This site is fairly remote with little human disturbance or mammalian predation. Cora June Island, Parnell Island and Clark Reef also supported good-sized colonies.

Three other species of early successional nesters; least, royal and sandwich terns; are fairing a bit better. Least tern numbers have been increasing steadily since about 1997. This trend continued in 2007 with an increase of 17% from 2004 counts. Least terns prefer to nest on barrier island beaches and would likely be displaying downward trends if not for their unique ability to utilize gravel roofs for nesting. In fact, approximately 34% of the state's population of least terns nested on roofs this year. While this adaptation has benefited least terns in the short term, there is concern that gravel roofs will be replaced by roofs made from other materials. This is a trend that has been observed in other states due to the high maintenance costs of gravel roofs. In addition, eggs and chicks are vulnerable to disturbance by rooftop workers and to heat stress from exposure to extreme temperatures. Because of their continued vulnerability, least terns are listed as a state species of special concern. The largest least tern colony in the state was located on Shark Tooth Island; a dredged material island near Bogue Inlet. Several roofs supported significant colonies including Emerald Isle Food Lion and Belk in Kill Devil Hills. The most important barrier beach nesting sites this year were at the north end of Wrightsville Beach, the south end of Topsail Island and Middle Core Banks.

Table 2. Estuarine and barrier island colonial waterbirds nesting in North Carolina, 1977-2007.

	Number of Nests (Number of Sites)										
Species	**1977**	**1983**	**1988**	**1993**	**1995**	**1997**	**1999**	**2001**	**2004**	**2007**	**Average**
White Ibis	1939(2)	3825(5)	6332(5)	10455(7)	9571(8)	9446(8)	8711(8)	17043(10)	14392(11)	16962(10)	9868(7)
Glossy Ibis	404(12)	291(7)	84(4)	526(15)	279(10)	482(9)	229(7)	600(11)	377(8)	356(7)	363(9)
Brown Pelican	82(2)	1586(5)	2637(8)	3327(7)	3290(4)	4145(9)	4350(11)	4137(8)	5173(9)	3452(10)	3218(7)
Green Heron*	42(5)	24(6)	64(7)	8(5)	8(2)	4(2)	15(2)	30(9)	47(5)	117(2)	36(5)
Black-crowned Night-heron	237(13)	269(12)	207(12)	251(16)	204(13)	233(16)	193(15)	262(15)	297(16)	177(18)	233(15)
Yellow-crowned Night-heron*	2(1)	9(2)	12(1)	18(2)	10(1)	21(4)	12(2)	5(1)	2(1)	14(4)	11(2)
Great Egret*	494(16)	832(17)	682(14)	1945(23)	1901(19)	3551(22)	1230(22)	1901(19)	1879(21)	1697(18)	1611(19)
Cattle Egret*	1137(9)	1754(9)	1919(8)	2271(12)	1517(7)	908(9)	3049(12)	342(7)	547(7)	479(9)	1392(9)
Snowy Egret**	1034(18)	716(15)	497(11)	904(20)	672(13)	676(16)	271(13)	349(12)	446(15)	386(15)	595(15)
Tricolored Heron	1479(18)	1436(17)	869(11)	1938(19)	1716(13)	1241(17)	701(18)	1219(17)	1702(17)	979(15)	1328(16)
Little Blue Heron**	802(16)	1178(13)	538(10)	1727(15)	1407(12)	679(12)	1025(13)	1349(14)	1354(16)	1090(13)	1115(13)
Least Tern	1925(38)	1653(32)	1528(20)	2188(24)	1993(31)	882(31)	1271(26)	1742(45)	2408(47)	2827(47)	1842(34)
Forster's Tern	1138(26)	936(15)	933(13)	1610(27)	1117(21)	867(16)	812(12)	1086(31)	828(28)	1034(18)	1036(21)
Royal Tern	9755(7)	17029(8)	11793(8)	14611(7)	14150(7)	10991(9)	12519(7)	10877(7)	13524(7)	10689(9)	12594(8)
Sandwich Tern	1190(5)	1850(7)	1199(7)	2700(5)	2905(6)	2766(9)	2425(8)	2487(6)	2635(6)	2786(7)	2356(7)
Caspian Tern	10(3)	6(2)	11(1)	33(2)	37(2)	26(1)	32(3)	22(2)	16(2)	15(3)	21(2)
Common Tern	2761(35)	2247(32)	2618(25)	2122(29)	1699(24)	952(19)	888(15)	1131(22)	570(25)	498(26)	1549(25)
Gull-billed Tern	268(9)	233(12)	161(17)	155(10)	249(10)	137(9)	154(5)	258(7)	99(8)	90(7)	180(9)
Black Skimmer	976(17)	797(18)	743(18)	1084(18)	819(18)	570(15)	681(14)	594(15)	623(13)	555(10)	744(16)
Laughing Gull	9369(16)	22903(16)	17478(15)	17970(20)	23567(16)	11325(16)	17960(14)	31749(17)	14922(19)	19964(16)	18721(17)
Herring Gull	433(7)	440(16)	353(13)	960(18)	516(18)	687(15)	746(16)	881(17)	663(19)	630(19)	631(16)
Great Black-backed Gull	9(4)	0(0)	3(1)	47(11)	92(9)	177(16)	201(12)	181(18)	176(21)	164(25)	105(12)
Total	**35486**	**60014**	**50661**	**66853**	**67719**	**50768**	**58091**	**78252**	**62680**	**64961**	**59549**

