Annual Program Report
2008-2009

Wildlife Diversity Program
Division of Wildlife Management
NC Wildlife Resources Commission

1751 Varsity Drive
Raleigh, NC 27606

CONTENTS

Final Performance Report

State: North Carolina **Project Number:** T - 7

Period Covered: July 1, 2008 - June 30, 2009

Grant Title: State Wildlife Grants T-7 (Planning)

Project Title: Piedmont Cooperative Land Conservation Project

Objectives:

The goal of the Piedmont Cooperative Land Conservation Project (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 objectives:

1. Priority lands assessment, mapping, protection and habitat conservation coordinated between stakeholders and partners including land trusts, state and federal agencies.
2. Work with county and municipal governments and industry representatives to develop land use plans and policies that will protect priority habitats identified in the Action Plan.
3. Coordinate and conduct biological surveys for priority species coupled with building landowner relationships to accomplish enhanced habitat management and conservation.
4. Communicate the need for and benefits of conservation coupled with sustainable development to local landowners, community leaders and decision makers.
5. Leverage grant funding in support of these activities.

A. Activity

The Piedmont Cooperative Land Conservation Project has worked toward completing project objectives, in this 3rd year of the project, with the following results during the 2008 – 2009 fiscal year.

Coordination and Facilitation of Conservation Partnerships

- Greater Uwharrie Conservation Partnership (GUCP) Forum and Steering Committee met 4 times
- GUCP Working Groups met 6 times this year
- Sandhills Conservation Partnership steering committee met 4 times
- Active information exchange occurred on email list serves and wiki-spaces for both partnerships

Priority lands assessment and mapping

- The Greater Uwharries Conservation Planning Map (GUCP Map) was used by 5 of 12 partners and 1 stakeholder (The Piedmont Triad Council of Government) to develop over 100 landowner contacts, 4 projects and 5 grants.
- Staff informed the Land Trust for Central NC board on the GUCP Map and the land trust is currently using the GUCP Map to assess priorities.
- The US Fish and Wildlife Service used the GUCP Map to identify priority areas for Piedmont longleaf restoration.
- Habitat guild mapping was completed for the Greater Uwharries by the NC Natural Heritage Program (NHP). WRC partnered with NHP to collect source data and map the guilds.
- Staff facilitated a scientific expert review of the conservation importance ranks. Ten of 26 experts contacted have provided reviews to date. A map and map distribution update is under way.

Priority lands protection and conservation

- The PCLCP assisted the Land Trust for Central NC with logistics and information in support of the purchase of the 355 acre King Mountain Tract, which connects the Uwharrie National Forest and contains Action Plan priority habitat and other high priority GUCP conservation targets. Staff are currently working to convey 227 acres of this tract to WRC.
- In this year, WRC purchased 830 acres of the 1665 acre Diggs tract from The Conservation Fund, with the remaining purchase scheduled for 2009-2010. The Wildlife Resources Commission approved the concept of a primitive campground on the site, and game lands staff erected 4 gates and conducted over 100 acres of controlled burns for habitat enhancement.
- The PCLCP assisted in a land trust application for a high ranking priority parcel on adjacent to the Pee Dee NWR with a great blue heron and anhinga rookery.
- The PCLCP worked with an Anson County landowner and WRC staff to develop a proposal outlining the process for purchase by WRC of the family's land totaling over 1,400 acres.

Technical guidance to local governments for land use planning that incorporates wildlife habitat conservation

Forecasting development in North Carolina's South Central Piedmont: historical trends versus conservation based planning

- The PCLCP funded and guided a research project through the Renaissance Computing Institute at the University of Charlotte to map projected development growth to 2030 under a scenario projecting forward historical trends, and another scenario which assumed local governments adopted the conservation recommendations contained in WRC's Green Growth Toolbox (GGT).

- Map results show that adoption of GGT practices would reduce conservation threats and conflict by 75%. Development was projected to increase from 13% (2006) to 25% by 2030 under both scenarios, and the primary difference between the 2 models is that development is located away from environmentally sensitive areas in the conservation scenario.
- Randolph and Rowan Counties would experience the greatest benefit of land conservation policies. Over 50 % of areas of conservation value in these counties would be conserved by adopting GGT practices. Cabarrus, Davidson, Richmond and Stanly Counties would be able to increase land conservation by at least 25% by adopting conservation policies.
- A PhD project for a UNC student was supported by this research. This student plans to develop additional research using the NC Wildlife Action Plan.

Technical Guidance

- All WRC recommendations were incorporated into the Montgomery (final draft) and Anson County (adopted) Land Use Plans and amendments.
- The PCLCP organized and held 4 meetings of GUCP partners, landowners, local leaders and businesses in Montgomery County to provide a forum for discussion on land use planning and habitat conservation. This led directly to the county commissioners appointing an official land use advisory committee of 20 community leaders, including the PLC biologist. The PLC Biologist has developed positive relationships with 2 county commissioners and the Chamber of Commerce.
- Anson County passed a Resolution of Support for the GGT proposed by the PCLCP. We are providing technical guidance on an Environmental Protection Overlay District.
- The complete Greater Uwharries Appendix and GIS for the GGT is available at: http://www.ncwildlife.org/greengrowth/documents/Manual/Greater_Uwharries_Appendix.pdf and http://www.ncwildlife.org/greengrowth/Conservation_Data.htm.
- The PCLCP developed materials for GGT training workshops.
- A presentation on the GGT organized by Stanly County Friends of the Land was given to the Stanly County planning director, manager and staff from many of the county's towns and cities.
- The PCLCP contributed significant time to developing terrestrial habitat conservation criteria for the WRC Wildlife Friendly Development Certification Program.

Biological surveys for priority species to promote habitat enhancement on private land

- Survey protocols for priority NC Wildlife Action Plan species and habitats were developed based on the US Forest Service Multiple Species Inventory and Monitoring Protocols.
- 16 private landowners with large landholdings in priority areas were contacted to ask permission to survey; 12 accepted.
- Surveys documented the third record of a ribbon snake (*Thamnophis sauritus*) in the Greater Uwharries region. Surveys on 11 sites documented 11 Action Plan priority species and 14 habitat guild indicator bird species, 1 priority reptile, and 6 priority amphibians. A total of 179 records of Action Plan species were gathered for the GUCP

Map and GGT databases on private lands. Eight of 11 sites had a species richness of 4 to 9 priority species. Bat surveys have been planned for late summer.

- Priority grassland birds were surveyed 3 times over 44 tracts along 2 driving point count routes.
- Landowners of sites with high priority species or habitats will be contacted to provide a survey report and gauge their interest in conservation information and options.

Number of Sites and Species Richness for Action Plan Priority Grassland Birds in Stanly County. Sites were surveyed 3 times each.

Number of sites	4	10	19	15	6	1	0
Species Richness	0	1	2	3	4	5	6

- 404 records of Action Plan priority grassland birds were added to the GUCP Map database.

Leverage grant funding

- Submitted grants to the NC Natural Heritage Trust Fund and NC Clean Water Management Trust Fund to purchase 227 acres of the King Mountain Tract.
- $29,500 was spent this year on longleaf restoration planning by the USFWS in partnership with GUCP partners. Over $80,000 of USFWS Partners Program funding is available over 4 years.
- $3,000 grant was awarded from the Conservation Trust of NC to the Land Trust for Central NC to promote the Wildlife Action Plan.
- $22,000 grant awarded to Montgomery Chamber of Commerce for canoe access to the Uwharrie River, WRC provided information on priority species in support of their grant application.

Communicate the need for and benefits of conservation to local landowners, community leaders and decision makers

- Five GUCP partners presented at the Biltmore Forest School, Piedmont Woodland Steward Series. At least 11 landowner habitat conservation projects resulted.
- WRC biologists cooperated to present information about wildlife habitat conservation cost-share programs at the Stanly County Friends Landowner Education Series.
- Focus groups were held with Cabarrus, Randolph and Anson County staff to gain feedback regarding the presentation of the Southern Piedmont Growth Forecasting Maps.
- The PCLCP delivered presentations about the GUCP to the NC Herpetological Society and the Savannah-Santee-Pee Dee Ecoteam.
- Presentation on the Wildlife Action Plan and the GUCP given in partnership with the land trust to local and state representatives and press.
- The GUCP was featured in a white paper by the National Parks Association as an example of lessons learned from conservation partnerships (http://www.npca.org/cpm/wildlife_report/Partnering-to-Preserve-Wildlife-Habitat.pdf)

PCLCP Summary Measures of Success

- 16 collaborative land and habitat conservation projects were undertaken or completed with 9 partner and stakeholder organizations
- 5 of 12 partners and 1 stakeholder used the Greater Uwharrie Conservation Planning Map and or map layers as a conservation tool
- Collaboration with 10 new stakeholders through the GUCP, no new GUCP partners joined the partnership
- 10 new landowner relationships formed
- 4 new local government representative working relationships formed
- 4 landowners engaged in areas of conservation priority
- 1 landowner who improved land management due to GUCP partner work
- 3 local government officials received technical guidance
- 23 presentations, meetings and other information exchanges with local decision-makers and landowners
- 11 local leaders received technical guidance through workshops and presentations
- comments provided on 2 land use plans, 1 plan with 100% recommendations adopted
- 8 exchanges of sets of wildlife habitat conservation map layers or data
- 583 new records of Action Plan priority species were gathered for the GUCP Map database and Green Growth Toolbox GIS.
- 12 priority Action Plan multi-species surveys completed on 12 sites and 3 repetitions of 2 grassland bird survey routes completed.

GUCP Partner Measures of Success Significantly Attributed to Participation in the GUCP from 2007 to 2009 (GUCP chose to report success biannually)

- 1159 (2008-2009) acres permanently protected
- 2154 acres of habitat enhancement
- 72 landowner relationships
- 7 strong working relationships with local government representatives
- $6,756,500 of state and $200,000 of federal funding applications and $1,143,093 of state match funds used in applications
- 141 sites surveyed for GUCP conservation targets
- 3 research projects and graduate student projects relevant to GUCP goals

Abbreviations and Acronyms
The land trust – Land Trust for Central North Carolina; NHP – Natural Heritage Program; USFWS – US Fish and Wildlife Service

B. Target Dates for Achievement and Accomplishment

Conservation projects will be continued and expanded where appropriate in the coming year.

C. Significant Deviations

None

D. Remarks

None

E. Recommendations

This project should be continued.

F. Estimated Cost

$155,490 (including in-kind contributions and non-federal partner match)

Prepared By:

Kacy Cook
Piedmont Land Conservation Biologist
Wildlife Diversity Program, Division of Wildlife Management
NC Wildlife Resources Commission

Final Annual Performance Report

State: North Carolina

Period Covered: July 1, 2008 - June 30, 2009

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 2009 nesting season, Wildlife Diversity staff posted 21 state-owned estuarine islands to protect nesting colonial waterbirds and shorebirds from human disturbance. The following islands were posted: D, E, F, G, H, I, MN, L, Parnell and Wells located near Oregon Inlet; Gull Island (recently purchased by NCWRC) located in Pamlico Sound near Salvo; 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; 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, east end Ocean Isle and Sunset Beach) as well as one estuarine island (Shark Tooth Island).

Technical Guidance

During the 08/09 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 (USACOE) on various beach stabilization and disposal projects to try to minimize and mitigate impacts to waterbirds. These included AIWW dredging events with beach disposal and beach stabilization projects on Figure Eight Island, North Topsail Beach and South Topsail Beach. We also provided input on the Morehead City Dredge Material Management Plan and the state-wide Beach and Inlet Management Plan. Lastly, we responded to many questions from the public regarding waterbirds.

B. Target Dates for Achievement and Accomplishment

All planned activities completed on schedule.

C. Significant Deviation

There were no significant deviations.

D. Remarks

None

E. Recommendations

We should continue to get permission from landowners to post barrier beach nesting sites before the start of the breeding season. There are still a number of beach sites at inlet spits that get ample nesting activity and are worth protecting. We were unable to post the west end of Holden Beach by the start of the season this year, but recommend posting this site next year as it hosts good numbers of Wilson's plovers and a few least terns. Historically it has also hosted piping plovers and with the growth in the population and appropriate habitat at this site, it could support nesting birds again.

F. Estimated Cost:

$12,029 (including in-kind contributions and non-federal partner match)

Prepared By: Susan Cameron
Waterbird Biologist
Wildlife Diversity Program
NC Wildlife Resources Commission

Final Annual Performance Report

State: North Carolina

Period Covered: July 1, 2008 - June 30, 2009

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

Project Title: CURE Songbird and Habitat Surveys

Objective:
To evaluate the impacts of the Cooperative Upland habitat Restoration and Enhancement (CURE) program on focal birds and habitat

A: Activity

Executive Summary

To evaluate the impacts of the CURE program we conducted spring and winter songbird surveys, summer vegetation surveys, a fall evaluation of useable early successional habitat, photoplot surveys, and an in-depth study of Bachman's sparrow population response to management. The 2008/2009 season represents the seventh year of post-treatment surveys for the CURE private cooperatives, the sixth year for the CURE Game Lands, and the third year for Corporate CURE.

CURE management on corporate and private cooperatives has been largely successful at converting cropland (which provides cover only in the summer months) into early successional habitat which is available year-round, almost doubling the amount of winter cover available on private landscapes (~4-6% of the landscape). Early successional habitat useable for ground dwelling birds has been slower to establish on forested CURE Game Lands.

Overall, focal songbirds are significantly increasing over time on both CURE and reference routes ($P = 0.046$). This increase is primarily driven by counts of shrub nesting birds, which have demonstrated the greatest increase on CURE landscapes. Within the shrub-nester group counts of indigo bunting, eastern towhee, and common yellowthroat have increased the most from CURE management. These species have benefited from the taller, denser understory cover produced in CURE timbered forest stands as well as dense vegetation and emergent shrubs in fallow areas. Greatest overall focal songbird responses were found on Sandhills Game Land, with increases in Bachman's sparrow populations most notable. Little change was noted in counts of other grassland nesting birds or birds that forage in early successional habitat, and grassland nesters continue to show lower populations and slower response on CURE areas than other guilds.

On Sandhills Game Land, populations of Bachman's sparrows have increased significantly on the CURE area since the initiation of management, with birds colonizing stands which were

previously not useable before management. Breeding males occur in similar densities in stands with wiregrass and other native ground cover, and in stands planted to off-site Atlantic Coastal Panicgrass. Initial results indicate that breeding males frequently establish territories near small (~0.5 ac) fields and other canopy gaps. Territory size is smaller (indicated better habitat) in stands that were burned in the previous year. The greatest overlap in quail and Bachman's sparrow habitat use is in recently thinned stands planted to Atlantic Coastal Panicgrass. Quail are more abundant in fields and drains, while sparrows are more abundant in longleaf uplands with native understory.

In 2008-2009 we initiated a cooperative research project with NC State University. This study examines songbird territory density and productivity in fields under varying grassland management regimes in the western Piedmont. The study also involves an analysis of the effects of habitat types on small mammal diversity and abundance, as well as vegetation measures to evaluate habitat quality.

Methods

Surveys conducted during the 2008-2009 year included breeding songbird point count surveys, useable habitat evaluations, summer vegetation surveys, and winter songbird strip transect surveys. Intensive point counts and territory mapping were used to evaluate response to CURE of Bachman's sparrows on Sandhills Game Land, and grassland birds in the Western Piedmont.

The 2008/2009 season represents the seventh year of habitat management for the private cooperatives and the sixth year for the CURE Game Lands. The stochastic variability inherent in this type of study currently limits the power of some possible long term trend analyses. 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. The following methods provide a brief description of basic protocol for each survey type. Detailed accounts of methods for each survey type can be found in previous CURE annual reports or by contacting LeAnne Bonner, CURE Surveys Biologist, leanne.bonner@ncwildlife.org.

Breeding Bird Surveys – Private Lands In 2007, breeding bird survey methodologies for private lands CURE were modified with the transition to the new phase of the CURE program ("CURE II") which included changes in the acres enrolled in the program. Starting in 2007, focal songbirds (Table 1) and quail were counted during the same point count survey (Hamel et al. 1996, Freemark and Rogers 1995) repeated three times from late May through June. A control area of similar size was also surveyed on the same morning as the CURE area. These surveys were designed to allow comparisons with the point count surveys established in 2002, the year of initial CURE habitat establishment.

Table 1. CURE II focal bird species.

CURE II Focal Breeding 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*

Breeding Bird Surveys- Game Lands 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 21-36 permanent survey points on each CURE area. Control routes on Sandhills and Caswell Game Lands were initiated in 2004. Regional Breeding Bird Survey (BBS) routes were selected from nearby counties to serve as a reference for South Mountains and Suggs Mill Game Lands (USGS 2007). 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 2). Habitat generalists that may utilize early succession habitats were not included in these groupings. BBS routes were conducted along road ways and used 3 minute counts, while CURE points were distributed across the landscape and used 5 minute counts. It was assumed that trends within CURE areas would be parallel to regional BBS trends if no habitat improvements had taken place. 2009 represents the sixth 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, some trends may become clearer.

Table 2. Songbird guild groupings for spring songbird point count analysis.

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*

Summer Vegetation Surveys In 2008, surveys of vegetative structure and composition continued on CURE Game Land habitat areas. These surveys measured the amount of cover provided for quail, vegetative growth forms, 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 early successional birds, 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). Vegetative composition and growth forms are other primary determinants of suitable early successional bird habitat (Kopp et al. 1998, Schroeder, 1985). Kopp et al. (1998) suggested that a disc of vulnerability of >11.6 m may represent inadequate ground cover for quail, and cone averages of <45 degrees may be inadequate for quail. We used these estimates as guides for determining suitability in our vegetative model.

Winter Bird 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, Table 3). Densities of wintering birds 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 in winter of 2003 for Suggs, Sandhills, and South Mountains Game Lands. Baseline surveys for Murphy Brown and Caswell CURE, and Sandhills and Caswell control areas were initiated in 2004.

In 2009, 244 stands were surveyed within the 4 CURE Game Lands, 2 control areas, and 1 CURE Corporate area. Winter songbird density estimates were determined for each stand type. Stands were stratified based on overstory tree type and management regime, and analyzed by stand type. Vegetation surveys were conducted through 2007 and future analyses will examine the relationships between bird densities and vegetative cover.

Table 3. Focal species in CURE winter bird surveys.

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

Useable Habitat Bobwhite quail depend upon lush herbaceous groundcover to carry out most life functions, and thus they serve as a good indicator of habitat quality for early successional bird species. While each bird species has unique habitat requirements, our index of useable habitat provides a broad indication of how much early successional habitat is available across each CURE area in the breeding and wintering periods. To track the quantity of quail habitat, we established useable habitat evaluations on each CURE area and associated control, if applicable. Useable habitat was defined as any area with sufficient cover for quail to carry out life functions (breed, forage, roost, etc) and is determined by a qualitative, eyeball assessment.

We classified useable habitat as breeding season only, non-breeding season only, or most-of-year. 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. 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. "Most of the year" habitat was habitat available to quail during both breeding and non-breeding seasons. "Not useable" habitat was all areas without suitable cover for quail.

Photoplots Photoplots provide a qualitative assessment of vegetative response to habitat management practices. Six to eight permanent photograph stations were established at Caswell, Sandhills, Suggs Mill, and Murphy Brown CURE areas. Digital photos were taken prior to habitat management, immediately after management action, and at regular intervals (winter and late summer) thereafter. These photos help to visually assess habitat work and communicate our habitat improvements to stakeholders. Photographs from photoplot stations can be obtained upon request.

CURE PRIVATE LANDS

Benthall Plantation

Breeding Songbirds This survey route consisted of 21 survey points on the CURE area and 23 points on the control. Previous to 2007, Breeding Bird Survey (BBS) data was used as reference data for Benthall Plantation.

In 2008, some focal songbird count averages were higher on the CURE area than the control area (Fig. 1). Indigo bunting was the most prevalent focal songbird species recorded at Benthall and was more abundant on the CURE area than the control. Some of the largest differences in abundance between treatment and control sites existed for the indigo bunting, common yellowthroat, and yellow-breasted chat, indicating that the CURE area is providing better shrubland habitat.

Counts of several grassland-associated species, such as eastern kingbird, eastern meadowlark, and grasshopper sparrow, were higher on the control area. The control area contains more pasture land than the CURE area, indicating that it may be an imperfect "control".

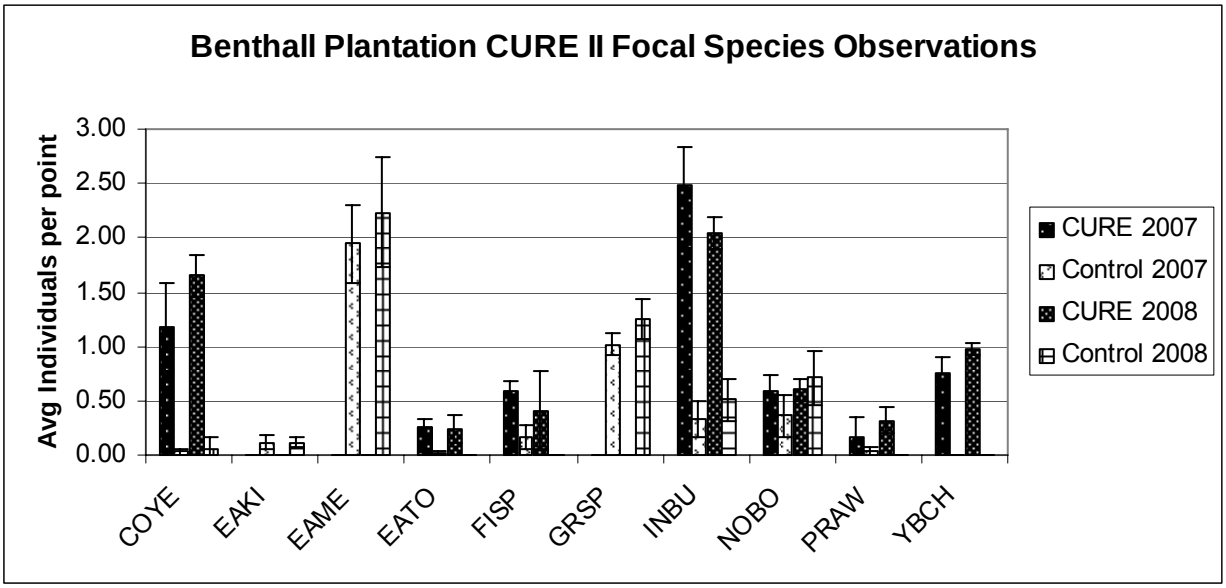


Figure 1. Relative abundance of focal songbird species on Benthall CURE II, based on unlimited distance, five minute counts.

Useable Habitat Useable quail habitat at Benthall Plantation in 2008 remained similar to 2007 (Fig. 2). Some forested tracts which were only suitable for non-breeding became suitable breeding habitat after they were thinned in 2007. There continued to be more acres of breeding habitat available than non-breeding, and the CURE area provided more useable habitat than the control.

During the first phase of CURE (2001-2006), Benthall's total useable habitat percentage gains were the lowest compared with the other private CURE cooperatives, in part because it started with the most acreage of cropland which already provided breeding habitat. Total useable habitat (habitat available during at least part of the year) increased by only 95 acres during this initial phase of CURE. However, in 2008, 199 additional acres were established as useable during some part of the year.

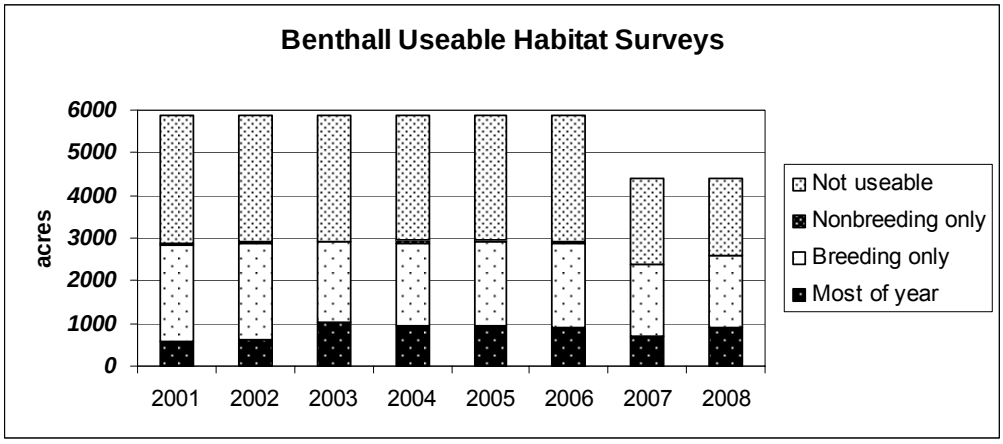


Figure 2. Acres of habitat suitable for quail use at Benthall Plantation, 2001-2008. Note that the total acreage of the CURE area was reduced in 2007 with the transition to CURE II.

Rowland

Breeding Songbirds This survey route consisted of 16 survey points on the Rowland CURE cooperative and 18 points on the control area. Previous to 2007, Breeding Bird Survey (BBS) data was used as reference data for Rowland CURE.

In 2008, count averages for northern bobwhite, field sparrow, and indigo bunting were higher on the CURE area than the control (Fig. 3). These observations were consistent with previous CURE I songbird counts which suggested that both the bunting and field sparrow showed the most positive response to CURE habitat enhancements.

Eastern meadowlark was the only species that occurred at higher levels on the control area than on the CURE area in 2008. Most other focal species were at similar levels for CURE and control. Worthy of note, the Rowland cooperative was the only CURE area with observations of loggerhead shrikes.

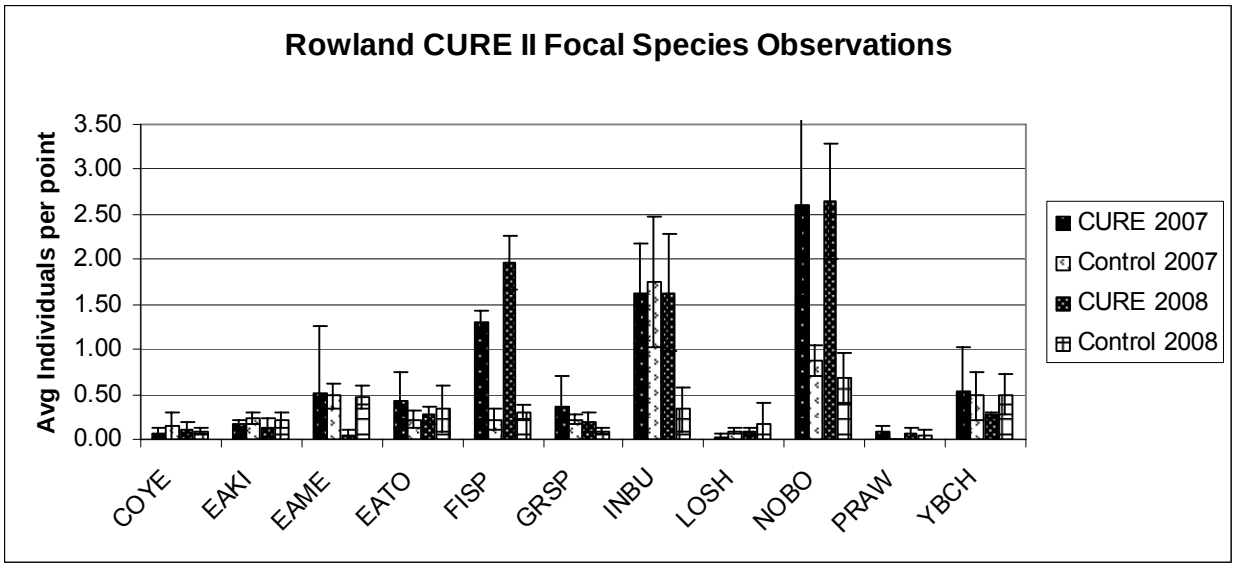


Figure 3. Relative abundance of focal songbird species on Rowland CURE II, based on unlimited distance, five-minute counts.

Useable Habitat In 2008 Rowland had similar percentages of habitat available during the breeding (56.4%) and non-breeding (18.8%) seasons as in 2007 (Fig. 4). Before CURE, useable habitat consisted mostly of "breeding only" row-crop fields, with some "most of year" longleaf CRP stands (old fields planted to young longleaf pine through the federal Conservation Reserve Program). Mature, closed-canopy pine and hardwood stands comprised most of the "not usable" habitat which contained little understory herbaceous cover. CURE treatments were implemented on 206ac of field and 218ac of forested habitat.

In CURE II, Rowland total acreages of useable habitat have remained relatively stable. Rowland gained a small number of acres (97) in 2008, due to increases in non-breeding habitat. The percentage of breeding habitat decreased by 5% as some "most of year" habitats became non-breeding only because some pine stands became thicker and no longer supported herbaceous vegetation needed during breeding. Rowland CURE retains greater amounts of year-round quail habitat than the control area, which experienced no discernible management changes compared to 2007.

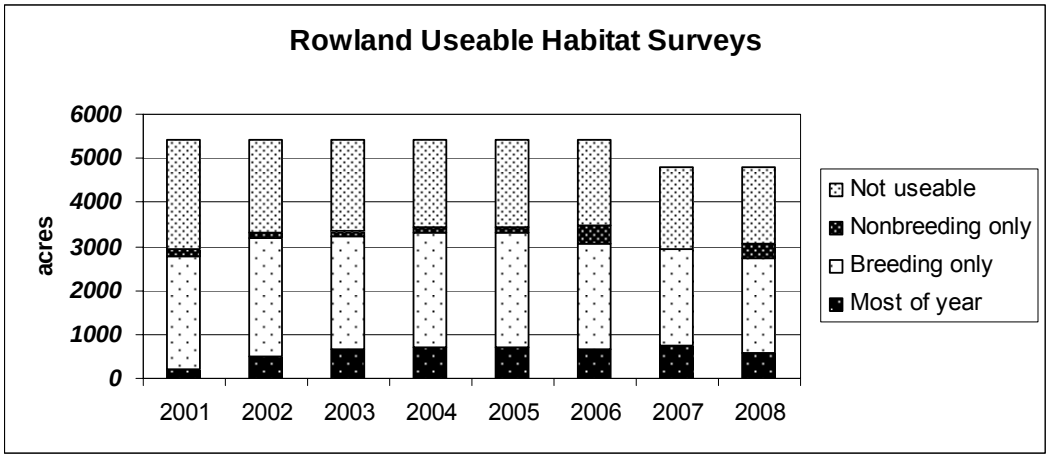


Figure 4. Acres of habitat suitable for quail use during some portion of the year at Rowland CURE, 2001-2008. Note that the total acreage of the CURE area was reduced in 2007 with the transition to CURE II.

Turnersburg

Breeding Songbirds Utilizing a paired, treatment/control comparison, surveys were conducted on 9 CURE contracted warm season grass fields which were paired with 9 nearby (1-3 km) non-CURE fescue pastures. Historical Turnersburg cooperative data is not comparable to CURE II to determine long-term trends, due to protocol shifts in 2007.

In 2008, the indigo bunting was the most abundant species on CURE fields (Fig. 5). Numbers of indigo buntings were higher on CURE fields in 2008 when compared to control fields. Most changes in focal species were minimal and non-significant. Eastern meadowlarks continued to be more abundant on control fields; however, numbers in 2008 were significantly lower than the counts recorded in 2007. Grasshopper sparrows had previously shown higher numbers in control fields; however, 2008 data suggests a similar abundance in CURE and control fields. No loggerhead shrikes or prairie warblers were recorded from 2007-2008 in the western Piedmont focal area.

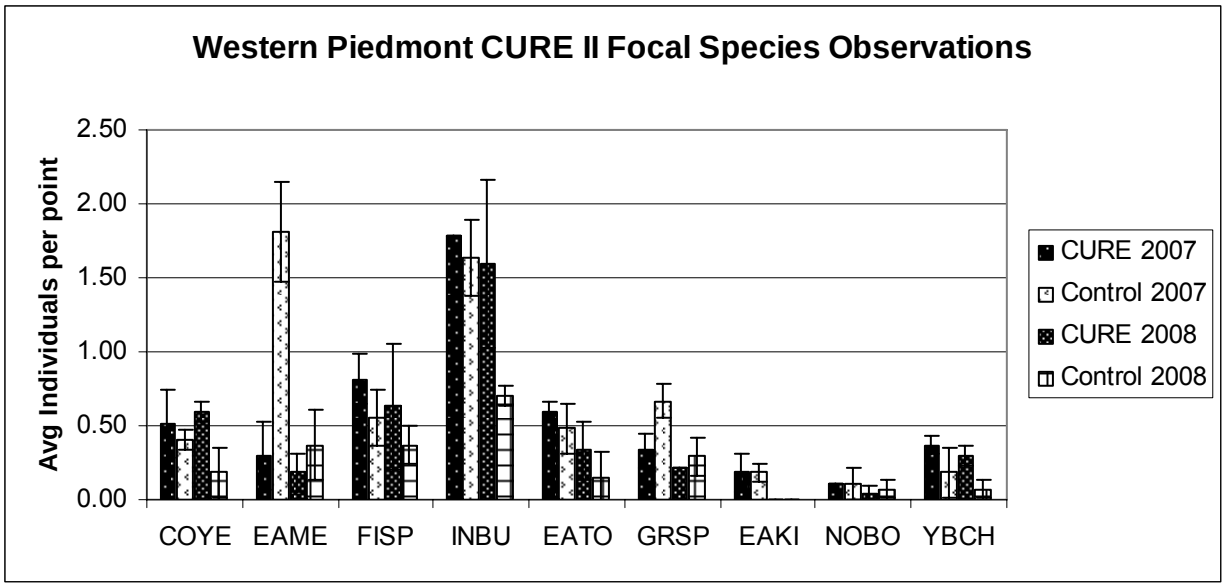


Figure 5. Relative abundance of focal songbird species in the Piedmont focal area during CURE II, based on unlimited distance, five-minute counts.

Useable Habitat In the Piedmont focal area, new NWSG fields have been established during CURE II. Fifty two percent of CURE NWSG field acreage provided useable habitat during at least part of the year. Fifty seven acres of fields provided "breeding only" habitat, 117 acres of fields provided year-round habitat, and 158 acres of CURE fields were not useable between October 2007 and September 2008. The NWSG practice takes longer to establish than fallow field practices. As such, the useable habitat numbers in the western Piedmont are expected to increase when NWSG become more stable and as new fields are converted to NWSG in 2009.

NCSU Research A graduate research project began April 2009 to evaluate the wildlife benefits of grassland management techniques in the western Piedmont. Methods include spot mapping, small mammal trapping, and vegetation surveys. Objectives will be to compare use and benefits to wildlife populations of native warm season grass fields under agricultural management, native warm season grass fields managed exclusively for wildlife, and exotic cool season grass fields managed for agriculture. Analyses will be conducted to compare songbird territory establishment and productivity and small mammal diversity and abundance in each field/management type. Vegetation measures will also be collected to relate results to habitat quality and vegetative structure. This project is a collaborative effort with NC State University, and research will be on-going through December 2010.

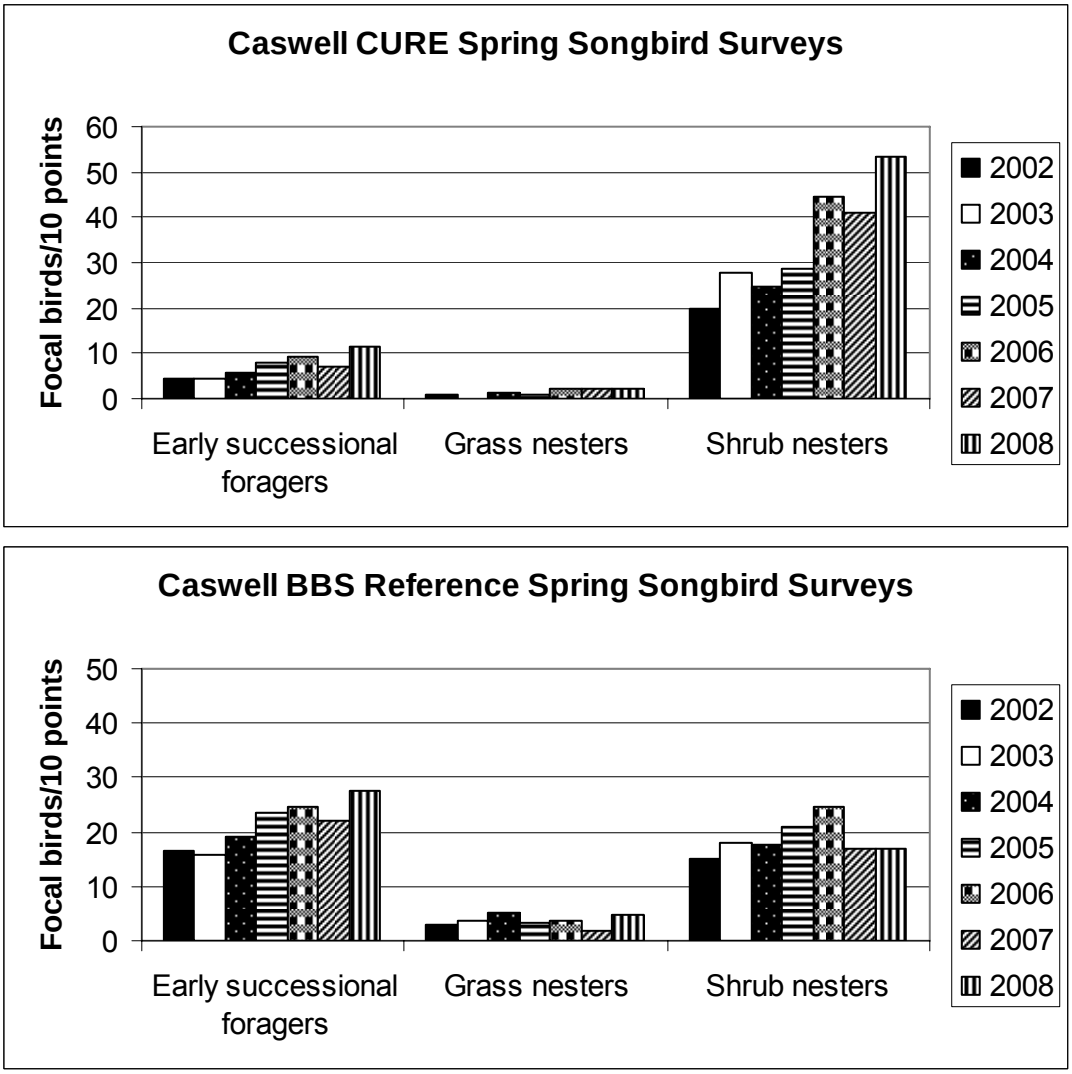
CURE GAME LANDS

Caswell Game Lands

Breeding Songbirds At Caswell Game Land shrubland nesters were the most abundant guild (Fig 6), with yellow-breasted chat and indigo bunting the most common species. The early

successional forager group was dominated by chipping sparrows and eastern wood peewees. The grassland nester group was entirely represented by northern bobwhite.

There is no significant difference between guild abundance on the Caswell CURE area compared to reference numbers, and there is no significant trend in counts throughout years. However, shrub nesting densities remain higher than other guilds, with 25.35 $\pm$ 6.64 and 13 $\pm$ 6.64 more birds per 10 points than grass nesters and early successional foragers, respectively ($F_{4,35} = 14.75$, $P < 0.001$). Early succession foragers also showed significantly higher numbers (12.35 $\pm$ 6.64) than grass nesting species.



Figures 6 and 7. Relative abundance (# focal birds per 10 survey points) of early succession songbird guilds on Caswell Game Land, 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.

Summer Vegetation Surveys Caswell summer vegetation surveys in 2008 consisted of monitoring 14 actively managed forest stands. Most stands were located within the southwest

portion of the CURE area which received management first. Surveys (n = 87) were conducted in 6 clearcut stands, 6 pine thinnings, and 2 hardwood thinnings since 2002. Clearcut prescriptions involved removing all overstory trees and planting loblolly pine (290 trees/ac) the following spring. Clearcuts were prescribed primarily for old field stands dominated by Virginia pine. Pine and hardwood thinning prescription objectives included reducing overstory trees to 40 $feet^2$/acre basal area, followed by prescribed burning on a 2-3 year rotation after the second growing season post harvest. Herbicide was aerially applied in late summer 2005 to control woody growth in two surveyed clearcuts and two surveyed thinned pine stands.

In 2008, vegetative growth trends and early responses were compared between harvest techniques and stand types (Fig. 8). Before timber harvest, basal area did not differ between pretreatment clearcuts and thinned pine stands (126.9 $\pm$ 4.8 ft^2, $F_{1,7} = 2.93$, $P = 0.14$). After initial prescriptions, pine thinnings contained an average basal area of 40.7 $\pm$ 11.2 ft^2.

1. Cover. Before any timber treatments, pine stands contained inadequate cover for quail based on large disc of vulnerability estimates (i.e. inadequate cover at ground level). Pretreatment stands contained disc averages of 12.5 $\pm$ 0.7 meters. Forest understories provided marginally adequate overhead cover predominantly provided by woody overhanging branches. Cone averages were estimated at 49.5 $\pm$ 1.8 degrees. Disc and cone averages were lower than Kopp et al.'s (1998) suggestions for suitable habitat.

After accounting for growing season affects after harvest, there was no significant difference in cover between Caswell CURE clearcuts and pine thinnings [cone ($F_{2,52} = 26.65$, $P = 0.2$) and disc ($F_{2,52} = 10.40$, $P = 0.19$)] throughout all survey years. Within the first growing season, Caswell managed pine stands did not provide adequate overhead cover for quail. Cone averages significantly decreased 13.10 $\pm$ 5.57 degrees ($P = 0.02$), indicating less overhead cover, after much of the woody shrubs and low-hanging branches were removed. However, woody slash and low growing vegetation decreased ($P < 0.01$) the disc of vulnerability 4.33 $\pm$ 1.09 meters, indicating better cover at ground level. After one growing season, cone averages significantly increased 11.46 $\pm$ 3.65 degrees ($P < 0.01$) and disc averages further decreased 2.69 $\pm$ 0.58 meters ($P < 0.01$) for both pine thinnings and clearcuts, indicating adequate horizontal and vertical cover for quail. There was less cover at ground level in hardwood thinnings compared to pine thinnings, with significantly higher (3.30 $\pm$ 1.35 m) disc estimates ($F_{2,14} = 7.93$, $P < 0.01$). Despite similar thinning treatments, overstory hardwoods may shade understory vegetation more than overstory pine stands therefore reducing understory growth.

2. Composition. Before CURE harvest treatments, groundcover in managed pine stands was primarily open (72.70 $\pm$ 3.20%) and contained a low percentage of herbaceous (grass and forb) vegetative cover (0.9 $\pm$ 0.4%) in the understory. The dominant understory woody vegetation (26.35 $\pm$ 3.00%) was red maple (*Acer*, 6.2%), oak (*Quercus*, 2.7%), and dogwood (*Cornus*, 2.0%). The small amount of herbaceous forbs consisted primarily of Christmas fern (*Polystichum*, 2.1%) and ground cedar (*Lycopodium*, 0.78%). Trace amounts of grasses included bluestems (*Andropogon*, 0.2%) and panic grasses (*Panicum*, 0.2%).

In the first growing season after harvest, there was no significant difference in any of the growth form responses between clearcuts and timber thinnings. Herbaceous components responded the

greatest to habitat improvement efforts within both treatment types. Grass increased 5.86 ± 2.34% ($F_{3,23} = 27.25$, $P = 0.02$), primarily from panic grasses and bluestems. Forbs increased 9.90 ± 2.88% ($P < 0.01$), largely from honeysuckle (*Lonicera*), horseweed (*Conyza*) and fireweed (*Chamerion*). Grass/forb components replaced areas which were previously open or covered by woody species.

In the second growing season, grasses (such as bluestems) continued to positively increase, 14.29 ± 2.32% ($P < 0.01$), in both treatment types, while forbs remained unchanged ($P = 0.60$). Woody growth forms responded dramatically in both clearcuts and thinnings. Results indicated woody growth significantly increased 23.95 ± 5.47% ($P < 0.01$) with no differences detected between clearcuts and pine thinnings. By the third and forth growing season, thinned stands received their first prescribed burn, reducing woody growth. Herbicide applications were also conducted in two pine thinnings and two clearcuts, increasing forb coverage (13.89 ± 4.04%, $P < 0.01$), after accounting for pre-existing conditions ($F_{2,9} = 6.94$, $P = 0.01$). Forb growth may have been due to a reduction in woody competition (-16.81 ± 10.05%, $P = 0.19$).

In the fifth growing season, no significant difference ($P > 0.05$) in cover was found after accounting for treatment and year effects. With increasing growing seasons, disc (-0.92 ± 0.41 m) and cone (8.4 ± 1.16°) continue to improve ($P < 0.001$). No changes were detected in forb growth or grasses between management types. However, woody cover is increasing with growing seasons in both pine thinnings and clearcuts ($F_{2,52} = 11.07$, $P < 0.001$).

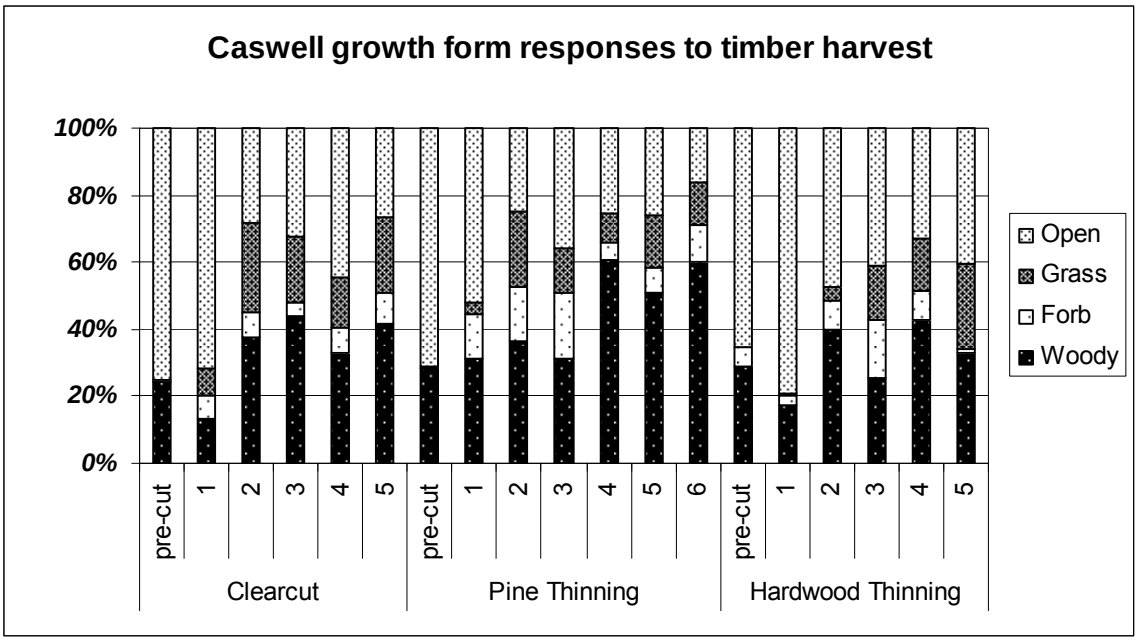


Figure 8. Relative proportion of growth form percentages in Caswell CURE managed stands based on years since timber harvest, July/August, 2002-2008.

Winter Songbirds Caswell stands were stratified into field, hardwood, and pine stands. In 2009, 39 stands were surveyed on the Caswell CURE area and 35 stands on the Caswell Frogsboro control area.

Caswell landscape focal songbird density estimates We determined the density of focal songbirds at the scale of the CURE area using randomly selected stands only, stratified by habitat type (Fig. 9). Intentionally selected stands were included only in stand-level evaluations of habitat improvements. To determine landscape trends, total acreage for each habitat type was estimated over the entire Caswell CURE (5,642 acres) and control (1,522 acres) landscape. Winter bird densities within habitat types were estimated in proportion to habitat type distributions.

Both CURE and control sites had similar proportions of hardwood and pine stands, with ~10% of the landscape in fields. Unknown sparrows, white-throated sparrows, song sparrows, and dark-eyed juncos comprised the majority of focal songbirds on both areas. Focal species were widely distributed throughout the landscape and were present within all stand types. Wide distribution of species could be related to the diverse mosaic of habitats contained within the Caswell landscape.

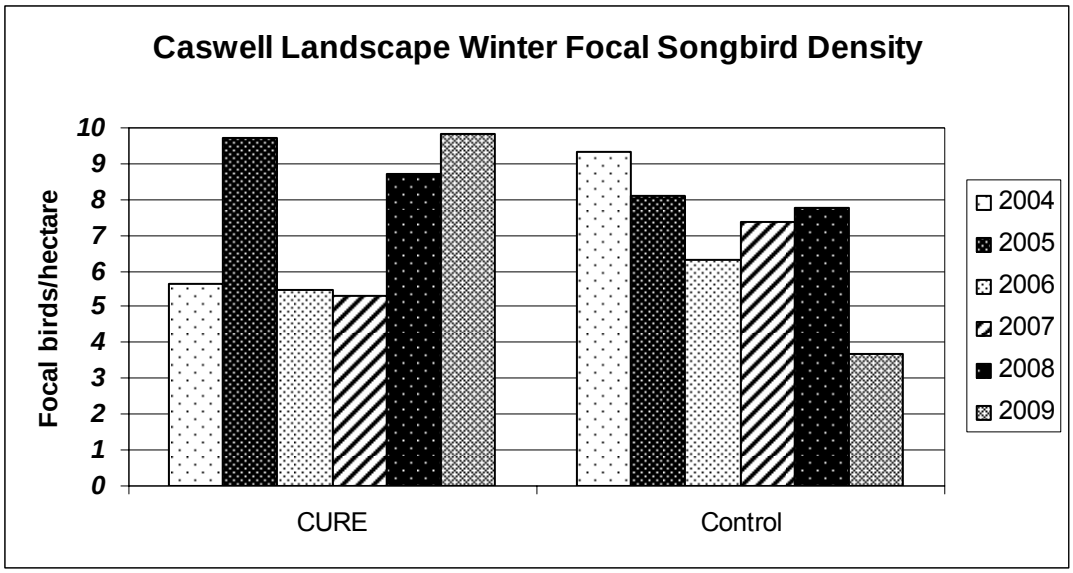
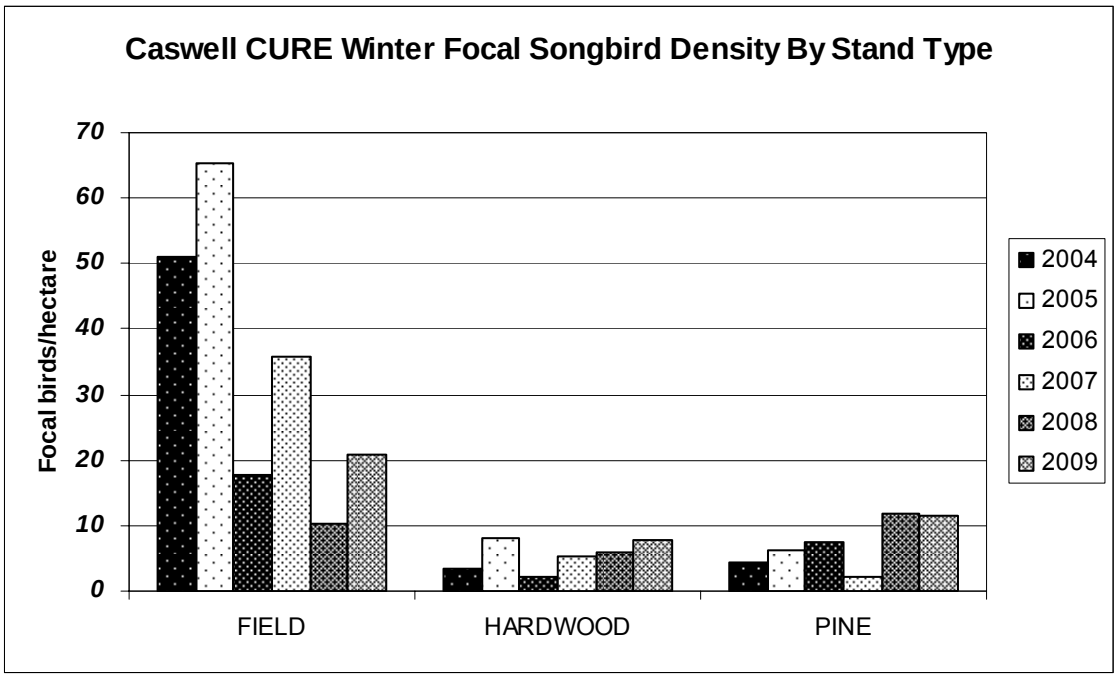
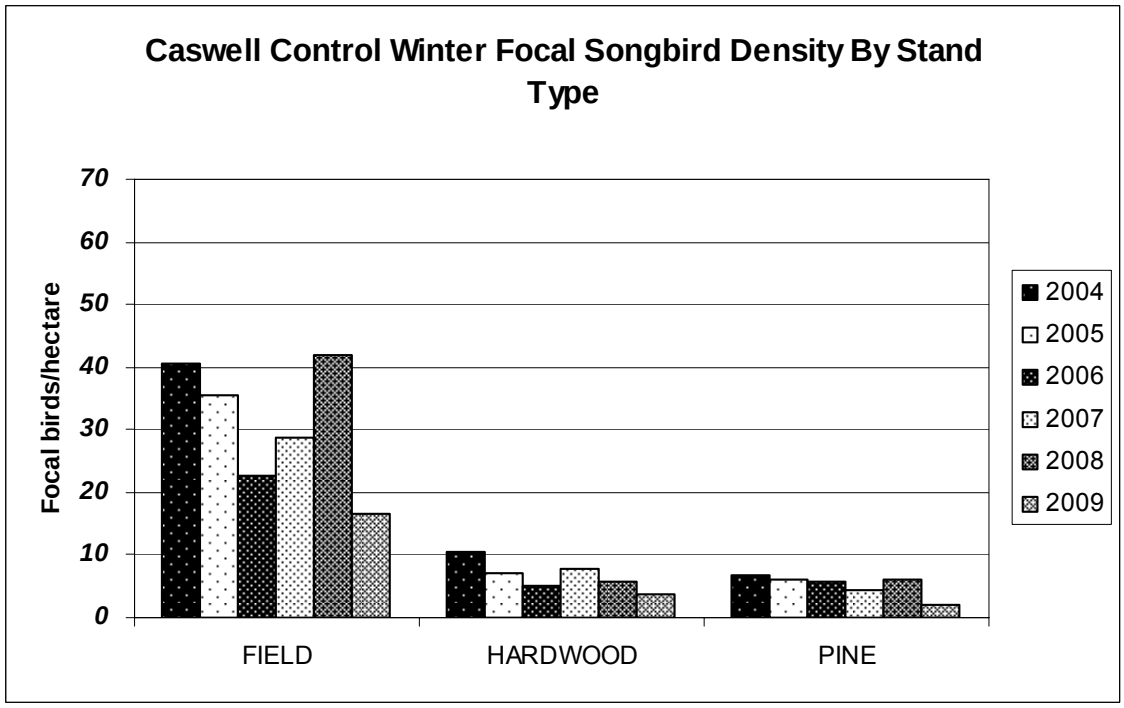


Figure 9.—Winter focal songbird densities across entire Caswell CURE and Frogsboro Control landscapes, 2004-2009. Observed densities within habitats were weighted by the proportion of a given habitat type within each study area.

Caswell Focal Songbird Density Estimates within Stand Types Annual average winter songbird densities within all randomly selected surveys were compared between sites and stand types (Fig. 10 & 11). Between sites (CURE vs. Control), there was no significant difference ($P = 0.62$) in wintering songbird densities, after accounting for year and stand type effects ($F_{4,435}=23.79$, $P<0.01$). Caswell fields had significantly more (24.63 ± 6.3) birds per hectare than both hardwood and pine stands ($P < 0.001$). There was no significant difference in wintering songbird densities between hardwood and pine stands ($P = 0.99$). Unknown sparrows, song

sparrows, and white-throated sparrows were the most common species found in Caswell fields; unknown sparrows and dark-eyed juncos were most common in forested stands.





Figures 10 & 11.--Caswell Game Land CURE and Frogsboro control area winter focal songbird densities by habitat type within randomly selected stands (managed and unmanaged), 2004-2009.

Focal Songbird Density Estimates within Improvement Areas Within the Caswell CURE area, habitat improved stands did not have significantly higher densities of focal birds than un-

improved stands (P=0.21), after accounting for stand type and year affects ($F_{4,249} = 14.34$, $P < 0.001$). Within each stand type, responses to habitat improvements could not yet be determined because of sample size limitations. Preliminary comparisons of management in wooded stands revealed no distinct trends (Fig. 12).

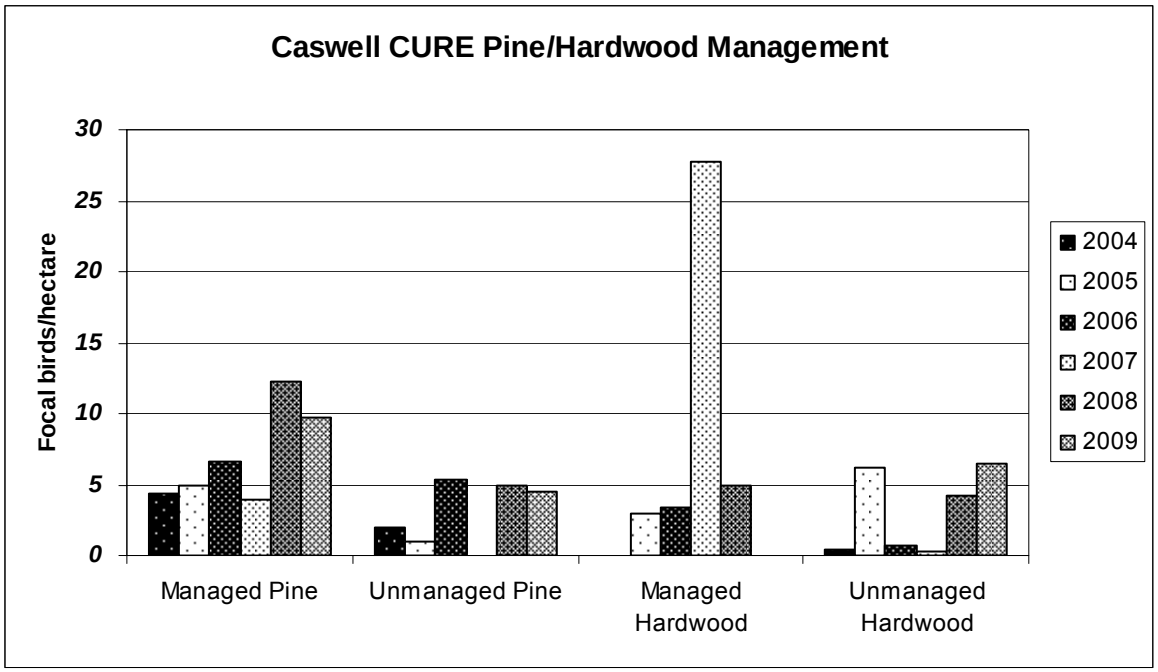


Figure 12.—Winter focal songbird densities within managed and unmanaged wooded stands on the Caswell CURE site, 2004-2009.

Useable Habitat 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, as well as clear-cutting Virginia pine stands and replanting with loblolly pine. In 2008, Caswell continued to increase amounts of breeding (29%) and non-breeding (31%) habitats, gaining 252 acres of habitat overall (Fig. 13). Most gains were seen in the tracts which were harvested (thinnings and clearcuts) and are now producing herbaceous understory. The majority of the non-useable habitat (67%) continued to be a mixture of unmanaged mature pine/hardwood stands and recently cut stands which have not yet responded with adequate groundcover. This was the 6th year of timber cutting in the 8-year management plan. Caswell's CURE goal is to establish and maintain ~51% of the area in early successional habitat by 2012.

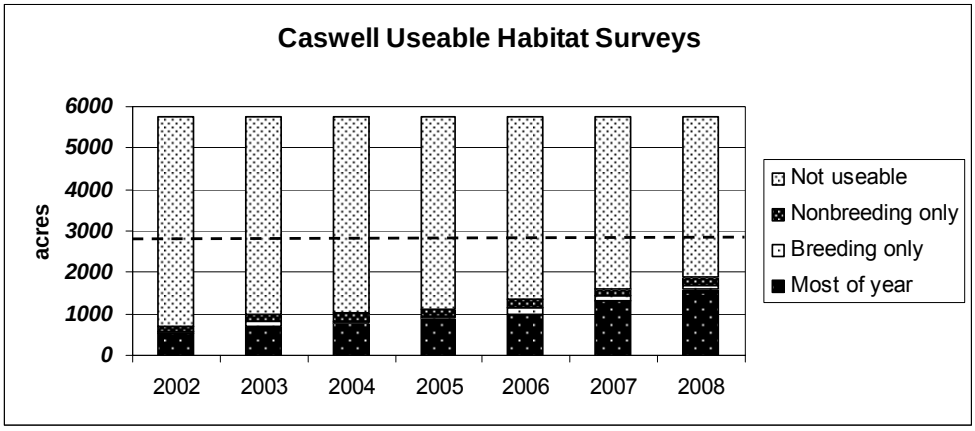
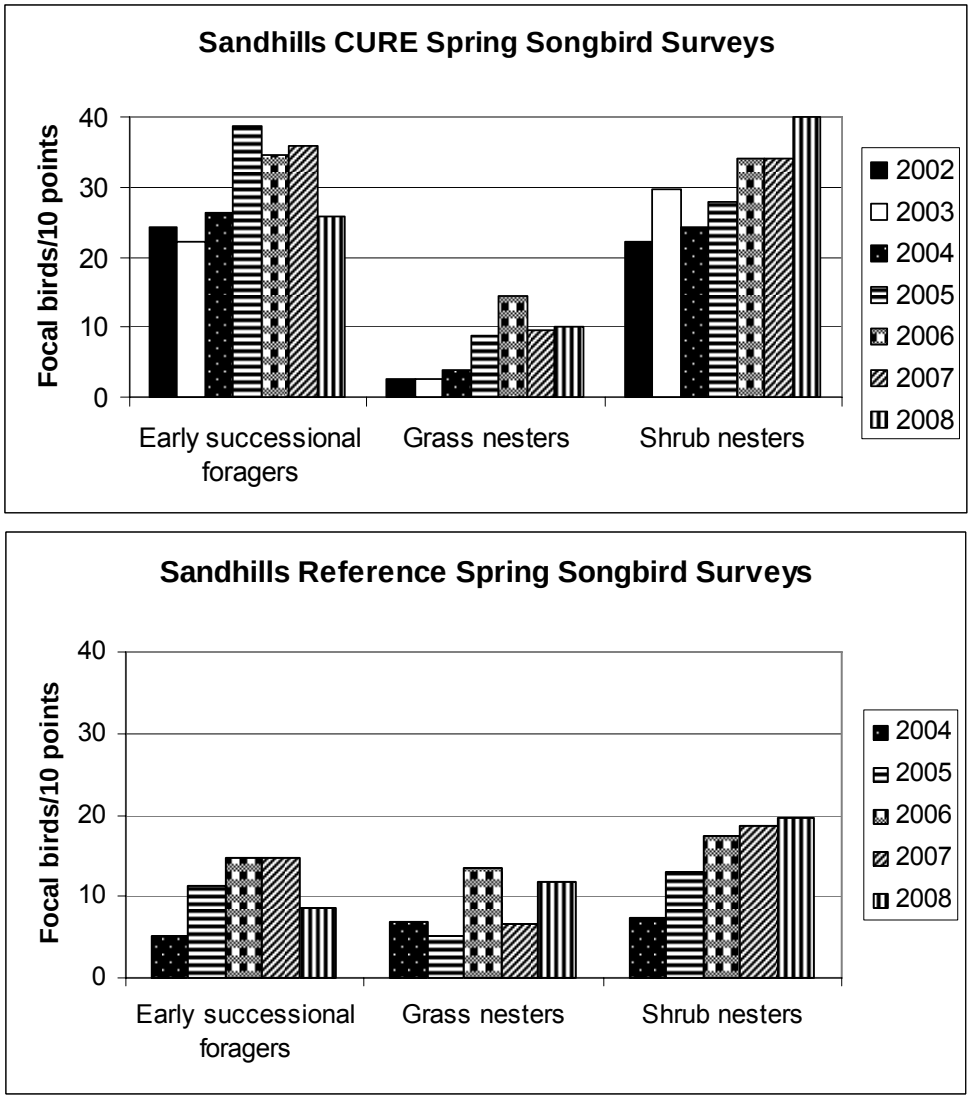


Figure 13. Acres of useable habitat for Northern bobwhite on Caswell CURE Game Lands, 2002-2008. (Note: Dashed line indicates early succession acreage goal stated in CURE area management plan.)

Sandhills Game Land

Breeding Songbirds At Sandhills Game Lands, shrubland nesters and early successional foragers were the most abundant guilds on the CURE area (Fig. 14). In the shrub nesting guild, indigo bunting and eastern towhee occurred most frequently. The early successional forager group was dominated by eastern bluebirds, red-headed woodpeckers, and chipping sparrows. The grassland nester group was composed of Bachman's sparrow and northern bobwhite, with one occurrence of red-winged blackbird.

Sandhills Game Land was the only CURE area to significantly increase overall focal songbird counts, after accounting for year and guild effects ($F_{4, 35} = 21.37$, $P < 0.001$). 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 showed numbers similar to early successional foragers. Numbers of grassland nesting species were significantly lower ($P < 0.001$) than both groups (-13.12 ± 4.85 and -15.57 ± 4.85, respectively); however, numbers of Bachman's sparrows on Sandhills Game Lands remain higher than those detected on the nearby Block B control route.



Figures 14 & 15. Relative abundance (# focal birds per 10 survey points) of early succession habitat songbird guilds on Sandhills Game Land CURE and control areas, based on unlimited distance, five minute counts. Habitat enhancements were initiated in the summer of 2003. Surveys on the control area were initiated in 2004.

Summer Vegetation Surveys In 2008, Sandhills CURE summer vegetation surveys monitored 22 managed forested stands, including 5 pond pine/hardwood drain thinnings, 10 plantation pine thinnings, and 7 natural longleaf pine thinnings. All upland pine stands had some form of burning history. Upland forest thinning objectives included reducing overstory stocking rates to 25-45 feet^2/acre basal area followed by prescribed burning on a 2-3 year rotation to control midstory woody growth. After thinning, some stands were burned within one growing season if substantial logging debris was present. In addition, all plantation pine thinnings were cleared of understory debris and planted with Atlantic Coastal Panic grass (*Panicum amarum*, ACP) or switchgrass (*Panicum virgatum*) within one year after timber thinning.

In 2008, vegetative responses to timber thinnings were compared to pre-treatment conditions (Fig. 16). Responses within the thinned pine stands were compounded by effects of rotational prescribed burning. Basal area averaged 86.4 $\pm$ 8.2 feet^2/acre in stands before management. After initial timber thinning, stands were significantly reduced (-54.9 $\pm$ 5.8 feet^2/acre, $P < 0.01$) and averaged 32.1 $\pm$ 2.0 feet^2/acre.

1. Cover. Before CURE thinnings, Sandhills hardwood drains were the only stands to provide adequate cover for quail (cone 63.7 $\pm$ 11.5° and disc 8.8 $\pm$ 2.5m) based on Kopp et al.'s (1998) estimates. Unthinned upland pine stands had unsuitable cover for quail (cone 34.0 $\pm$ 7.3° and disc 14.7 $\pm$ 1.3m). Before CURE treatments, all stand types had relatively high overstory basal areas, suppressing understory cover. Most plantation pine stands were managed for pine straw production and were raked every year. Natural longleaf stands were prescribed burned on a 2-3 year rotation. Most drains had a history of fire exclusion.

After CURE treatments, drain, natural, and plantation pine stands responded differently in the amount of cover (disc and cone) produced, after accounting for basal area and growing season affects ($P < 0.05$). Drains provided the most cover. Plantation pine stands planted in ACP grasses had significantly higher cone and lower disc estimates than natural pine stands.

In the second growing season after thinning, significant increases in cover were noted in all stand types. Reductions in average disc of vulnerability (-6.5 $\pm$ 1.7 meters, $F_{5,50} = 7.29$, $P < 0.01$) and increases in cone of vulnerability (20.54 $\pm$ 7.48°, $F_{5,50} = 6.32$, $P < 0.01$) were noted after accounting for stand type and previous year effects. In pine plantations planted with ACP, vertical cover was significantly improved during the second growing season (disc of vulnerability of -8.09 $\pm$ 2.50m, $F_{3,23} = 5.06$, $P < 0.01$). Results continued to suggest that most understory vegetation cover continued to improve into the 5th growing season. Forb cover values within upland stand types appeared to equalize by the 4th year post-thinning, whereas grass and cone of vulnerability values continue to improve throughout growing seasons.

2. Composition Before Sandhills CURE thinnings, drains had significantly more woody cover compared to either natural ($P = 0.03$) or plantation pine stands ($P = 0.03$). Forb genera consisted predominantly of bracken fern in both the drains (5%) and natural pine stands (11%). A small percentage of grass was present and predominantly consisted of switch cane (2%) in the drains and wiregrass (2-3%) in the natural stands. In 2008, managed drains continued to maintain significantly more forb (9.84 $\pm$ 3.89%, $P <0.001$) and woody (20.18 $\pm$ 7.01%, $P <0.001$) growth forms than upland pine stands, after accounting for stand type, growing season and basal area affects. Drains also had significantly smaller disc of vulnerability ($P < 0.001$) and higher cone of vulnerability ($P < 0.001$) than other management types, indicating denser groundcover.

After one growing season in drains, herbaceous genera such as ferns (16%) and switchcane (*Arundinaria*, 12%) had the greatest responses By the second and third year, other genera arose such as rushes (8%), dogfennel (*Eupatorium*, 4%), blackberry (*Rubus*, 4%), sedges, meadow beauty (*Rhexia*), broomstraw, and panic grasses. Within drains, blueberry (*Vaccinium*), sparkleberry (*Galacacia*), and inkberry (*Ilex*) were the most predominant woody genera

throughout all survey years. In the sixth growing season, switchcane maintained the highest cover percentage (17.64%) of all recorded genera.

Through 2008, managed pine plantations contained significantly more grass compared to drains (-8.76 $\pm$ 6.41%, $P = 0.01$) and natural pine stands (-15.97 $\pm$ 5.90%, $P < 0.001$) after accounting for growing season and basal area effects. Within the second growing season, grass components, primarily ACP, significantly increased (16.49 $\pm$ 7.63%, $F_{4,23} = 3.04$, $P = 0.04$) over the previous year. After canopy thinning, site prep, and planting; ACP coverage increased to 5.8% by year one and to 21.5% by year four. To date, ACP has not crowded out native vegetation. Other grasses have also increased in the plantations such as other panic grasses, bluestems, and wiregrass (*Aristida*). Forb community responses in plantation stands are comparable to responses in natural stands. Forb genera (<2%), such as pokeberry (*Phytolacca*), horseweed, goldenrods (*Solidago*), and various legumes were recorded for all surveys. Some woody species present included oaks (*Quercus*), sassafras (*Sassafras*), sumac (*Rhus*), and wax myrtle (*Myrica*).

For three years post-thinning, natural longleaf pine stands did not demonstrate much change in understory growth forms. After the 4th growing season and 1-2 prescribed burns, grasses and forbs dramatically increased in natural stands. Grasses such as bluestems (8.9%) and wire grass (8.5%) emerged to become the dominant genera. Oaks sprouts remained present in the understory (7.0%), but were no longer dominant. Noteworthy increases in legumes (e.g. *Lespedeza*, 4.4%) were also observed from the previous growing season (0.8%). In the fifth growing season, forbs in natural stands increased to levels similar to those in plantation stands. The most dominant growth forms in the 5th growing season were oaks (11.08%) and wiregrass (10.6%), whereas coverage of legumes (2.39%) decreased from the previous season.

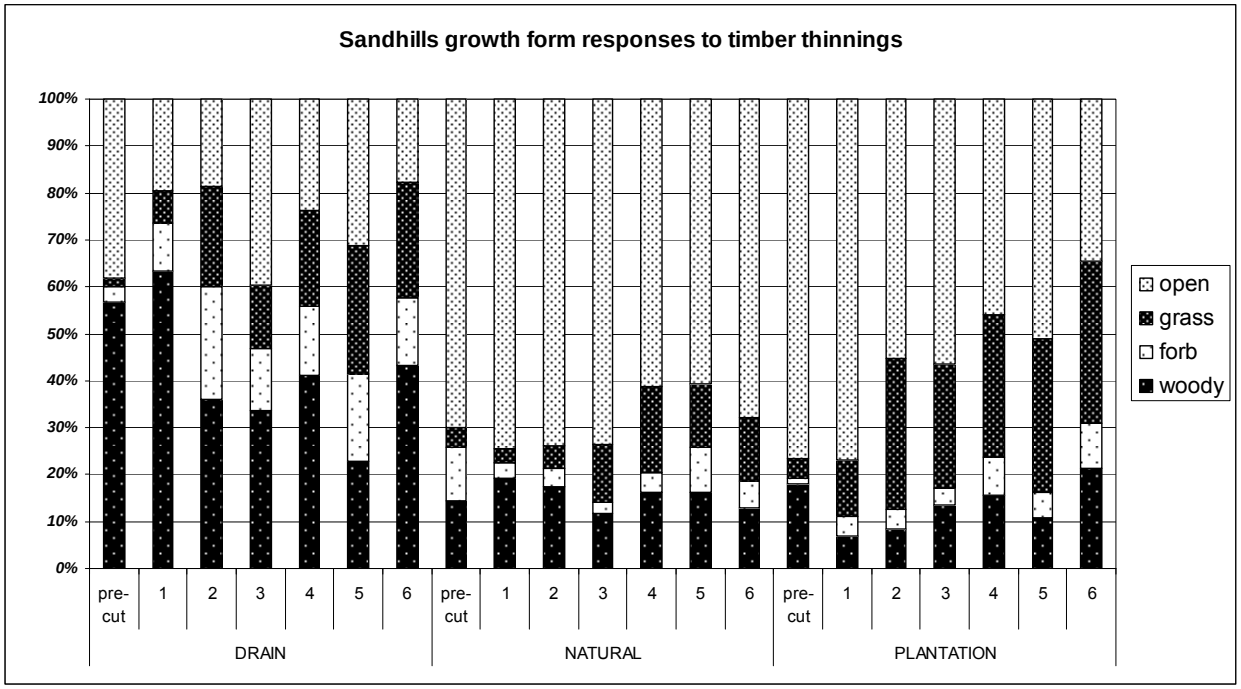


Figure 16. Relative proportion of Sandhills vegetative growth from responses to CURE timber thinning by number of growing seasons, July/Aug 2002-2008.

Winter Songbirds Sandhills stands were stratified by drain, field, hedgerow, natural pine, and plantation pine stands for winter bird surveys.

Sandhills landscape focal songbird density estimates We determined the density of focal songbirds at the scale of the CURE area using randomly selected stands only, stratified by habitat type (Fig. 17). Intentionally selected stands were included only in stand-level evaluations of habitat improvements. To determine landscape trends, total acreage for each habitat type was estimated over the entire Sandhills CURE (5,065 acres) and control (5,133 acres) landscapes. Winter bird densities within habitat types were estimated in proportion to habitat type distributions. Both sites had approximately equal proportions of drains, fields, hedgerows, and upland pine stands. However, the CURE area contained a greater area of plantation pine stands (957 acres) than the control (76 acres). In 2009, there continues to be no detectable differences ($P = 0.19$) in focal bird densities between Sandhills CURE and control ($F_{6,535}=18.60$, $P<0.001$).

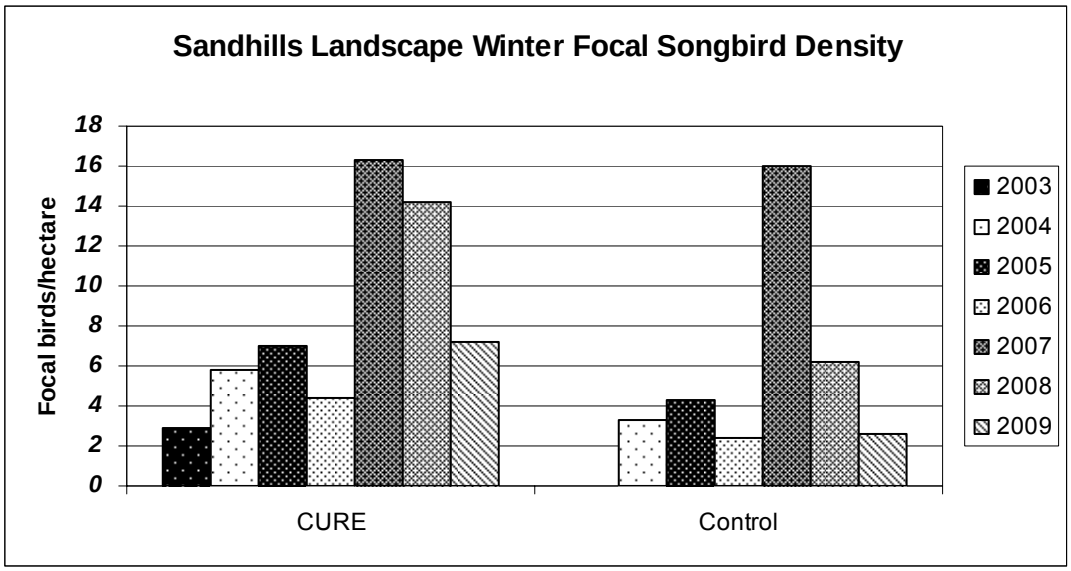
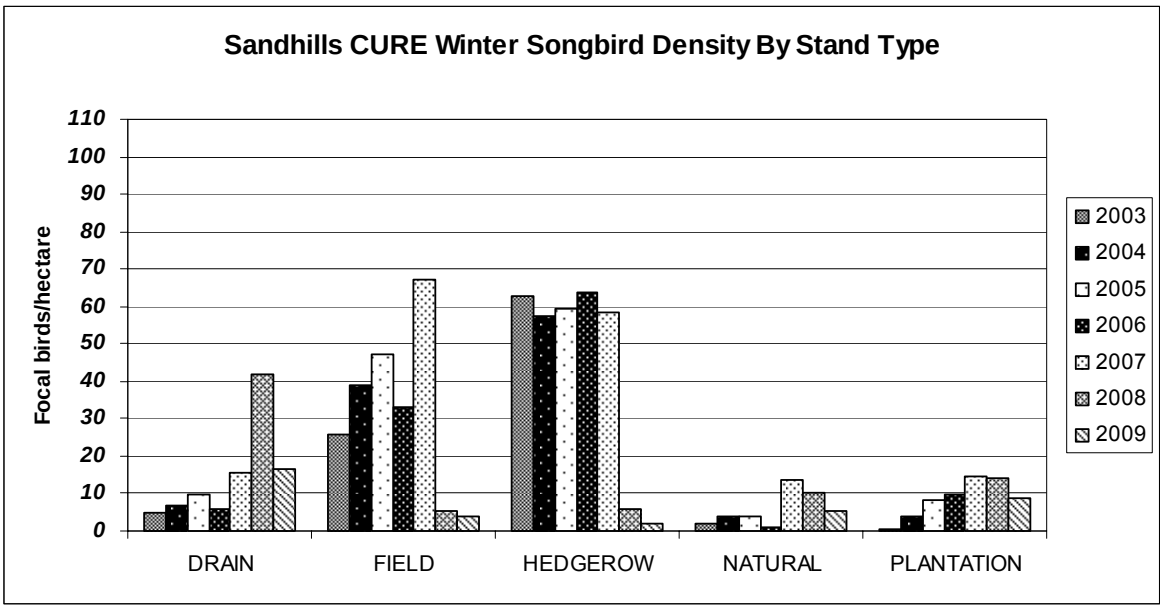


Figure 17. Winter focal songbird densities across the Sandhills CURE and control landscapes, 2003-2009 and 2004-2009 respectively. Observed densities within habitats were weighted by the proportion of a given habitat type within the CURE landscape.

Sandhills Focal Songbird Density Estimates within Stand Types Annual winter songbird densities within all randomly selected surveys were compared between stand types on CURE and control areas (Fig. 18 & 19). There was no significant difference (P=0.19) in overall wintering songbird densities between sites, after accounting for year and stand type effects ($F_{6,535}=18.60$, $P<0.001$). Sandhills fields ($P < 0.001$) and hedge rows ($P < 0.001$) had significantly more focal birds per hectare than drains, pine plantations, and natural pine stands. There was no significant difference in wintering songbird densities between drains, pine plantations, and natural pine stands ($P > 0.05$). Various sparrows, eastern towhees, and dark-eyed juncos were the most abundant focal birds in fields and hedgerows on Sandhills Game Land. A variety of sparrows, along with the brown-headed nuthatch, comprised the majority of focal birds in the drains and upland pine stands. Although there was no overall difference in focal bird densities between landscapes, some significant differences are evident in direct comparisons. Hedgerows (55.24 ± 18.4, $P < 0.001$) and plantation (7.09 ± 5.3, $P = 0.01$) stands within the CURE area contained

significantly greater densities than those found in the control area, after accounting for year effects. Densities within other stand types were not significantly different between sites ($P > 0.05$). In 2009, observations on the Sandhills CURE and control sites were more evenly distributed throughout habitat types. There remained a higher density of focal birds in control area fields. Fields may have contained the best suitable habitat in a landscape with more limited early successional habitats. Conversely, more suitable habitat may have existed within the various stand types within the CURE landscape, due to CURE management prescriptions.



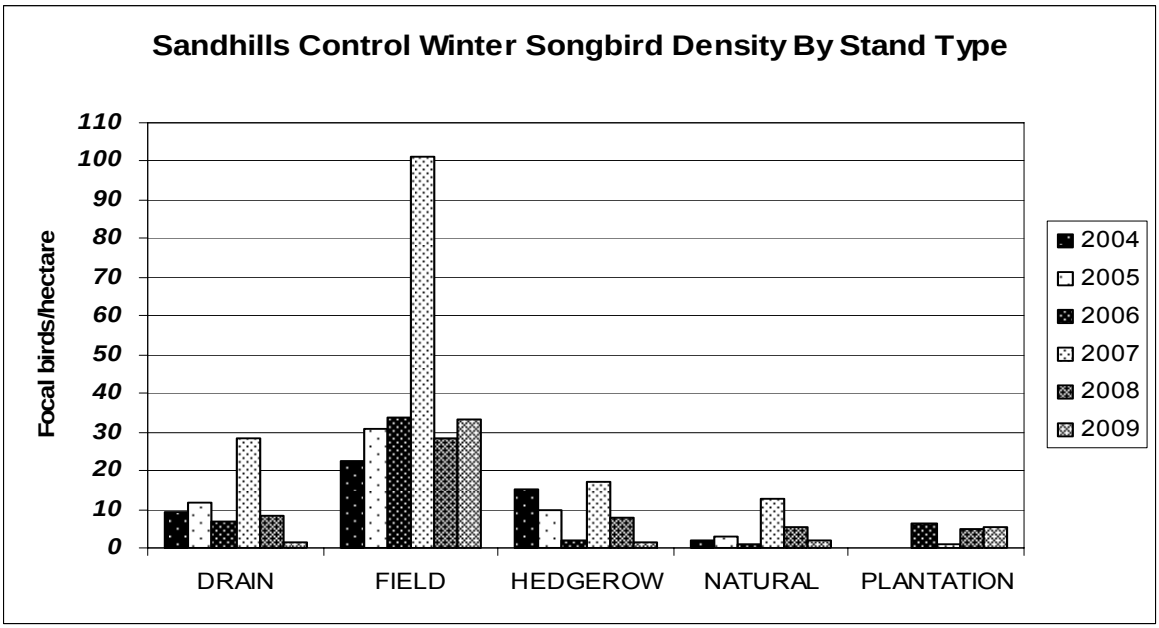


Figure 18 & 19. Sandhills Game Lands CURE and control winter focal songbird densities by habitat type, 2003-2009. Control surveys began in 2004. Plantation pine stands were first surveyed on the control area in 2005 when no birds were detected (additional plantation pine stands were added in 2007).

Bachman's Sparrows Bachman's sparrow surveys were initiated in 2006 to monitor populations of this priority species after observational data indicated an increase throughout CURE-managed areas. The study occurred on the Sandhills CURE and control (Block B) areas. Repeated point count surveys with song playback were employed to develop a relative abundance estimate for Bachman's sparrow. Useable habitat was discerned at the stand level during the point count survey window. 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. Most data was collected over a three year period (2006-2008). However, point counts and useable habitat surveys will continue as part of a long-term monitoring effort.

Preliminary results indicate a similar relative abundance between control and CURE treatment areas (Fig. 20). Further analysis is necessary to determine any statistically significant trends. Useable habitat data will be used to correlate habitat suitability with population shifts. In 2009 we continued to monitor playback calling efficacy, with results reflecting higher calling rates after song playback (Fig. 21). This mirrors results in earlier years of these point count surveys.

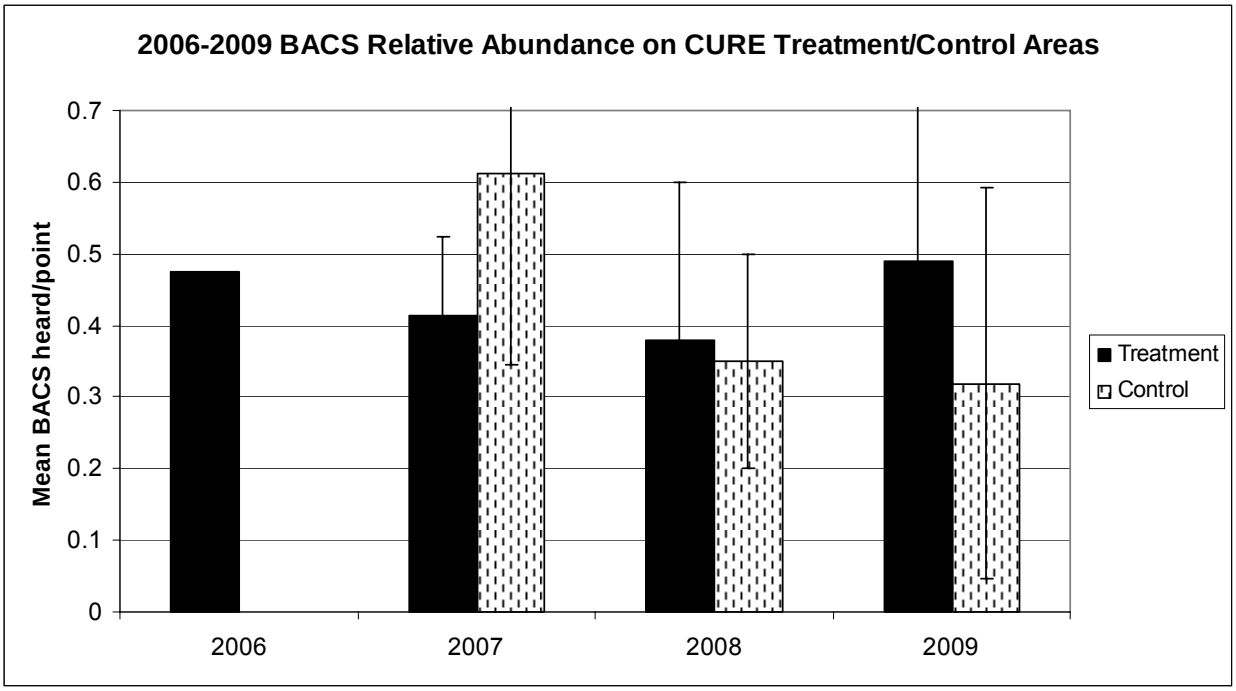


Figure 20. Relative abundance of Bachman's sparrows on the Sandhills Game Lands CURE and Block B (control) areas, 2006-2009. Control area surveys were initiated in 2007.

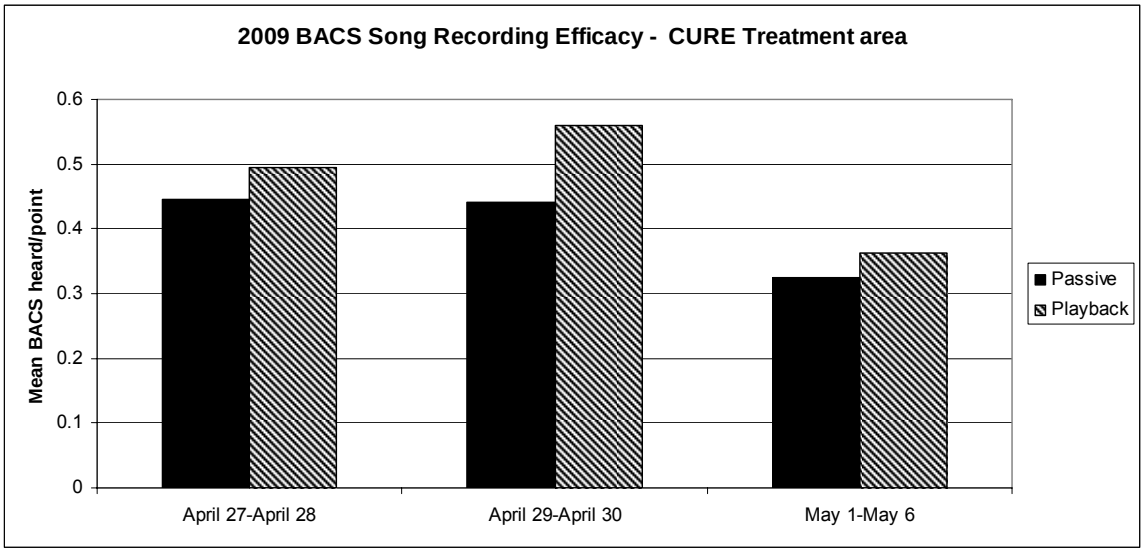


Figure 21. Mean number of Bachman's sparrows per point during passive listening and song playback periods, April-May 2009.