* A significant amount of additional nesting for this species occurs inland.
** A small amount of additional nesting for this species occurs inland.

Table 3. Changes in numbers of pairs and nesting sites of colonial waterbirds in North Carolina between 2004 and 2007.

Species	2004 # Pairs	2004 # Colonies	2007 # Pairs	2007 # Colonies	% Change in # Pairs	% Change in # Colonies
White Ibis	14392	11	16962	10	17.9	-9.1
Glossy Ibis	377	8	356	7	-5.6	-12.5
Brown Pelican	5173	9	3452	10	-33.3	11.1
Black-crowned Night-heron	297	16	177	18	-40.4	12.5
Great Egret*	1879	21	1697	18	-9.7	-14.3
Cattle Egret*	547	7	479	9	-12.4	28.6
Snowy Egret**	446	15	386	15	-13.5	0.0
Tricolored Heron	1702	17	979	15	-42.5	-11.8
Little Blue Heron**	1354	16	1090	13	-19.5	-18.8
Least Tern	2408	47	2827	47	17.4	0.0
Forster's Tern	828	28	1034	18	24.9	-35.7
Royal Tern	13524	7	10689	9	-21.0	28.6
Sandwich Tern	2635	6	2786	7	5.7	16.7
Caspian Tern	16	2	15	3	-6.3	50.0
Common Tern	570	25	498	26	-12.6	4.0
Gull-billed Tern	99	8	90	7	-9.1	-12.5
Black Skimmer	623	13	555	10	-10.9	-23.1
Laughing Gull	14922	19	19964	16	33.8	-15.8
Herring Gull	663	19	630	19	-5.0	0.0
Great Black-backed Gull	177	21	164	25	-7.3	19.0
Total	62681	108	64961	110	3.6	1.9

* A significant amount of additional nesting for this species occurs inland.
** A small amount of additional nesting for this species occurs inland.

Royal tern numbers were down from 2004 counts, but were comparable to long-term average with 10,689 nests counted. Sandwich terns have been experiencing an increasing trend and are up 6% from 2004 and 18% from the long-term average with 2,786 nests counted. Royal and sandwich terns nest together primarily on dredged material islands. These species' tendency to nest on dredged material is likely why their populations are more stable than other species of early successional nesting terns. This year, both species were observed nesting at more sites and all nests were found on dredged material. A few colony shifts are worth mentioning. With changes in habitat, nesting has shifted from New Dump Island to Wainwright Island in Core Sound and from Islands L and MN to Parnell Island near Oregon Inlet. Cora June Island also supported a colony after its restoration this spring.

Caspian terns have historically only nested in small numbers in North Carolina. Most Caspian terns nest in the Great Lakes and northwest regions of the United States. Fifteen Caspian tern nests were counted at three sites this year. This is down slightly from the 2004 count of 16 nests and highlights the continued decline this species has experienced since the mid-1990s.

Forster's terns are unique among the terns in that they nest almost exclusively on wrack in marshes. Forester's terns nested at fewer sites this year, but were up 25% from 2004. Forster's tern numbers have been fairly stable since surveys started, fluctuating between roughly 800 and 1100 pairs. This proved to be a good year with 1,034 nests tallied. The most important sites were Great Island, Hog Island, Middle Marsh and Raccoon Island.

Nesting brown pelicans have been increasing in the state and expanding their range since the ban of DDT in 1972. They reached a peak of 5,173 pairs in 2004, but were down considerably this

year with just 3,452 nests counted. Declines were seen at most nesting sites along our coast as well as in the neighboring states of Virginia and South Carolina. This suggests declines are not the result of local habitat changes or disturbances, but rather the consequence of a larger scale issue such as changes in food resources.

Three species of gulls nest in North Carolina: laughing gull, herring gull and great black-backed gull. Over the long term, gull numbers have been increasing in the state. Herring gulls and great black-backed gulls historically did not nest in North Carolina in significant numbers, but both have been expanding their range southward. Range expansion and population increases of these species are due in large part to their ability to benefit from human refuse. Gulls, unlike many other colonial waterbirds, have the remarkable ability to adapt to and benefit from human-altered environments. These unnatural increases in gull populations can cause problems for other species of colonial nesting waterbirds as gulls compete for nesting sites and depredate eggs and chicks of other species.

Great black-backed gulls continued to expand their range in North Carolina, nesting at four more sites this year. In 2004, the southernmost site hosting nesting great black-backed gulls was located in Core Sound. This year, a single pair was found nesting much farther south, in the Cape Fear River. Herring gulls nested at the same number of sites this year as in 2004. Luckily, populations of both species seem to have stabilized in recent years and counts this year were similar to those in 2004. Laughing gulls are native to North Carolina and have also been increasing due to their propensity for eating trash. Laughing gull numbers are up by 34% from 2004 counts and are slightly above the long-term average.

Counts for almost all of the wading birds were down this year when compared with 2004 and only populations of white ibis experienced an increase. Additionally, most wading birds were found nesting at fewer sites this year. Glossy ibis, great egret, and little blue heron counts were below 2004 levels, but close to their respective long-term averages. Black-crowned night heron, snowy egret and tri-colored heron numbers were below the 2004 levels and were off long-term averages by 24%, 35% and 26 % respectively. Two tropical systems struck our coastline this spring, one in early May and one in early June. These ill-timed storms undoubtedly led to nest failures and may have impacted counts of wading birds. Another potential factor in lower counts is the loss of habitat at two sites that once supported large heronries; DOT Island and Rawls Island. Both sites have experienced significant erosion and Rawls Island is almost gone. The most important heronries in the state this year were located on Monkey Island, Island G, Hog Island, Morgan Island and Battery Island. An island near Stumpy Point Bay deserves further mention. It supported only a small number of green herons in 2004, but has grown considerably in recent years and now hosts an impressive heronry consisting on green herons, little blue herons and snowy egrets.