Territory mapping results have been analyzed from 2006 and 2007. Across CURE and control sites, 62 of 109 (57%) randomly selected Bachman's sparrow locations became territories, the rest were abandoned. Territory establishment rates did not differ between CURE and control areas or between natural wiregrass stands and stands planted to Atlantic coastal panicgrass (ACP). Territory size was slightly smaller (3.5 acres/territory, n=35 territories) in natural wiregrass stands compared to ACP stands (4.5 acres/territory, n=12). A slightly higher proportion of territories in wiregrass stands produced fledglings than those in ACP.

Territory size was smallest (~3 acres/territory) in stands burned one year previously, compared to stands burned in the current year or 2-3 years ago (average ~4 acres/territory). While all territories were comprised almost entirely of upland longleaf woods, 23 of 64 (36%) territories included or were adjacent to small fields, while fields comprised only 4% of the acreage in the landscape, suggesting that Bachman's sparrows may select territories close to small fields.

Fifty six percent of Bachman's sparrow territories had at least one observation of a northern bobwhite in or near the territory, indicating significant habitat overlap. The greatest amount of habitat overlap was in ACP stands. Quail were more frequently observed in or near fields and drains, while Bachman's sparrows were more frequently observed in upland wiregrass stands.

Further analyses of this data will include a non-parametric ordination technique to determine any over-lapping habitat requirements of Bachman's sparrows and Northern bobwhite. We expect to develop one or more scientific publications pertaining to this project

Useable Habitat At Sandhills Game Land, useable habitat also continued increasing with gains in both breeding (50.8%) and non-breeding (49.1%) habitat (Fig. 22). Management included prescribed burning and thinning forested areas to less than 40 ft^2/acre basal area (or to a basal area of 40-50 ft^2/ac in red-cockaded woodpecker partitions). The initial timber cutting was completed in 2007, and habitat management has entered the "maintenance" phase, primarily with

the use of prescribed fire. Many forest stands without adequate understory in 2007 developed vegetation appropriate for meeting the needs of quail by 2008. Sandhills' CURE goal is to maintain 74.7% of the CURE area in early successional habitat by 2009. In 2008, 56.25% of the Sandhills CURE area was suitable for quail during some portion of the year.

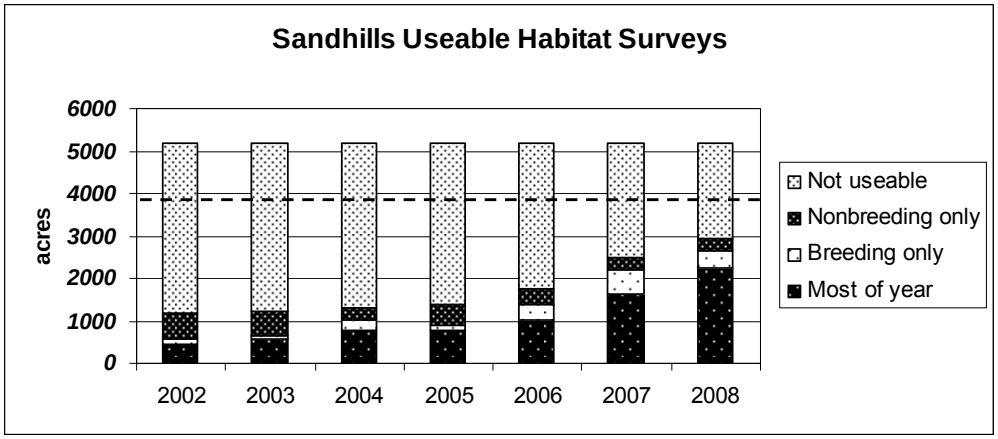
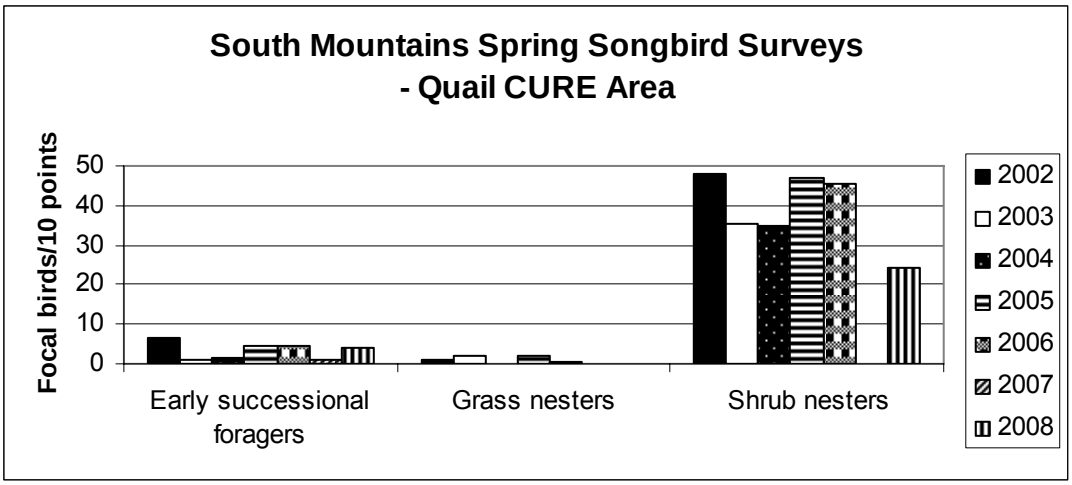


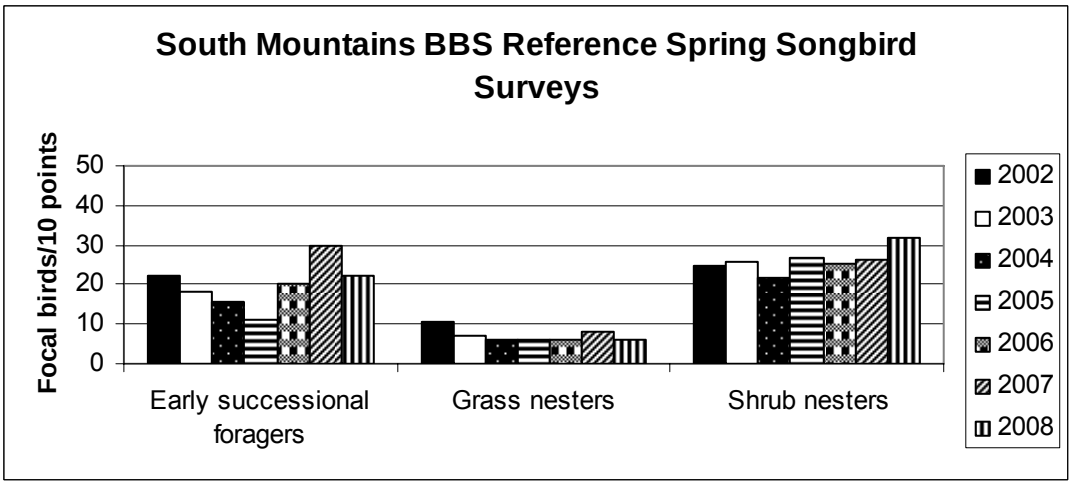
Figure 22. Acres of useable habitat for Northern bobwhite on the Sandhills CURE area, 2002-2008. (Note: Dashed line indicates early successional acreage goal as stated in CURE area management plan.)

South Mountains Game Land

Breeding Songbirds Only one survey route (10 points) was conducted in the CURE low elevation area for the 2008 breeding season. Yellow-breasted chat and prairie warblers were the most recorded shrub-nesting species. The early successional forager group was composed of wild turkey and eastern phoebe. No grassland nesting species were recorded during the survey.

There were no significant differences between South Mountain bird densities and regional reference routes (Fig. 23 and 24). Overall trends in guild counts were similar to other CURE Game Lands. Shrub nesting species were detected in greater abundance than both early succession foragers (21.14 $\pm$ 6.39) and grassland nesters (29.03 $\pm$ 6.39, $F_{4,35} = 21.63$, $P < 0.001$). Grassland nesters were significantly lower ($P < 0.001$) than early succession foragers (7.89 $\pm$ 6.39, $P = 0.02$).





Figures 23 and 24. Relative abundance (# focal birds per 10 survey points) of early succession songbird guilds on South Mountains Game Land CURE area (lower elevation 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.

Summer Vegetation Surveys Summer vegetation surveys were not conducted at South Mountains Game Land during the 2008 field season due to time constraints for personnel. Vegetation surveys are scheduled to continue in 2009.

Winter Songbirds South Mountains stands were stratified by woods height (2-3m, 5-7m, and >7m median canopy height). Winter bird surveys were discontinued at South Mountains after 2008.

South Mountains landscape focal songbird density estimates We determined the density of focal songbirds at the scale of the CURE area using randomly selected forest/clearcut stands (Fig. 25). Fields (47 acres) comprise a small part (1.5%) of the South Mountain Quail landscape (3035 acres) and were not included in the estimate. 2005 marked a peak in focal songbird densities. Subsequent declines may be associated with clearcut maintenance activities after 2005 surveys.

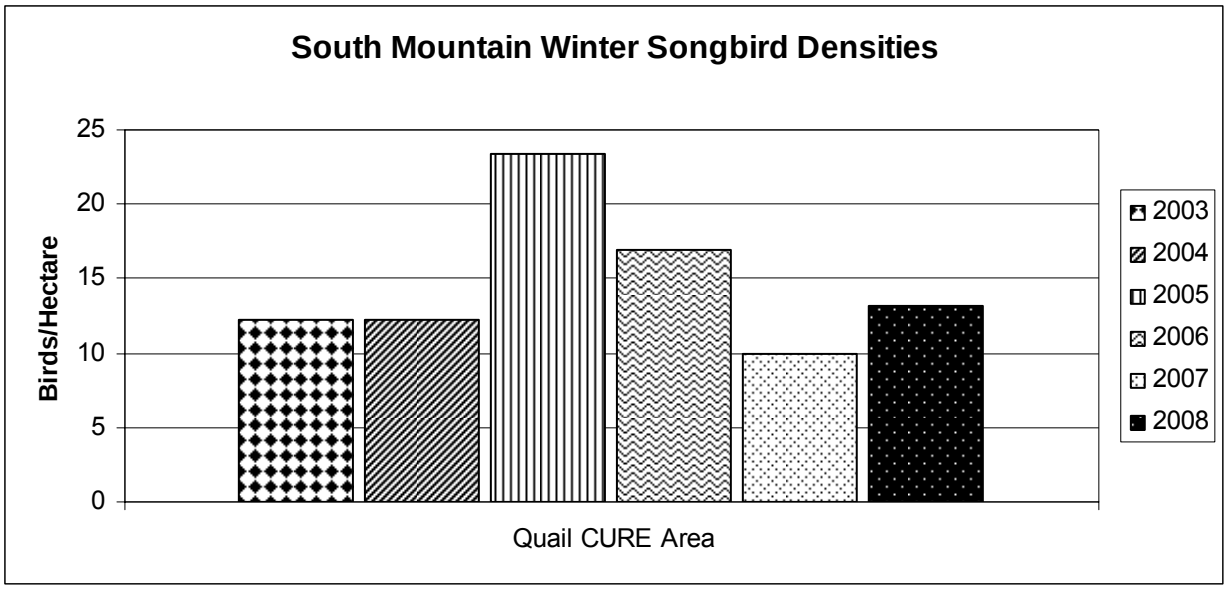


Figure 25. Winter focal songbird density estimates on entire low elevation CURE area of South Mountain Game Land, 2003-2008.

Focal Songbird Density Estimates within Stand Types Annual winter songbird densities within all randomly selected surveys were compared between stand height categories (Fig. 26). Results indicated significantly more focal songbirds (20.80 $\pm$ 7.74, $P < 0.001$) were found in the 3-4m clearcuts stands compared to all other height categories, after accounting for year affects ($F_{2,92}$=14.01, P<0.001). There were no significant differences in focal songbird densities between all other height categories, after accounting for year affects (P>0.05). The 3-4m clearcuts appear to maximize suitable habitat conditions for many early-successional songbirds wintering at South Mountains. Regenerating clearcuts (<7m) had a greater diversity of focal birds than mature stands (>7m), including eastern towhee, dark-eyed juncos, a variety of sparrows, and one northern bobwhite. In the mature woods, focal bird observations were limited to song sparrows, white-throated sparrows, and a Carolina wren.

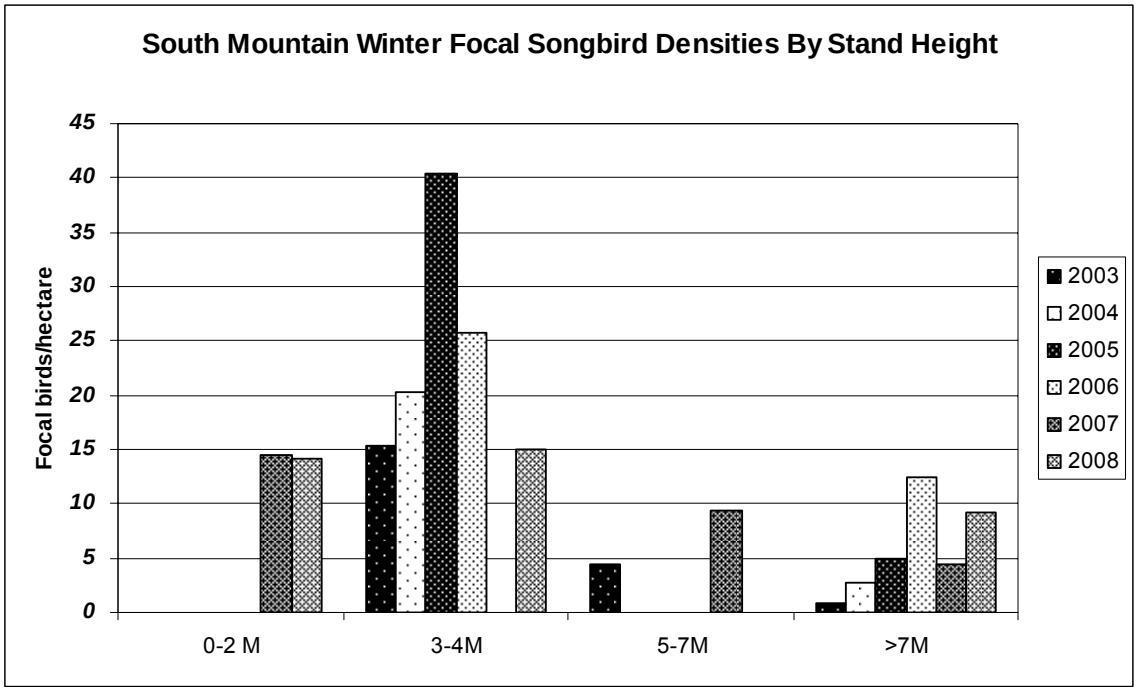


Figure 26.--South Mountains CURE (Quail Area) winter focal songbird densities by stand height, 2003-2008. Note: Not all stand height categories were available in all years.

Useable Habitat At South Mountains, useable habitat continued increasing in 2008 with substantial gains in both the breeding (20%) and non-breeding (20%) seasons (Fig. 27). In 2008, net gains (112 ac) in useable habitat were primarily created by prescribed burning and suitable understory establishment in stands thinned in previous years. Previously established useable habitat was maintained within the 8-year old clearcuts (Potts Branch and Golden Valley) and small fields. The remainder of the landscape which was non-useable habitat (77.5%), 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.

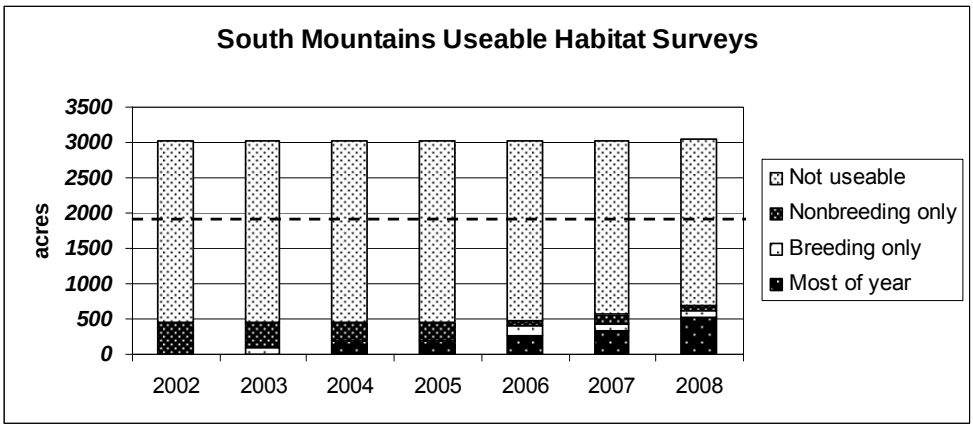
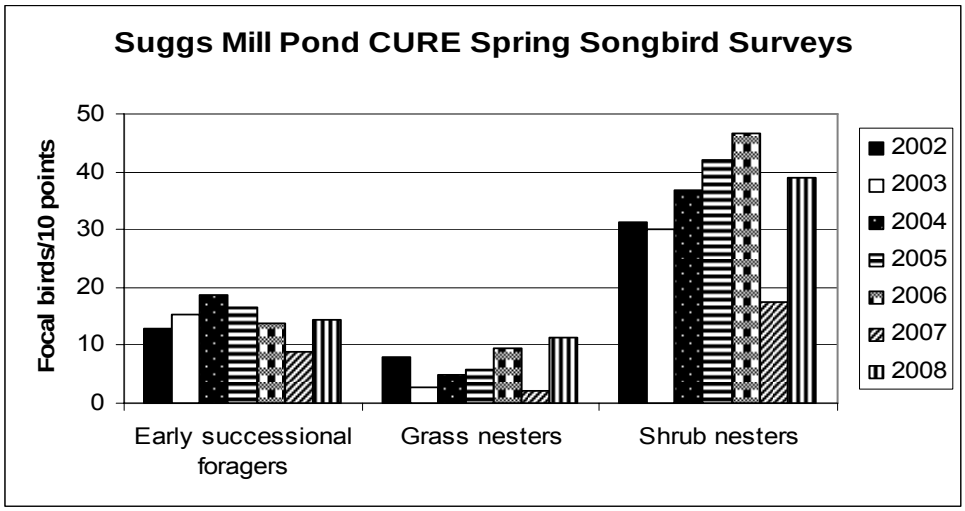


Figure 27. Acres of useable habitat for Northern bobwhite on South Mountains CURE Game Land areas, 2002-2008. (Note: Dashed line indicates early successional acreage goal as stated in CURE area management plan.)

Suggs Mill Pond Game Land

Breeding Songbirds At Suggs Mill Pond Game Land, the most common early successional forager was the eastern wood peewee. The grassland nester group was almost entirely represented by northern bobwhite, with one red-winged blackbird observation. The most commonly recorded shrubland nesting birds were the eastern towhee and prairie warbler.

Shrub nesting species have been increasing at a higher rate than other early successional guilds. At Suggs Mill Pond, shrub nesters have significantly higher relative abundance than grassland nesters ($P < 0.001$) and early succession foragers ($P = 0.02$). Grass nesters maintained significantly lower trend rates than either shrub or early successional foragers ($P < 0.001$), but count trends appear to be relatively stable with no significant decrease throughout years (Fig. 28 and 29).



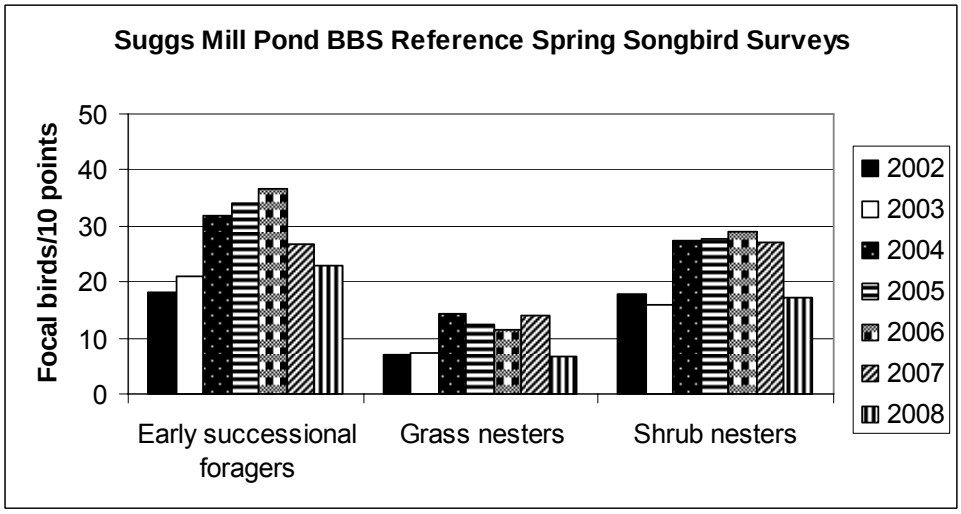


Figure 28 & 29. Relative abundance (# focal birds per 10 survey points) of early succession habitat songbird guilds on Suggs Mill Pond Game Land CURE area, based on unlimited distance, five minute counts. Habitat enhancements were initiated in the summer of 2003. Comparisons between BBS and CURE should be made only for count trends.

Summer Vegetation Surveys In 2008, Suggs Mill Pond CURE summer vegetation surveys consisted of eight managed pine stands. CURE management in forested stands included reducing basal area to 40 feet^2/ac followed by prescribed burning within 1-1.5 growing seasons. Before Game Land acquisition, Suggs Mill Pond had a history of fire exclusion and a relatively high stocking of pine. Stands were dominated by loblolly and slash pine interspersed with longleaf and pond pine. All CURE thinnings were closely followed by prescribed burns to reduce the accumulated pine duff and slash material.

Because Suggs Mill Pond Game Land management prescriptions were already underway during the initiation of CURE, pretreatment conditions were not fully evaluated. Within three stands which had not yet been thinned, basal area averaged 83.0 $\pm$ 9.4 feet^2/acre. Initial thinnings

reduced average basal area to 46.9 $\pm$ 13.2 feet^2/ac ($P < 0.01$). All surveyed stands were managed on a 2-3 year burning regime (Fig. 30).

1. Cover Managed pine stands provided adequate cover during the summer months within most survey years, based on Kopp et al.'s (1998) estimates for quail suitability. Woody growth forms provided most of the cover currently in the thinned pine understories. Variation between thinned stands limited adequate statistical comparison of cover values between growing seasons. However, raw data suggests a slow recovery of growth forms and a gradual decrease in open ground since the 1st post-treatment growing season. Overall high estimates in open ground may be related to a 2-3 year prescribed burn rotation, which controls woody growth in the understory.

2. Composition Before thinnings, pine stands were primarily open (45.02 $\pm$ 6.62 %) in the understory with tall woody shrubs (39.94 $\pm$ 12.84 %), such as fetterbush (*Lyonia*) and pepperbush (*Clethra*). Some forbs were also present (11.18 $\pm$ 5.84 %), including bracken fern, honeysuckle and legumes. However, observers included some shrubs and vines such as blueberry, sparkleberry, gallberry and grape (*Vitis*) in the forb category, inflating reported forb coverage. Scattered grasses (3.85 $\pm$ 0.64 %) were comprised of wiregrass, bluestems, and switchcane.

In the first growing season post-thinning, understory vegetation responded slowly. Understory vegetation continued to be dominated by woody genera such as *Vaccinium/Galacacia* (41.2%), gallberry (26.9%), and pepperbush (8.6%). Herbaceous genera such as nutgrasses (*Cyperus*, 18.6%), horseweed (9.0%), and Dallis grass (*Paspallum*, 6%) were recorded the first year in thinned stands. All understory vegetation (grass, forbs, and woody between 0.15 and 2 m) appeared to decrease, possibly from the physical disturbance created by logging machinery.

In the second growing season after thinning, a prescribed burn rotation was initiated. Grasses significantly increased 5.27 $\pm$ 1.88 % ($F_{3,22} = 4.70$, $P < 0.01$). The positive grass response was driven in large part by wiregrass, which was stimulated to flower after burning. In the third, fourth, and fifth growing seasons, other grasses (e.g. panic grass, bluestems, crabgrass) appeared to slowly increase, but remained relatively short in thinned pine stands. Grasses showed a small, but still statistically significant, increase 0.86 $\pm$ 0.81% ($F_{2,43} = 4.74$, $P = 0.01$) through growing seasons by the sixth year post-thinning. This continued to be driven by early gains in grass cover, as increases have slowed in recent years. Long term trends for most cover variables could not be determined at this time, but there appeared to be a gradual reduction in woody growth, while forb components appeared to be unchanged after the first growing season.

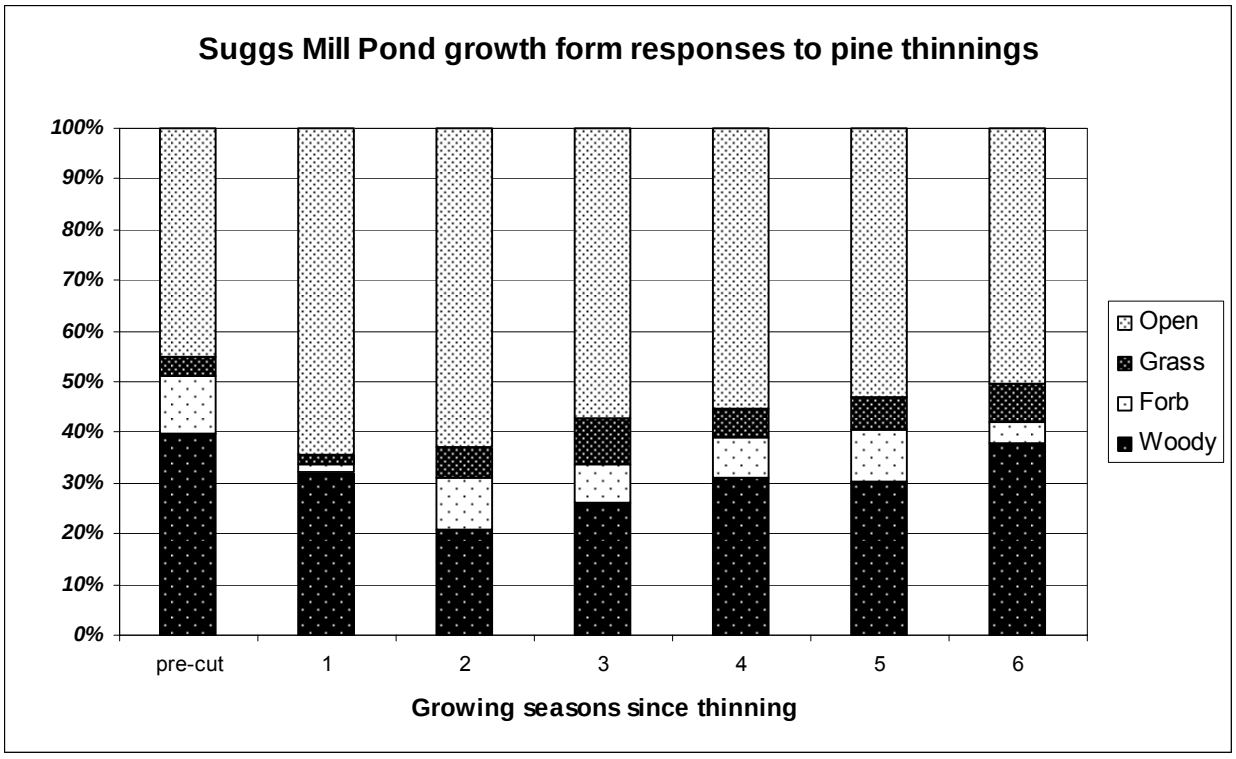


Figure 30. Relative proportion of Suggs Mill Pond vegetative growth form responses to timber thinning and prescribed burning by number of growing seasons, July/Aug 2002-2008.

Winter Songbirds Suggs Mill Pond stands were stratified into fields, linear openings, and mature pine woods (>7m).

Suggs Mill Pond landscape focal songbird density estimates To determine landscape trends, we determined the density of focal songbirds at the scale of the CURE area using randomly selected stands only, stratified by habitat type (Fig. 31). Winter bird densities within habitat types were estimated in proportion to habitat type distributions. Total upland acreage (2,800 acres) was used to estimate landscape trends. Uplands comprise only 30% of the wetland-dominated Suggs landscape (9,280 ac) originally documented in management plans.

In 2009, landscape density estimates of wintering focal species declined dramatically. Focal bird density decreases were observed across all stand types and in both managed and unmanaged stands. However, analysis of year effects continue to show a slight, but significant, increase (1.19 ± 1.1 birds/ha, $P = 0.03$) in focal bird densities through 2009.

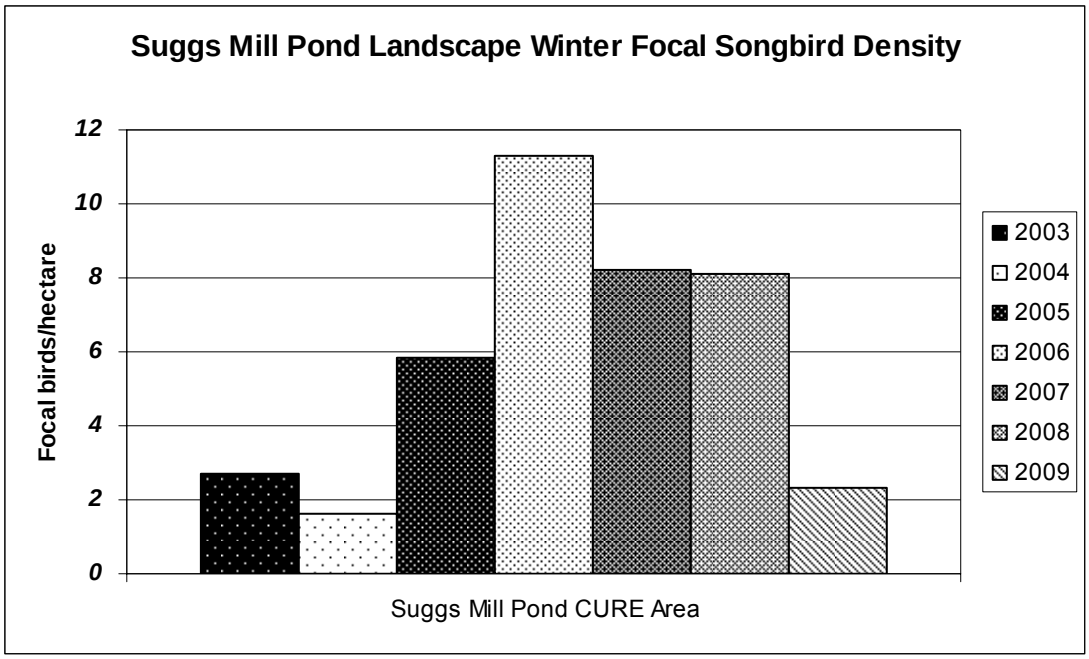


Figure 31.—Winter focal songbird density estimates within upland habitats on the Suggs Mill Pond CURE landscape, 2003-2009. Observed densities were weighted by the proportion of a given habitat type within the CURE area.

Suggs Mill Pond Focal Winter Songbird Density Estimates within Stand Types Average annual songbird densities within all randomly selected stands were compared between stand types (Fig. 32). Three stand types were categorized within the CURE area: fields, linear openings, and pine woods > 7m in height. Results indicate significantly more focal songbirds ($+5.12 \pm 5.04$, $P < 0.048$) in linear openings compared to other stand types, after accounting for year affects ($F_{2,268}=4.28$, $P = 0.015$). There was no difference between fields and pine woods ($P=0.06$), after accounting for year and stand type effects ($F_{3,268}=4.10$, $P=0.01$). The most abundant focal species varied by year at Suggs Mill. In 2009, various sparrows were documented in linear openings and brown-headed nuthatches were most abundant in pine stands; however, no birds were recorded in field transects.

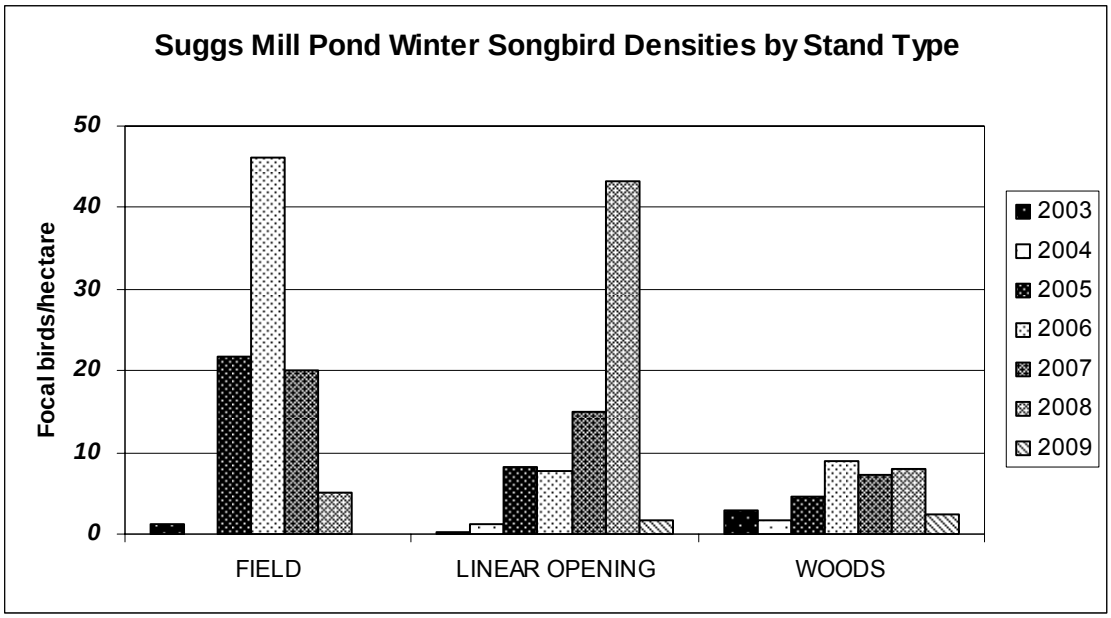


Figure 32.--Suggs Mill Pond Game Land CURE winter focal songbird densities by habitat type, 2003-2009.

Useable Habitat At Suggs Mill Pond, useable habitat continued to make gains within the breeding (13.5%) season, but non-breeding (16.1%) habitat decreased during 2008 (Fig. 33). Net gains (30 ac) in useable habitat were primarily created within loblolly pine stands thinned in 2006 and 2007, converting non-breeding habitat to breeding or "most of year" habitat. Many stands were extensively thinned near the end of the 2008 growing season, which will not provide suitable habitat conditions until 2009 or later. There are currently estimated to be 1,755 acres of useable quail habitat at Suggs Mill. The majority of the non-useable habitat remained in mature loblolly/pond pine forest and pocosin with inadequate herbaceous understory. Suggs Mill Pond's CURE goal is to establish and maintain 2,492 acres in early successional habitat by 2014.

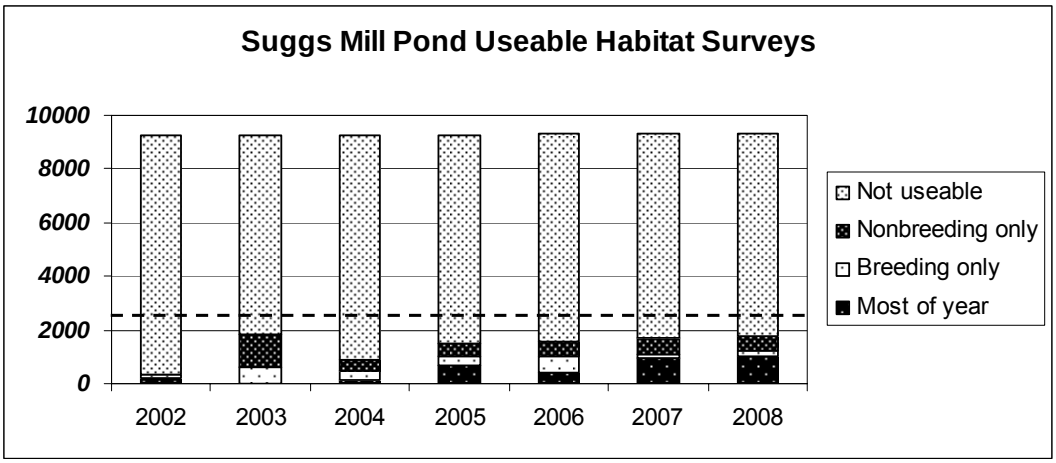
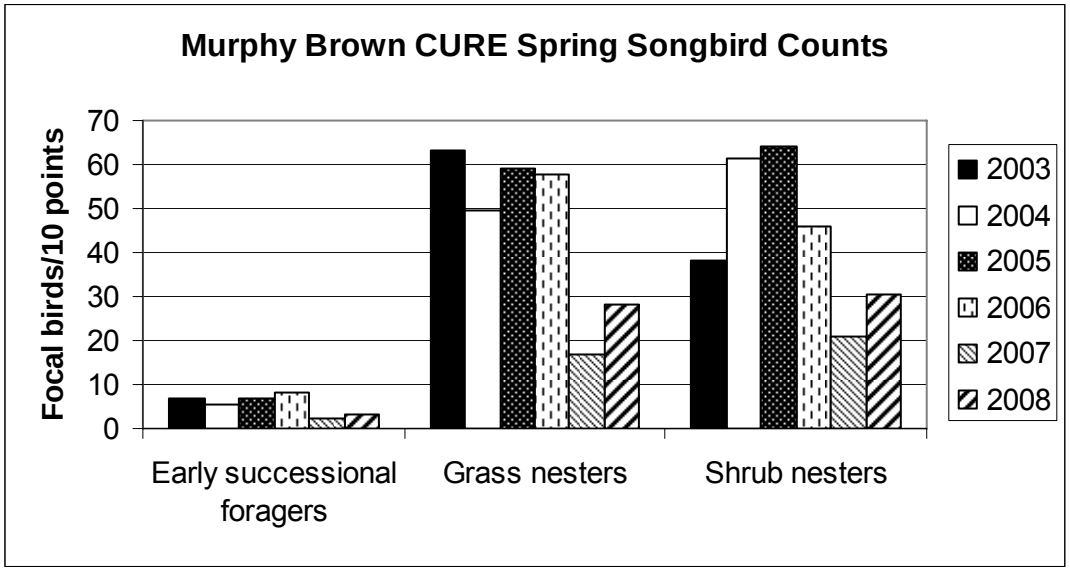
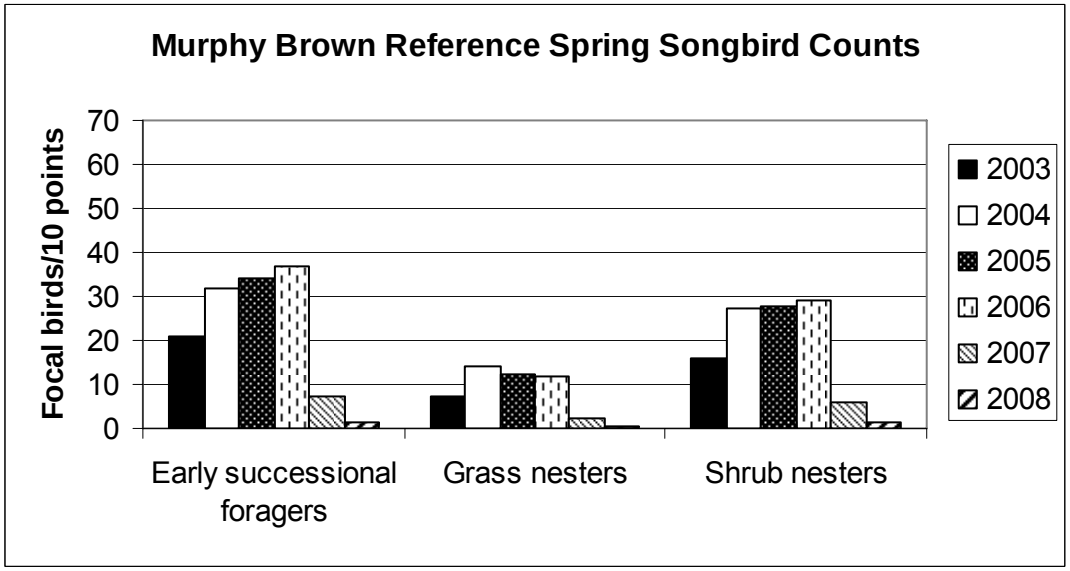


Figure 33. Acres of useable habitat for Northern bobwhite on Suggs Mill Pond CURE area, 2002-2008. (Dashed line indicates early succession acreage goal stated in CURE area management plan. Note that only 2800 acres of Suggs Game Land is upland with potential for CURE management.)

Corporate CURE

Breeding Songbirds An index of spring songbird abundance at the scale of the CURE area was tracked using point count methodologies similar to the CURE Game Lands spring songbird surveys (see previous section). 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 late May and mid-June. Preliminary data indicates an abundance of shrub and grassland nesters on the Murphy Brown CURE area (Fig. 34 & 35). Breeding songbird data also shows a dramatic decrease in bird numbers on both treatment and reference sites after 2006.





Figures 34 & 35. Relative abundance (# focal birds per 10 survey points) of early succession habitat songbird guilds on the Murphy Brown Ammon Farm, based on unlimited distance, five minute counts. Note: Habitat enhancements were initiated in 2006 on the CURE site.

Winter Songbirds The corporate CURE site is composed primarily of agricultural fields, and songbirds were surveyed within 5 stand type categories: cropped agricultural fields (field), fallow fields (fallow), field border, grazed pasture (pasture), and managed or unmanaged woods (woods). Some stands were intentionally selected and surveyed to evaluate specific CURE habitat improvement areas. However, randomly selected stands will be used to determine focal songbird densities at the scale of the CURE area.

Murphy Brown Focal Songbird Density Estimates within Stand Types Winter songbird densities within all randomly selected surveys were compared between stand types (Fig. 36).

Large peaks in fallow and field border bird densities, due primarily to savanna sparrows, have produced large amounts of annual variation, most notably in 2006 and 2008. Sparrows were the most abundant birds in fields, field borders, and fallow areas. Sparrows and common grackle were the most abundant birds in woods stands, whereas killdeer and horned lark were common in pastures.

CURE habitat improvements were initiated in some fields, field borders, and fallow areas during the spring of 2006. Habitat improvements for woods and pasture areas on Murphy Brown are planned for subsequent years. Although the dataset is limited, current analysis shows significantly higher focal bird densities in field borders compared to woods (-5.57 $\pm$ 4.6, P=0.02) and fields (-9.74 $\pm$ 4.6, P<0.001), after accounting for year effects ($F_{5,161}$=5.36, P<0.001). All other stands contained statistically similar densities of wintering focal songbirds.