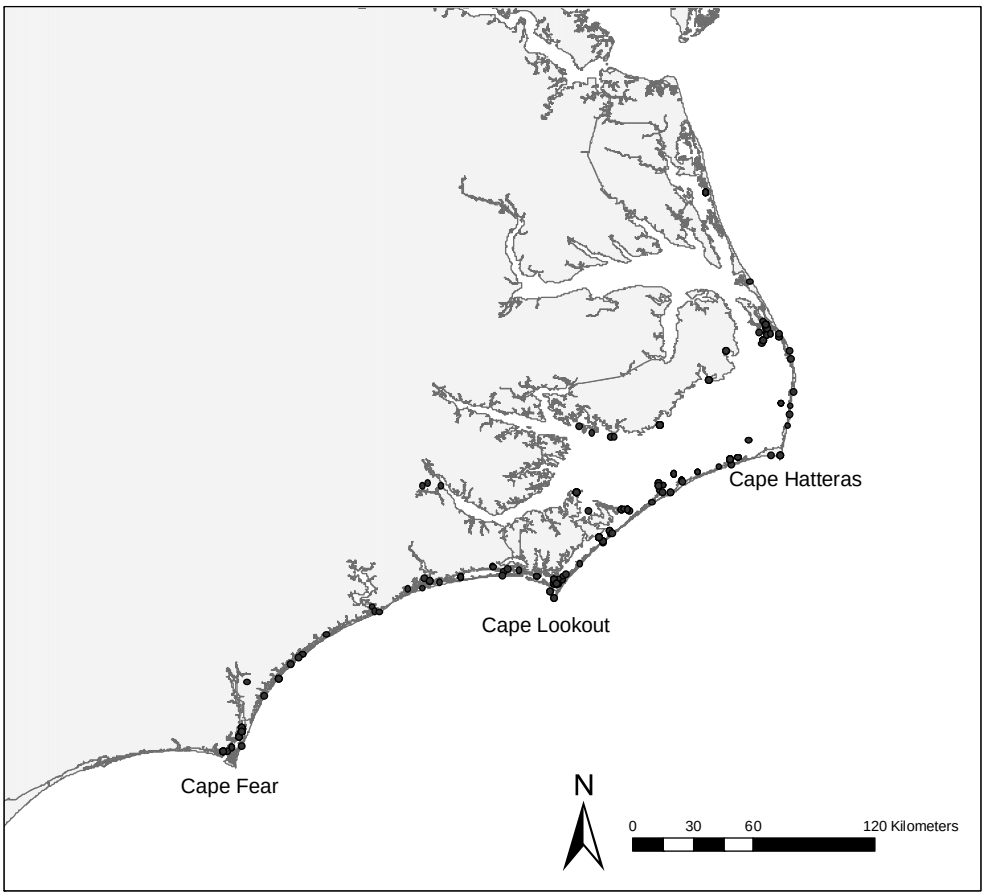
Green herons are less colonial than most of the colonial nesters and thus are poorly sampled by our survey techniques. Furthermore, many of our green herons nest inland near swamps, beaver ponds, farm ponds, and even in suburbs where habitat is suitable. Likewise, yellow-crowned night-herons nest primarily inland and are not well surveyed by our coastal surveys. Numbers of both species counted along the coast were up compared to the 2004 counts. Cattle egrets nest in significant numbers inland and also initiate nesting later than other wading birds so numbers

counted along the coast are not representative of the state's population. It is interesting to note that counts of cattle egrets have been very low during the last three survey years and it is possible that some birds that once nested along the coast have moved further inland.

Distribution

Colony sites were distributed along the coastline from Currituck Sound to the mouth of the Cape Fear River with the northernmost colony located on Monkey Island and the southernmost colony on Battery Island (Figure 1). No colonial waterbirds were found nesting on the highly developed beaches north of Bodie Island or south of the Cape Fear River. There is still some suitable habitat along the inlet spits on the Brunswick County beaches and if adequately protected these sites could support future nesting by terns and skimmers. Additionally, a strong storm and protection of resulting overwash fans would likely lead to a return of nesting terns to Currituck National Wildlife Refuge in the northernmost region of the state. Not surprisingly, many colony sites were clustered near inlets, which are typically very productive areas with ample food resources and also where many of the dredged material islands are located. Nearly 70% of the 110 active colony sites were found under the jurisdiction of federal, state or private management agencies and most were afforded at least minimal protection. In addition, NCWRC received permission from several private landowners to post active nesting sites on barrier island beaches. The majority of nesting colonial waterbirds were found in Pamlico Sound, Core Sound and the lower Cape Fear River.

Figure 1. Colony site distribution.



To summarize distribution, sites were divided into four major types: barrier island, natural estuarine island, dredged material island and rooftop (Figure 2). The majority (38%) of North Carolina's 110 colony sites were on natural islands. Twenty-seven percent were on barrier islands and 25% were on dredged material islands. Eleven roofs representing 10% of all sites were used by nesting terns this year.

Dredged material islands continue to provide important nesting sites for colonial waterbirds. In fact, nearly 60% of all of the colonial waterbird nests tallied this season were found on dredge islands (Table 4). This was largely due to use of dredged material sites by royal terns and white ibis, which nest in large numbers along our coast. Dredged material islands also proved important for brown pelicans, black-crowned night herons, great black-backed gulls, herring gulls, sandwich and Caspian terns.

As in the 2004 census, we surveyed the length of the Atlantic Intracoastal Waterway (AIWW) from Morehead City to Bird Island. Surveys of diked dredge disposal islands along the AIWW yielded mostly small colonies of least terns. One exception was Shark Tooth Island located near Bogue Inlet, which supported the largest colony of least terns in the state (307 nests) and a small number of common terns and black skimmers. Undiked dredge islands continue to provide more valuable nesting habitat than diked islands. Diked islands are, however, important to nesting shorebirds and several American oystercatcher, Wilson's plover, and willet nests were observed this season.

Figure 2. Percentage of colonies by site type.

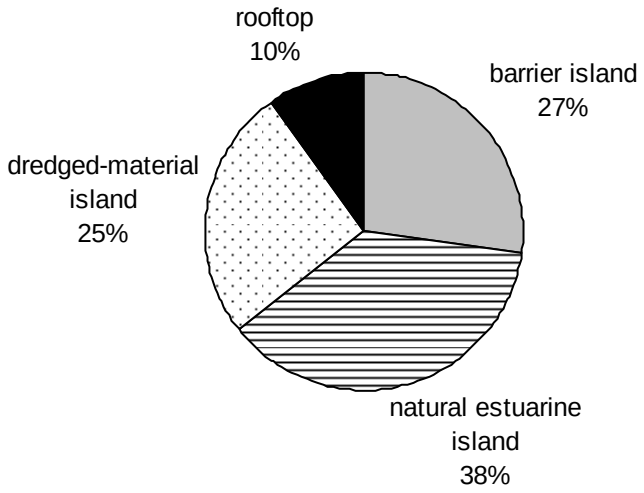


Table 4. Percentage of total colonial waterbird nests found on dredged material, natural island, beach, and rooftop habitats in 2007.

Species	Dredged material (islands built with or covered by)	Natural island and mainland	Beach	Rooftop
White ibis	93.6%	6.4%		
Glossy ibis	12.1%	87.9%		
Brown pelican	78.9%	21.1%		
Black crowned night heron	74.6%	25.4%		
Great egret*	27.7%	72.3%		
Cattle egret*	55.1%	44.9%		
Snowy egret**	24.4%	75.7%		
Tricolored heron	55.9%	44.1%		
Little blue heron**	45.7%	54.3%		
Least tern	18.9%	3.7%	43.3%	34.1%
Forster's tern	0.4%	99.6%		
Royal tern	100.0%			
Sandwich tern	100.0%			
Caspian tern	100.0%			
Common tern	24.3%	50.4%	24.9%	0.4%
Gull-billed tern	18.9%	15.6%	65.6%	
Black skimmer	41.8%	8.7%	49.6%	
Laughing gull	10.2%	89.8%		
Herring gull	82.1%	17.9%		
Great black-backed gull	76.8%	23.2%		
Total	58.2%	37.7%	2.6%	1.5%

* A significant amount of additional nesting for this species occurs inland.
** A small amount of additional nesting for this species occurs inland.

Natural islands within North Carolina's estuaries provided nesting habitat for approximately 38% of the colonial waterbirds in 2007. Most of the Forster's terns, glossy ibis, great egrets, snowy egrets and laughing gulls were found nesting on natural islands within the sounds. In addition, natural islands with fringing beaches or beach ridges were important for common terns with greater than 50% of nesting pairs using these sites.