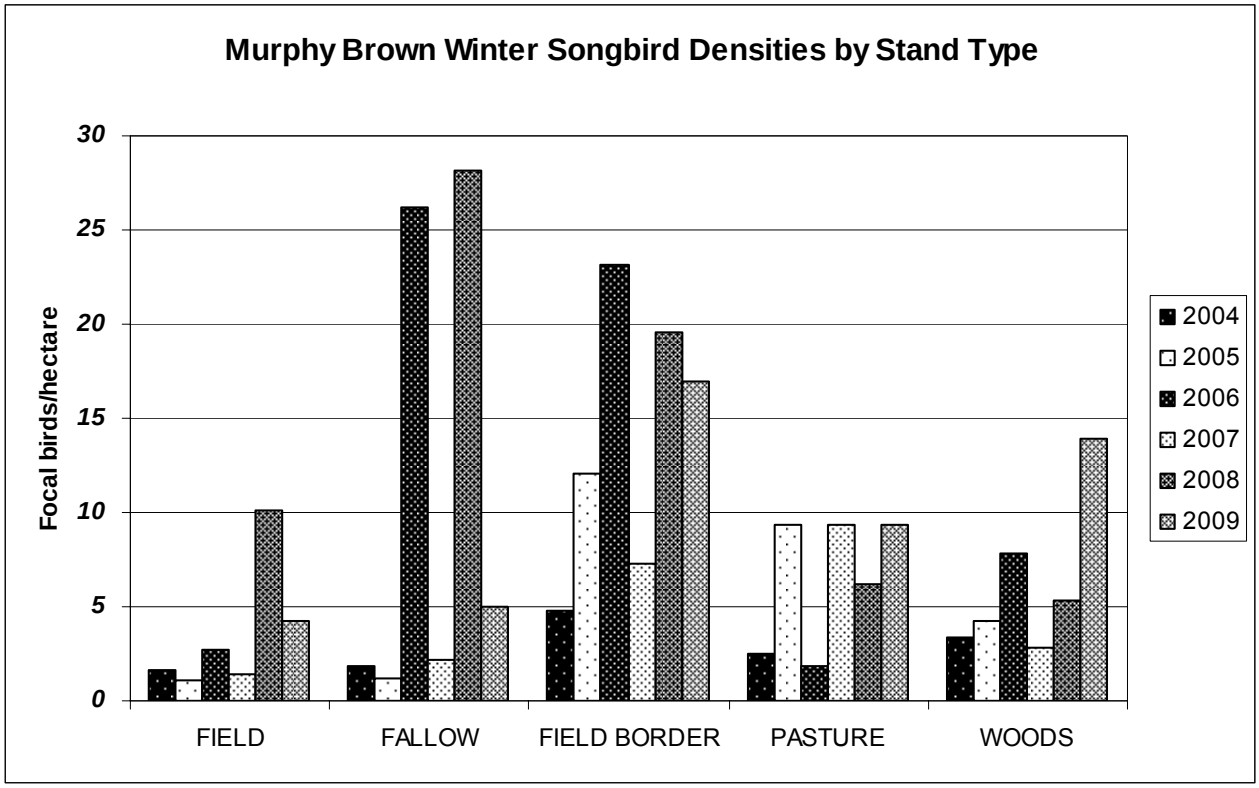


Figure 36. Murphy Brown Corporate CURE Area winter focal songbird densities by habitat type within randomly selected stands, 2004-2009. *Note: 2006 was the first post-treatment year for any habitat type.

Useable Habitat Murphy Brown Corporate CURE cooperative consisted of 4,315 acres under various management regimes. Stands were dominated by agricultural row crop fields with some surrounding pine forest/pocosin and pastureland. Murphy Brown CURE goals include the conversion of 250 acres, primarily to improve water quality while concurrently enhancing early successional habitat conditions. In 2008, gains of habitat suitable for quail continued as landscape coverage increased in both breeding (54.7%) and non-breeding (36.5%) habitats (Fig. 37). Currently 83.5% (3,605 ac) of the Ammon CURE area is being maintained as habitat suitable for quail during some period of the year. Acreages are expected to continue increasing in future years as new CURE management areas are established on additional farms.

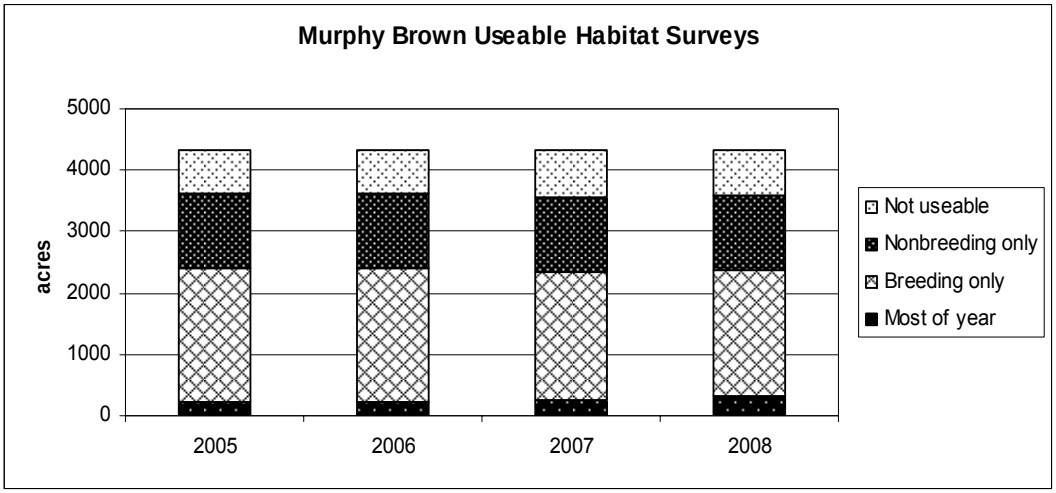


Figure 37. Acres of useable habitat for Northern bobwhite on Murphy Brown - Ammon CURE area, 2005-2008.

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B: Target Dates for Achievement and Accomplishment

During the 2009-2010 FY, the CURE Surveys project will continue surveys on CURE areas, continue the collaborate native warm season grass research project with NC State University, complete further data analyses, publish and present results, and plan for future project activities.

C: Significant Deviations

None

D. Remarks

None

E. Recommendations

This project should be continued during the next period.

F. Estimated Cost

$84,829 (including in-kind and non-federal partner match)

Prepared By:

Jerri LeAnne Bonner
CURE Surveys Biologist
Wildlife Diversity Program, Division of Wildlife Management
NC Wildlife Resources Commission

Final Annual Performance Report

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

Period Covered: July 1, 2008 – June 30, 2009

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 been progressing on several long-term projects:

1. BIODE: This project's goal is to incorporate all data collected by the Diversity Program into a single, spatially-explicit database (BIOdiversity DatabasE – BIODE). A basic architecture has been developed to store the data, and each of 14 existing databases are being incorporated individually.
    a. Box Turtle Database: This year, we incorporated the Box Turtle Database into BIODE. This database allows volunteers involved in the Box Turtle Connection program to log in and record data including location and marking information of box turtles into a central database for review and summarization by Wildlife Resource Commission (WRC) Biologists.
    b. Aquatics Database: A working prototype has been developed and is being evaluated by WRC biologists. The database is accessed through the internet (rather than through Microsoft Access), allowing more flexibility. It also conforms to the BIODE data structure.
    c. We have begun preliminary work on incorporating the next two datasets to be included in BIODE: Colonial Waterbird/Shorebird data and Statewide Herpetological data.
2. Project Tracking Database: This database is designed to track performance of WRC programs towards the NC Wildlife Action Plan goals. A set of requirements has been developed and documented for WRC biologists to log accomplishments, and work began with programmers to start building the database structure. Requirements for partners and other outside organizations to contribute to the database are being assessed.
3. CASP Interactive Mapping Application: Developed a web application to display frog-call routes surveyed by volunteers in the Calling Amphibian Survey Protocol (CASP) program.
4. Primary Inland Nursery Areas: Developed a draft version of this spatially-explicit data for use by WRC biologists.

5. Ad hoc cartographic services: Developed maps for the Green Growth Toolbox and Green Salamander projects.
6. GIS Training: Provided 6-hour training session on the use of GIS technology to WRC biologists.
7. We provided technical support for currently deployed GPS/GIS hardware and software to field biologists in the Wildlife Diversity program.
8. We provided technical assistance in the use of GIS/GPS technologies to Wildlife Diversity Program Biologists.

B. Target Dates for Achievement and Accomplishment

The project is progressing with many short term accomplishments and work on longer-term data systems that will lead to more comprehensive data management and tools to inform the next revision of the NC Wildlife Action Plan.

C. Significant Deviations

Progress on larger internet-based data systems requires involvement of many individuals and compliance with state information technology protocol and procedure, thus requiring more interaction and integrated action. Therefore projected completion of some of the data management systems is taking longer than originally anticipated. However, we are moving forward and addressing the project objectives, albeit at a slower pace than projected and provided that we continue toward achievement prior to Action Plan revision, we do not consider these delays significant deviations from the project objectives.

D. Remarks

None

E. Recommendations

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

- Migrate the prototype version of the Aquatics Database to production, incorporating comments from field biologists.
- Complete conversion of 1-2 other species-specific databases to the BIODE format.
- Complete and deploy the Project-Tracking Database for internal use. Begin testing/evaluating methods for collecting data from Wildlife Action Plan partners.
- Continue to provide technical support for GPS/GIS hardware and software to field biologists

F. Estimated Cost

$ 30,830

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

Final Annual Performance Report

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

Period Covered: July 1, 2008 – June 30, 2009

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

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

Objectives:

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 and Sandhills regions of NC.
2. Develop inventory and monitoring 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 and Sandhills.
4. Conduct research projects to address declines in target amphibian and reptile populations.

A. Activity

Over the past year, the staff has continued several projects begun in 2007 as well as implemented several new projects and numerous site surveys to assess the status of amphibians and reptiles. Projects completed during FY 2008-2009 included 1) Herpetological survey of the Pee Dee National Wildlife Refuge; 2) Movement and home range study of Eastern Box Turtles on the Sandhills Game Land; 3) Carolina Gopher Frog status, movements, and habitat use on the Sandhills Game Land and throughout the species' NC range. Other surveys of targeted species and habitats were also conducted throughout the Piedmont and Sandhills, including continued amphibian surveys of the Triangle area and "bioblitzes" conducted in the south-central Piedmont.

Herpetological Survey 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 had impeded such an effort.

We conducted surveys for amphibians and reptiles using tin and wood coverboards and PVC pipes placed at 31 sites throughout the refuge representing most of the habitat types that occur on site (Fig 1). "Trapping" arrays consisted of 12 wooden coverboard sites (2' x 4', 3/8" boards; 120 boards total), 9 pond sites with PVC pipes for treefrogs (1.5 in dia, 1 m tall; 90 pipes total), and 11 tin sites (3' x 8'roofing tin; 65 pieces of tin total). We visited the survey sites 10 times from Oct 2007 – May 2009. Animals captured were not given individual marks, except for large snakes which were given an individual scale mark using a medical cauterizing unit. Therefore, with the exception of large snakes, the number of animals reported does not necessarily indicate the number of "new" individuals observed – some individuals of some species, such as treefrogs, were likely captured multiple times.

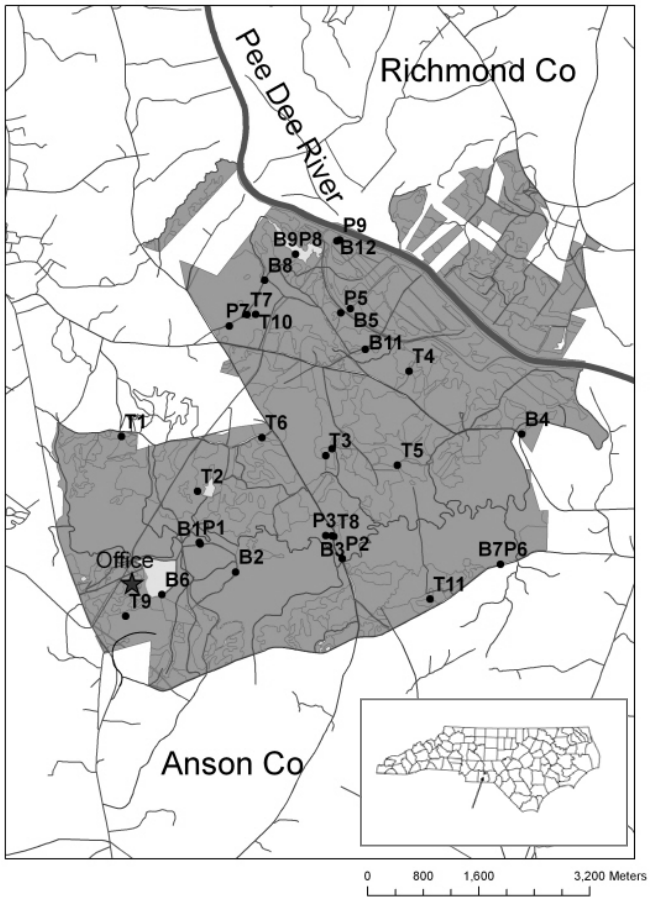


Figure 1. Map of the Pee Dee National Wildlife Refuge showing sampling sites for amphibians and reptiles. T = Tin, B = Wooden Boards, P = PVC Pipes. Inset map shows location of the Pee Dee NWR in North Carolina.

The Pee Dee NWR supports quite a large diversity of amphibians and reptiles for its area. We captured 29 species of amphibians and reptiles, including 10 frog and toad species, 3 salamander species, 10 snake species, 3 lizard species, and 3 turtle species (Table 1). The four most commonly encountered species were Northern Cricket Frogs (*Acris crepitans*), Marbled Salamanders (*Ambystoma opacum*), Green Treefrogs (*Hyla cinerea*), and Black Racers (*Coluber constrictor*).

The Brown Creek floodplain is an important ecosystem for species like Marbled Salamanders and Spotted Salamanders, where very large populations of both species appear to occur – only a few adult Spotted Salamanders were recorded, but egg masses were commonly seen in ephemeral pools. The Brown Creek area, with its wide floodplain and numerous oxbows, is also important to many other species, including Spotted Turtles, Sliders, various treefrog species, and

snake species such as Redbelly Watersnakes. Some of the Pee Dee river floodplains on the refuge are maintained as agricultural fields which are partially harvested on a lease-basis and flooded during winter months to benefit waterfowl. We were not able to survey these river floodplain habitats during prime breeding seasons for amphibians because the areas were closed off to reduce disturbance to waterfowl.

Upland habitats on the refuge have been altered a great deal by past land use practices; mainly agriculture, resulting in second-growth loblolly pine and mixed pine-hardwood forests. Small areas of longleaf pine forest still exist on the refuge and prescribed burning is important for maintaining an herbaceous understory on these sites. Many species of reptiles would likely benefit from upland restoration efforts currently underway, including the use of prescribed fire (especially summer fires) and thinning of planted pine. Corn Snakes and Eastern Kingsnakes occur on the refuge, but in apparently low numbers. Upland habitat restoration would benefit these priority species. Other species such as Slender Glass Lizards and Mole Kingsnakes would also likely benefit from pine thinning and prescribed fire. These species were not found on the refuge during this survey, probably because of difficulty in sampling them, but they are likely to occur there.

Upland fields and field borders support numerous snakes, including Copperheads, Black Racers, Black Rat Snakes, Eastern Kingsnakes, and Cornsnakes. These species were found under metal cover placed near field edges and were often associated with cover objects that supported small mammals. Snakes are obviously attracted to upland fields, but tilling and planting crops in these areas often results in snakes being killed by equipment. We recommend minimizing heavy equipment use in fields, such as shifting from planting annual crops to planting perennial warm season grasses maintained by summer burning. Otherwise, shifting to no-till planting or other practices that do not involve drastic soil disturbance would likely reduce mortality on large snakes.

Many species of amphibians and reptiles not encountered during our surveys are still likely to occur on the refuge. Some of these species include Mole Kingsnake, Eastern Garter Snake, Slender Glass Lizard, Broad-headed Skink, Fowler's Toad, and Eastern Spadefoot. More intense surveys in the future could show some of these species to be present on the Pee Dee NWR.

Table 1. Species captured on the Pee Dee National Wildlife Refuge, Anson County, NC during 2007 – 2009. "*" indicates a NC Wildlife Action Plan priority species. "Incidental" indicates a species was observed or heard in an area away from our sampling sites.

Scientific Name	Common Name	Number Captured	Capture Sites
Frogs			
Acris crepitans	Northern Cricket Frog	198	P1, P8, P9 and incidental
Bufo americanus	American Toad	11	P1 and incidental
Hyla chrysoscelis	Cope's Gray Treefrog	5	P2, P3, P9 and incidental
Hyla cinerea	Green Treefrog	56	P1, P2, P3, P5, P6, P7, P8, P9
Hyla crucifer	Spring Peeper	1	P9
Hyla squirella	Squirrel Treefrog	9	P5, P7, P9
Pseudacris feriarum	Upland Chorus Frog	10	Incidental
Rana catesbeiana	American Bullfrog	1	Incidental
Rana clamitans	Green Frog	10	Incidental
Rana palustris	Pickerel Frog	8	Incidental
Salamanders			
Ambystoma maculatum *	Spotted Salamander	3	B1, P7, T2
Ambystoma opacum *	Marbled Salamander	163	B1, B4, B7, P1, P2, P5, P6, P7, P8
Plethodon cylindraceus *	White-spotted Slimy Salamander	3	P5, P8
Snakes			
Agkistrodon contortrix	Copperhead	5	T3, T5, T8, B12 and incidental
Carphophis amoenus	Eastern Worm Snake	4	B4, B9, P1
Coluber constrictor	Black Racer	30	T1, T2, T3, T4, T5, T6, T8, T10, T12
Elaphe guttata *	Corn Snake	1	T3
Elaphe obsoleta	Black Rat Snake	5	T1, T2, T4 and incidental
Lampropeltis getula *	Eastern Kingsnake	6	T1, T4, T9
Nerodia erythrogaster	Redbelly Watersnake	7	P1 and incidental
Storeria dekayi	Brown Snake	3	B6
Storeria occipitomaculata	Redbellied Snake	1	P6
Thamnophis sauritus *	Ribbon Snake	1	P9
Lizards			
Anolis carolinensis	Green Anole	6	B5, B12, T1, T2
Eumeces inexpectatus	Southeastern Five-lined Skink	1	T6
Eumeces sp.	*Eumeces* skink species	>20 escapes	
Scincella lateralis	Ground Skink	6	T1, T2, T5, T6, T7
Turtles			
Chrysemys picta	Eastern Painted Turtle	11	B5 and incidental
Terrapene carolina *	Eastern Box Turtle	3	T1, T4 and incidental
Trachemys scripta	Yellowbelly Slider	12	P1 and incidental

Gopher Frog Status, Movements, and Habitat Use

The Gopher Frog (*Rana capito*) is a medium-sized frog native to the southeastern Coastal Plain of the United States, ranging from North Carolina, through South Carolina, Georgia, Florida and Alabama. The Sandhills Region and coastal Longleaf Pine forests of North Carolina are home to the northern limit of the Carolina Gopher Frog (*Rana c. capito*). Gopher Frogs breed in isolated ephemeral wetlands that are dominated by emergent vegetation and contain little to no overstory trees. During the non-breeding season, Gopher Frogs rely upon upland Longleaf Pine habitats where they utilize subterranean burrows created by small mammals, rotting stumps, or Gopher Tortoises (where the two species occur together). The loss and fragmentation of Longleaf Pine ecosystems as well as the loss and degradation of associated isolated wetlands have greatly reduced the number of viable gopher frog populations in the Southeast. Remaining suitable habitat is also currently threatened by the exclusion of seasonably appropriate fire that is critical to maintaining the frog's breeding and terrestrial habitats. Consequently, the Gopher Frog is a species of conservation concern across the southeast with populations on the western edge of the range currently listed as Endangered by the U.S. Fish and Wildlife Service and the Carolina Gopher Frog is currently recognized as a federal Species of Concern (Linda LaClaire, USFWS Jackson MS, pers. comm.). In North Carolina, the Gopher Frog is state listed as Threatened by the NC Wildlife Resources Commission.

Currently, we are studying Gopher Frogs in North Carolina through the use of drift fence surveys at an ideal gopher frog breeding site, in order to begin defining the demographics and breeding biology of the resident population, and by conducting a radiotelemetry study to evaluate the species' upland habitat requirements at the same site. Also, because Gopher Frog populations in the state are already known to be in decline (Braswell, 1993), we have initiated a preliminary assessment of suitable habitat across the species range in North Carolina in order to 1) update the species current status, 2) begin to formulate management recommendations for degraded sites, 3) identify ways to help ensure the persistence of existing healthy populations and 4), identify locations that with proper restoration could serve as future reintroduction sites.

Drift Fence Monitoring

The drift fence study was conducted at 17-Frog Pond on Sandhills Game Land in Scotland County, a pond known to support a robust population of Gopher Frogs. In order to monitor the movements of frogs in and out of the pond, eight 60-m drift fences were installed around the pond with 20-m gaps between each one. The fences were partially buried in the ground and each was fitted with three pairs (one inside and one outside) of standard 5-gallon (18.9 L) buckets buried along the fence. Bucket traps were positioned at the 2 ends of each fence and in the middle. A total of 48 buckets (8 fences x 6 buckets) were employed around the pond. Because adult Gopher Frogs can often escape from standard buckets, funnel-type box traps were also installed on the ends of each fence (one inside and one outside). The funnel traps consisted of a rectangular box (90.2 cm L x 30.5 cm W x 30.5 cm H) constructed of plywood with a removable lid on the top. The end of each box was fitted with a funnel constructed of 1/8" (0.3175 cm) hardware cloth, recessed 12.7 cm from the face of the box and containing a square opening 6.4 cm by 6.4cm. A total of 32 traps (8 fences x 4 traps) were employed around the pond. In order to

help ensure the capture of any remaining Gopher Frogs, the pond was completely encircled with drift fence by installing plastic silt fence in each 20 m gap between 31 March and 2 April.

The drift fence was monitored for 40 days between 27 February and 10 April when adult Gopher Frogs were expected to be moving in and out of the pond. Traps were checked in the morning during dry or cold weather when little activity was expected, and twice a day (morning and evening) during ideal weather conditions. In order to minimize the amount of time that frogs spent in traps, considerable time was spent checking traps on nights when Gopher Frog movements were heavy – during warm, rainy nights, the fence was generally walked from dark until after midnight. When not being monitored, the buckets were covered with lids, the funnel traps were turned on their sides with lids removed, and gaps in the fence were created by pulling 5 m sections of fence out of the ground at 60 meter intervals. All captured frogs were: 1) sexed by looking for the presence of lateral vocal sacs and enlarged thumbs used to identify males, 2) weighed in a plastic bag with a spring-type Pesola scale, 3) measured (snout-vent length, SVL) with a pair of dial calipers and 4), inspected for external anomalies, injuries, or signs of disease. Also, the distinctive pattern on the lower lip of each frog was photographed so that individual frogs could be recognized if recaptured. With the exception of some of the gopher frogs used in a corresponding radiotelemetry study (see below), all captured frogs were released on the opposite side of the fence following processing.

Drift fence monitoring resulted in 58 captures of 52 individual adult Gopher Frogs between 28 Feb and 10 April. Of these, 34 were identified as male, and 18 were identified as female. Another frog captured during this time period was recorded as a juvenile and was not sexed. Most (85 %) of the adult frogs captured, were caught only as they left the pond. Mean male SVL was 77.9 mm (r = 66-93 mm, n = 32). Mean female SVL was 88.1 mm (r = 71-99 mm, n = 18). With a few minor exceptions, the Gopher Frogs caught at the drift fence showed no signs of disease or injury. Subsequent monitoring of a small portion of the drift fence resulted in the capture of 3 newly metamorphosed Gopher Frogs between 18 June and 8 July. SVLs for these individuals were 32, 32, and 33mm respectively.

Though our results seem to suggest a significantly male biased population, this is likely explained by significant migrations of Gopher Frogs prior to the initiation of drift fence monitoring. Because most of the Gopher Frogs captured at the drift fence were only caught leaving the pond at the end of the breeding season, and because male Gopher Frogs in other populations are known to demonstrate a longer residency period within their respective breeding ponds (e.g., Palis, 1998) we assume that we would have caught more females leaving the pond earlier in the season had monitoring efforts been active at that time. The large range in recorded adult SVL is favorable compared to other studied Gopher Frog populations (e.g., Richter and Seigel, 2002) and seems to indicate a robust local population with recent and regular adult recruitment, and high adult survivorship. Curiously, the SVLs recorded for the three newly metamorphosed gopher frogs caught leaving the pond were below those reported for animals measured at populations in South Carolina (41-43 mm) and peninsular Florida (37-43 mm), and within the size range reported for animals on the western edge of the species range in Alabama (32.3-37.5 mm) and western Florida (31-38 mm), (Richter and Seigel 2002, and references therein).

Radiotelemetry

A small number of the Gopher Frogs caught leaving the breeding pond were used in a radiotelemetry study to investigate the species use of upland habitats. We used external transmitters (L.L. Electronics, 2g transmitter) by attaching them to a metal clasp used to secure a bead belt around the animal's waist. Only frogs 50g or greater were used for radiotelemetry, so that the weight of the transmitters never exceeded four percent of the total mass of a telemetered frog. Transmitters initially purchased for the project failed to produce adequate signals and therefore, it was necessary to collect and temporarily hold thirteen of the frogs used in this study while new transmitters were being prepared. The first group of frogs we tracked were held in ventilated plastic shoeboxes with damp leaf litter for periods ranging from one to eight days before being released with transmitters outside of the drift fence, near the point of capture. The frogs we discuss in this report were fitted with transmitters and released either the night they were captured leaving the pond, or the morning after they were captured. With few exceptions, transmittered frogs were tracked and located daily.

A total of nineteen individual frogs were fitted with transmitters and tracked for varying lengths of time (10 males and 9 females). We experienced problems with our transmitters and attachment method at the beginning of the study, which led to several frogs either shedding their belts early or having their belts removed by us out of concern for the frog's health. One frog was eaten by an unknown predator after 11 days of tracking. Once we perfected transmitter attachment techniques, we were able to gather useful data on the remaining frogs.

Four of the frogs fitted with transmitters during this study (two males and two females) were tracked for periods of time sufficient to gain insight into the species' use of upland habitats. Table 2 summarizes the movements of these four individuals. The final locations of three of these animals were holes associated with deteriorating stumps. The signal was lost on the fourth frog following 41 days of tracking, and its final location was not determined. Only one of the frogs (Frog A) moved to its final recorded location, in a stump hole, in one movement. Another frog (Frog B) took shelter under a fallen log (10 days), a brush pile created by a recent logging operation (20 days), and in a small mammal burrow in the middle of a fallow food plot (11 days) while migrating from the pond. Frog C (Table 2) remained above ground at three separate locations (total of 9 days) before finding an underground retreat. At all three locations this individual took shelter at the base of a clump of wiregrass (*Aristida stricta*). Frog D also remained on the surface for extensive periods of time while migrating to its underground retreat. The first recorded location for this animal was a small shallow burrow of unknown origin where it remained for four days. Subsequent locations consisted of two separate clumps of wiregrass (total of 3 days), a small pile of oak leaves (2 days), and a stand of switch cane (*Arundinaria gigantea*) adjacent to a drain (15 days). This frog moved 3.5 km (2.2 mi) from the pond until it settled into a stump hole.

Biologists have recently raised questions regarding the susceptibility of Gopher Frogs to mortality from prescribed fire (e.g., Roznik and Johnson, 2009). Our results suggest that, because gopher frogs in our study often shelter above ground while emigrating from their breeding pond, the use of early season prescribed fire may indeed pose a risk to Gopher Frogs. We note that at least three of the four frogs that we successfully tracked were in appropriate sub-surface refugia

by the beginning of the natural fire season. That is, the frogs we tracked began to use underground refugia at the same time natural fires would be likely to occur (from lightning strikes), but oftentimes remained on the surface during times when natural fires would be unlikely. Tracking of more individuals should further elucidate the patterns of frog movements and habitat use compared to winter and summer burning regimes.

Of particular interest, is the distances moved by our telemetered frogs. The migratory distance covered by frog D, (Table 2) is considerably greater than the currently known maximum distance of 2 km reported by Franz et al. (1988). Because of problems encountered with transmitters and the subsequent need to temporarily hold some of the frogs used in this study, we consider our results to be somewhat preliminary. Therefore, we plan to attempt to track a larger number of frogs in 2010.

Table 2. Movement patterns of four Carolina Gopher Frogs (*Rana c. capito*) on the Sandhills Game Land, Scotland County, NC during Apr-Jun 2009. Frogs were originally captured and fitted with transmitters at their breeding pond.

Frog ID	Days Tracked	Number of Moves	Longest One-Night Move (m)	Distance Moved from Pond (m)	End location	Fate
A	67	1	738	738	Stump hole	Transmitter removed
B	41	3	263	698	Unknown	Lost signal
C	69	4	851	1,238	Stump hole	Transmitter removed
D	61	6	1,150	3,470	Stump hole	Transmitter removed

Pond Surveys and Management

Surveys of known and potential Gopher Frog populations were initiated to begin an assessment of the species' current status within the state and suggest management recommendations where needed. Though expected to be a multi-year effort, restoration and management prescriptions are currently being prepared for a number of ponds located on public lands. Through these continuing efforts, it is our intention to attempt to reverse the current decline of Gopher Frog populations in North Carolina while simultaneously benefiting other priority species that also depend on isolated wetlands.

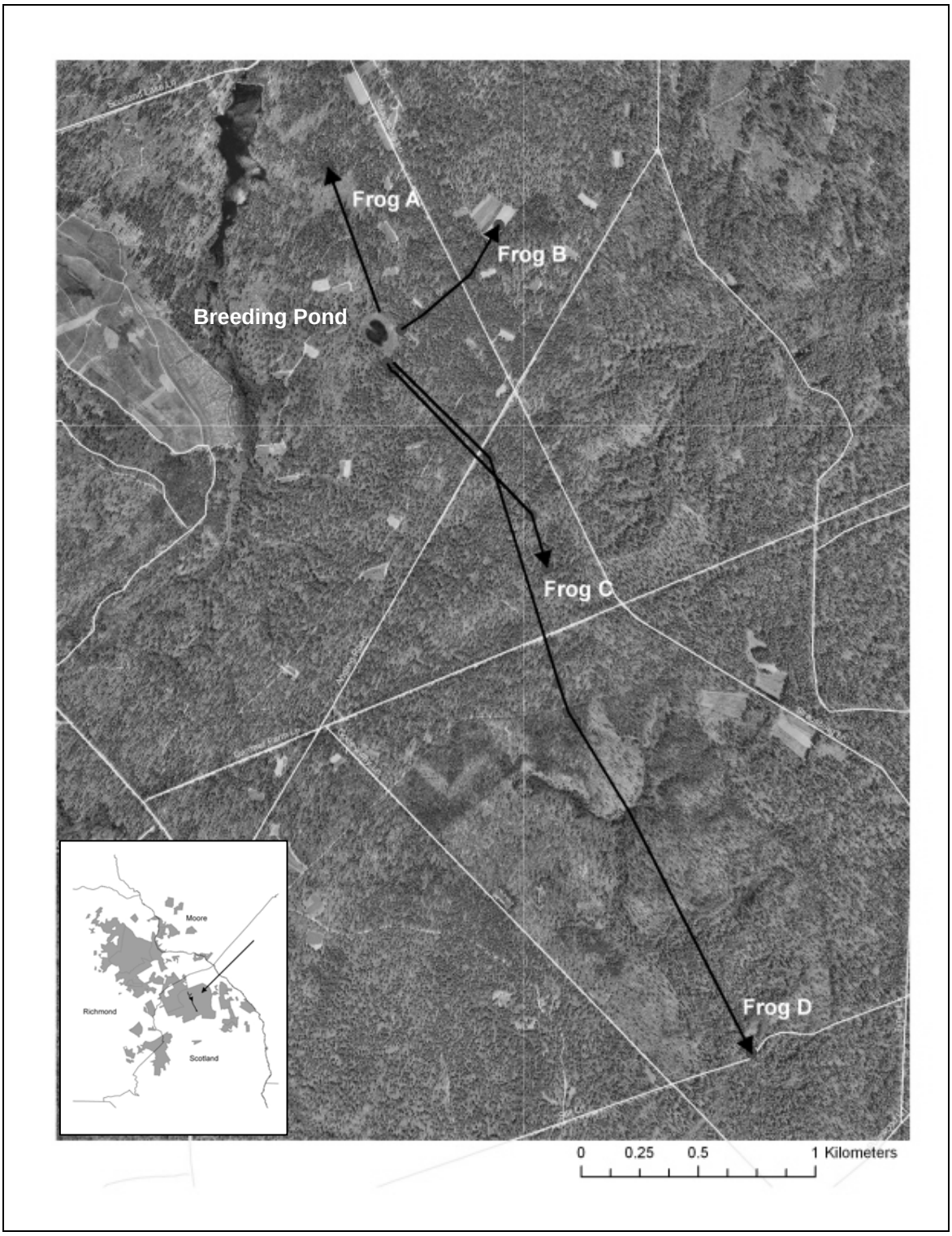


Figure 2. Movement patterns of four Carolina gopher frogs (*Rana capito*) radiotracked on the Sandhills Game Land during Apr-June 2009. All frogs were captured at "17-Frog-Pond" – a prominent feature on the map. Inset map shows location of the study site and frog movements in relationship to the Game Land property.

Box Turtle Movement and Home Range in the NC Sandhills

The Eastern Box Turtle (*Terrapene c. carolina*) is a priority species in the NC Wildlife Action Plan, mainly because of perceived declines in abundance due to habitat loss, forest fragmentation, and direct mortality from vehicles (Dodd 2002). Several radiotelemetry studies are currently underway in the Mountains and Piedmont of North Carolina, but little is known about the movements and habitat use of Box Turtles in the Sandhills region. Box Turtles appear to be fairly rare on the Sandhills Game Land (SGL), though shells of dead turtles are occasionally found (personal observation). This species is probably naturally rare in much of the Sandhills because the system is characterized by fire-maintained upland habitat with relatively sparse canopy; whereas Box Turtles are usually associated with more closed-canopy hardwood forests. Unlike many of the amphibian and reptile species associated with the Sandhills region, Box Turtles are not highly adapted to frequent fire regimes, though they are still able to survive in some areas of the landscape. We studied the movements and habitat use of Box Turtles to inform management decisions on the SGL, from the perspective of a generally fire-intolerant species.

Summary of Movement and Home Range

Eight adult turtles were fitted with transmitters in 2008 on SGL in Richmond and Scotland Counties. Additionally, one turtle was fitted with a transmitter in the town of Aberdeen in Moore County (an urbanized landscape). Of the nine turtles tracked, seven turtles retained operational transmitters long enough to gather useful data on movements and habitat use. We tracked 2 males and 5 females (including the Aberdeen turtle) for a range of 252 – 350 days (Table 3). Home ranges (Minimum Convex Polygon) ranged from 5 – 71 acres and turtles moved as far as 1.6 km between their two most distant points. One turtle died within a week of fitting it with a transmitter, though a necropsy revealed no obvious reason for its death. Otherwise, all turtles survived the entire tracking period.

The home range of Eastern Box Turtles has been reported to average between 0.5 and 25 acres, though home ranges of up to 47 acres have been reported (Dodd, 2002). Most of the turtles on the SGL had typical home ranges, though two turtles exhibited home ranges much larger (63 and 71 acres) than reported in other studies. These large home ranges may be due to the landscape structure of the SGL, where suitable turtle habitat occurs as small slivers of hardwood along creeks separated by large areas of open pine-savanna habitat.

Table 3. Summary of Box Turtle movement and home range data from turtles tracked in the Sandhills region during 2008-09.

Turtle ID	Sex	Days Tracked	Home Range (Acres)	Distance Between Farthest Two Points (m)	Fate
A	F	336	12	521	End of battery
B	F	254	71	1,626	Lost transmitter
C	F	324	63	1,135	End of battery
D	F	350	15	696	End of battery
E	M	340	5	338	End of battery
F	M	252	8	459	Lost transmitter
G	F	333	6	241	End of battery

Summary of Habitat Use

Habitat use was analyzed for six turtles on the SGL, but not for the one turtle tracked in the town of Aberdeen (because of difficulty in comparison). The single turtle tracked in Aberdeen maintained a small home range, mainly within small patches of forest among houses. Six general habitat types were identified within the home range of turtles on the SGL. These included Field, Upland Pine, Mixed Pine-Hardwood, Herbaceous Drain, Drain Ecotone, and Woody Drain. The term "drain" refers to small to medium-sized streams and their associated mesic habitats. "Herbaceous Drains" have an open canopy and an understory dominated by switchcane and other herbaceous plants. "Woody Drains" have a closed canopy and an understory dominated by inkberry and other evergreen shrubs.

Box Turtles used woody drains more than other habitat types throughout the year (74 % of locations) and during summer months (51 % of locations). During the summer (May – August), turtles tended to shift their habitat use from woody drains to drain ecotone habitats (27 % of locations in ecotones during summer compared to 13 % all year), but some turtles continued to use woody drain habitat frequently (Figure 3). Several turtles used field habitats during the summer, probably to feed on ripening blackberries, sometimes traveling hundreds of meters to get to the field, and one turtle used mixed pine-hardwood habitat more than other habitats both during the summer and throughout the year. In general, however, a shift toward upland habitat use was not common among Box Turtles and usually only took place during a few weeks when turtles were either crossing uplands to get to another drainage, or when they were feeding in old field habitat. Five of six turtles overwintered in woody drains with relatively dense shrub cover, burying themselves approximately 10-20 cm beneath leaf litter and soil. One turtle overwintered in open, mixed pine-hardwood habitat within 20 m of a woody drain. All turtles overwintered near the base of saplings, shrubs, or stumps of dead trees. Dates when turtles burrowed underground for overwintering varied from 24 October – 15 December. Turtle emergence in spring varied from 17 March – 20 April. Turtles generally did not move from their overwintering sites during winter, with the exception of a few turtles moving short distances (≤ 10 m) during several days of warm weather.

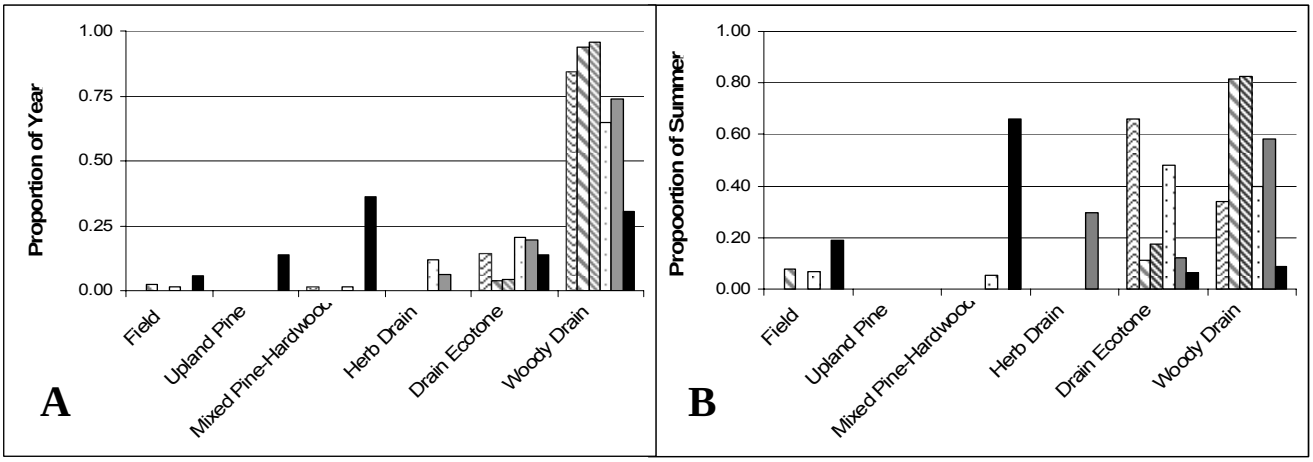


Figure 3**.** Proportion of time spent by six box turtles in each of six habitat types on the Sandhills Game Land, NC during a year (A) and during summer, May-August (B). Shaded bars represent individual turtles.

Management Implications

Our sample size of six radiotracked turtles is very small, and our estimates of home range and habitat use probably do not represent the full range of variability in Box Turtles in the Sandhills of North Carolina. However, several of the turtles that we tracked had very large home ranges; two turtles had larger home ranges than has ever been reported in the literature for this species (Dodd 2002). With home ranges of 60 + acres, these turtles would likely experience high mortality in an urbanized landscape, especially if they had to cross heavily-traveled roads. The fact that Box Turtles need large tracts of unfragmented land should be taken into consideration in parts of the Sandhills where development pressures are likely. For this species in particular, floodplains along drains should not be bisected by roads. If roads must cross floodplains, mitigation measures such as underpasses or long bridge crossings might lessen mortality rates of Box Turtles. However, our results showed that turtles will cross long distances (up to 1.6 km in this study) across upland habitat to get to other drainages, so fragmentation by roads should be minimized across the entire landscape.

On the Sandhills Game Land, Box Turtles tended to occupy habitats associated with a series of drainages contained within a matrix of frequently burned upland Longleaf Pine systems. The results of our telemetry study do not suggest the need for any major changes in management of this system to benefit Box Turtles. Winter burning should not affect Box Turtles, as they tended to overwinter beneath ground until at least early April. One turtle survived a winter burn, as it was overwintering below ground. However, the fire did not burn at a high intensity in its lowland habitat because of wet conditions. Summer burning is likely only detrimental to a small percentage of Box Turtles, as few made major moves across upland habitat during summer months when burning would take place. A larger sample size of telemetered animals would be needed to make more specific management recommendations, but it appears that Box Turtles are able to persist, though in low numbers, within the mosaic of forested lowlands and upland Longleaf Pine of the Sandhills Game Land.

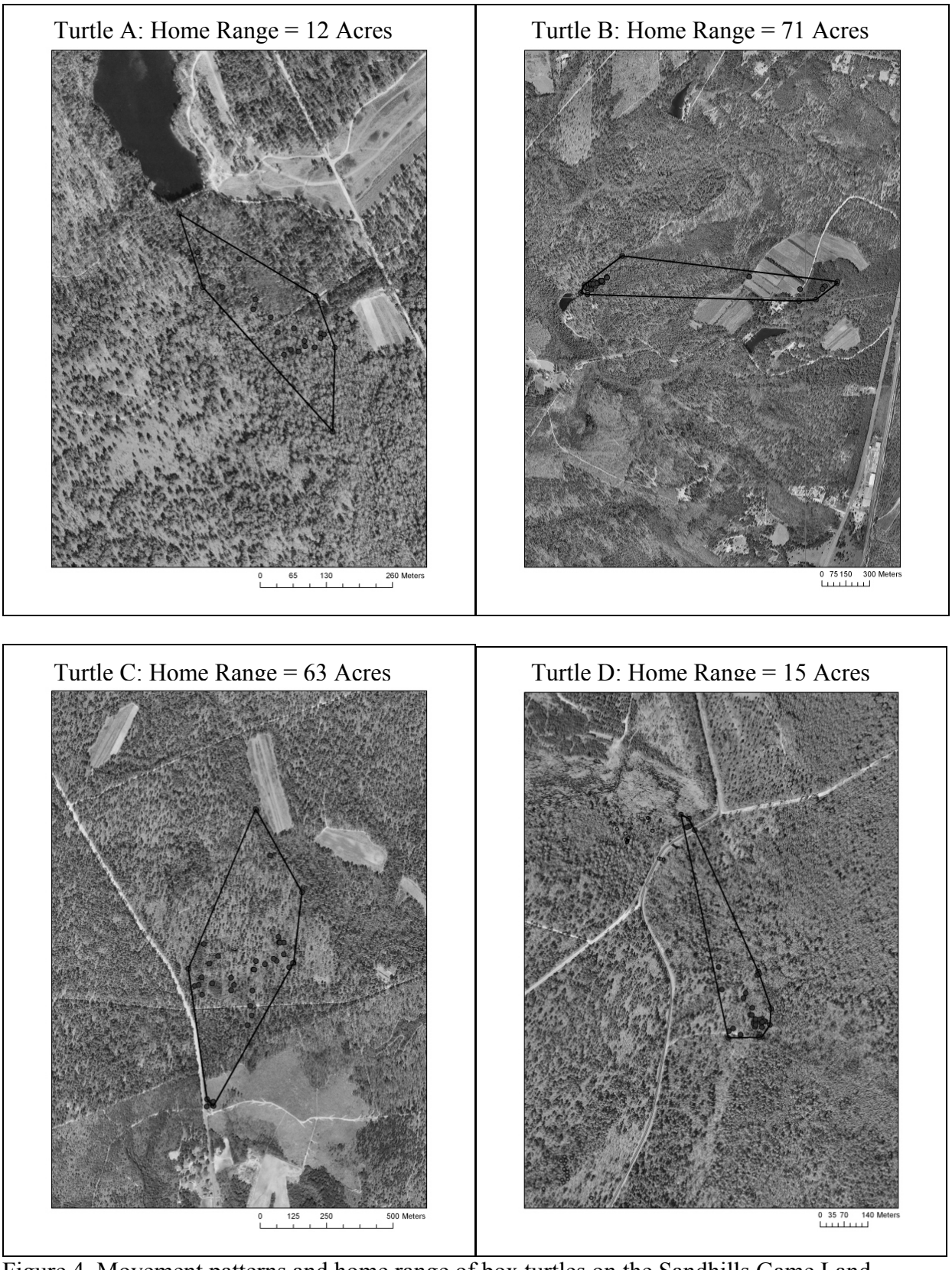
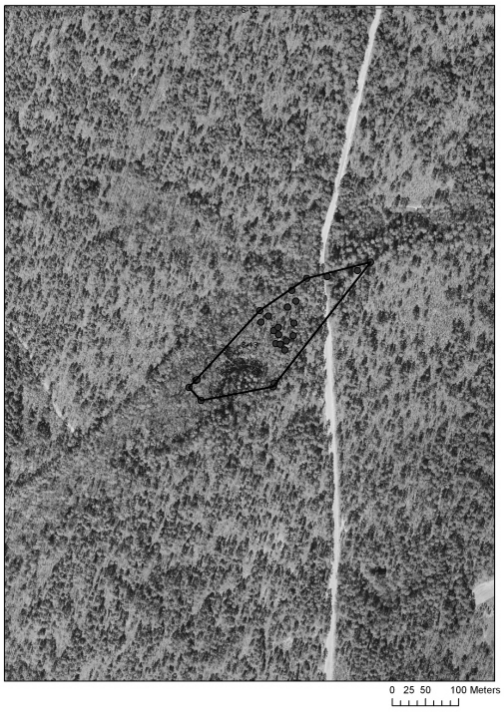
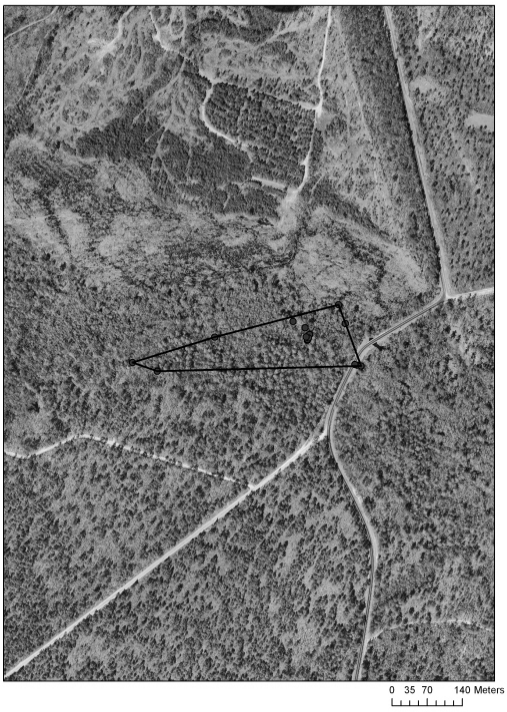


Figure 4. Movement patterns and home range of box turtles on the Sandhills Game Land, Richmond and Scotland Co., NC during 2008-09.