Barrier island beaches continue to provide important habitat for gull-billed terns, common terns, least terns and black skimmers. As previously mentioned many of these sites are severely degraded because of coastal development and associated increases in human disturbance and predation by overabundant species. Their preference for barrier beaches is likely why we have seen population declines in three of these species. When compared to the 2004 distribution, there was a decline of least terns using barrier islands and a corresponding increase in use of gravel roofs. The percentage of least tern nests on gravel roofs increased from 29% in 2004 to 34% in 2007. Common tern and black skimmer numbers also declined on barrier beaches and increased on dredged material islands. Only gull-billed terns were found in greater numbers on barrier island beaches this year and this is because two-thirds of gull-billed terns nested on Middle Core Banks. This shift suggests a continued deterioration of barrier island nesting sites, which is further supported by the almost complete loss of tern/skimmer colonies on some barrier islands (e.g. south end of Ocracoke Island, Bear Island, Masonboro Island).

Conclusions and Recommendations:

Overall, the populations of most colonial waterbirds nesting in North Carolina have remained relatively stable and many species' population levels are at or above the goals set for North Carolina. There continues to be concern, however, for many of the early successional nesting colonial waterbirds. Common terns and gull-billed terns, the two species showing the most marked declines over the 30 years since surveys began, continue to decline and are well below their respective population goals of 2,500 and 300 pairs. As their populations decline, we are seeing smaller and smaller colonies of these species. Small colonies are likely not very successful as they don't afford the predator protection provided by larger colonies. Continued declines indicate that not enough is being done to protect tern and skimmer nesting sites. There is a clear need to increase both the quantity and quality of habitat particularly on barrier islands. Predator management and better protection against human disturbance are warranted at many sites and needed if we hope to reverse declines.

With over 60% of the state's colonial waterbirds nesting on dredged material islands, there is clearly a need to continue management of these sites for nesting waterbirds. Due to the dedication of USACOE to creating and enhancing habitat on dredged material islands, three important waterbird nesting sites received material this spring: Cora June Island, Wainwright Island and New Dump Island. We are happy to report that terns returned to nest at all three sites this year. Furthermore, Cora June Island proved to be one of the most important tern nesting sites in the state and supported black skimmers, royal, sandwich, least, common and gull-billed terns. From a visual assessment of habitat at nesting sites this summer it is clear that a few additional dredge islands are in need of sand. Sandbag Island is now almost completely covered in vegetation and is in danger of loosing its royal and sandwich tern colony. As previously mentioned, DOT Island is quickly eroding and will likely disappear in the next ten years if it doesn't receive material. Lastly, the New River Inlet islands are also in need of sand and deposition of material at these sites has great potential to benefit species of concern in the region.

Losses and changes in habitat on several natural islands were also observed this season. Monkey Island, located in Currituck Sound, supports the only heronry north of Oregon Inlet and is the most important nesting site in the state for great egrets and little blue herons. Monkey Island was once about seven acres in size. It has been eroding over the years and now covers roughly three acres. There has been a concerted effort among numerous agencies to stabilize Monkey Island, although this has been somewhat hampered by changes in USFWS personnel. This effort should be renewed so that we don't loose this important heronry. As previously mentioned, Rawls Island (privately owned) located along the western shoreline of the Pamlico Sound is disappearing. Tump Island located behind Cedar Island hosted terns in the past, but is eroding and no longer has fringing beaches to support nesting terns. The Judith Island Complex and Audubon Islands near Ocracoke Inlet are also eroding. Lastly, Cat Island was battered by Hurricane Ophelia, which killed most of the trees and shrubs on the island. This likely impacted the heronry at this site, but shrubs are growing back and the site is expected to recover.

Continued monitoring and management is vital for the conservation of our coastal birds. There is a clear need to further enhance and restore lost habitat for species experiencing declines. Human disturbance continues to be a concern at beach nesting sites and is a growing concern at

estuarine sites as the coastal human population increases with more and more people seeking out isolated spots for recreation. Further protection of existing habitat from human disturbance and predators will be needed to halt declines of terns and skimmers. Finally, public education to decrease disturbance at all nesting areas and enforcement of seasonal closures needs to be an ongoing effort.

B. Estimated Cost:

$17,390.17

This project spanned two fiscal years so cost reflects money spent in 06/07 and 07/08.

C. References:

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Prepared By: Susan Cameron
Waterbird Biologist
Wildlife Diversity Program