Turtle E: Home Range = 5 Acres



Turtle F: Home Range = 8 Acres



Turtle G: Home Range = 6 Acres

Figure 4, continued. Note: Turtle "G" was tracked in a neighborhood in Aberdeen, NC.

Triangle Region Amphibian Assessment

This project aims to determine amphibian species distribution and abundance at floodplain ephemeral pools and hillside seeps in the Triangle region (Wake, Durham and Orange counties) and relate species assemblages to land use and various habitat features. This project will increase our knowledge about priority species and will help inform efforts of the WRC's Urban Wildlife Project. Eight pools and 6 seeps have been surveyed by checking artificial cover and conducting egg and larval surveys since 2007. New species have not been identified at these sites since the FY 08 report; the count remains at 21 species of amphibians and reptiles, but we are continuing to monitor sites to get better estimates of species abundance. This study will continue through early 2010, including surveys of additional ephemeral pools in the area.

Caswell Game Land Herpetological Survey

The Caswell Game Land in Caswell County, NC was surveyed for amphibians and reptiles using a variety of techniques from 2004 – late 2008. Over 600 amphibians and reptiles (and frog choruses) of 31 species were documented during the survey. More specifics about the study can be found in the FY 2008 annual report. We are currently in the process of organizing capture data and will provide reports to Game Land staff and other interested groups when completed. Data from this survey is already being used as part of a guild mapping project initiated by the NC Natural Heritage Program.

Piedmont Amphibian and Reptile Bioblitzes

This year the NCWRC organized "bioblitzes" of several central Piedmont sites, where large groups of experts on numerous species (not only amphibians and reptiles) surveyed private and public lands in under-studied areas. The Uwharrie region was chosen for these surveys in order to provide additional species data to the WRC's Piedmont Cooperative Land Conservation Project. We surveyed four areas in Stanly, Montgomery, and Randolph Counties and identified 34 species, including 20 reptile and 14 amphibian species (in addition to numerous other species of vertebrates, invertebrates, and plants). Priority species encountered included Broadhead Skink, Corn Snake, Mole Kingsnake, Scarlet Kingsnake, Smooth Earthsnake, Timber Rattlesnake, Marbled Salamander, Mole Salamander, and Spotted Salamander. Using experts and additional enthusiastic volunteers, the "bioblitz" approach was a good method of documenting several priority species on numerous sites in a short period of time. Additional bioblitzes will be organized in other under-studied areas of the Piedmont in the future.

B. Target Dates for Achievement and Accomplishment

Studies of gopher frog distribution, status, and habitat use will continue in FY 2009-2010. In the coming year, seasonal wetland restoration management recommendations will be completed and restoration work will be initiated. Field work for the Triangle amphibian project will likely be completed in the coming year, and other inventory projects will continue as appropriate.

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. Further research on the movements, habitat use, and status of the Carolina Gopher Frog in North Carolina is needed to increase the viability of this species in NC and to inform the USFWS on the species' range-wide status. Our pilot project of Gopher Frog movements suggests that this species requires very large tracts of well-managed upland Longleaf Pine habitat. However, because of small sample size, this project should continue for another year in order to obtain better information about this species. Habitat restoration and protection should be a continued focus for priority species. Additionally, status assessments of other amphibians that use upland pools and adjacent upland habitat on the lower Piedmont and Coastal Plain are very much needed.

F. Estimated Cost

$91,913 (including in-kind and non-federal partner match)

G. References

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Prepared by: Jeff Humphries and Michael Sisson
Piedmont Wildlife Diversity Biologist, Piedmont Field Technician
NC Wildlife Resources Commission

Final Annual Performance Report

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

Period Covered: July 1, 2008 – June 30, 2009

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

Study 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 the 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 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. The biologist was promoted in February 2009 and the Coastal Wildlife Diversity Biologist position remained vacant the rest of the reporting period due to a statewide hiring freeze.

Priority species for the Coastal Plain as described in the North Carolina Wildlife Action Plan (NCWRC 2005) include 23 amphibians and 38 reptiles. 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 covered by this project.

Survey sites in included public and private lands and waters of the U.S. Game Lands surveyed included Holly Shelter, Stones Creek, Suggs Mill Pond, Bladen Lakes State Forest, Croatan National Forest, Green Swamp, Juniper Creek, Columbus County, and Gull Rock. Federal and private lands were briefly surveyed on the Albemarle Peninsula in 2008. Private lands surveyed include Resource Management Services, Inc. (RMS; Pender, Columbus, and Brunswick Counties) and Progress Energy Carolinas, Inc (Sutton Lake). Other lands were surveyed incidentally during travel to and from survey sites (i.e. road cruising). Survey techniques implemented included artificial cover transects, aquatic funnel trapping, turtle trapping, dip-netting, frog call monitoring, road cruising, and general habitat surveys. 62 species (22 amphibians and 40 reptiles) were observed during the project (all years combined), of which 24 were priority species (6 amphibians and 18 reptiles; Table 1).

Table 1. Priority species (24) encountered during 2007-2009 in the NC Coastal Plain.

Priority Species	Common Name	Site (County);Counties
Amphibians (6)		
Bufo quercicus	Oak toad	Green Swamp (Brunswick and Columbus), RMS (Pender)
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), Croatan NF (Carteret)
Plethodon chlorobryonis	Slimy salamander	Croatan NF (Jones), Holly Shelter (Pender), Bladen Lakes SF (Bladen), Suggs Mill Pond (Bladen)
Ambystoma opacum	Marbled salamander	Holly Shelter (Pender)
Reptiles (18)		
Crotalus horridus	Canebrake rattlesnake	Bladen Lakes (Bladen); Pender, Robeson, Tyrrell
Sistrurus miliarius miliarius	Carolina pygmy rattlesnake	Holly Shelter (Pender), Croatan NF (Carteret), Sutton Lake (New Hanover)
Cemophora coccinea	Northern scarlet snake	Sutton Lake (New Hanover), Suggs Mill Pond (Bladen)
Elaphe guttata	Corn snake	Holly Shelter (Pender), Juniper Creek (Brunswick), Croatan NF (Carteret), Bladen Lakes SF (Bladen), Suggs Mill Pond (Bladen); Columbus, Hyde
Heterodon platirhinos	Eastern hognose snake	Suggs Mill Pond (Bladen), Croatan NF (Carteret), Holly Shelter (Pender)
Heterodon simus	Southern hognose snake	Sutton Lake (New Hanover)
Masticophis flagellum	Eastern Coachwhip	Bladen Lakes SF (Bladen), Suggs Mill Pond (Bladen)
Lampropeltis calligaster rhombomaculata	Mole kingsnake	Croatan NF (Carteret); Pender
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 ribbon snake	Holly Shelter (Pender)
Farancia abacura	Eastern mud snake	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), Juniper Creek (Brunswick)
Alligator mississippiensis	American alligator	Juniper Creek (Columbus), Holly Shelter (Pender)

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 in 2007, 2008 and 2009. Coverboard material consisted of old roofing tin which can withstand periodic prescribed fire. A total of 36 transects consisting of 15 coverboards each were established on six sites; Croatan National Forest (7), Stones Creek (2), Holly Shelter (5), Sutton Lake (4), Bladen Lakes State Forest (10), and Suggs Mill Pond (8) for a total of 540 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 are more conducive to snake use. A total of 9090 trap days (606 transect checks) yielded one amphibian and 17 reptile species (**7 priority species**) under coverboards (Table 2); 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*), Southern ringneck snake (*Diadophis punctatus*), Eastern glass lizard (*Ophisaurus ventralis*), redbelly snake (*Storeria occipitomaculata*), **Eastern hognose (*Heterodon platirhinos*), Eastern coachwhip (*Masticophis flagellum*)** (Figure 1)**, corn snake (*Elaphe guttata*), Eastern kingsnake (*Lampropeltis getula getula*), mole kingsnake (*Lampropeltis calligaster rhombomaculata*), Southeastern crowned snake (*Tantilla coronata*), and Carolina pigmy rattlesnake (*Sistrurus miliarius;* Table 2)**. Priority snake species were marked (Winne et al. 2006), sexed, measured, and weighed to gain detailed information on individuals and populations.

Figure 1. Eastern coachwhip under coverboard at Suggs Mill Pond.

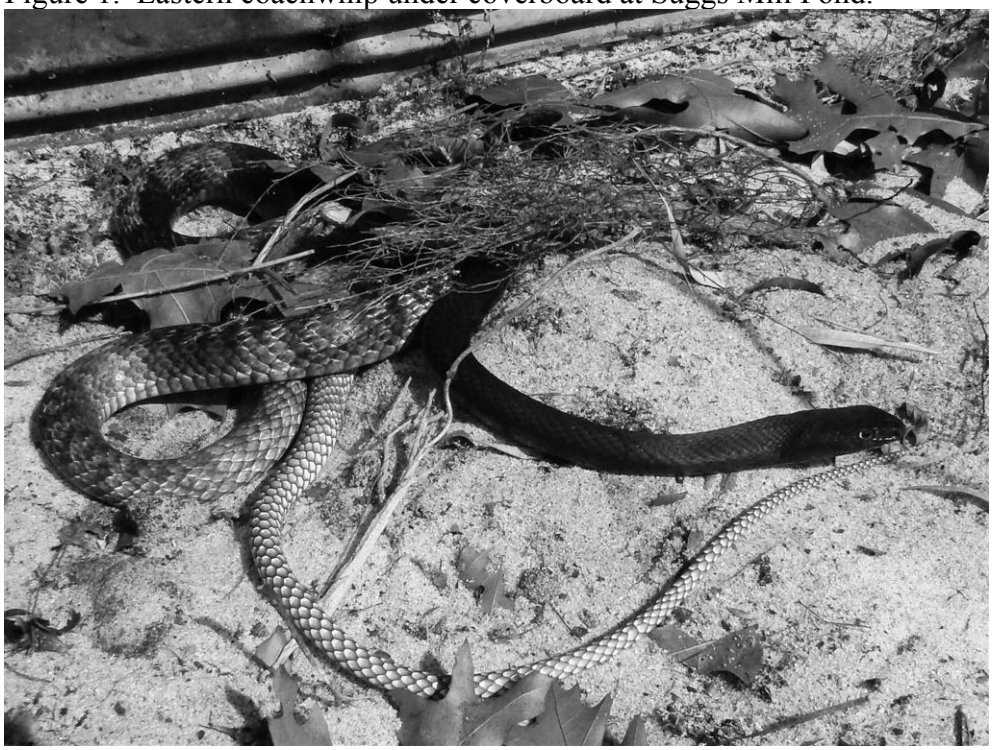


Table 2. Species number detected under coverboards by site.

Species/ Site (Trap Days)	Bladen Lakes (2250)	Croatan (1770)	Holly Shelter (1410)	Stones Creek (375)	Suggs Millpond (2580)	Sutton Lake (705)
Anolis carolinensis	23		4		9	
Bufo terrestris			1		10	
Cnemidophorus sexlineatus	4	1		5	6	2
Coluber constrictor	4	30	17		10	2
Diadophis punctatus			1			
Elaphe guttata		**1**	**2**			
Elaphe obsoleta		1				
Eumeces inexpectatus	44	96	13	10	56	
Eumeces sp_	9	43	6	1	9	1
Heterodon platirhinos			**1**			
Lampropeltis calligaster rhombomaculata		**5**	**1**			
Lampropeltis getula getula		**3**	**1**			
Masticophis flagellum	**1**				**1**	
Ophisaurus ventralis			1			
Sceloporus undulatus	46			1	45	7
Scincella lateralis	28	49	22	4	20	
Sistrurus miliarius		**2**				
Storeria occipitomaculata			1			
Tantilla coronata	**2**					
UNK lizard	1	3	6	3	2	
Total Individuals (species)	**162 (9)**	**234 (10)**	**77 (13)**	**24 (5)**	**168 (9)**	**12 (4)**

Note: Priority species in **bold.**

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. Aquatic funnel traps were set at Suggs Mill Pond, Juniper Creek, Green Swamp, Holly Shelter, and various Cape Fear River Basin creeks in Pender County for a total of 235 trap nights. Five amphibian and four reptile species were captured using this method; Southern cricket frog (*Acris gryllus*), green frog (*Rana clamitans*), squirrel treefrog (*Hyla squirella*), pinewoods treefrog (*Hyla femoralis*), **ornate chorus frog (*Pseudacris ornata*)**, **Carolina gopher frog (*Rana capito capito*)**, two-toed amphiuma (*Amphiuma means*), **striped mud turtle (*Kinosternon baurii*)** (Figure 2), banded water snake (*Nerodia fasciatus*), brown water snake (*Nerodia taxispilota*), and cottonmouth (*Agkistrodon piscivorous*).

Figure 2. Striped mud turtle caught in aquatic funnel trap at Juniper Creek.

Turtle Trapping

Turtle trapping was conducted for a workshop at Croatan NF but generally was extensive or long-term. Species trapped over 10 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 in 2008 and two were ground-truthed in the Coastal Plain region. In addition to CASP, 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, thirteen priority species were detected during road cruising surveys; **American alligator (*Alligator mississippiensis*), chicken turtle (*Deirochelys reticularia*), timber rattlesnake (*Crotalus horridus*), corn snake, Eastern mud snake (*Farancia abacura*), Eastern hognose, Southern hognose (*Heterodon simus*)** (Figure 3)**, mole kingsnake, Eastern kingsnake, scarlet kingsnake (*Lampropeltis triangulum elapsoides*), Eastern coachwhip, Eastern box turtle (*Terrapene carolina*), and Common ribbon snake (*Thamnophis sauritus*)**. Two hundred sixty-eight individuals of 42 species were detected during road cruising (Table 3), 145 of these were found dead on the road (DOR) and 92 were found alive on the road (AOR). The remaining 31 observations were of free-living individuals, or groups of individuals, seen or heard (choruses) from the road (i.e. Other). All box turtles and chicken turtles were mark by notching three marginal scutes following the Box Turtle Connection protocol (Somers and Matthews 2006).

Figure 3. Southern hognose found road cruising

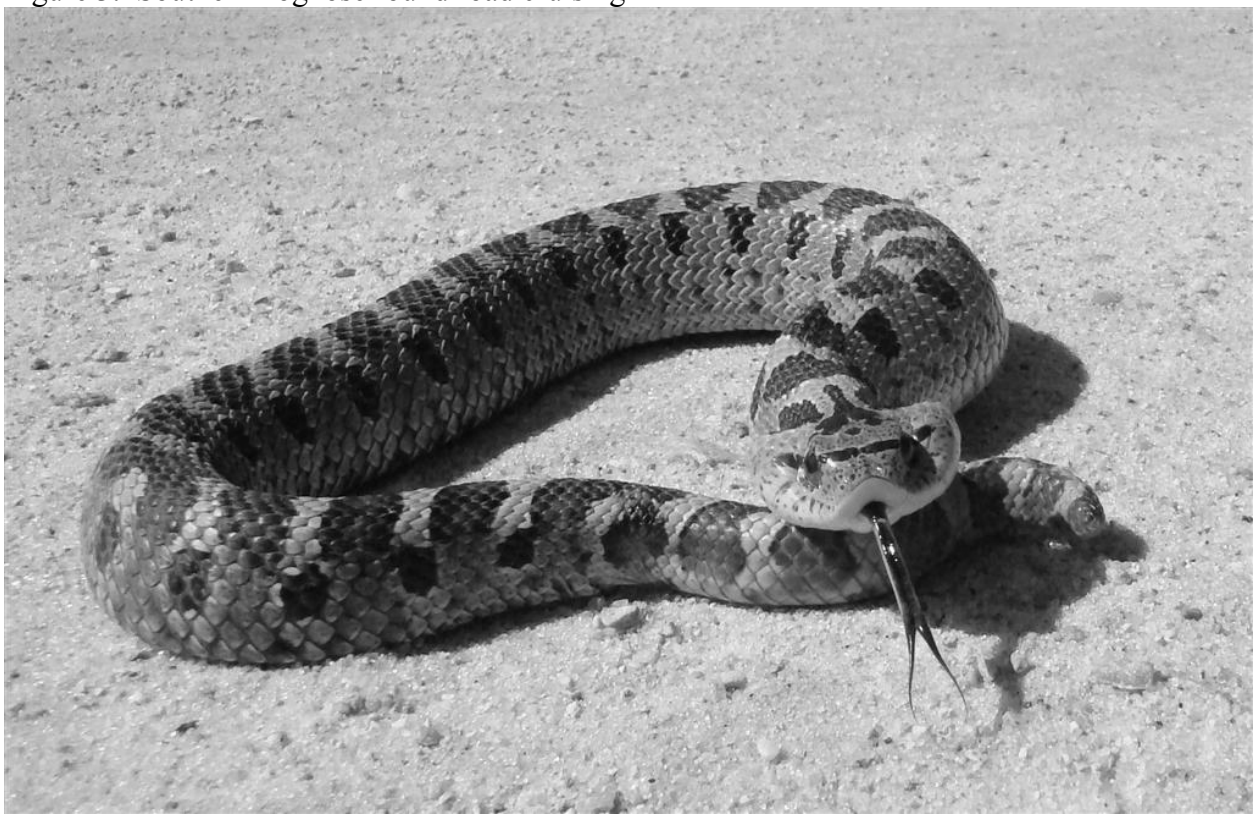


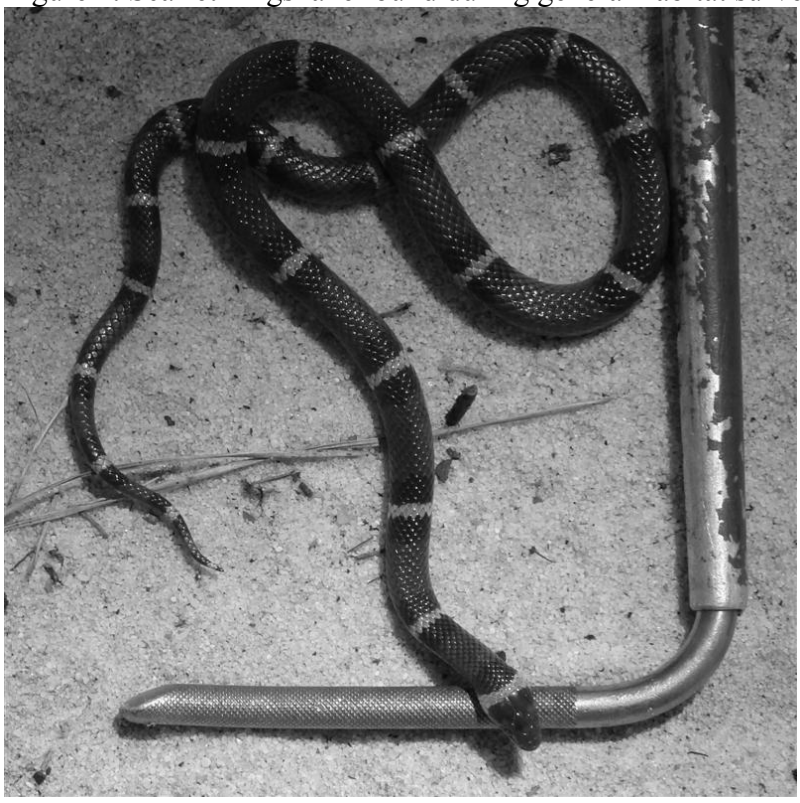
Table 3. Species (**Priority**) observed road-cruising

Species	Total	Other	AOR	DOR
Acris gryllus	1	1		
Agkistrodon contortrix	7		2	5
Agkistrodon piscivorous	13		4	9
Alligator mississippiensis	4	4		
Anolis carolinensis	1		1	
Bufo quercicus	11	11		
Bufo terrestris	4		4	
Chelydra serpentina	1		1	
Chrysemys picta	1		1	
Coluber constrictor	37		16	21
Crotalus horridus	13			13
Deirochelys reticularia	3		3	
Elaphe alleghaniensis	26		5	21
Elaphe guttata	17		3	14
Farancia abacura	5			5
Gastrophryne carolinensis	2	2		
Heterodon platirhinos	6		4	2
Heterodon simus	2		2	
Hyla chrysoscelis	1	1		
Hyla femoralis	4	4		
Hyla gratiosa	2	2		
Hyla squirella	3	2		1
Kinosternon subrubrum	3		2	1
Lampropeltis calligaster rhombomaculata	1			1
Lampropeltis getula getula	16		6	10
Lampropeltis triangulum elapsoides	1		1	
Masticophis flagellum	4		1	3
Nerodia erythrogaster	11			11
Nerodia fasciatus	11		2	9
Opheodrys aestivus	21		11	10
Ophisaurus sp.	2		1	1
Ophisaurus ventralis	2			2
Pseudacris ocularis	2	2		
Rana catesbeiana	1		1	
Rana sphenocephala	1		1	
Rana virgatipes	1	1		
Scincella lateralis	1		1	
Sistrurus miliarius	2		1	1
Storeria occipitomaculata	2		2	
Terrapene carolina	10		8	2
Thamnophis sauritus	3		3	
Thamnophis sirtalis	4		1	3
Trachemys scripta	5		4	1
Total Individuals	**268**	**31**	**92**	**145**
Total Species	**43**	**11**	**28**	**22**

General Habitat Surveys

Turning natural cover and other visual encounter surveys, and incidental observations while in the field, yielded 87 individuals, or choruses, of 35 species, of which fifteen were priority species; **American Alligator, marbled salamander (*Ambystoma opacum*), Northern scarlet snake (*Cemophora coccinea*), chicken turtle, scarlet kingsnake** (Figure 4)**, broadhead skink (*Eumeces laticeps*), striped mud turtle, Eastern kingsnake, scarlet kingsnake, slimy salamander (*Plethodon chlorobryonis*), ornate chorus frog, Carolina gopher frog, Carolina pigmy rattlesnake, Southeastern crowned snake, and Eastern box turtle**.

Figure 4. Scarlet kingsnake found during general habitat survey at Suggs Mill Pond



Technical Guidance

Coastal Wildlife Diversity staff coordinated with various groups across the state involved with reptile and amphibian research and monitoring including: NC Aquarium at Fort Fisher, NC Museum of Natural Sciences, NC State Parks, University of North Carolina at Wilmington, Natural Heritage Program, 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.

B. Target Dates for Achievement and Accomplishment

The Coastal Wildlife Diversity Biologist position remains vacant, but efforts by the NCPARC Coordinator and Coastal Wildlife Diversity Supervisor continue to document species occurrences

and monitor established coverboard transects in Croatan, Holly Shelter, and other areas as time allows.

C. Significant Deviations

None.

D. Remarks

None.

E. Recommendations

This project should be continued. Although continuing the coverboard surveys is recommended, capture probabilities are so low that fewer transect runs (approximately one per month) would allow for more intensive surveys using drift fences with funnel traps and pitfall traps. These techniques could potentially increase capture probabilities and reduce biases associated with coverboard surveys. Aquatic funnel trapping should also be expanded to more thoroughly document aquatic snakes. The Piedmont Wildlife Diversity Biologist, in coordination with the NCPARC coordinator and Coastal Wildlife Diversity Supervisor, will expand herpetological surveys to the Coastal Plain region in 2009-2010 in order to continue surveys for priority amphibians and reptiles.

F. Estimated Cost

$34,664 (including in-kind contributions)

G. References

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Winne, Christopher T., John D. Willson, Kimberly M. Andrews, and Robert N. Reed. 2006. Efficacy of marking snakes with disposable medical cautery units. Herpetological Review 37(1): 52-54.

Prepared by: Kendrick Weeks
Mountain Wildlife Diversity Supervisor
Division of Wildlife Management
North Carolina Wildlife Resources Commission

Final Annual Performance Report

State: North Carolina

Project Number: T - 9
Amendment Number: 1

Period Covered: July 1, 2008 - June 30, 2009

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 other stakeholders in rapidly urbanizing areas of the state.

A. Activity

The 2008-2009 fiscal year was the Urban Wildlife Project's fourth year of working to minimize the impacts of rapid urbanization on wildlife populations and habitats. The main goal of the Urban Wildlife Project is to help North Carolina's communities proactively conserve important species, habitats, and ecosystems alongside urban development. Project objectives for the past year included:

1) To provide proactive technical guidance to local governments on how to plan for growth in a way 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 2008-2009 fiscal year, the Urban Wildlife Biologist provided technical guidance to local governments on:

- Chatham Parks and Recreation Master Plan
- Harris Area Land Use Study
- Chatham County Subdivision Ordinance revisions
- City of Raleigh's Comprehensive Plan

- 3 park planning issues in Apex, Garner, and Raleigh
- 1 development proposal in Orange County
- Wake County's open space acquisition program

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 the development proposal in Orange County were taken into consideration by planning staff, elected officials, and the developer. The town council denied the development proposal.
- In Chatham County, guidance on the subdivision ordinance revisions were used by the consultant to develop conservation subdivision provisions in the county's subdivision ordinance that are linked to NC Wildlife Action Plan priority habitats.
- Comments on the City of Raleigh's Comprehensive Plan were integrated into a final draft of the plan.
- GIS map layers shared with the consultant for the Harris Area Land Use Study were included in a final draft of the study document. Comments on the land use study were taken into consideration by the consultant and Wake County planning staff.

2) Participation in conservation partnership efforts--The Urban Wildlife Biologist is continuing to participate in and support regional conservation partnership efforts. During the 2008-2009 reporting year, the Urban Wildlife Project:

- Participated in meetings of the Chatham Conservation Partnership
- Participated in activities of the Wake Nature Preserves partnership
- Participated in meetings of the Johnston County Green Infrastructure partnership
- Helped facilitate the 1st annual NC Urban Forestry conference

Outcomes from these partnership efforts include:

- Public meeting in Johnston County that brought together citizens, county and town staff, elected officials, natural resource professionals, and developers to discuss the notion of a "green infrastructure" plan for Johnston County.
- Two "capacity building" workshops that brought together staff from Wake County's municipalities to learn about the Wildlife Action Plan and why/how to inventory parks for important wildlife habitats and ecological resources.
- Continued 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.

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 of development on priority habitats and species.

Development of this project began during the 06-07 fiscal year, and was released in January 2009. During the past year, the Urban Wildlife Project:

- Coordinated editing, layout, and graphic design with the WRC's publications staff
- Worked with the WRC's Information Technology department to develop a website
- Publicly released the Green Growth Toolbox in January 2009 through wide distribution of press releases.
- Responded to inquiries and communicated with stakeholders about the project.
- In partnership with the Piedmont Land Conservation Biologist, developed training workshop materials.
- Delivered presentations on the Green Growth Toolbox to approximately 320 stakeholders (planners, elected officials, developers, resource professionals) around the state (and nation) in the following venues:
    - Isothermal Planning and Development COG meeting
    - Mountain Green Conference
    - Sandhills Regional Land Use Advisory Committee meeting
    - Triangle Conservation Summit
    - The Wildlife Society Annual Meeting
    - Western Piedmont Council of Governments
- In response to demand for training workshops in various regions of the state, wrote and submitted a grant proposal to the Wildlife Conservation Society's Wildlife Action Opportunities Fund to expand implementation of the Green Growth Toolbox.
- Initiated a "train-the-trainer" process to enable partners from the US Fish and Wildlife Service and Sustainable Sandhills to implement the Green Growth Toolbox in the Sandhills region of NC.

Since the release of the Green Growth Toolbox website in January 09, the following statistics indicate significant interest in the project.

- 7,310 unique visitors to the website
- Requests for training workshops from 12 local governments across the state

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 08-09 fiscal year, the Urban Wildlife Biologist drafted comments for the Aydan Court development project in Orange County, and interacted numerous times with the developer.
- The Urban Wildlife Project contributed to the development of the Wildlife Friendly Development certification program
- The Urban Wildlife Biologist met with the chair of the Triangle Green Homebuilders Association and discussed pursuing partnerships in the future.

5) Terrestrial Conservation Recommendations project—During the past year, the Urban Wildlife Project initiated a project to produce a series of science-based conservation recommendations for priority habitats and terrestrial species in the NC Wildlife Action Plan. This past year, an advisory committee of experts from the USFWS, Natural Heritage Program, NC State University, and NC Wildlife Resources Commission was convened. A research

technician was hired to conduct an extensive literature review. The project is ongoing, and the final product will be a document that presents science-based recommendations that local governments, developers, and resource managers could use to conserve and manage priority habitats alongside urban development.

6) Other outreach activities—During the past year, the Urban Wildlife Project delivered presentations on urbanization and wildlife to approximately 185 individuals (wildlife biologists, general public, planners, resource professionals, educators, and others). Presentation venues included:

- Sustainable Communities conference in Charleston, SC
- NC chapter of the Wildlife Society
- Centennial Campus Center for Wildlife Education's speaker series
- NC Urban Forestry Conference

In addition, the Urban Wildlife Biologist partnered with the Triangle Greenways Council to facilitate 2 workshops for park and greenway planners and landscape architects in the Triangle Region. Through these workshops, approximately 65 planners and landscape architects were educated on how to use the NC Wildlife Action Plan, and how parks and greenways can be designed to benefit priority species of wildlife.

B. Target Dates for Achievement and Accomplishment

During the 2009-2010 FY, the Urban Wildlife Project will continue to build partnerships and provide an important link between wildlife science and land use planning. Target dates for accomplishments in 2009-2010 include:

- Late summer/Fall 2009→Deliver first Green Growth Toolbox workshops in the Triangle and Uwharries regions
- Fall 2009→Organize and facilitate a "train the trainer" workshop for resource professionals interested in assisting with implementation of the Green Growth Toolbox
- Spring 2010→Complete draft terrestrial conservation recommendations document

C. Significant Deviations

None

D. Remarks

None

E. Recommendations

This project should be continued during the next period. 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 helping lead the way in North Carolina to develop a proactive and effective approach to integrating wildlife biology and land use planning.

F. Estimated Cost

$92,094 (including in-kind contributions)

Prepared By:

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

Final Annual Performance Report

State: North Carolina

Project Number: T-9
Amendment Number: 1

Period Covered: July 1, 2008 – June 30, 2009

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 research 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 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 fifth annual meeting jointly with the Southeast chapter of PARC (SEPARC) February 19-22 in the mountains at Montreat Conference Center in Montreat, NC. This meeting was well attended with over 160 registered participants from state and federal agency personnel, university affiliates, scientific societies, and the general public. The theme of the meeting was "Conservation Successes & Lessons Learned along the Way." To help keep costs of the meeting low, sponsors for the meeting included the North Carolina Herpetological Society, the North Carolina Wildlife Resources Commission, the University of Georgia's Warnell School of Forestry and Natural Resources, and Highlands Brewery Company. Many items were also donated to the silent auction from which proceeds were used to offset costs of the meeting.

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.

The meeting was split into three sections: symposium presentations; task teams and workshops; and field trips. The full agenda including speaker abstracts can be found on-line (www.uga.edu/separc/Meetings/2009/index.htm). The first day and a half featured a keynote speaker followed by 19 talks focused on four different themes. These themes were Landscape Scale Conservation, Neighborhood/Backyard Conservation and Citizen Science, Land Management, and North Carolina Herp Conservation. Task team meetings, discussion groups, and workshops included: Eco-friendly Roads; Development; Reintroduction, Repatriation and Relocation; Invasive Species; Diseases/Pathogens/Parasites; Important Herp Areas; Diamondback Terrapins; Effective Outreach & Education – Hands-on Activities & Discussion; Wetland Workshops – Bog Restoration and Ephemeral Pond Construction; GIS Techniques I and II; Eastern Diamondback Rattlesnakes; How to do Citizen Science Projects; and Anuran Acoustics Workshop. Field trips highlighted these areas: Herp Blitz at a unique wetland complex near Montreat; herpetology in the upstate of South Carolina; hellbendering in Pisgah National Forest; and Montreat Wilderness salamander hike.

As in previous NCPARC meetings, a poster session was held allowing information about reptile and amphibian conservation projects all across the southeast to be shared. This allowed for discussion and collaboration on how researchers and educators across the southeast are conducting their work. Many participants noted this was an extremely valuable aspect of the meeting. Poster abstracts are on-line (www.uga.edu/separc/Meetings/2009/index.htm).

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.

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. The group discussed the need for monitoring of both cricket frog species found in the state in light of recent data presented from graduate students at UNC Chapel Hill showing declines of cricket frogs in parts of the state. The RIMM group also continues to discuss research needs regarding chytrid fungus as a potential threat to amphibian populations.

For issues surrounding the legal status of reptiles and amphibians, NCPARC utilizes the Policy, Regulation & Trade (PRT) working group. PRT members continued to review all North Carolina regulations affecting reptiles and amphibians. The PRT group also monitored the progress of legislation that would regulate potentially dangerous animals (giant constrictors, venomous reptiles, and crocodilians). Group members discussed 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 continued 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.

Largely perceived as dangerous or of little environmental or economic value, convincing the general public of the worthiness of conserving reptiles and amphibians and their habitats 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 Show in Raleigh, "Snaketacular" Festival at the Greensboro Natural Science Center, The Dixie Deer Classic 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.

The NCPARC Steering Committee is composed of 11 members (9 voting): 1) the NCPARC Coordinator (cannot vote), 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 (cannot vote), 8) a representative from industry, 9) a representative from nonprofits, 10) a representative from universities and colleges, and 11) an at-large position potentially with ties to the herpetoculturist community. Issues discussed by the Steering Committee included help in the planning of meetings and events, reviewing PRT working group recommendations, and approval of an NCPARC endorsement letter for recommendations regarding potential legislation covering potentially dangerous reptiles.

Professional Training and Technical Guidance

The NCPARC biologist helped plan and facilitate two workshops on reptile and/or amphibian identification, management and conservation held at Carolina Beach State Park and Weyerhaeuser's Cool Springs Environmental Education Center near New Bern. These workshops continue to be well attended due to continuing demand from 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 including the NC Forestry Association's Teacher Tour, the Onslow Bight Conservation Forum, NCSU Leopold Wildlife Club, the Charlotte regional meeting of the National Science Teachers Association, and to the fall meeting of the NC Herpetological Society. PARC Joint National Steering Committee conference calls were regularly attended and participated in by staff. The NCPARC biologist also responded to numerous calls and emails from the public regarding general reptile and amphibian identification and ecology.

Numerous landowners both public and private were contacted. The NCPARC biologist met with staff at Talecris Biotherapeutics to discuss habitat management recommendations for reptiles and amphibians. Staff met with a private citizen in Randolph County to discuss habitat management for rattlesnakes and research possibilities in nearby Uwharrie National Forest. Potential for future amphibian conservation projects on Weyerhaeuser lands were discussed with newly hired Weyerhaeuser biologist. Along with other members of the Cape Fear Arch Collaborative, staff met with Resource Management Service (RMS) region manager to discuss reptile and amphibian management opportunities across RMS lands in southeast NC. The NCPARC biologist met with Camp Lejeune staff to discuss upland snake and gopher frog management issues and coordinated surveys in recently burned areas on-site. Finally, the NCPARC biologist continued meeting 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

$ 87,521 (including in-kind contributions)

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

Final Annual Performance Report

State: North Carolina

Project Number: T-9
Amendment Number: 1

Period Covered: July 1, 2008 – June 30, 2009

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

Study 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

Through the North American Amphibian Monitoring Program (NAAMP), North Carolina has 139 frog call routes. Of these routes, 101 were assigned among 105 observers (some observers run multiple routes) for the 2008 field season. Observers (mostly volunteers) were responsible for running at least three surveys of each route during the 2008 season corresponding to three different windows of breeding activity. However, only fifty-eight of the assigned observers were able to pass the on-line quiz through NAAMP in order to verify their data. Of these observers, forty-nine of them actually sent data through either the mail or via on-line entry for fifty-two routes.

As in 2006 and 2007, most volunteers entered their data and metadata directly into the NAAMP website and the local database CASPADGDB was used to import data and metadata directly from text files downloaded from NAAMP. This 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). One significant addition to web-based utilities was the addition of a new on-line route mapping tool for observers. This tool was developed in coordination with additional WRC staff (http://216.27.39.120/caspmaps/) and has received many compliments from active observers.

Through efforts by the CASP coordinator and the NCPARC Education and Outreach working group, recruitment of volunteers continued leading up to the 2009 field season. Public

interest has been maintained in CASP and as a result, the observer database has increased from 151 to 177 potential observers. Also, with the help of CASP observers, several routes were ground-truthed in late 2008/early 2009. Of the total 139 routes, 102 are currently ground-truthed.

Data Analysis

In this third year of piloting the CASP program, twenty-five of the thirty anurans occurring in the state were detected. Interestingly, none of the three years of the project have seen the same species (Table 1). Many priority species were detected in 2008 including: oak toad (*Bufo quercicus*), barking treefrog (*Hyla gratiosa*), gray treefrog (*Hyla versicolor*), Brimley's chorus frog (*Pseudacris brimleyi*), ornate chorus frog (*Pseudacris ornata*), and Eastern spadefoot toad (*Scaphiopus holbrookii*). Over the three year period, only three of the thirty native frog species have not been 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 2008, ten species were detected in the mountains, eighteen in the piedmont, and twenty-three species in the coastal plain (Table 2). As in 2006 and 2007, spring peepers (*Pseudacris crucifer*) were the most common anuran detected and were detected at the highest maximum indices in all regions of the state (Table 2). Other commonly detected species included Northern cricket frog (*Acris crepitans*), American toad (*Bufo americanus*), green treefrog (*Hyla cinerea*), Cope's gray treefrog (*Hyla chrysoscelis*), and Southern leopard frog (*Rana sphenocephala*).

Data from the 2009 season is still undergoing entry and review and will not be available for analysis until after November 2009.

Table 1. Species Detected by Year. y = species detected in that year; * = priority species within the Wildlife Action Plan.

Common Name	**Species**	**2006**	**2007**	**2008**
Northern Cricket Frog	*Acris crepitans*	y	y	y
Southern Cricket Frog	*Acris gryllus*	y	y	y
American Toad	*Bufo americanus*	y	y	y
Fowler's Toad	*Bufo fowleri*	y	y	y
Oak Toad*	*Bufo quercicus*	y	y	y
Southern Toad	*Bufo terrestris*	y	y	y
Eastern Narrow-mouthed Toad	*Gastrophryne carolinensis*	y	y	y
Pine Barrens Treefrog*	*Hyla andersonii*			
Cope's Gray Treefrog	*Hyla chrysoscelis*	y	y	y
Green Treefrog	*Hyla cinerea*	y	y	y
Pine Woods Treefrog	*Hyla femoralis*	y	y	y
Barking Treefrog*	*Hyla gratiosa*	y	y	y
Squirrel Treefrog	*Hyla squirella*	y	y	y
Gray Treefrog*	*Hyla versicolor*	y		y
Mountain Chorus Frog*	*Pseudacris brachyphona*		y	
Brimley's Chorus Frog*	*Pseudacris brimleyi*		y	y
Spring Peeper	*Pseudacris crucifer*	y	y	y
Southeastern Chorus Frog	*Pseudacris feriarum*	y	y	y
Southern Chorus Frog*	*Pseudacris nigrita*	y	y	
Little Grass Frog	*Pseudacris ocularis*	y	y	y
Ornate Chorus Frog*	*Pseudacris ornata*		y	y
Gopher Frog*	*Rana capito*			
Bullfrog	*Rana catesbeiana*	y	y	y
Green Frog	*Rana clamitans*	y	y	y
River Frog*	*Rana heckscheri*			
Pickerel Frog	*Rana palustris*	y	y	y
Southern Leopard Frog	*Rana sphenocephala*	y	y	y
Wood Frog	*Rana sylvatica*	y	y	y
Carpenter Frog	*Rana virgatipes*	y	y	y
Eastern Spadefoot*	*Scaphiopus holbrookii*			y
Total Species	**30**	**23**	**25**	**25**

Table 2. 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	3	3	3
Acris gryllus	3	3	
Bufo americanus	3	3	3
Bufo fowleri	2	3	1
Bufo quercicus	1		
Bufo terrestris	3	1	
Gastrophryne carolinensis	3	1	
Hyla chrysoscelis	3	3	3
Hyla cinerea	3	3	
Hyla femoralis	2		
Hyla gratiosa	3	3	
Hyla squirella	2	1	
Hyla versicolor		3	
Pseudacris brimleyi	3		
Pseudacris crucifer	3	3	3
Pseudacris feriarum	1	3	1
Pseudacris ocularis	2		
Pseudacris ornata	1		
Rana catesbeiana	2	2	3
Rana clamitans	2	2	3
Rana palustris	3	3	3
Rana sphenocephala	3	3	
Rana sylvatica			3
Rana virgatipes	2		
Scaphiopus holbrookii	2	1	
Total Species	**23**	**18**	**10**

Professional Training

CASP frog call identification workshops were held in early spring of 2009. 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 planned 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. NCWRC staff helped plan and facilitate four of these workshops held at Halyburton Park in Wilmington, Hemlock Bluffs

Nature Preserve in Cary, Roanoke/Cashie River Center in Windsor, and Betsy-Jeff Penn 4-H Center near Reidsville. One additional CASP workshop was held and NCWRC staff assisted with registrations at Falls Lake State Recreation Area near Raleigh. Three workshops had to be cancelled due to low registration. These trainings have been well attended in the past so likely the downturn in the economy affected participation.

Technical Guidance

WRC staff participated in a field study nicknamed "Ribbet Radio" seeking to determine the detectability of frog calls at varying distances. Modeled after a similar study examining the ability of bird observers to hear and correctly identify bird calls, Ribbet Radio seeks to learn whether frog call observers can hear and correctly identify anuran calls in the field. Initial testing of the protocols for this study began in fall of 2008 and likely will require additional work in the future.

The CASP coordinator met with staff from Marine Corps Base Camp Lejeune to implement four CASP routes on the base. After several trials and various issues, they decided to only add two routes this year and perhaps add additional routes in the future. WRC biologists and Davidson College also collaborated on green treefrog research utilizing CASP data. In addition, the CASP coordinator was asked to continue with review of NAAMP protocols, website materials, and overall program with USGS staff. Due to the successful nature of the NC CASP program, USGS hopes to incorporate some of its design into the national program.

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

$ 24,778 (including in-kind contributions)

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

Final Annual Performance Report

State: North Carolina

Project Number: T - 9
Amendment Number: 1

Period Covered: July 1, 2008 – June 30, 2009

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 2008 breeding season, conducted migration surveys in the fall of 2008 and spring of 2009, collected data for the 2009 winter bird surveys, and conducted spring point counts in 2009.

Background

The NC Wildlife Resources Commission (NCWRC) manages 297,378 acres of public game lands in the Piedmont and Sandhills regions of NC. These lands are managed for wildlife conservation and wildlife-related recreation. To make wise management decisions, information is needed on which priority species are present and how they respond to various management activities. Further, to make assessments on conservation status of priority species, it is necessary to gather information on relative abundance and population trends. In order to conserve populations, it is necessary to have an understanding of habitat use, productivity, and other factors which may be limiting populations.

In 2002, breeding songbird point count surveys and winter bird strip transect surveys were initiated on portions of Caswell and Sandhills Game Lands being intensively managed as part of the Cooperative Upland habitat Restoration and Enhancement (CURE) program. In 2004, these surveys were expanded to additional portions of Sandhills and Caswell Game Lands to meet additional inventory and monitoring objectives. In 2004, a study was initiated on both Caswell and Sandhills Game Lands to measure territory density and reproductive success within key habitats and under various management regimes. Caswell Game Land consists of ~16,000 acres located in the north-central Piedmont in Caswell County. Sandhills Game Land consists of ~62,000 acres spread across Moore, Richmond, Scotland, and Hoke counties in the NC Sandhills.

One focus of this study is to evaluate the impacts of habitat management actions. On Sandhills Game Land, closed canopy pine plantations which had a history of pine straw raking and fire suppression were heavily thinned as part of CURE management. Logging debris was cleared and the understory was planted to Atlantic coastal panicgrass (*Panicum amarum,* 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. Another management practice of interest was mechanically removing hardwoods and other overstory trees next to Sandhills creeks or "drains". These drains, or streamhead pocosins, had been fire suppressed for many years, allowing hardwood trees and evergreen shrubs to crowd out switchcane (*Arundinaria giganteum*) and other herbaceous plants. On Caswell Game Land, we had an interest in learning more about the effects of thinning mature (100+ year old) oak-hickory forests in order to create early successional habitat.

Methods

Nest searching, spot mapping, breeding bird point count surveys, winter strip transect surveys, and fall and spring migration surveys (Ralph et al. 1993) have been conducted on Sandhills and Caswell Game Lands since 2004. The objectives of these studies are to determine relative abundance and distribution of birds across the game lands; to monitor bird populations over time; to assess territory densities, nesting effort, and reproductive success within key, limiting habitats; and to gather information about the impacts of habitat management practices on breeding birds. Some of 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 plantations, hardwood removal in Sandhills drains, and thinning in Caswell oak woodlands.

Point Count Surveys

Point count routes were initiated on the Sandhills and Caswell CURE areas in 2002; Sandhills Block B south, Block C, Field Trial area, and the Caswell Frogsboro tract in 2004; and the Caswell High Rock area in 2005. Surveys were conducted once for each route during the first 2 weeks of June using 5 minute, unlimited distance counts 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.

Territory mapping

Territory or "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 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. In 2008 we only surveyed herbaceous and woody drains at Sandhills and thinned and unthinned oak at Caswell.

Plots were visited once every 7-10 days between sunrise and noon on mornings without heavy precipitation or strong winds. The observer 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, counter-singing, and all movements within the plot.

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). For some analyses, we grouped species into nesting guilds based on where a species typically nests, including ground, shrub, mid-story, canopy, and cavity nesters.

Nest searching and monitoring

Nest searching was conducted in the spot mapping plots approximately once every 2 weeks throughout the breeding season. Nests were found through systematic searches and using behavioral clues (alarm calls, following bird with nesting material or food, etc). Observers recorded time spent in each plot to measure encounter rates for nests. Nests were revisited twice per week until fledging or failure and nest success was calculated according to Mayfield (1961, 1975).

Migration surveys

During the spring and fall migration passing periods (about mid March to mid June and late July to late October respectively) migrants were recorded when observed during other field activities. We recorded all observations of "pass through" migrants- those species that neither breed nor overwinter in the region. We also recorded the first observed arrival of breeding migrants in the spring, and winter migrants in the fall.

Winter songbird surveys

Winter songbird surveys were conducted on Sandhills Game Land on the 5065 acre CURE area and a comparable 5133 acre area on the southeast portion of block B. On Caswell surveys were conducted on the 5642 acre CURE area and the 1522 acre Frogsboro tract. 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, thinned plantation, drain, field, and hedgerow while on Caswell we surveyed 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. 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

Point Counts

On the Sandhills field trial route, the most frequently detected species across years 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 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, 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 Sandhills Game Land are being more closely monitored through the CURE Surveys State Wildlife Grant project.

Table 1. Relative abundance of Bachman's sparrow (# birds per 10 survey points) detected during point count surveys, 2002-2009, Sandhills Game Land. Note that in 2002 and 2003 point counts were only conducted on the CURE area.

	2002	2003	2004	2005	2006	2007	2008	2009
CURE area	0	0.83	0.42	2.08	5.00	3.75	4.40	5.00
Block B south			1.74	0.43	3.48	3.04	5.22	3.48
Block C			1.36	0.45	4.55	4.55	3.18	0
Field trial			5.00	10.70	13.57	6.07	3.21	5.77

Table 2. Distribution of Bachman's sparrow across point count routes (% of points at which at least one bird was detected), 2002-2009, Sandhills Game Land. Note that in 2002 and 2003 point counts were only conducted on the CURE area.

	2002	2003	2004	2005	2006	2007	2008	2009
CURE area	0	4.2	4.2	20.8	37.5	25.0	37.5	29.2
Block B south			13.0	4.3	30.4	21.7	21.7	30.4
Block C			9.1	4.5	27.3	27.3	18.2	0
Field trial			38.5	57.1	71.4	35.7	25.0	34.6

Red-eyed vireo, indigo bunting, and northern cardinal were the most frequently encountered species on Caswell Game Land across all routes and years. 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 (Figure 1), which has dramatically increased both in relative abundance and distribution ($F=25.51$, $P = 0.0023$) across the CURE area from 2002-2009, while counts increased modestly on Frogsboro ($F=23.59$, $P=0.008$) and did not change significantly on High Rock ($F=0.36$, $P=0.59$). Counts of field sparrows have also significantly increased on the CURE area ($F=47.47$, $P=0.0005$), while counts have been variable and trending lower on the other 2 routes (Figure 2). Bobwhite quail counts have been relatively low, but trending positive ($F=15.58$, $P=0.007$) on the CURE area (Figure 3). Both ovenbird and wood thrush counts dipped on the CURE area compared to the baseline year, but counts have rebounded in recent years and overall there has been no significant trend ($P>0.40$) on the CURE area (Figures 4 & 5). Relative abundance across the entire CURE area is comparable to other portions of the game land which have not undergone recent intensive tree harvest. See territory mapping section below for discussion of stand-scale impacts of CURE management on these species.

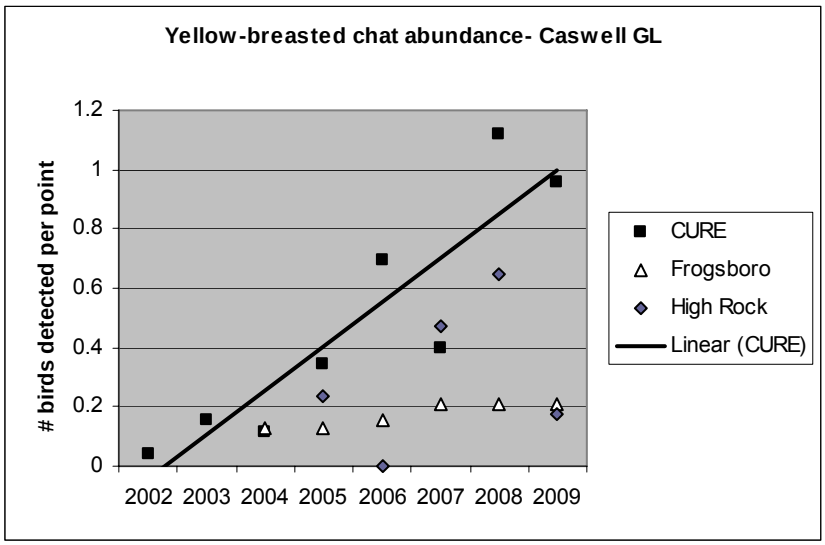

Figure 1. Counts of yellow-breasted chat on Caswell Game Land from breeding season point count surveys, 2002-2009. Line is linear regression trend line for CURE area. Note that the Frogsboro route was initiated in 2004 and High Rock in 2005.

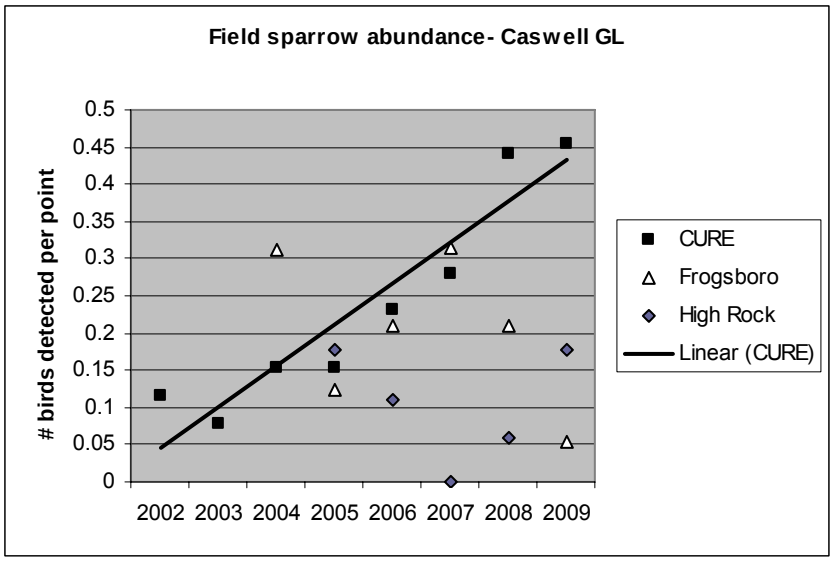

Figure 2. Counts of field sparrow on Caswell Game Land from breeding season point count surveys, 2002-2009. Line is linear regression trend line for CURE area. Note that the Frogsboro route was initiated in 2004 and High Rock in 2005.

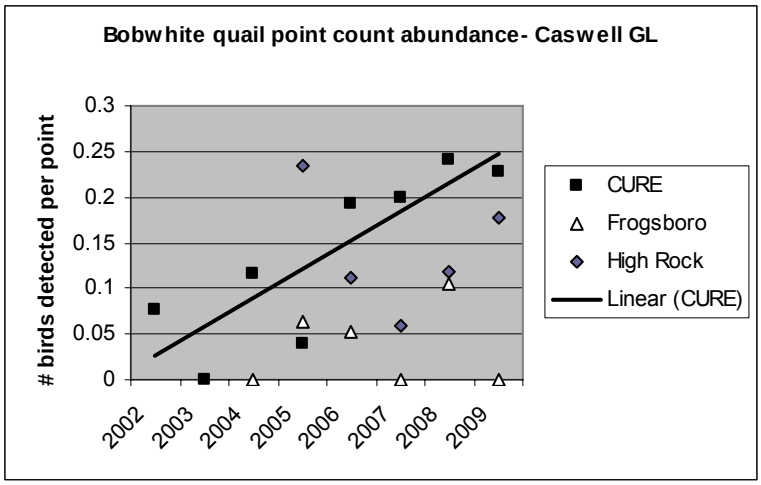

Figure 3. Counts of bobwhite quail on Caswell Game Land from breeding season, all-bird point count surveys, 2002-2009. Line is linear regression trend line for CURE area. Note that the Frogsboro route was initiated in 2004 and High Rock in 2005.

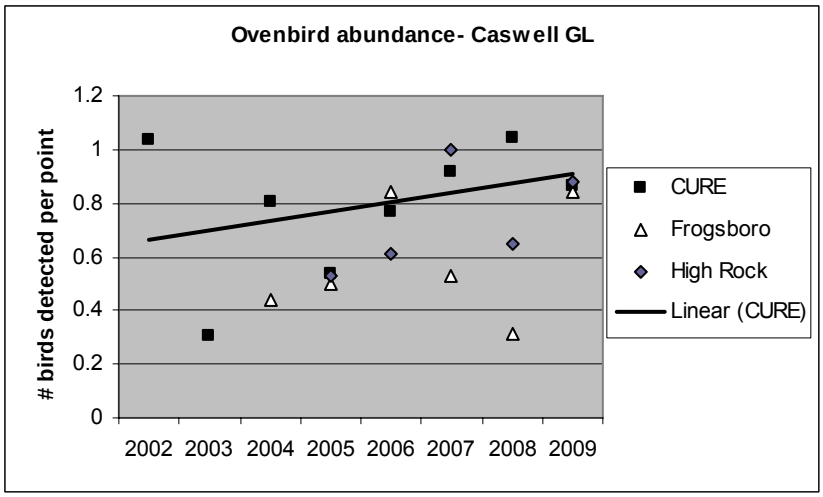

Figure 4. Counts of ovenbird on Caswell Game Land from breeding season point count surveys, 2002-2009. Line is linear regression trend line for CURE area. Note that the Frogsboro route was initiated in 2004 and High Rock in 2005.

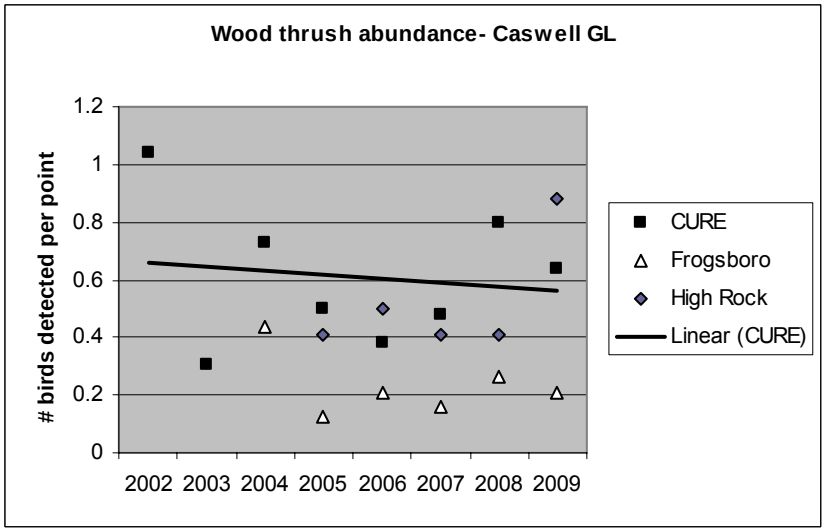

Figure 5. Counts of wood thrush on Caswell Game Land from breeding season point count surveys, 2002-2009. Line is linear regression trend line for CURE area. Note that the Frogsboro route was initiated in 2004 and High Rock in 2005.

With CURE management, brown-headed cowbirds have increased their distribution on the Caswell CURE area. In 2002 no cowbirds were detected on the point count survey. Distribution and abundance spiked in 2005 when cowbirds were detected on about a quarter of all survey points and remained constant through 2008. Though elevated relative to baseline counts, cowbird abundance on the CURE area is similar to levels detected on the Frogsboro and High Rock routes.

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.

Territory Mapping

Sandhills

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. In most Sandhills habitats this guild was comprised primarily of bobwhite quail and Bachman's sparrow.

Across all habitats we observed higher densities of shrub nesters than any other guild except in natural longleaf where canopy and cavity nesters were most abundant. The field trial habitat supported the greatest densities of shrub nesters (2.0 territories/acre) followed closely by herbaceous drain. 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 orchard oriole (0.26 territories/acre) and northern cardinal (0.22). 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, with the highest densities observed in herbaceous drains. 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.

Wildlife Action Plan priority species were found in all habitats, but were most abundant in field trial plots which supported high numbers of eastern kingbird, orchard oriole, and field sparrow among many others. Natural longleaf plots contained 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. Herbaceous drains supported many priority species, while woody drains supported very few (see below for more detail). Bobwhite quail were most abundant in field trial plots, followed by thinned plantation, and they established territories in all habitats.

Caswell

On Caswell Game Land, bottomlands contained the highest territory densities for canopy (1.18 territories/acre), cavity (0.73), mid-story (0.86), and ground nesters (0.34). Within bottomland plots, red-eyed vireo (0.65) 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, yellow-throated warbler, and red-shouldered hawk.

Thinned pine stands supported the greatest number of shrub nesting birds. Very few shrub nesters used thinned oak stands in the first year after thinning, but more species and greater numbers colonized these stands in each subsequent year, and by the last year of the study densities of many shrub nesters in thinned oak were similar to thinned pine.

From 2004-2007, 37 species established a territory in thinned pine plots, the most of any Caswell habitat. The most abundant species in thinned pine included indigo bunting (0.28 territories/acre), eastern towhee (0.21), pine warbler (0.15), and common yellowthroat (0.12). We observed the greatest numbers of brown-headed cowbirds in thinned pine. Surprisingly, we did not document any northern bobwhite territories in our thinned pine plots.

Caswell Game Land supports relatively high numbers of some Wildlife Action Plan priority species including wood thrush, Acadian flycatcher, Kentucky warbler, and hooded warbler. Among habitats, bottomlands supported the greatest numbers of priority species including Acadian flycatcher (0.32 territories/acre), Kentucky warbler (0.17), yellow-billed cuckoo (0.17), and hooded warbler (0.12), among others. Northern bobwhite territories were only documented in thinned oak, where the first territory was established 2 years after thinning in one plot, and 3 years after thinning in the other. Swainson's warbler was observed in 3 different plots (1 bottomland, 2 thinned pine) during spot mapping, but no territories were established.

Management evaluations

For all years combined (2004-2007), Sandhills thinned plantations supported similar numbers of canopy nesters (T=1.66, df=21, P=0.11), cavity nesters (T=1.35, df=28, P=0.19), and ground nesters (T=1.23, df=28, P=0.23) as natural longleaf stands (Figure 6). Natural longleaf supported marginally more mid-story nesters (0.046 vs 0.019 territories/acre, T=1.89, df=28, P=0.07) while thinned plantations supported significantly more shrub nesting birds (0.55 vs 0.07 territories/acre, T=5.55, df=14.8, P=0.0001). Somewhat surprisingly, there was no difference in territory densities for Wildlife Action Plan priority species between natural longleaf and thinned plantations (0.42 vs 0.33 territories/acre, T=1.44, df=28, P=0.16). While densities of Bachman's sparrow and brown-headed nuthatch were low in plantations shortly after management, by the end of the study they reached densities similar to high quality natural longleaf. Natural longleaf stands supported more red-cockaded woodpeckers, in part because timber was generally older in those stands, but thinned plantations supported greater numbers of priority shrub nesting birds after the site prep ground disturbance stimulated the growth of emergent shrubs.

While we did not collect data in unthinned Sandhills plantation stands (which are known anecdotally to support very few breeding birds), it is clear that thinning plantations is beneficial

to birds because thinned stands can support similar densities of breeding birds as the best examples of natural longleaf/wiregrass. While concerns have been raised about the intensive site-prep and the planting of off-site ACP, our data suggest that the resulting habitat is as good as or better than native wiregrass for priority bird species that nest in or among grasses, such as Bachman's sparrow, bobwhite quail, and field sparrow. A more detailed evaluation of the impacts of ACP on quail and Bachman's sparrow is presented in the CURE Surveys annual report. The effects of ACP on other taxa were not studied as part of this project.

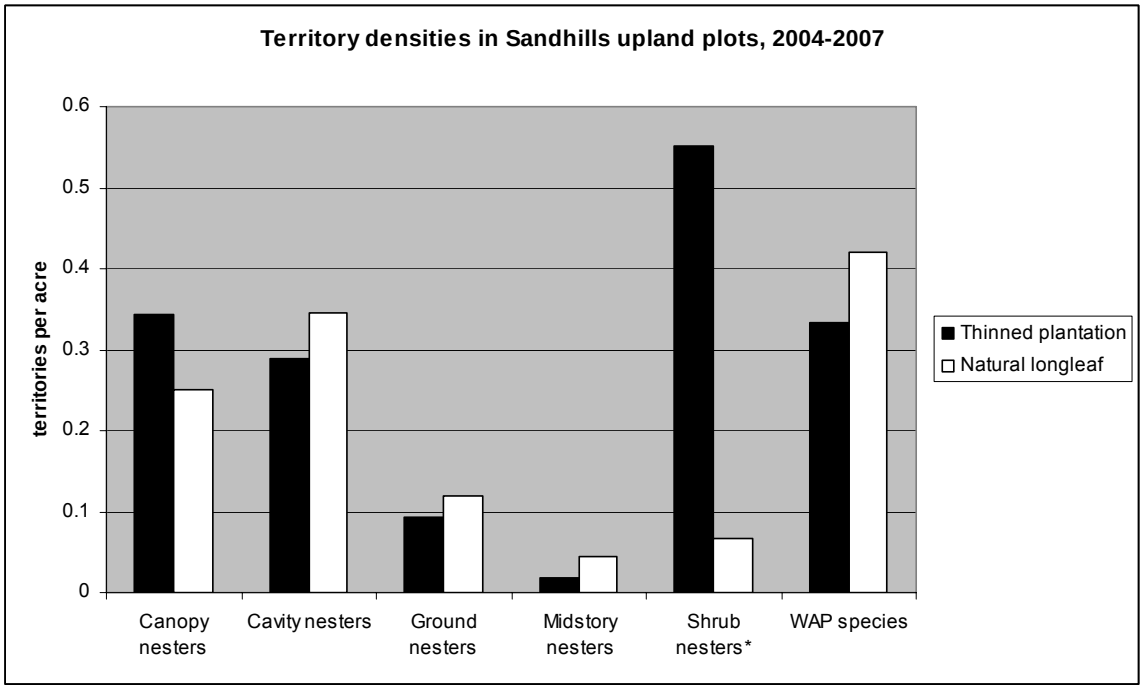

Figure 6. Territory densities for different nesting guilds and for NC Wildlife Action Plan (WAP) priority species, in thinned plantation and natural longleaf plots, Sandhills Game Land, 2004-2007. There is a statistically significant difference ($P<0.05$) in territory density between habitats for those guilds with a (*).

For all years combined (2004-2008), Sandhills herbaceous drains supported similar numbers of canopy nesters (T=0.26, df=28, $P=0.79$), cavity nesters (T=1.55, df=28, $P=0.13$), midstory nesters (T=1.22, df=28, $P=0.23$), and ground nesters (T=0.62, df=28, $P=0.54$) as woody drains. Herbaceous drains supported significantly more shrub nesting birds (1.91 vs 0.79 territories/acre, T=6.09, df=28, $P<0.0001$) and more WAP priority species (0.46 vs 0.11 territories/acre, T=5.88, df=28, $P<0.0001$). Herbaceous drains supported very high numbers of red-headed woodpeckers, many brown-headed nuthatches and orchard orioles, and also prairie warbler, eastern wood-pewee, eastern kingbird, American kestrel, northern bobwhite, Bachman's sparrow, northern flicker, and yellow-billed cuckoo. The most abundant priority species in woody drains was hooded warbler. Some species, such as great-crested flycatcher, tufted titmouse, and yellow-billed cuckoo were found in the greater numbers in woody drains and hooded warbler, white-eyed vireo, red-eyed vireo and ovenbird territories were only found in woody drains on Sandhills Game Land. However, converting woody drains to herbaceous drains through thinning and burning seems to benefit a greater array of priority species, while still providing habitat for most species that require canopy trees.

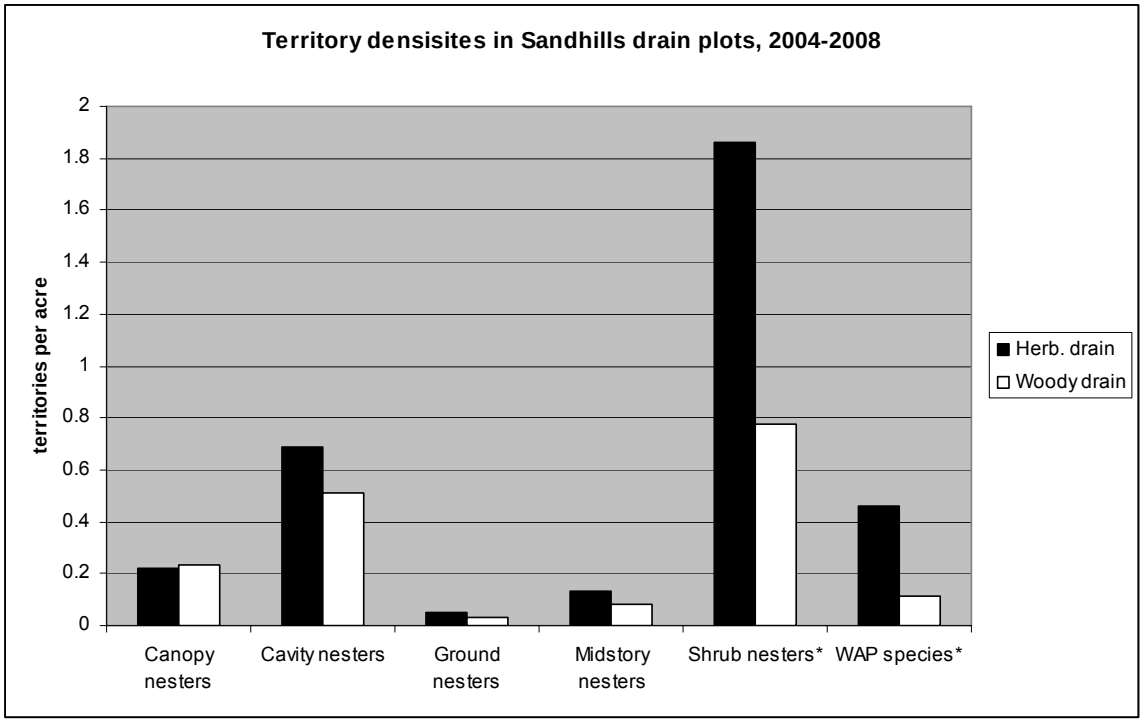

Figure 7. Territory densities for different nesting guilds and for NC Wildlife Action Plan (WAP) priority species, in herbaceous and woody drain plots, Sandhills Game Land, 2004-2008. There is a statistically significant difference ($P<0.05$) in territory density between habitats for those guilds with a (*).

At Caswell for all years combined (2004-2008), thinned oak stands supported similar numbers of canopy nesters (T=0.93, df=20, $P=0.36$), and cavity nesters (T=0.57, df=20, $P=0.58$) as unthinned oak stands. Unthinned oak supported significantly more midstory nesters (0.45 vs. 0.16 territories/acre, T=3.52, df=18.2, $P=0.0024$) driven by wood thrush, Acadian flycatcher, and blue-grey gnatcatcher numbers. Unthinned oak also supported significantly more ground nesters (0.32 vs. 0.05 territories/acre, T=4.45, df=15.6, $P=0.0004$) primarily driven by ovenbirds. Thinned oak supported more shrub nesting birds by almost an order of magnitude (1.15 vs 0.12 territories/acre, T=2.62, df=7.2, $P=0.034$). There was no difference in WAP priority species between the 2 habitats (T=0.23, df=20, $P=0.82$).

There seems to be a greater tradeoff involved with thinning oak stands than with some of the other CURE management practices. More species established a territory (at least 1 territory established in at least one year) in thinned oak stands (34 species), than in unthinned oak (25 species) from 2004-2008, indicating that thinning hardwoods can increase stand-scale species diversity. There were 15 species that occurred in thinned oak stands which did not establish territories in unthinned stands, including many shrub nesters, brown-headed nuthatch, red-headed woodpecker and northern bobwhite. However, many of the species that are lost or reduced in number with thinning are priority species. Unthinned stands supported 5 species which were not found in thinned stands (wood thrush, Acadian flycatcher, pileated woodpecker, hairy woodpecker, and yellow-billed cuckoo) and several other species, such as ovenbird, red-eyed vireo, and scarlet tanager were found in greater densities in unthinned oak.

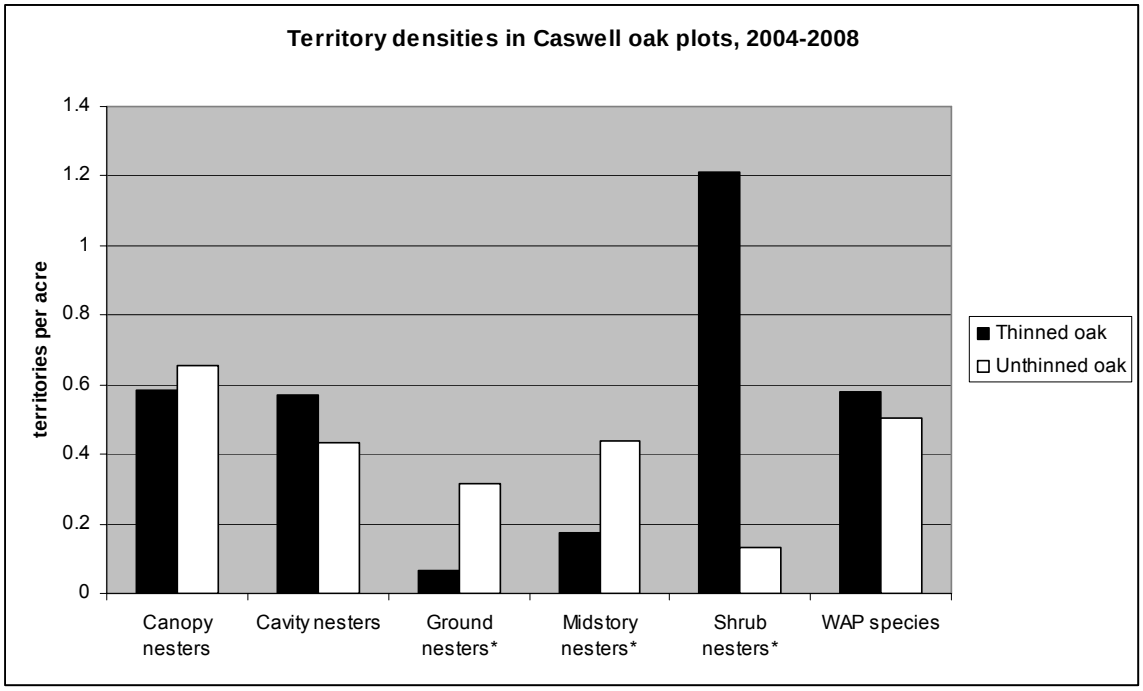

Figure 8. Territory densities for different nesting guilds and for NC Wildlife Action Plan (WAP) priority species, in thinned and unthinned oak plots, Caswell Game Land, 2004-2008. There is a statistically significant difference ($P<0.05$) in territory density between habitats for those guilds with a (*).

Nest searching and monitoring

In 2008, we did not conduct fixed effort nest searches, but we recorded nests found incidental to other field activities. From 2004-2008 we documented more than 766 nests of 50 total species; 544 nests of 41 species on Sandhills and 222 nests of 32 species on Caswell Game Land.

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).

Depredation was the leading cause of nest failure on Sandhills Game Land, followed by abandonment (71% of nest failures were attributed to predation, and 16% to abandonment). In most cases of depredation the predator could not be identified. A few nests (4% of nest failures) were lost to management activities such as controlled burning and mowing. Cowbird parasitism was not a major source of nest failure on Sandhills Game Land, accounting for 2% of nest failures. Parasitism rates were higher on Caswell Game Land, with 12% of nest failures attributed to cowbirds.

No patterns have been identified to help explain what made nests vulnerable to depredation or abandonment. There was no difference in nest height (1.10 vs. 1.02m) or height of the plant the nest was placed in (1.99 vs. 2.00m) for successful vs. unsuccessful shrub nests.

Across all habitats on Sandhills Game Land, nest success appeared to be relatively high for red-cockaded woodpecker, 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 - 2008, Sandhills Game Land, minimum 80 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
Red-cockaded Woodpecker	5	129	0.9845	0.00012	54%
Blue Grosbeak	33	383.5	0.9687	0.00008	47%
Northern Cardinal	18	185	0.9676	0.00017	45%
Northern Mockingbird	20	229	0.9651	0.00015	38%
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	11	82.5	0.9273	0.00082	18%
Eastern Towhee	23	160.5	0.9128	0.00050	9%

Table 4. Mayfield nest success by species, for all habitats combined, 2004 - 2008, Caswell Game Land, minimum 80 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
Indigo Bunting	15	182	0.9945	0.00003	87%
Wood Thrush	16	215.5	0.9907	0.00004	77%
Northern Cardinal	12	92.5	0.9892	0.00012	77%
Eastern Phoebe	5	90	0.9889	0.00012	69%
Acadian Flycatcher	3	80	0.9875	0.00015	69%

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 ($Z = 2.53$, $P < 0.01$).

Migration surveys

Sandhills Migration Results

Of the 93 sightings of 37 "pass through" migrant bird species in the Sandhills region between fall of 2003 and spring of 2009 (Table 5), 25 sightings were in wetland or drain habitats, 24 were associated with lakes, 8 were associated with fields, and 31 were in forested upland habitats, primarily longleaf pine (Figure 9). The fact that over 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 2009.

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

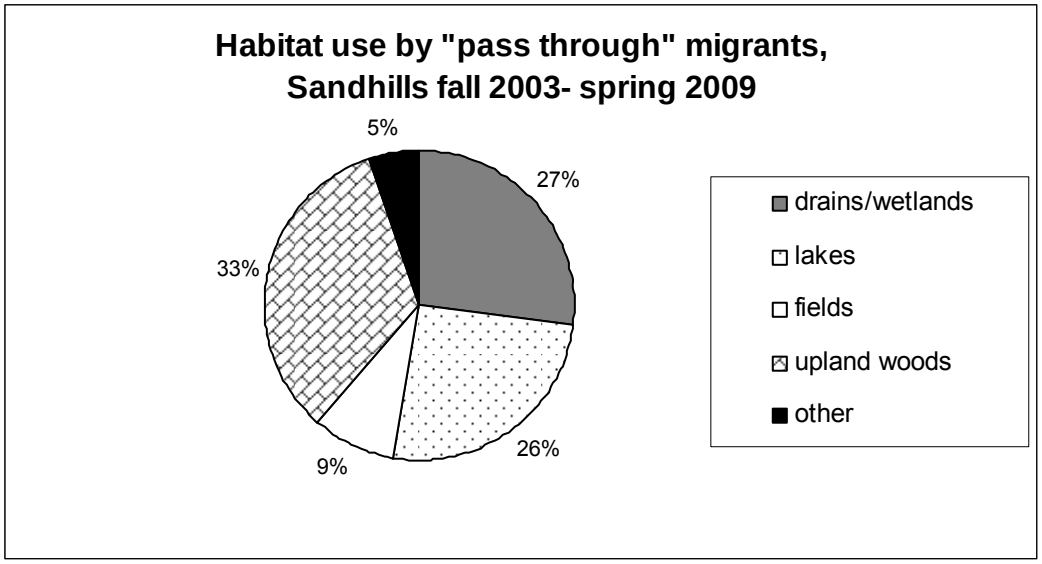

Figure 9. Habitats in which migrants were observed, Sandhills region 2003-2009.

Most migrants that breed in the Sandhills arrive between late march and early May. The earliest observed arrival of a migrant breeder was a black-and-white warbler on March 13, 2006. The latest observed first arrival was yellow-billed cuckoo which was first observed on May 5 in 2006. No pattern was observed in timing of first arrival and habitat use.

Migrants that overwinter in the Sandhills typically arrive between September and December. The earliest observed arrival of a wintering species was a song sparrow seen on August 3 in 2007. Among species that typically join mixed species flocks in the winter, only 1/3 of the observations of first arrival were within mixed species flocks, suggesting that these species migrate with conspecifics and join mixed species foraging groups after arrival.

Caswell Migration Results

There were 100 "pass through" migrants of 19 species observed on Caswell Game Land between May 2003 and November 2008 (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 – fall 2008.

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

Most migrant breeders at Caswell were first observed between late March and mid-May. The earliest observed arrival was Louisiana waterthrush, blue-grey gnatcatcher, and yellow-throated warbler on March 24, in 2007. Migrants that overwinter at Caswell were first observed between mid-march and mid-November. The earliest observed arrival was a ruby-crowned kinglet and a hermit thrush on September 12 in 2004.

Winter bird surveys

On Sandhills Game Land, the highest densities of wintering birds were found in hedgerows, while relatively high densities were observed in drains and fields. Upland pine stands supported the lowest winter bird densities, and transect counts in upland woods were highly variable with most birds observed in large, mixed species flocks. Plantations that were thinned and planted to ACP supported much higher densities of winter birds than pre-treatment plantation stands. Notable was the presence of sparrows, towhees, and other ground-foraging species in treated stands which were mostly absent from pre-treatment stands.

On Caswell Game Land, fields supported the highest densities of birds, predominantly sparrows. Hardwood and pine stands supported similar densities of wintering birds. While birds were observed in mixed species flocks at Caswell, these flocks were not as large or diverse as those flocks observed on Sandhills Game Land. There was large year to year variation in counts at Caswell Game Land on both the CURE and Frogsboro tracts.

Few species of conservation concern winter on Sandhills and Caswell Game Land. Most of the Action Plan priority species present in winter are year-round residents, such as red-cockaded woodpecker and Bachman's sparrow on Sandhills, and brown-headed nuthatch, field sparrow, cooper's hawk, northern flicker, northern bobwhite, American kestrel, American woodcock, red-headed woodpecker, and hairy woodpecker on both Sandhills and Caswell. The only Action Plan priority species present only in the winter are low numbers of northern harrier and savanna sparrow.

More detailed results on focal early successional wintering birds at both Caswell and Sandhills Game Lands are presented in the CURE Songbird and Habitat Surveys annual report.

Communicating Results

In the past year staff communicated results of songbird surveys to 4 groups and approximately 68 people. Results were communicated to school groups, conservation groups, and natural resources managers through formal talks and field trips.

B. Target Dates for Achievement and Accomplishment

Field data collection has been completed for the territory mapping and nest searching studies, and further data analysis and publication of results will occur in the coming year. Winter bird surveys have been completed on Sandhills Game Land and one more year of data will be collected on Caswell in 2010. Point count surveys and migration observations will be continued indefinitely.

C. Significant Deviations

None

D. Remarks

None

E. Recommendations

This project should be continued during the next period.

F. Estimated Cost

$20,184 (including in-kind contributions)

G. Literature Cited

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Prepared By: Jeffrey Marcus
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Division of Wildlife Management
NC Wildlife Resources Commission

Final Annual Performance Report

State: North Carolina

Project Number: T - 9
Amendment Number: 1

Period Covered: July 1, 2008 - June 30, 2009

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 2008-2009, 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, summer and transitional/migratory roost surveys, and summer mist net surveys at various non-roost sites.

Hibernacula surveys:

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 2009. Hibernating bats are sometimes difficult to identify due to roost location (e.g., height, obstructed views, mixed colonies). 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.

During hibernation counts, ten sites (7 caves and 3 mines) in five counties were surveyed (Table 1). A total of 2853 bats were counted, representing seven species (Table 2). Two-hundred and thirty-six (236) Virginia big-eared bats (state & federally listed endangered), 1294 Rafinesque's

big-eared bats (state listed threatened), and 1 eastern small-footed bat (state special concern) were observed during these surveys.

Table 1. North Carolina Wildlife Resources Commission bat hibernacula survey locations and species assemblages in the mountain region, January – February, 2009.

Site Name	County	Property Ownership	Survey Date	Species	Number
Cranberry Iron Mine	Avery	Waterfront Group	1/21/2009	*Eptesicus fuscus*	15
				Myotis lucifugus	149
				Myotis septentrionalis	40
				Myotis species	279
				Perimyotis subflavus	208
				Unknown	4
					695
Black Rock Cliffs Cave	Avery	Grandfather Mountain/TNC	1/26/2009	*Corynorhinus townsendii virginianus*	231
				Myotis species	1
				Perimyotis subflavus	1
					233
Black Rocks Mystery Hole	Avery	Grandfather Mountain/TNC	1/26/2009	*Corynorhinus townsendii virginianus*	**5**
Eagle Creek Copper Mine	Swain	NPS (Great Smoky Mountains NP)	1/30/2009	*Corynorhinus rafinesquii rafinesquii*	854
				Eptesicus fuscus	1
					855
Hazel Creek or Sugar Fork Copper Mine	Swain	NPS (Great Smoky Mountains NP)	1/30/2009	*Corynorhinus rafinesquii rafinesquii*	440
				Eptesicus fuscus	1
				Myotis leibii	1
				Perimyotis subflavus	2
					444
Kitchen Cave 1-3	Jackson	Private (Murray Hill)	2/6/2009	*Eptesicus fuscus*	1
				Myotis lucifugus	1
				Perimyotis subflavus	31
					33
Radford Cave 1 & 2	Cherokee	USFS (Nantahala NF)	2/9/2009	*Myotis lucifugus*	180
				Myotis septentrionalis	1
				Myotis species	23
				Perimyotis subflavus	187
					391
Limekiln	McDowell	USFS (Pisgah NF)	2/10/2009	*Myotis lucifugus*	3
				Myotis septentrionalis	2
				Perimyotis subflavus	29
					34
Pseudosaltpeter	McDowell	USFS (Pisgah NF)	2/10/2009	*Eptesicus fuscus*	1
				Perimyotis subflavus	20
					21
Wind Cave	McDowell	USFS (Pisgah NF)	2/10/2009	*Myotis lucifugus*	10
				Myotis septentrionalis	3
				Myotis species	2
				Perimyotis subflavus	127
					142

Table 2. North Carolina Wildlife Resources Commission summary of bat species observed during hibernacula surveys in the mountain region, January – February, 2009.

Species	Number
Rafinesque's Big-eared Bat** (*Corynorhinus rafinesquii rafinesquii*)	1294
Virginia Big-eared Bat*** (*Corynorhinus townsendii virginianus*)	236
Big Brown Bat (*Eptesicus fuscus*)	19
Eastern Small-footed Bat* (*Myotis leibii*)	1
Little Brown Bat (*Myotis lucifugus*)	343
Northern Long-eared Bat (*Myotis septentrionalis*)	46
Myotis species	305
Eastern Pipistrelle (*Perimyotis subflavus*)	605
Unknown species	4
TOTAL	**2853**

*state listed special concern
**state listed threatened
*** state & federally listed endangered

Summer and transitional roost surveys:

In the summer of 2007 as a part of a Section 6 project, Wildlife Diversity staff constructed two artificial roost structures in an effort to provide permanent summer roosting habitat for Rafinesque's big-eared bats and facilitate future monitoring of the species. Structures were erected on Pisgah National Forest land in Haywood County near a recently destroyed abandoned house which contained a maternity colony of big-eared bats. The structures were checked once in the summer and fall in an effort to document big-eared bat use. Additionally, anticipating changes in Wildlife Diversity staff responsibility, roost surveys were also conducted at three mines and one cave during the fall to ensure staff were knowledgeable of roost locations and survey techniques. Observational methods were used at the structures and mines and a single mist-net was used at the cave entrance to capture bats entering or leaving the roost. Observed bats were identified and counted. All bats captured were identified, weighed, sexed, aged, and released. Six roost sites in four counties were surveyed (Table 3). A total of 2464 bats were observed or captured, representing seven species (Table 4). Significant observations included one female Indiana bat (state & federally listed endangered), one Rafinesque's big-eared bat (state listed threatened), and one eastern small-footed bat (state special concern).

Table 3. North Carolina Wildlife Resources Commission summer and transitional/migratory roost survey locations and bat species assemblages in the mountain region, July 1, 2008 to June 30, 2009.

Site Name	County	Property Ownership	Survey Date	Species	Number
Cranberry Iron Mine	Avery	Waterfront Group	11/17/2008	*Eptesicus fuscus*	19
				Myotis lucifugus	424
				Myotis septentrionalis	62
				Myotis species	1056
				Perimyotis subflavus	279
					1840
Radford Cave 2 (Large)	Cherokee	USFS (Nantahala NF)	10/9/2008	*Myotis septentrionalis*	**2**
Big Ridge Mine	Haywood	City of Waynesville	10/14/2008	*Myotis lucifugus*	100
				Myotis septentrionalis	1
				Myotis sodalis	1
				Myotis leibii	1
				Perimyotis subflavus	500
					603
Harmon Den/Hurricane Creek Cinderblock Structure	Haywood	USFS (Pisgah NF)	10/14/2008	None	**0**
			6/2/2009	None	**0**
Harmon Den/Hurricane Creek Culvert Structure	Haywood	USFS (Pisgah NF)	10/14/2008	None	**0**
			6/2/2009	None	**0**
Bull Pen Mine	Jackson	USFS (Nantahala NF)	10/29/2008	*Corynorhinus rafinesquii rafinesquii*	1
				Perimyotis subflavus	18
					19

Table 4. North Carolina Wildlife Resources Commission summary of summer and transitional/migratory roost surveys in the mountain region, July 1, 2008 to June 30, 2009.

Species	Number
Rafinesque's Big-eared Bat** (*Corynorhinus rafinesquii rafinesquii*)	1
Big Brown Bat (*Eptesicus fuscus*)	19
Little Brown Bat (*Myotis lucifugus*)	524
Northern Long-eared Bat (*Myotis septentrionalis*)	65
Indiana Bat*** (*Myotis sodalis*)	1
Eastern Small-footed Bat* (*Myotis lebeii*)	1
Myotis species	1056
Eastern Pipistrelle (*Pipistrellus subflavus*)	797
TOTAL	**2464**

*state listed special concern
**state listed threatened
*** state & federally listed endangered

Mist-netting:

Summer mist netting efforts were conducted in July and August. 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. No surveys were conducted during precipitation events.

Two sites in two counties were surveyed with mist nets (Table 5). A total of 10 net hours yielded 60 captures representing five species (Table 6). No state or federally listed species were captured.

Table 5. North Carolina Wildlife Resources Commission summer mist net survey locations and bat species assemblages in the mountain region, July 1, 2008 to June 30, 2009.

Site Name	Property Ownership	County	Survey Date	Species	Number
Davidson River/Pisgah Education Center	USFS (Pisgah National Forest)	Transylvania	7/23/2008	*Myotis lucifugus*	14
				Myotis septentrionalis	7
				Perimyotis subflavus	4
					25
Cold Knob/FS 479H	USFS (Bent Creek Experimental Forest)	Buncombe	8/7/2008	*Eptesicus fuscus*	18
				Lasiurus borealis	12
				Myotis septentrionalis	4
				Perimyotis subflavus	1
					35

Table 6. North Carolina Wildlife Resources Commission summary of summer mist net surveys in the mountain region, July 1, 2008 to June 30, 2009.

Species	Number
Big Brown Bat (*Eptesicus fuscus*)	18
Red Bat (*Lasiurus borealis*)	12
Little Brown Bat (*Myotis lucifugus*)	14
Northern Long-eared Bat (*Myotis septentrionalis*)	11
Eastern Pipistrelle (*Perimyotis subflavus*)	5
TOTAL	**60**

*state listed special concern
**state listed threatened
*** state & federally listed endangered

B. Target Dates for Achievement and Accomplishment

On schedule.

C. Significant Deviations

None

D. Remarks

Roost surveys during the month of October at two mines resulted in a couple of interesting findings. At Big Ridge Mine in Haywood County a female Indiana bat was observed roosting next to two little brown bats and one eastern small-footed bat. Indiana bats have now been documented twice in the same location within the mine, the first being a male observed in January 2008. This provides further support that Indiana bats are using this roost and present in Haywood County during the transition/migratory and hibernation periods. Further surveys are needed to determine if Indiana bats are present in Haywood County during the maternity season. The other interesting finding occurred at Bull Pen Mine in Jackson County where a Rafinesque's big-eared bat was observed roosting. This observation is the first time a big-eared bat has been documented in this mine since December 2003. The mine's proximity to a road and well known location has undoubtedly contributed to recent gate vandalism which has allowed access to the public potentially increasing disturbance to bats. Efforts should be made to secure the mine gate to provide a more suitable roost.

Wildlife Diversity staff participated in a two day bat blitz in early June 2009 in Cherokee and Clay Counties. Conducted mist net surveys at 9 locations during the blitz, capturing 20 bats, including 1 priority species (1 Silver-haired bat; Significantly Rare). Participants/partners included the Eastern Band of Cherokee Indians, USFWS, USFS, NCDOT, NC Museum of Natural Sciences, SE Bat Diversity Network, among others.

Several key steps have been taken in anticipation of the potential spread and subsequent effects of White-nose syndrome (WNS) on bats in North Carolina. First of all, we collaborated with several groups, including USFWS, Clemson University, UNC-Asheville, USFS, and the caving and outdoor community, among others, to provide an informational presentation to the public in Spring 2009. In addition, a WNS working group was formed with the objective to improve communication and coordination among all interested agencies, organizations, and stakeholder groups about WNS in NC.

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. 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

$36,750 (including in-kind contributions)

Prepared By: Gabrielle Graeter
Wildlife Diversity Biologist, Division of Wildlife Management

Final Annual Performance Report

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

Period Covered: July 1, 2008 – June 30, 2009

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

Study Title: Mountain Reptile Inventory and Monitoring

Objectives:

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 NC.
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 NC Wildlife Action Plan as well as the individual landowners.

A. Activity

This year's activities included continued efforts on the bog turtle project, the coordination of a statewide mark-recapture box turtle study, and continued 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, five species are listed as Special Concern, and the others are priority species according to the North Carolina Wildlife Action Plan (NCWRC 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 2008-2009 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. One hundred and seven (107) bog turtles (including 49 new individuals) were captured during 43 site visits (Table 2). Compared to sampling efforts in 2007-2008, we sampled fewer sites this year but captured more 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 reduced staff in the program.

Table 2. Summary by NC County of reported survey visits from July 31, 2008 – June 30, 2009 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 some sites were visited multiple times.

NC County	Known Sites	Potential Sites	New Sites Discovered	Total Visits	New Turtles	Recaptured Turtles	Total Captures
Alleghany	8	1	0	9	3	3	6
Ashe	6	3	1	9	16	16	32
Buncombe	8	0	0	8	0	1	1
Gaston	1	0	0	1	0	4	4
Henderson	4	0	0	4	1	6	7
Iredell	1	2	0	3	0	0	0
Watauga	3	0	0	3	0	0	0
Wilkes	15	0	0	15	32	31	63
TOTALS	**38**	**5**	**1**	**43**	**49**	**58**	**107**

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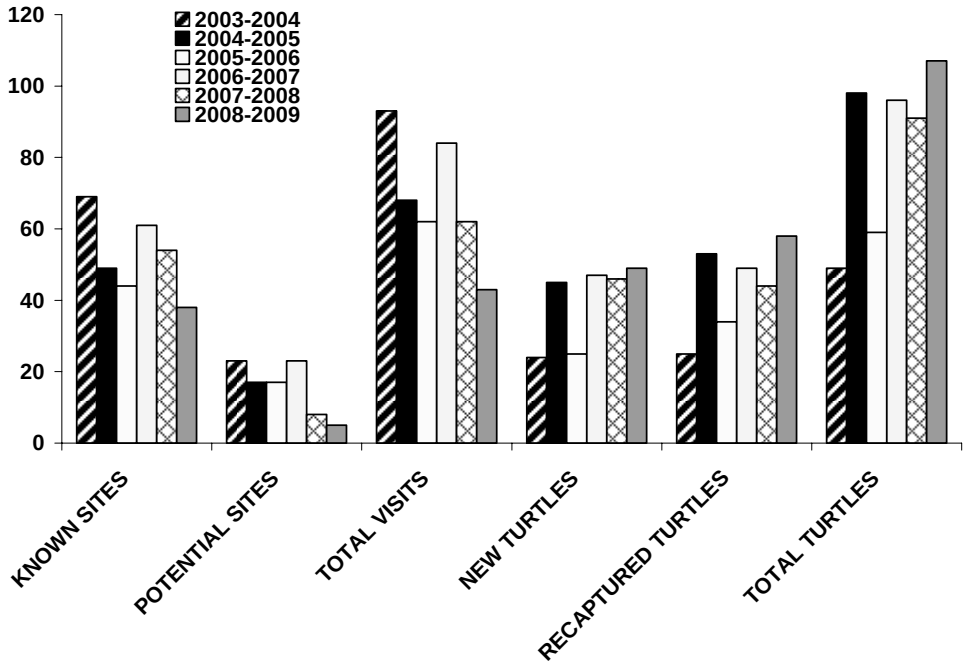

Figure 1. North Carolina Wildlife Resources Commission bog turtle site visits and survey results shown for every year beginning with the 2003-2004 fiscal year and up to the 2008-2009 fiscal year.

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 three occasions from August – October 2008. Traps were set for three trap nights during each trapping event. The two areas with known populations of stripeneck musk turtle will be trapped on an annual basis to learn more about these populations and improve our understanding of their habitat use.

In total, three locations were trapped (Table 3). All turtles captured were measured and marked before release 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*) and the common musk turtle (*Sternotherus odoratus*).

Table 3. Aquatic Turtle Trapping between August 1, 2008 and June 30, 2009 for stripeneck musk turtles (*Sternotherus minor peltifer*) and eastern spiny softshell turtles (*Apalone spinifera spinifera*).

Trapping Site	County	Month/Year	Target species (# captured)
Shuler Creek	Cherokee	August 2008	Sternotherus minor peltifer (5)
French Broad River and Spring Creek at Hot Springs	Madison	September 2008	Apalone spinifera spinifera (3)
Sandy Bottoms pond	Buncombe	October 2008	none captured

Box Turtles

Box turtles, the state reptile of North Carolina, are believed to be declining across the state due to several different threats, 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 provide better technical guidance. Quite a few people have submitted records for box turtle observations since the beginning of this project. 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, and landscape level influences to compare among ecosystem types across the state. In March 2009, we had a 2nd training session at Haw River State Park with 20 new project leaders for 2009. There are currently 31 project leaders across North Carolina, each running their own mark-recapture study. The data from 2008 was evaluated and study design improved for the 2009 year. Several box turtle project leaders are currently collecting data in western North Carolina.

A major accomplishment in the Box Turtle Connection project this year was the successful creation and continual management of an online data entry website for the project leaders. In addition to streamlining the data entry process for staff, it also has the benefit of having the data regularly backed up on the server. As of July 2009, there had been 427 turtle captures thus far in the project across the state. After a few more years of this Mark-Recapture study, we should have some interesting findings to report.

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 4). The focus this fiscal year for priority snakes and lizards (Table 1) was on surveying the artificial cover study sites that were set up in 2007-2008, 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 regularly surveying artificial cover that is set up in ideal habitats. All three methods have been employed this fiscal year.

Northern pine snakes, *Pituophis melanoleucus melanoleucus*, had not been documented in many years in western North Carolina until a recent sighting in Spring 2009. 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 next 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.

Table 4. Target snake and lizard species documented in western North Carolina in FY 2008-2009, method employed to find the species, and site and county where observed.

Target Species Observed	Common Name	Sampling Methods	Site (County)
Pituophis melanoleucus melanoleucus	Northern pinesnake	Visual Encounter Survey	Murphy (Cherokee)
Heterodon platirhinos	Eastern hog-nosed snake	Visual Encounter Survey	Green River Game lands (Polk); Rocky Bluff (Madison)
Thamnophis sauritus sauritus	Common ribbon snake	Visual Encounter Surveys	West Jefferson (Ashe); Idlewild (Ashe); US 20 (Alleghany);

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 2007-2008 fiscal year, 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 5).

The overall objective 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. Only 3 locations (North Mills River, Sandy Bottoms, Pilot Mountain SP) have been surveyed this year due to decreased staffing in our program.

Table 5. Sites in western North Carolina set up with artificial cover (tin) for a snake and lizard study. GL = Game land; 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
Talula bog	Graham	NC DOT/EEP

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, 43 site visits were made to bog habitats, resulting in the observance of 49 new and 58 recaptured bog turtles (Table 2). Bog turtle presence was confirmed at a new site in Ashe County by Dennis Herman. In FY 2008-2009, fewer site visits were made, but more turtles were captured than last year (FY 2007-2008).

In the aquatic turtle surveys and trapping project, three (3) eastern spiny softshell turtles (*Apalone spinifera spinifera*) and five (5) stripeneck musk turtles (*Sternotherus minor peltifer*) were captured.

The state-wide mark-recapture box turtle study, the Box Turtle Connection, was continued in 2008-2009, with the assistance of 31 project leaders and collaboration of many partners throughout the state. Of note is the successful creation of an online data entry website for this project, thereby streamlining and improving data security and management.

Of particular note is the first new confirmed record of a northern pinesnake (*Pituophis melanoleucus melanoleucus)* in the mountain region of NC since 1983. Records submitted by the public and government agencies have proven invaluable for gaining new locality records for the priority snakes and lizards in the mountain region.

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, however, 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 distribution of bog turtles in western North Carolina.

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.

We should continue to nurture positive relationships with private individuals and landowners in order to educate them about government agencies, the value of this resource, 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) we could use 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

$116,352 (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 (NCWRC). 2005. North Carolina Wildlife Action Plan. Raleigh, North Carolina.

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

Final Annual Performance Report

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

Period Covered: July 1, 2008 – June 30, 2009

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

Study Title: Western Region Amphibian Inventory

Objectives:

1. Compile existing information from all sources (e.g., state, federal, universities, and 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 and one frog species are all designated as priority species in the NC Wildlife Action Plan (2005). Seven salamander species considered Significantly 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. Reviews of permit applications and reports provided important data and a means to control data acquisition and impacts of collection on local populations. 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 those activities have 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 amphibian 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
*Pseudacris brachyphona	Mountain Chorus Frog		SC

*NCWAP Priority Species

FSC = Federal Species of Concern
SC = Special Concern Species
SR = Significantly Rare Species
E = Endangered Species
T = Threatened Species
W = Watch List Species

Aquatic Salamanders

On April 17, 2008, NC State Museum of Natural Sciences and North Carolina Wildlife Resources Commission staff captured a Common Mudpuppy (*Necturus maculosus*) in the French Broad River, near Huff Island, in NW Madison County, resulting in the first documented specimen of this species in the county (Beane et al. 2008). The 2007 observation from the Ivy River in Madison County (Williams 2008), reported by a private landowner and deemed reliable, had no voucher specimen. In March of 2009, staff used baited minnow traps (n=150 trap nights) to survey for mudpuppies in a two-mile section of the French Broad River near Mills River (Henderson County), but none were found.

Aquatic survey techniques (rock-flipping, snorkeling, cobble searches, and dip-netting) resulted in an update of two historical records for Junaluska Salamander (*Eurycea junaluska*) in the Cheoah River (Graham County), an update of one historical record for Mole Salamander (*Ambystoma talpoideum*) in a floodplain pool (Macon County), and updates of eight out of twelve historical records for Hellbender (*Cryptobranchus alleganiensis*) in seven counties. In addition, four new hellbender sites were documented in three counties (Table 2).

Table 2. North Carolina Wildlife Resources Commission selected results for target salamander species from mountain region aquatic surveys, FY 2008-2009.

TARGET SPECIES OBSERVED	COMMON NAME	SITE AND COUNTY
Ambystoma talpoideum	Mole Salamander	Rainbow Springs_ floodplain pool (Macon)
Cryptobranchus alleganiensis	Hellbender	Scotts Creek_near confl Tuckasegee River (Jackson)*
Cryptobranchus alleganiensis	Hellbender	Tuckasegee River_Dillsboro Dam (Jackson)
Cryptobranchus alleganiensis	Hellbender	Tuckasegee River_Webster (Jackson)*
Cryptobranchus alleganiensis	Hellbender	Tuckasegee River_E. LaPorte Park (Jackson)
Cryptobranchus alleganiensis	Hellbender	Tuckasegee River_Ela (Swain)
Cryptobranchus alleganiensis	Hellbender	Shuler Creek (Cherokee)
Cryptobranchus alleganiensis	Hellbender	S. Hominy Creek_Rt. 151 bridge (Buncombe)
Cryptobranchus alleganiensis	Hellbender	SF New River_NRSP Visitor Center (Ashe)
Cryptobranchus alleganiensis	Hellbender	EF French Broad River_EF Road (Transylvania)*
Cryptobranchus alleganiensis	Hellbender	Big Laurel Creek_Big Laurel Church (Madison)
Cryptobranchus alleganiensis	Hellbender	Big Laurel Creek_Revere Road (Madison)
Cryptobranchus alleganiensis	Hellbender	Big Laurel River_upstrm confl FBR_dwnstrm Rt. 70 bridge (Madison)*
Eurycea junaluska	Junaluska Salamander	Cheoah River_Joyce Kilmer Rd. bridge (Graham)
Eurycea junaluska	Junaluska Salamander	Cheoah River_Santeetlah Dam (Graham)

* New or Previously Undocumented Record

High-Elevation, Spruce/Fir Salamander Communities

High-elevation, spruce/fir forests are considered top priority habitats in the NC Wildlife Action Plan (2005; pg 65), and as some scientists speculate, will become more at risk from effects of climate change. In the spring of 2009, staff began focusing survey efforts in these habitats to document and monitor salamander communities; two priority salamanders targeted with these efforts include: Weller's Salamander (*Plethodon welleri*) and Pigmy Salamander (*Desmognathus wrighti*) (NCWRC 2005). In FY 2008-2009 a few surveys at Yancey County historical Pigmy Salamander sites (Mt. Mitchell, Bald Knob, and Armstrong Creek) and Weller's Salamander sites (Flattop Mountain) were unsuccessful. However, in other areas staff did document one new site for Pigmy Salamander and five for Weller's Salamander (Table 3).

Table 3. North Carolina Wildlife Resources Commission selected results for target salamander species from mountain region high-elevation, spruce/fir habitat surveys, FY 2008-2009.

TARGET SPECIES OBSERVED	COMMON NAME	SITE AND COUNTY
Desmognathus wrighti	Pigmy Salamander	Richland Balsam Nature Trail_several locations (Haywood)*
Plethodon welleri	Weller's Salamander	Unaka Mtn._AT_W of Beauty Spot_Unaka Mtn. Rd. (Mitchell)*
Plethodon welleri	Weller's Salamander	Unaka Mtn._Beauty Spot (Mitchell)*
Plethodon welleri	Weller's Salamander	Unaka Mtn._E of Beauty Spot (Mitchell)*
Plethodon welleri	Weller's Salamander	Unaka Mtn._AT_W of summit (Mitchell)*
Plethodon welleri	Weller's Salamander	Unaka Mtn._AT_E of summit (Mitchell)*

* New or Previously Undocumented Record

Green Salamanders

Staff and volunteers completed another year of long-term monitoring for Green Salamanders (*Aneides aeneus*) by conducting three independent surveys of each site in the same random subset (n=20) of all known sites that was chosen in 2005. Presence/absence data were analyzed using PRESENCE 2.2 software to generate a detection probability. This metric was monitored over the past four years for this same subset of sites 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 2008 was 86%, similar to that of 2005, 2006, and 2007 (81-82% each year) (Williams 2008). In an earlier three-year study (2002-2004) of a different random subset of known sites, staff observed almost identical detection probabilities of 82-85% (McGrath 2005). Staff and volunteers will revisit this methodology in

the future, monitoring new random subsets of all known sites; however, in the meantime efforts will focus on documenting new sites to expand the known distribution range for this species.

To summarize efforts in FY 2008-2009, a total of 170 samples were conducted at randomly-chosen and historical Green Salamander sites as well as new, potential sites. Green Salamanders were detected in 75 of the samples. Seven new locations were documented for this species, four in Dupont State Forest (Henderson, Transylvania Counties), two in a private development at Round Mountain (Transylvania County), and one at the Glen Falls Recreation Area (Macon County). Since beginning to monitor and inventory Green Salamanders in 2002, staff and volunteers have almost tripled the number of known locations for this species (Figure 1).

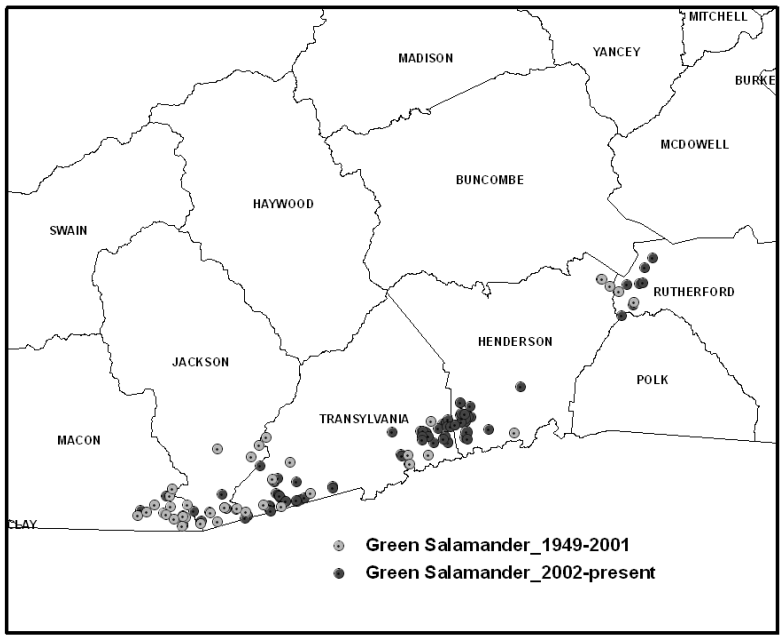

Figure 1. Historical occurrences (2001 and earlier) versus recently documented occurrences (2002-2009) for Green Salamander (*Aneides aeneus*) in the mountain region of North Carolina.

Other Target Salamanders

Staff and volunteers documented the continued presence of 17 target species at 13 different historical sites and 23 new, or previously unreported, sites (Table 4). Observations of common species were recorded and will be used in the future to track changes in salamander communities as monitoring continues over time.

Table 4. North Carolina Wildlife Resources Commission selected results for several target salamander species from mountain region surveys, FY 2008-2009.

TARGET SPECIES OBSERVED	COMMON NAME	SAMPLING METHODS USED	SITE(S) AND COUNTY
Ambystoma maculatum	Spotted Salamander	visual encounter surveys; egg mass counts; coverboard surveys	Sandy Bottom Preserve (Buncombe); Cheoah River pool (Graham)*; Nottely River_Die Bend (Cherokee); Dupont SF_Buck Forest Rd. pools (Henderson)*; Talulah bog (Graham); Richmond Hill Park (Buncombe)
Ambystoma opacum	Marbled Salamander	coverboard surveys	Nottely River_Die Bend (Cherokee)
Ambystoma talpoideum	Mole Salamander	coverboard surveys	Sandy Bottom Preserve (Buncombe)
Desmognathus aeneus	Seepage Salamander	visual encounter surveys; coverboard surveys	Talulah Bog (Graham)*; Clear Creek floodplain (Clay)*; Joyce Kilmer_Naked Ground Trail (Graham); Rainbow Springs creeks and seeps (Macon)
Desmognathus santeetlah	Santeetlah Dusky Salamander	visual encounter surveys	Cheoah River_riparian (Graham)*
Eurycea guttolineata	Three-lined Salamander	incidental observation; nighttime surveys	Jack Davis Branch (Cherokee)*; Hwy 129_Cheoah River (Graham); Joyce Kilmer Rd._Cheoah River (Graham); Foothills Trail_Horsepasture River W (Transylvania)*; Santeetlah Creek_Rattler Ford (Graham)*
Eurycea junaluska	Junaluska Salamander	nighttime surveys	Joyce Kilmer Rd._Cheoah River (Graham)
Eurycea longicauda	Longtail Salamander	visual encounter surveys; nighttime surveys	Nantahala River_below dam (Macon); Harmon Den_Cold Springs Rd. (Haywood)*
Hemidactylium scutatum	Four-toed Salamander	coverboard surveys	Sandy Bottom Preserve (Buncombe)
Plethodon amplus	Blue Ridge Gray-cheeked Salamander	visual encounter surveys	Bearwallow Mtn. fire tower (Henderson)*; Florence Preserve (Henderson)*; Alpine Mtn. subdivision (Buncombe)*; North side of Burntshirt Mtn. (Henderson)*
Plethodon glutinosus	Northern Slimy Salamander	visual encounter surveys; coverboard surveys; nighttime surveys	Joyce Kilmer Rd._Cheoah River riparian (Graham)*

TARGET SPECIES OBSERVED	COMMON NAME	SAMPLING METHODS USED	SITE(S) AND COUNTY
Plethodon meridianus	South Mountain Gray-cheeked Salamander	visual encounter surveys	South Mountain Game Land (Cleveland)*
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); Rainbow Springs_floodplain pool (Macon); Roaring Fork (Macon)*; Winespring Bald (Macon)*; Wayah Creek (Macon)*; Wayah Bald (Macon)*; Wilson Lick (Macon)*; Robin Branch (Macon)*
Plethodon ventralis	Southern Zigzag Salamander	coverboard surveys	Richmond Hill Park (Buncombe)
Plethodon wehrlei	Wehrle's Salamander	nighttime surveys	Saddle Mtn. (Surry); Bullhead Mtn. State Natural Area (Alleghany)
Plethodon yonahlossee pop. 1	Crevice Salamander	visual encounter surveys	Bearwallow Mtn. fire tower (Henderson)*; Florence Preserve (Henderson)*; North side of Burntshirt Mtn. (Henderson)*

* New or Previously Undocumented Record

Frogs

As a Special Concern and priority species, Mountain Chorus Frog (*Pseudacris brachyphona*) continues to require further study. Historically, from 1949 to 2005 only seven locations were known, all in Cherokee County. Eight new locations in Cherokee County were documented in 2008 (Williams 2008), and on the rainy night of March 26, 2009, staff documented another 22 new sites (and one across the border in Polk Co., TN) (Figure 2). Digital sound recordings were made to confirm species identity. This species will continue to be monitored each spring with concerted efforts to document previously unknown sites within and outside of Cherokee County.

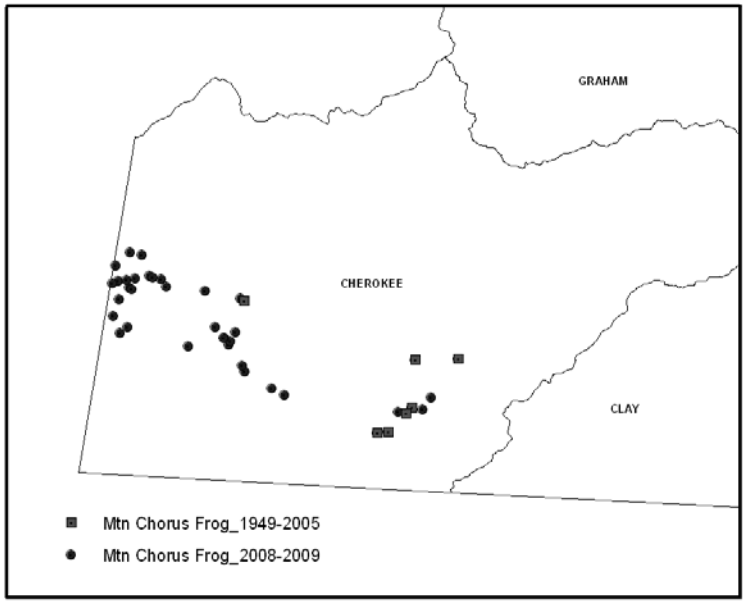

Figure 2. Historical occurrences (2005 and earlier) versus recently documented occurrences (2008-2009) for Mountain Chorus Frog (*Pseudacris brachyphona*) in Cherokee County, North Carolina.

B. Target Dates for Achievement and Accomplishment

On schedule

C. Significant Deviations

None

D. Remarks

The majority of historical and newly discovered sites for Mountain Chorus Frogs are in 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 could be in jeopardy.

Overall, the mountain amphibian project will experience a shift in some areas of focus beginning in FY 2009-2010. Staff will concentrate on documenting new sites for Green Salamanders instead of continuing to monitor the same subset of sites with three independent samples. Inventorying salamander communities in high-elevation, spruce/fir forests will be considered a priority for survey work. Likewise, as time and resources permit, staff will seek opportunities to

partner with other agencies and other programs within the NC Wildlife Resources Commission to monitor long-term effects of land management activities such as prescribed fire and/or silviculture on amphibian communities and habitats.

E. Recommendations

Data sharing, collaboration, and coordination of survey efforts must continue with academic researchers, other state and federal agencies, NGOs, and private individuals to ensure an efficient and extensive coverage of western North Carolina amphibian surveys.

The inherently 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 (such as was experienced in 2007-2008) 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 could become a priority, as well as long-term monitoring to gauge effects such activities might have on local amphibian populations.

F. Estimated Cost

$77,585 (Including in-kind contributions)

G. References

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Prepared by: Lori A. Williams
Mountain Wildlife Diversity Biologist
Division of Wildlife Management

Final Annual Performance Report

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

Period Covered: July 1, 2008 – June 30, 2009

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

Study Title: Western North Carolina Small Mammal Surveys

Objectives:

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 continued survey efforts of select small mammal communities throughout western North Carolina (hereafter termed mountain region). Species occurrence records in the mountain region were compiled from the NC Natural Heritage Program database (Table 1). Areas previously surveyed in 2003-2008 were mapped using ArcGIS in conjunction with historical locations of target species from the Natural Heritage Program 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.

Table 1. 2008-2009 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
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

The only significant survey effort this fiscal year was directed towards the expansion of the known water shrew distribution. Incidental observation and capture data were also incorporated into the NC Wildlife Resources Commission's mammal database.

Thirty-two trap nights (25 snap and 7 pitfall) along Sand Creek in Graham County yielded eight mammal captures representing four species, one of which was a water shrew (state and federal special concern) (Table 2). Incidental observations of a meadow vole (*Microtus pennsylvanicus*) during a bog turtle survey and a fresh latrine of a Southern Appalachian woodrat (*Neotoma floridana haematoreia*) during a green salamander survey were reported (Table 2). An additional noteworthy finding came from the WNC Nature Center in Asheville, NC when a least weasel (significantly rare) was reportedly found injured on the side of a road in Buncombe County and brought to their facility for rehabilitation. The weasel has recovered and is currently on display at the Nature Center.

Table 2. North Carolina Wildlife Resources Commission small mammal incidental observation/survey locations and species assemblages in the mountain region, July 1, 2008 to June 30, 2009.

Site name	County	Property	Start Date End Date	Species	N
Sand Creek	Graham	USFS	08-Sep-08 09-Sep-08	*Myodes gapperi*	5
				Peromyscus maniculatus	1
				Blarina brevicauda	1
				Sorex palustris	1
					8
Granite City	Jackson	USFS	27-Oct-08	*Neotoma floridana haematoreia*	**1**
Hurricane Creek Bog	Macon	USFS	15-Jul-08	*Microtus pennsylvanicus*	**1**
Unknown Road	Buncombe	NCDOT	29-Jul-08	*Mustela nivalis*	**1**

B. Target Dates for Achievement and Accomplishment

Mammal sampling was hampered by loss of staff in the agency and a limited effort was undertaken on this project during its final year. Overall, significant achievement was obtained to enhance our knowledge of small mammal distribution in North Carolina.

C. Significant Deviations

During this fiscal year the Wildlife Diversity program experienced staff turnover during a time of budgetary constraints. Unfortunately the small mammal project leader resigned during this period which resulted in the inability to fill the position vacancy. Activities reported in this document occurred from July to November 2008 at which time the position was vacated.

D. Remarks

Wildlife Diversity staff continue to gain a better understanding of small mammal biology and distributions throughout the mountain region. The water shrew capture in Graham County along Sand Creek fills in a distributional gap and is a new county. Additionally, we continue to gather information from citizens that have incidentally observed or captured least weasels. The injured weasel found in July 2008 on the side of a road in Buncombe County follows two other recent observations from a county resident when two weasels were observed and photographed in their basement window well in July 2007. Although weasel surveys have been unsuccessful to date, 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 may continue over a period of several years to continue to gather baseline information on the current distribution and population status of priority species. Information gained will be critical to conservation strategies that will ensure the continued existence of priority species in North Carolina.

E. Recommendations

Survey efforts should continue throughout western North Carolina to document the presence and distribution of priority 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

$11,171 (Including in-kind contributions)

Prepared By: Kendrick Weeks
Mountain Region Wildlife Diversity Supervisor
Division of Wildlife Management

Final Annual Performance Report

State: North Carolina

Project Number: T - 9
Amendment Number: 1

Period Covered: July 1, 2008 – June 30, 2009

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 2009 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.

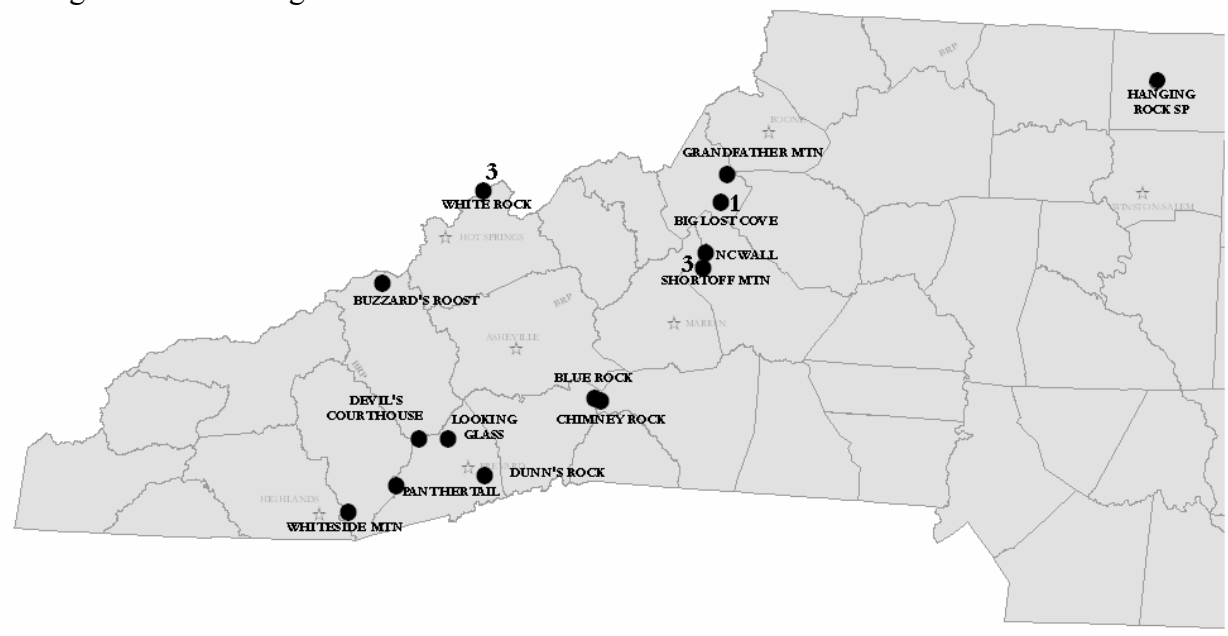
The survey followed protocol set forth in the U.S. Fish and Wildlife Service Monitoring Plan for the American Peregrine Falcon (USFWS 2003). Efforts focused on the 13 territories surveyed in 2008 (Kelly 2008) with a combined effort of 243 observer hours (Table 1). Of the twelve occupied monitoring sites, nestlings and/or fledglings were confirmed at only three sites (Table 1 and Figure 1). Three secondary sites (Victory Wall, Pickens Nose, and Roan Mountain) were checked for falcons, but time constraints prevented complete four-hour observation sessions.

Table 1. Peregrine Falcon survey efforts at territories in western North Carolina, 2009.

SITE	OBSERVER HOURS	FALCONS OBSERVED	PAIR PRESENT	DETECTED NESTLINGS >28 days old	OBSERVED FLEDGED
Big Lost Cove	20	Yes	Yes	Yes	Yes-1
Hickory Nut Gorge (Blue Rock and Chimney Rock)	35	Yes	Yes	No	No
Devil's Courthouse	18.5	Yes	Yes	No	No
Grandfather Mountain	>20	Yes	Yes	No	No
Hanging Rock State Park	18.5	No	No	No	No
Shortoff Mountain	6	Yes	Yes	Yes- 3	No[a]
NC Wall	15	Yes	Yes	No	No
Looking Glass Rock	16.5	Yes	Yes	No	No
Panthertail Mountain	13.25	Yes	Yes	No	No
Buzzard's Roost	5.25	Yes	Yes	No	No
White Rock Cliff	7	Yes	Yes	No[b]	Yes- 3
Whiteside Mountain	41	Yes	Yes	No	No
Dunn's Rock	27	Yes	Yes	No	No
TOTAL	243	12 Sites	12 Sites	2 sites	2 Sites

[a] at last observation session, nestlings were old enough to count toward nest success (>28 days, per USFWS protocol), but had not yet fledged.
[b] nestlings never detected; first detected after fledging

Figure 1. Peregrine falcon territories in North Carolina, showing number of nestlings detected during the 2009 nesting season. No number indicates nest failure.



Site Summaries- Primary Sites

Although numerous pair bonds were observed early in the nesting season, very few chicks or fledglings were later observed, and nest failure was confirmed for nine out of thirteen sites monitored (Table 2).

Table 2. North Carolina Wildlife Resources Commission initial observation dates of nesting chronology phases for peregrine falcons at 13 sites in western North Carolina, 2009.

SITE	BONDED PAIR	INCUBATION	CHICKS (Number)	FLEDGLINGS Date (Number)	CONFIRMED FAILURE [a]
Big Lost Cove	April 6		July 7	July 27 (1)	
Chimney Rock	April 5	April 5			May 16
Devil's Courthouse	March 30	March 30			May 13
Grandfather Mountain	April 21				May 12
Hanging Rock State Park					n/a
Shortoff Mountain	March 4		April 27 (3)	[b]	
NC Wall	March 6				April 25
Looking Glass	April 8				April 21 & rechecked June 16
Panthertail Mountain	March 5	March 5			April 29 & rechecked July 14
Buzzard's Roost	March 23	March 23			May 18
White Rock Cliff	April 24			June 23 (3)	
Whiteside Mountain	March 31 and May 19	March 23			July 14
Dunn's Rock	March 30				May 18

[a] In most cases, nest failure was suspected well before it was confirmed.

[b] Confirmed nestlings >28 days of age earlier in season, but unable to return to document fledging.

Site Summaries- Secondary Sites

Staff and time shortages permitted only cursory surveys of three secondary sites. An adult peregrine falcon exhibited territorial circling during an observation session at Victory Wall (Haywood County) on June 6, 2009. An accumulation of white wash and scattered downy white feathers on a nest ledge, along with prey remains at the base of the cliff suggest a nesting attempt. However, nesting could not be confirmed during a follow up visit; given the lateness of the season, the nest could already have failed or the young could already have fledged. The peregrine falcon biologist followed up on a report of falcons at Pickens Nose in Macon County in April. A brief observation session and use of audio playback was unsuccessful; a longer observation session is warranted at this site, earlier in the season. The Roan High Bluff platform was visited briefly in mid April after a day of flying squirrel surveys. A pair of common ravens was very active in the vicinity of Roan High Bluff. No falcons were seen or heard, but additional observations are warranted.

Technical Guidance

In this official monitoring year, ten years following delisting, a cooperative effort was made by NCWRC, USFWS, and U.S. Forest Service to highlight successes of peregrine falcon recovery and to increase awareness of cliff closures. NCWRC provided technical guidance to the USFWS in the preparation of a press release geared toward rock climbers to request their continued cooperation in adhering to cliff closures. There were no new cliff closures this year. NCWRC recommended that the U.S. Forest Service renew the closure order, set to expire in January 2009, for another five years.

B. Target Date for Achievement and Accomplishment

On schedule.

C. Significant Deviations

None

D. Remarks

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

The USFWS 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 observed at >28 days old per occupied territory. In North Carolina, although site occupancy was high (92%), nesting success and productivity in 2009 were lower than the 1999-2002 national average (Table 3). Productivity of 1.0 – 2.0 should result in at least a stable population. These estimates were also below the "thresholds for Agency response" set by the USFWS (i.e., <90% Confidence Intervals). However, these "response triggers" are evaluated at a regional scale and are considered in the context of various factors contributing to nest failure; they do not automatically prompt a proposal to relist. These numbers will be sent to the USFWS to combine with results from the southeastern region and then compared to national numbers. While North Carolina's peregrine falcon population is small in comparison to western states, it was given close consideration in the 2006 monitoring year report (USFWS 2008).

Table 3. North Carolina Wildlife Resources Commission peregrine falcon population health indices; western North Carolina 2009 – vs – national average.

	TERRITORIAL OCCUPANCY	NEST SUCCESS	PRODUCTIVITY
North Carolina (2009)	92% (12 of 13 sites)	25% (3 confirmed of 12 pairs)	*0.58 (7 young/12 nesting pairs)
National Average (recent years)	84%	68%	1.2 – 1.9

* Young fledged at one site before we could obtain a complete count of nestlings (Big Lost Cove), so productivity may have been higher.

Population Parameters in WNC: 2009 –vs- Past Years

Nest failure was widespread this year, with only three successful nests from twelve occupied territories. The Moore's Wall territory at Hanging Rock State Park was unoccupied this year. Although exact causes of nest failure could not be determined, several potential contributing factors are worth noting. Total rainfall in April was normal, but there were isolated periods of heavy rainfall and cool temperatures in early to mid April that corresponded to typical timing of incubation or hatching at some of the sites in the southern mountains. This may have impacted nesting attempts at Devil's Courthouse and Buzzard's Roost. While cold, wet weather is a known contributor of nest failure, most nests failed prior to May, when western North Carolina received twice the normal amount of monthly rainfall. One pair delayed egg-laying until mid May (Big Lost Cove).

The presence of young, inexperienced birds could contribute to nest failure. There is evidence of population turnover with several second year birds (by plumage) on territory in recent years: three second-year birds in 2008 (White Rock, Grandfather Mountain, and Chimney Rock) and two second-year males in 2009 (Panthertail and Dunn's Rock). There was a second-year female at White Rock Cliff in 2008; this year the female had an overall blond wash of a sub-adult bird. Sub-adult birds usually are not successful, but NCWRC has documented a few successful nesting attempts by young birds. As the population increases, invasion of territories by unpaired "floater" birds could present a nuisance to a nesting pair, as appears to have been the case at NC Wall and Whiteside Mountain this year. The origin of NC's rising peregrine population remains unknown. To date, no banded birds have been observed, despite extensive banding efforts in West Virginia and Virginia and satellite telemetry data showing brief post-fledging dispersal into western NC from these states (NPS 2009; VA Falcons 2009). Recreational human use at cliffs appears to be increasing, reinforcing the need for seasonal closures on nest sites. Disturbance from recreational activities may have interfered with nesting at Looking Glass Rock and Whiteside Mountain. The degree to which predation is a problem at nests is not known.

Widespread nest failure in some years is a reminder that continued monitoring of NC peregrines is important for determining natural demographic fluctuations versus real population declines. Occupancy is fairly high at most sites, but varied at some, in part due to difficulty in detecting birds in extensive remote cliff habitat (e.g., Grandfather Mountain) (Table 4). Shortoff Mountain is the most consistently successful site, contributing young to NC's growing population in over 90% of nesting attempts. Four sites have produced over 20 nestlings each since monitoring began at these sites. Though nest success has been more variable at Whiteside Mountain, over 20% of NC's total fledglings hatched here. The 2009 monitoring year had the lowest observed offspring produced since delisting 10 years prior (Figure 2). After a decrease in productivity in the late 1990's, the period 1999 to 2008 was fairly strong (Figure 3).

Table 4. Summary of peregrine falcon territory occupancy, nest success, and productivity in western North Carolina, 1987-2009.

SITE	# years surveyed (1st year)[1]	# years occupied (percent[1])	# years successful (percent)	total # fledglings	# fledglings/ years surveyed	# fledglings/ years occupied	# fledglings 2009
Big Lost Cove	13 (1997)	13 (100%)	6 (46%)	9	0.69	0.69	1
Chimney Rock	21 (1989)	19 (90%)	2 (10%)	3	0.14	0.16	0
Devil's Courthouse	11 (1999)	11 (100%)	8 (72%)	14	1.27	1.27	0
Grandfather Mountain	20 (1990)	12 (60%)[2]	4 (33%)	9	0.45	0.75	0
Hanging Rock State Park	10 (2000)	7 (70%)	2 (28%)	2	0.20	0.29	0
Shortoff Mountain	12 (1998)	11 (92%)	10 (91%)	24	2.00	2.18	3
NC Wall	16 (1987)	14 (87%)	3 (21%)	5	0.03	0.36	0
Looking Glass	22 (1988)	22 (100%)	12 (54%)	31	1.41	1.41	0
Panthertail Mountain	17 (1993)	17 (100%)	11 (64%)	27	1.59	1.59	0
Pigeon River Gorge	6 (2004)	6 (100%)	3 (50%)	10	1.67	1.67	0
White Rock Cliff	22 (1988)	19 (86%)	7 (37%)	13	0.59	0.68	3
Whiteside Mountain	22 (1988)	22 (100%)	17 (77%)	43	1.95	1.95	0
Dunn's Rock	3 (2007)	3 (100%)	1 (33%)	2	0.67	0.67	0
Table Rock	4 (2006)	2 (50%)[3]	1 (50%)	3	0.75	1.50	0
Total	-	-	-	195			7
Mean (SE)	-	-	-		0.96 (0.18)	1.08 (0.17)	

[1] Not all sites were surveyed annually. E.g., NC Wall has been surveyed intermittently for just 16 years since 1987. Percentage adjusted for number of years surveyed.
[2] Detection of the resident pair at Grandfather Mountain is extremely difficult and may have resulted in reports of false absences some years.
[3] In 2008, the resident pair at north end of Linville Gorge relocated from Table Rock to NC Wall.

Figure 2. North Carolina Wildlife Resources Commission data regarding peregrine falcons hacked, pairs observed, and number of offspring in North Carolina, 1984-2009.

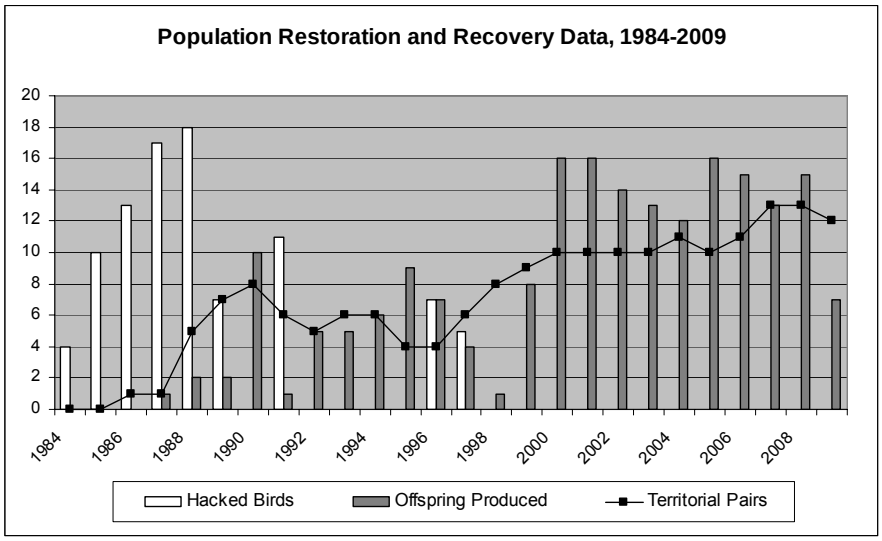
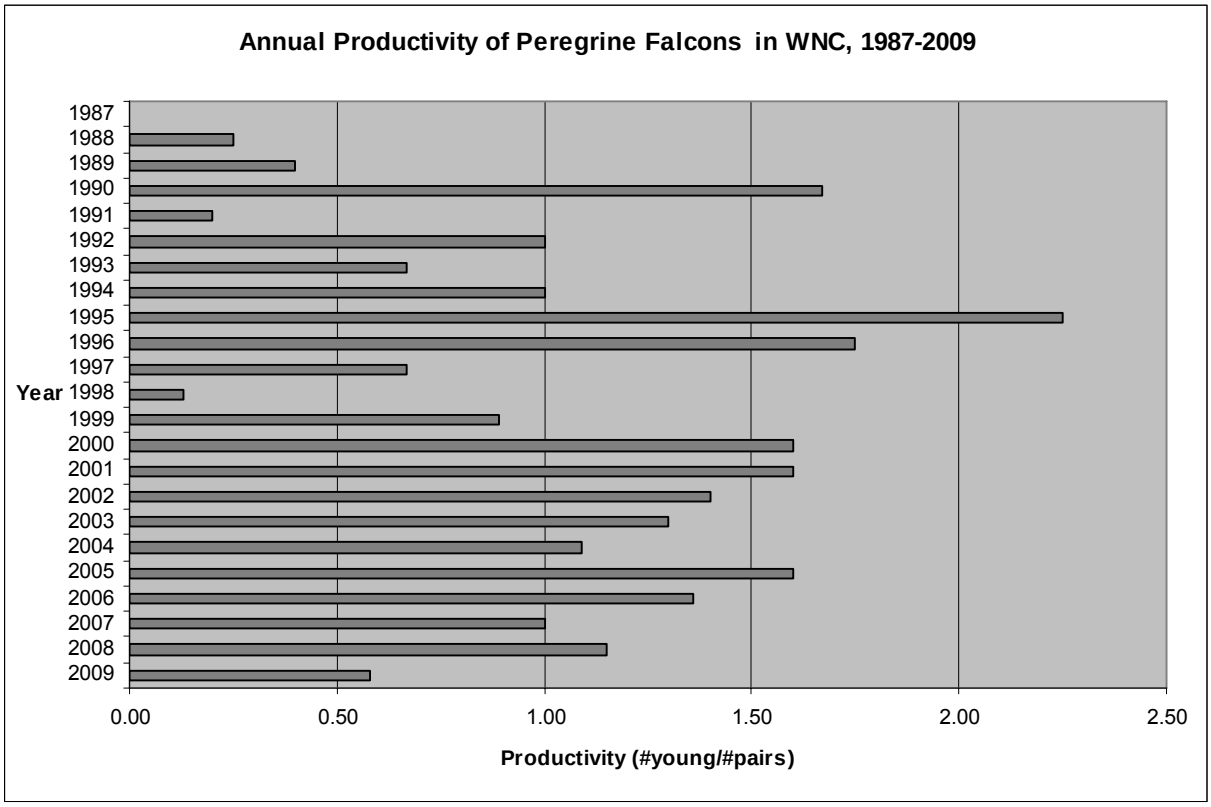


Figure 3. Annual productivity of peregrine falcons, 1987-2009.



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. Time constraints, difficult access, and dangerous conditions for those involved have prevented implementation of this aspect of nest monitoring.

E. Recommendations

Because there is insufficient time to conduct an inventory of new sites and keep up with monitoring of known sites, NCWRC's efforts in 2010 will focus on an inventory of suitable cliff habitat for new nesting pairs, at the expense of full monitoring of known occupied sites. A few dedicated volunteers will be enlisted to help monitor some known sites in order to advise the U.S. Forest Service on updates to the cliff closure throughout the season. The U.S. Forest Service has also been asked to contribute to monitoring on National Forest sites in order to free up time for NCWRC to focus on an inventory survey. This project is being rolled into the broader NCWRC Mountain Region Bird Conservation project.

F. Estimated Cost

$21,713 (including in-kind contributions)

G. References

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Final Annual Performance Report

State: North Carolina

Project Number: T - 9
Amendment Number: 1

Period Covered: July 1, 2008 – June 30, 2009

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

Project Title: Western North Carolina Songbird Inventory

Objectives:

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

A. Activity

Game land Songbird Surveys

Surveys were conducted, following the established point system layout and protocol (Kelly, 2008) on the Big Hungry section of Green River Game Land. Thurmond Chatham game land was not surveyed due to unsuitable weather and time constraints. Relative to the Green River Cove Road section, the Big Hungry section is characterized by a greater component of mature forest, recently burned or thinned forest, and a lesser component of clearcuts, open fields, and food plots. Elevations of survey locations ranged from 1,650 to 2,700 feet on Laurel Mountain. Surveys of the Big Hungry section of Green River game land in 2009 yielded 493 individual birds, comprised of 40 species. The five most abundant species of Neotropical migrants in 2009 were red-eyed vireo, hooded warbler, ovenbird, black-throated green warbler, and indigo bunting. Winter wren, a non-nesting migrant, was a new addition to the list of species detected on point counts. Additional non-nesting migrants detected in mid May included Swainson's thrush. The game land's species total is 85, including both breeders and non-breeders.

Table 1. Green River game land bird relative abundance, based on point counts 2006, 2007, 2009 in the Big Hungry section[1].

Species[2]	Number detected 2009	Number detected 2007	Number detected 2006
Red-eyed vireo	60	36	58
Hooded warbler	50	23	38
Ovenbird	49	33	42
Black-thr. green warbler	37	14	18
Eastern towhee	36	34	32
Carolina wren	25	30	27
Eastern tufted titmouse	24	12	31
Blue-headed vireo	16	14	7

Species[2]	Number detected 2009	Number detected 2007	Number detected 2006
Indigo bunting	16	25	25
Scarlet tanager	15	20	40
Blue jay	14	16	9
Pileated woodpecker	13	13	10
Black and white warbler	12	8	16
Eastern wood-pewee	12	11	15
American crow	11	17	29
Mourning dove	11	11	3
Acadian flycatcher	10	6	7
Wood thrush	10	17	24
Worm-eating warbler	9	9	15
Carolina chickadee	7	7	7
Northern cardinal	7	9	11
White-breasted nuthatch	7	3	17
American goldfinch	5	15	11
Blue-gray gnatcatcher	5	0	5
Downy woodpecker	5	8	2
Pine warbler	4	0	1
Prairie warbler	4	0	3
Cedar waxwing	2	9	9
Chimney swift	2	1	0
Hairy woodpecker	2	0	3
Northern parula	2	2	2
Swainson's thrush	2	0	1
Yellow-shafted flicker	2	1	2
Belted kingfisher	1	0	0
Broad-winged hawk	1	0	1
Chipping sparrow	1	0	0
Field sparrow	1	0	0
Wild turkey	1	0	0
Winter wren	1	0	0
Yellow-breasted chat	1	0	0
American redstart	0	0	0
American robin	0	0	1
Barred owl	0	0	0
Blackburnian warbler	0	0	0
Blackpoll warbler	0	0	1
Blue grosbeak	0	0	0
Brown-headed cowbird	0	0	0
Canada goose	0	0	0
Cerulean warbler	0	0	0
Common grackle	0	0	0
Common yellowthroat	0	0	1
Eastern bluebird	0	0	1
Eastern kingbird	0	0	0
Eastern phoebe	0	0	2
Eastern screech owl	0	0	0
Great-crested flycatcher	0	0	0
House wren[3]	0	0	0

Species[2]	Number detected 2009	Number detected 2007	Number detected 2006
Kentucky warbler	0	0	1
Louisiana waterthrush	0	0	0
Red-bellied woodpecker	0	0	4
Ruby-thr. Hummingbird	0	0	2
Summer tanager	0	0	0
Swainson's warbler	0	0	0
Turkey vulture	0	0	0
Whip-poor-will	0	0	1
White-eyed vireo	0	0	0
Yellow-billed cuckoo	0	0	1
Yellow-throated vireo	0	0	1
Yellow-throated warbler	0	0	0
Brown thrasher	0	0	3
Gray catbird	0	0	1
Song sparrow	0	0	1
Total	493	404	542

[1] Routes AE, BC, G, FGQ; Species observed just in the last three surveys are shown in table.
[2] 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.
[3] Recorded one "new" species, house wren, not detected in previous years on a point count.

Nightjar Survey

In an effort to address conservation of priority species, the nightjar survey was carried out again in 2009. 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. The objectives in 2009 were to continue our effort to obtain baseline data, provide more data for fine-tuning the national standardized survey protocol, obtain data that will guide research into habitat conservation, and develop a volunteer pool.

We used methods developed by NCWRC, the Northeast Nightjar Monitoring Program, and the Southeast U.S. Nightjar Survey (Hunt 2007, Kelly 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 (Wilson and Watts 2006). Surveys were conducted once within a 16 day window around the June 7, 2009 full moon. Eighteen routes were surveyed this year in 15 counties in the Mountains, Foothills, and western Piedmont (Table 2, Figure 1). This included one new route in the Foothills. In an effort to obtain basic landscape data, volunteers were asked to record the general habitat type and the number of houses visible at each survey point. A few routes that documented significant numbers of whip-poor-wills in 2007 and 2008 were not surveyed in 2009 due to volunteers' availability and weather constraints.

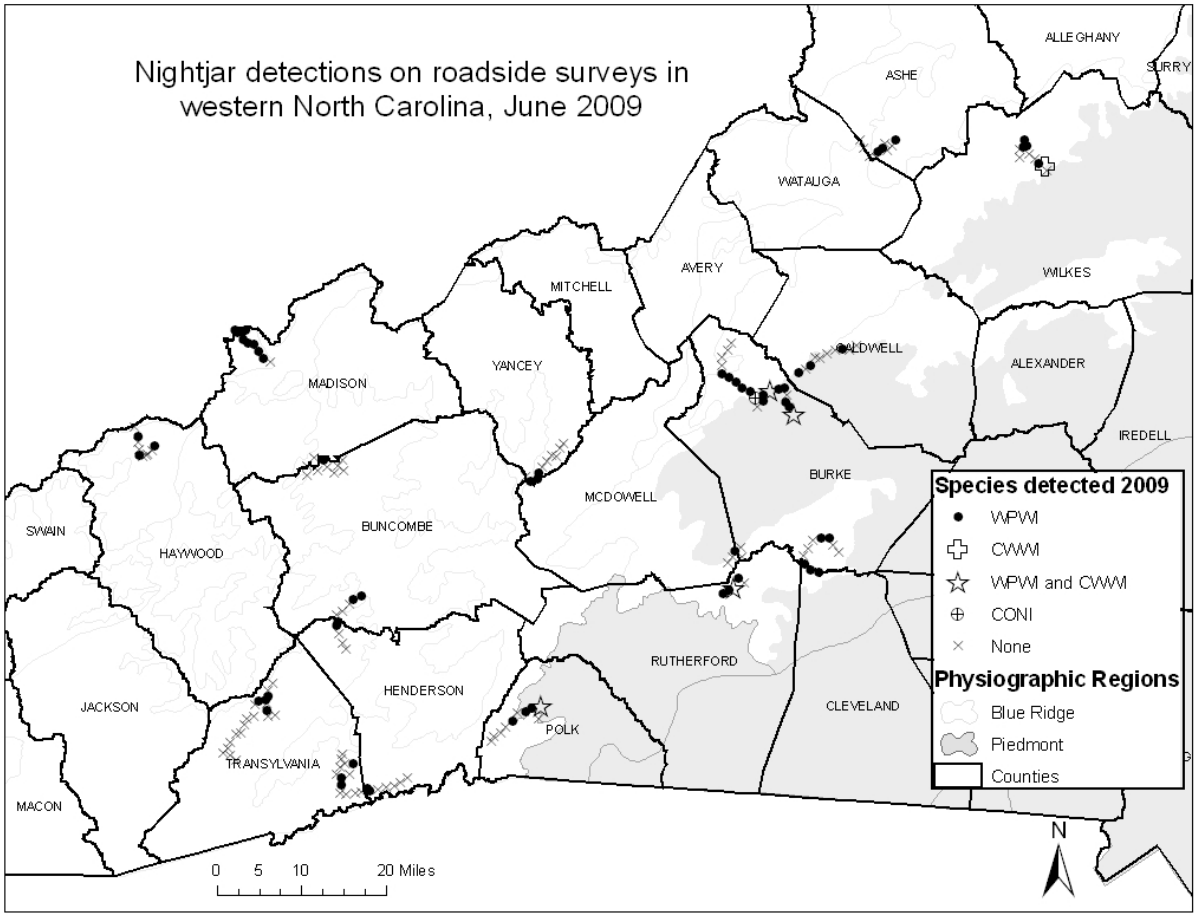
Table 2. Distribution of nightjar survey routes, whip-poor-wills (WPWI), and chuck-will's-widow (CWWI) by physiographic region.

Region	# of routes[1]	# routes with WPWI	# routes with CWWI
Mountains	10	9	0
Foothills[2]	5	5	3
western Piedmont	2	2	1

[1] Analyses are based on 17 of 18 routes for which data were collected according to protocol.

[2] Two routes in the South Mountains area; three below the Blue Ridge Escarpment

Figure 1. Nightjar detections on roadside survey routes in western North Carolina, June 2009.



Whip-poor-will detections were higher on the western Piedmont and Foothills routes than Mountain routes (Table 3). Chuck-will's widows were encountered on four routes in five counties (Burke, McDowell, Polk, Rutherford, and Wilkes). Of these routes, chuck-will's widow was documented in the Foothills in Polk County; the remainder was found in the western Piedmont. Both species were detected on each of these four survey routes. Furthermore, both species were detected at the same survey point on three occasions; once on a Foothills route in Polk County, once on a Foothills route traversing McDowell and Rutherford Counties, and twice

on a western Piedmont route in Burke County (Figure 1). A common nighthawk was recorded for the first time in the three year history of this survey, at a survey point in Burke County. Observers also tallied calling owls and documented the presence of eastern screech owl, great-horned owl, and barred owl. Incidental observations were collected from three mountain counties where roadside surveys have not been conducted in the three year history of this project. Both whip-poor-wills and chuck-will's widows were documented in Cherokee, Graham, and Jackson Counties. This project also generated interest and reports from North Carolina birders, suggesting a possible expansion in the range of chuck-will's widow in the western Piedmont and displacement of whip-poor-will.

Table 3. Mountain, Foothills, and western Piedmont regions summary of western NC nightjar survey results for June 2009. WPWI = whip-poor-will. CWWI = chuck will's widow.

	Mountains	**Foothills**	**Western Piedmont**
# routes surveyed	10	5	2
# routes with WPWI	9 of 10	5 of 5	2 of 2
Max # WPWI	45	35	18
# WPWI per route (S.E.)	4.5 (1.39)	7.0 (0.55)	9.0 (4.00)
# WPWI per route with WPWI (S.E.)[1]	5.0 (1.45)	7.0 (0.55)	9.0 (4.00)
# routes with CWWI	0 of 10	3 of 5	1 of 2
# CWWI	0	4	2

[1] Total number of WPWI divided by number of routes where WPWI were detected.

B. Target Dates for Achievement and Accomplishment

On schedule

C. Significant Deviations

None

D. Remarks

Game land Songbird Surveys

Changes in counts of three priority songbirds are noteworthy: Hooded warbler numbers increased by 40% from 2007, possibly reflecting a regenerating shrub-sapling layer in several managed units. Prairie warblers were detected on transect BC for the first time this year where the woods have been repeatedly burned, creating an open oak-pine woodland structure. This species was documented on another transect (AE) traversing patches of regenerating clear cut for the second time since 2006.

Nightjar Survey

The 2009 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 (Table 3). As with the 2008 data, the 2009 data will also be submitted to the national database managed by the

Northeast Nightjar Monitoring Program (http://www.nhaudubon.org/detail.php?entry_id=421 and http://www.nebirdmonitor.org/framework/workgroups/nightbirds/nightjar08summary/view). The number of routes for which general habitat descriptors and number of houses were tallied this year was insufficient for meaningful analysis. These data can be collected at any time of year. 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.

E. Recommendations

Western region bird conservation efforts should focus future efforts on (1) collecting baseline data on other western region game lands, (2) investigating species response to active management, (3) collaborating on conservation efforts for high elevation bird communities, and (4) developing a plan for the survey, study, and management of additional priority species.

The first two focus areas will capitalize on opportunities in the NCWRC game land system, as well as other actively managed tracts. Collection of data before and after habitat management treatments will inform technical guidance that is frequently sought by other land managers and often lacking for the Southern Appalachians. NCWRC will guide mountain bird survey efforts in partnership with the Appalachian Mountain Joint Venture, which provides an opportunity to collaborate on bird conservation in high elevations, using standardized protocols, toward common goals. Lastly, similar to the nightjar project, strategies will be outlined for other priority species that are not well represented by existing efforts (e.g., barn owl).

Specific changes will be implemented to address program modifications and limited staff time. Staff is working with the Southeast Nightjar Survey Network to transfer management of the nightjar roadside survey to the regional coordinator. NCWRC will shift its focus to the next steps for nightjar conservation (e.g., habitat management studies), in collaboration with regional efforts. While NCWRC may not directly coordinate nightjar volunteers, it will encourage citizen participation in nightjar conservation efforts to help answer questions about habitat loss or population declines. Finally, peregrine falcon inventory, monitoring, and technical guidance on cliff closure management will be carried out under the western region bird conservation project.

F. Estimated Cost

$17,413 (including in-kind contributions)

G. References

Hunt, P. 2007. *Northeast Nightbird Monitoring* proposal to American Bird Conservancy.

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Prepared By: Chris Kelly
Division of Wildlife Management

Final Annual Performance Report

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

Period Covered: July 1, 2008 – June 30, 2009

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

The Carolina northern flying squirrel project consisted of both winter nest box surveys as well as trapping and establishment of nest boxes in suitable habitat within and outside of recovery areas. Considerable time was also spent providing technical guidance to conservation partners.

After an experimental survey in 2008, concentrating efforts on the Great Balsams, the traditional nest box network spanning seven geographic recovery areas was surveyed in winter 2009. Of these, all productive transects were surveyed except in the Smokies where only one transect was surveyed due to limited staff and time. With the exception of a stand-alone project in the Unicois that required additional survey effort, each box was checked just once for northern flying squirrels or nests. Captured animals were weighed, measured, ear-tagged, and released.

The nest box network was expanded to other sites within and outside of recovery areas during the summer, 2008. Twenty-one boxes were posted along the under-sampled 3800 to 4500 feet elevation gradient in the Unicoi Mountains recovery area in northern hardwood forest. Six boxes were posted around Alarka Laurel spruce bog (Swain County), one of the southernmost and lowest elevation spruce stands. Though habitat was atypical in this spruce bog, consisting of red spruce mixed with more xeric oak species (e.g., chestnut oak, etc), the investment to post and check boxes in a few years was minimal. The flying squirrel biologist also assisted with nest box surveys on the Cherokee Reservation and on Mt. Pisgah.

NCWRC and NC State Parks partnered on a live-trapping effort at Sugar Mountain Bog significant natural area (Avery County) in October 2008 to supplement new nest box surveys.

The flying squirrel biologist had an opportunity to tour the Long Hope Valley recovery area in May, 2009, and conduct a cursory habitat survey.

Technical Guidance

NCWRC submitted comments on three proposals from the National Forests in North Carolina. First, NCWRC provided recommendations for protecting the integrity of limited northern hardwood and hemlock forest and for enhancing the conifer component within a timber sale analysis area in the Unicoi Mountains (Nantahala National Forest). Second, recreation facilities upgrades at Roan Mountain (Pisgah National Forest) were reviewed for impacts to northern flying squirrels. Third, initial recommendations were made for management of woody encroachment onto the Roan Mountain balds; a site visit with the Forest Service is pending. Also this year, NCWRC responded to a request for technical guidance from biologists on the neighboring Cherokee National Forest about their proposal to establish a nest box network in the Unicoi Mountains and Roan Mountain.

Other habitat assessments consisted of a site visit to the Cherokee Reservation to review a rock harvesting permit and a road reconstruction proposal. NCWRC also provided initial feedback to the U.S. Fish and Wildlife Service on a housing development in the Plott Balsams; a site visit is pending permission from the property owner.

NCWRC reviewed four endangered species permits (two consultants, one NC State Parks biologist, and one university researcher) and coordinated with a researcher regarding a genetics study proposal. The flying squirrel biologist also provided initial training in live-trapping and handling techniques to NC State Parks biologists.

Results

Between late November and mid April, staff conducted checks of boxes in the Unicois, Smokies, Great Balsams, Plott Balsams, Black and Craggy Mountains, Grandfather Mountain, and Roan Mountain.

Altogether, 118 NFSQs were detected including 13 previously tagged individuals (Table 1). Eighty-nine of these 118 animals were fitted with ear tags for the first time. Sixteen of the 118 squirrels were either seen leaving the box or escaped before the observer could determine whether or not the animal had an ear tag.

Active nests can provide some insight, albeit limited, into the squirrel's presence in an area. In total, 222 boxes contained NFSQ nests, although just 55 of the 222 were occupied by NFSQs. Overall, across all GRAs, 33% of boxes were found to contain nest material identified as NFSQ nests (Table 2). However, only 25% of those nests and just 8% of all boxes we checked were occupied by NFSQs. Due to recent colonization of more boxes in the Daniel Boone Trail area of Grandfather Mountain, an impressive 49% of boxes in this recovery area contained active nests, several of which were boxes that had not previously contained flying squirrel nests.

Squirrel detections fluctuated once again this year. While the number of nests remained relatively steady, captures increased dramatically in the Great Balsams and decreased in the Black and Craggy Mountains (Figure 2). In contrast, an increase in detections on Grandfather Mountain was associated with a 72% increase in nests, suggestive of colonization of that area or those boxes within the last two years.

Table 1. North Carolina Wildlife Resources Commission northern flying squirrel capture summary, 2009.

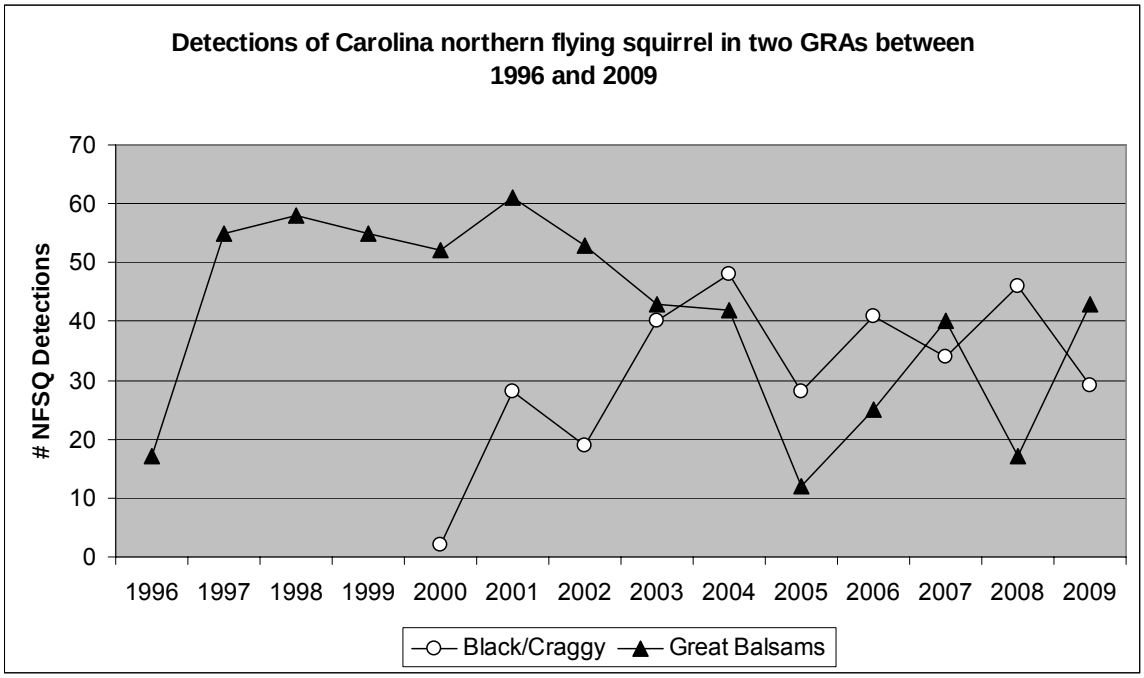
Mountain Range/GRA	# Boxes Checked[1]	# NFSQ Detected	# Recaptures	# NFSQ Newly Tagged
Black & Craggy Mtns	180	**29**	8	18
Great Balsams	210	**43**	2	34
Unicoi Mountains	68	**4**	1	3
Plott Balsams	48	**13**	0	13
Roan Mountain	41	**5**	2	3
Smokies	15	**0**	0	0
Grandfather Mountain	77	**24**	0	18
Beech Creek Bog SNA	12	**0**	0	0
Sugar Mtn Bog SNA	20	**0**	0	0
Totals	**671**	**118**	**13**	**89**

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

Table 2. North Carolina Wildlife Resources Commission northern flying squirrel nest summary, 2009.

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	180	65	36 %	7 %	18 %
Great Balsams	210	72	34 %	10 %	29 %
Unicoi Mountains	68	19	28 %	4 %	16 %
Plott Balsams	48	18	38 %	17 %	44 %
Roan Mountain	41	6	15 %	2 %	17 %
Smokies	15	4	27 %	0 %	0 %
Grandfather Mountain	77	38	49 %	13 %	26 %
Beech Creek Bog SNA	12	0	0 %	0 %	0 %
Sugar Mtn Bog SNA	20	0	0 %	0 %	0 %
Totals	**671**	**222**	**33 %**	**8 %**	**25 %**

Figure 1. North Carolina Wildlife Resources Commission detections of northern flying squirrels between 1996 and 2009 in the two GRAs with the largest squirrel box networks.



B. Target Dates for Achievement and Accomplishment

On schedule

C. Significant Deviations

None

D. Remarks

While this year's approach returned to the traditional once-annual box checks, we simultaneously gathered information on feasibility of switching to multiple visit occupancy surveys in the future and on usefulness of the tattoo marking system. To accommodate an occupancy survey with multiple visits per year, recovery areas would have to be checked on a schedule of alternating years, leaving a two year gap in box maintenance work (e.g., repairs and replacements). We wanted to see if that would impact the number of available sampling units (i.e. useable boxes). Results were mixed: the number of boxes needing to be re-hung, repaired, or replaced following a year without maintenance was minimal at Roan Mountain and the Plott Balsams but higher at Grandfather Mountain where they suffer extensive damage from red squirrels. There may be opportunities to enlist the help of Grandfather Mountain staff to repair boxes at this site between years and to employ alternative survey techniques or more durable artificial dens (e.g., pvc tubes).

Six tattooed squirrels were recaptured this year. Legibility of tattoos varied. This likely reflects the handler's technique in marking the tattoo and setting the ink. While this marking method

holds promise, it has proven fairly challenging and adds to handling time in the field.

Several recommendations from the 2007-2008 fiscal year were addressed this year including expansion of nest box network into secondary sites and lower elevations in the Unicois, and research into other survey methods. Preliminary discussions are underway with the National Park Service that would address the need to shift the nest box network in the Smokies and address concerns about mercury. NCWRC will advise the Park as they attempt to incorporate flying squirrel surveys into a multi-taxa, multi-disciplinary study of pollution in the Noland Creek Watershed. Finally, analyses of the 2008 occupancy trial study and the long-term dataset are on-going and will inform the future of the flying squirrel monitoring program.

E. Recommendations

The highest priorities concerning the Carolina northern flying squirrel winter nest box survey are to adapt long term monitoring to a reduced staff and to share our findings (e.g., technical reports, manuscripts) given the increasing demand for technical guidance for this species. Analysis of the accumulated data is needed for addressing both of these priorities. Biologists working with the West Virginia northern flying squirrel used program PRESENCE to analyze capture and habitat data in order to evaluate the level of effort needed to track changes in occupancy over time. A similar exercise is in progress for the Carolina northern flying squirrel. The efforts of the last three years, including the 2008 occupancy survey, research into acoustic monitoring, and analysis of data are intended to guide a biologically sound revision of a plan for sustainable, long term monitoring of Carolina northern flying squirrel.

There is a continued 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.

F. Estimated Cost

$47,536 (including in-kind contributions)

G. References

US Fish and Wildlife Service. 1990. Appalachian northern flying squirrels (*Glaucomys sabrinus fuscus* and *Glaucomys sabrinus coloratus*) recovery plan. Newton Corner, MA. 53pp.

Weigl, P.D., T.W. Knowles, and A.C. Boynton. 1992. *The distribution and ecology of the northern flying squirrel, Glaucomys sabrinus coloratus, in the Southern Appalachians*. North Carolina Wildlife Resources Commission, Raleigh, NC. 120pp.

Prepared By: Chris Kelly
Wildlife Diversity Biologist
Division of Wildlife Management

Final Annual Performance Report

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

Period Covered: July 1, 2008 – June 30, 2009

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 (section 6 ESA, and SWG, primarily) 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 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 and Ecological Services (FWS) 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, and that Federal Assistance projects are coordinated with other projects and activities of the Wildlife Diversity Program, this project should continue.

F. Estimated Cost

$95,805

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

Final Annual Performance Report

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

Period Covered: July 1, 2008 – June 30, 2009

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

Project Title: North Carolina Partners in Flight

Objectives:

- Continue to develop and reinforce partnerships that will benefit bird conservation in the state and region through increased communication, cooperation and collaboration.
- Provide technical assistance to local, state and federal agencies, private business, conservation groups and private citizens on matters related to bird conservation.
- Coordinate the Breeding Bird Survey in North Carolina.
- Plan and develop outreach materials to help create and improve awareness about the status and needs of migratory birds for citizens and natural resource professionals.
- Train and recruit natural resource professionals and volunteers to help survey bird populations, and assist agencies, non-governmental organizations and private industry to implement bird monitoring and research programs.

A. Activity

A major goal of the NC Partners in Flight Program (NC PIF) was 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 was responsible for coordinating all Partners in Flight activities in the state for the Wildlife Resources Commission. In September 2008, the NC PIF biologist resigned from NCWRC, and the position remained vacant for the remainder of the project period. As a result, other staff of the Commission fulfilled some of the duties of continuing the NC PIF project, however certain aspects of the program were scaled back. The focus of the project for the remainder of the year was continuing cooperative research projects, planning and conducting a fall Partners in Flight meeting, and participating in the Forest Landbird Legacy Program.

A regional fall NC PIF meeting was held in November of 2008 at Riverbend Park in Catawba County, North Carolina focusing on bird conservation efforts in the western region of North Carolina. Presentations and topics of discussion included: Riverbend Park Bird Monitoring and Research Projects, Mecklenburg County Div. of Natural Resources Bird Research, Strategic Habitat Conservation in the Greater Uwharries of NC, Davidson College Bluebird and Brown-

headed Nuthatch Research, WRC Bird Research Projects of the Southern Blue Ridge, and the effects of ORV disturbance on nonbreeding shorebirds. Thirty-one attendees representing 13 agencies and organizations attended the meeting.

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. NCWRC staff working on the Partners in Flight project were involved this period with bird conservation efforts involving or related to the multi-agency Forest Landbird Legacy Program. In December 2008, the partners involved participated in a coordination meeting to review the status of the program and provide updates upon the status of the projects.

NC Partners in Flight continued involvement with partner organizations to further address research and conservation activities for bird species of high conservation concern including the Eastern Painted Bunting and Swainson's warbler.

Research Partnership Reports

1-Work continued during this period on the 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 2008-2009.

Interim report for field work investigating the breeding biology of the Swainson's warbler along the Roanoke River, North Carolina.

Period of Performance: July 2008– June 2009

Neil Chartier, North Carolina State University Fisheries and Wildlife Sciences Program

Field work begun in mid-April 2008 at the Roanoke River National Wildlife Refuge, North Carolina continued through 31 July 2008. During the 2008 field season, 45 Swainson's warbler (SWWA) nests were monitored. Preliminary results indicate 27% apparent nest survival (12/45). Twenty-four SWWA young fledged from 12 nests (average two young fledged per successful nest).

Of the 45 total nests monitored, infrared video cameras continuously monitored 42 nests. Three nests failed before cameras could be deployed. Among nests with known outcomes, black rat snakes depredated 16 nests (38%), which accounted for 55% of all known nest failures (n = 29). Five nests were abandoned, of which three were likely the result of researchers putting radio transmitters on incubating females. Two nests with nestlings failed (one with two nestlings, one nest with four nestlings) when the nestlings died of unknown causes. A corn snake depredated one nest (likely the first record for this species as a SWWA nest predator). What is thought to be an Eastern screech owl depredated one nest. There was an 11% rate of Brown-headed cowbird

parasitism and one nest was abandoned after three unsuccessful Brown-headed cowbird attempts to parasitize the nest. One-hundred and twenty-seven SWWA were captured (see Table 1 for summary). Radio telemetry was used on 42 birds (males $n = 28$, females $n = 14$)

During fall 2008 and winter 2008-2009, North Carolina State University Ph.D. Candidate Neil Chartier, who has a 2007-2009 Hofmann Fellowship from NCSU, refined his dissertation research. Eight-hundred video tapes have been reviewed for depredation events and interspecies interactions. In addition, parental behaviors were recorded and quantified (e.g., duration of times for incubation, brooding, provisioning, nest guarding). Twenty-two refurbished radio transmitters were ordered in November 2008 and delivered by April 2009.

Chartier conducted interviews for field technicians in January 2009. Four field technicians (including one North Carolina State University Fisheries and Wildlife Sciences Program intern) were hired by March 2009.

Field work began 27 April 2009. The first nests were found in early late April 2009 and the first infrared video cameras were deployed. By late June 2009, 27 nests had been monitored to completion. Preliminary results indicate 26% apparent nest survival (7/27). Fifteen SWWA young had fledged from 7 nests (average 2.1 young fledged per successful nest). Seven nests are currently being monitored.

Of the 27 nests monitored to completion, infrared video cameras continuously monitored 23 nests. Four nests failed before cameras could be deployed. Among nests with known outcomes, black rat snakes depredated 9 nests (39%), which accounted for 56% of all known nest failures ($n = 16$). Brown-headed cowbirds parasitized 11% of the nests ($n = 3$) and partially depredated 11% of the nests ($n = 3$). One nest was abandoned, likely due to flooding.

By late June, 62 SWWA had been captured (see Table 1 for summary). Radio telemetry has been used on 19 birds (males $n = 12$, females $n = 7$). Field work will continue through 31 July 2009.

Table 1. SWWA banding summary at Roanoke River National Wildlife Refuge, NC 2006–2009.

SWWA	2006 new	2006 recaptures in 2007	2006 recaptures in 2008	2006 recaptures in 2009	2007 new	2007 recaptures in 2008	2007 recaptures in 2009	2008 New	2008 recaptures in 2009	2009 new	Total
Male	32	17 (53%)	10 (31%)	5 (16%)	15	7(47%)	2 (13%)	19	5 (26%)	5	71
Female	11	3 (27%)	2 (18%)	1 (9%)	10	3 (33%)	3 (30%)	31	7 (23%)	4	56
Hatch-year	12	-	-	-	34	2 (6%)	-	53	3 (6%)	27	126
Total	55	20 (36%)	12 (22%)	6 (11%)	59	12 (20%)	5 (8%)	103	15 (15%)	36	253

2-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 contracts for services for $4,500.00 with the NC Museum of Natural Sciences during this period of performance.

Interim Report: Surveys and research for a status assessment of breeding Painted Buntings
Principal Investigator: John A. Gerwin, NC Museum of Natural Sciences

Funds from this contract agreement have been used to hire a field technician, and cover some travel costs for her and a Museum biologist. Stacey Ann Roach was hired to do most of the surveys for the point counts. Some travel was reimbursed to Becky Desjardins for banding work done in conjunction with the Painted Bunting Observer Team component (see www.paintedbuntings.org).

The project is a multi-faceted one that includes point count surveys and banding Painted Buntings at selected sites. Additional funds for Becky's time and some travel were provided by the Museum of Natural Sciences. The point counts range from the Beaufort, NC area south to the Sunset Beach, NC/SC State line. The banding sites we were responsible for this year included Hammocks Beach State Park, Camp Lejeune, and 6 private residences on Bald Head Island. Each site was visited three times.

Point count locations were selected by staff from the Atlantic Coast Joint Venture, using Land Cover data from 2001, after a workshop with the Eastern Painted Bunting Working Group. A new protocol was devised by this group for the 2008 season. Points installed and surveyed in 2008 were surveyed again in 2009. The newer land cover data provided better choices for bunting surveys, and the new protocol allowed for more flexibility in placing points on the ground while maintaining statistical rigor. Points are placed within "clusters", and a cluster can contain up to 6 survey points, within a 500 square meter block. Stacey did the point count surveys at most of these. One volunteer assisted with surveys near Beaufort; one staff member from WRC with some near Morehead City; and Desjardins did the surveys on Camp Lejeune. Surveys were completed between May 1 and June 15th.

In 2009, spring was relatively wet and cool. May was fairly rainy and overcast most of the time and few buntings were detected in May versus June. Painted buntings were not detected at the most northern sites near Beaufort/Morehead City, and only one was detected at Lejeune. The latter results from most of the points falling within suitable habitat but too far from the coast, we believe. Within North Carolina, breeding buntings are seldom found further than 1 kilometer from the coast. A total of 21 clusters were done. Stacey surveyed within 11 clusters that included 53 points. She detected a total of 117 birds (only one bird detected within the other 10 clusters as noted above). As expected, bird detections increased from NE to SW along the coast – thus, the most birds were detected from Carolina Beach to Sunset Beach. Within that area, more detections occurred at Carolina Beach and the Southport areas. Heavily developed residential areas in the absence of bird feeders proved to be poor habitat for Painted Buntings, despite surrounding habitat types or location within the range.

The survey work in NC is part of a multi-state, range-wide effort to refine Painted Bunting distribution, and estimate the abundance of the southeastern population. During August, survey data were entered into the regional database. These data are being analyzed this fall and a large summary will occur at a meeting of the Eastern Painted Bunting Working Group at the Museum of Natural Sciences, 9-10 November. Some banding (with other funding) will occur through September. Afterwards, this year's data will be entered in the banding database by Jamie Rotenberg at UNC-Wilmington.

B. Target Dates for Achievement and Accomplishment

During this project year, efforts were curtailed due to loss of staff positions within WRC. Activities associated with partnerships proceeded according to schedule and coordination meetings occurred as planned. The scale of coordination and provision of technical guidance on bird conservation were the primary project objectives that were decreased during this final year of the project.

C. Significant Deviations

During this final year of the overall project, we were unable to conduct bird identification and survey training, and our participation in technical guidance, bird conservation events, and recruitment of Breeding Bird Survey participants were decreased relative to previous years of the project due to loss of staff. However, we did conduct activities related to each of the project objectives and do not consider there to be significant deviations to the overall project objectives.

D. Remarks

None

E. Recommendations

While we hope to continue to pursue the objectives of this project in future years, it remains uncertain whether we will have dedicated staff on a project such as this.

F. Estimated Cost

$34,392 (including non-federal partner match)

G. References

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

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

Final Annual Performance Report

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

Period Covered: July 1, 2008 - June 30, 2009

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

Project Title: Coastal Region Waterbird Investigations

Objectives:

1. Collect baseline data on inland heronries.
2. Collect baseline data on species and relative abundance of non-breeding shorebirds.
3. Coordinate waterbird activities in North Carolina.

Activity

Inland Heronry Surveys

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 update our database on the location of new heronries and status of existing heronries. Furthermore, surveying and monitoring heronries is listed as a priority in the NC Wildlife Action Plan (NCWRC 2005).

As reported last year, aerial surveys for inland heronries began in 2008 with portions of the Coastal Plain and Piedmont surveyed. During the 08/09 fiscal year Wildlife Diversity Program biologists continued entering data into the colonial waterbird database and summarizing results from the 2008 surveys. A total of 56 new heronries were discovered in the Coastal Plain and Piedmont (Lumber and Yadkin/Pee-Dee river basins) (Table 1). Biologists were also able to check 34 known sites for nesting activity and of those 17 were relocated. The majority of the colonies (67) were relatively small containing <= 100 pairs. Although four medium sized (101-500 pairs) and one large colony (>500 pairs) were also detected.

Eleven species, including four identified as priority species in the NC Wildlife Action Plan (NCWRC 2005), were found nesting although not all were detected from the air. Smaller species that nest in the mid-story such as little-blue heron (*Egretta caerulea*) and snowy egret (*Egretta thula)* are difficult to detect from the air and were counted during ground surveys. Great blue herons (*Ardea herodias*) were most abundant and were present in 91.3% of colonies. Great egrets (*Ardea alba)* and anhingas (*Anhinga anhinga)* were also abundant and were found in 12.2% and 8.3% of colonies respectively. Just a couple of sites supported cattle egrets (*Bubulcus ibis*), little blue herons and double-crested cormorants (*Phalacrocorax auritus*) and

only a single and previously know colony (Lay's Lake) supported snowy egrets, wood storks (*Mycteria americana*), white ibis (*Eudocimus albus)*, black-crowned night herons (*Nycticorax nycticorax)* and green herons (*Butorides virescens)*. Based on our observations, it appeared many small flooded swamps supported small colonies of nesting great blue herons, however large great blue heron sites appeared to be primarily found in large flood plain forests with large buffers. This was also true of the large great egret sites. It's likely at least some of the species such as green heron and anhinga were present at additional sites, but were not detected from the air.

Table 1. Results of aerial and ground surveys conducted by NC Wildlife Resource Commission (NCWRC) biologists in 2008.

	Coastal Plain	Piedmont	Total
# Flight Days	5	8	13
# Sites Detected	34	39	73
# Known Sites	10	7	17
# New Sites	24	32	56
# (%) Sites w/ Great blue herons	32 (94.1%)	34 (100%)	71 (97.3%)
# (%) Sites w/ Anhingas	9 (26.5%)	0 (0.0%)	9 (12.3%)
# (%) Sites w/ Great egrets	6 (17.6%)	0 (0.0%)	6 (8.2%)
# (%) Sites w/ Cattle egrets	3 (8.8%)	0 (0.0%)	3 (4.1%)
# (%) Sites w/ Little blue herons	2 (5.9%)	0 (0.0%)	2 (2.7%)
# (%) Sites w/ Double-crested cormorants	0 (0.0%)	2 (5.1%)	2 (2.7%)
# (%) Sites w/ Snowy egrets	1(2.9%)	0 (0.0%)	1 (1.4%)
# (%) Sites w/ Wood storks	1(2.9%)	0 (0.0%)	1 (1.4%)
# (%) Sites w/ White Ibis	1(2.9%)	0 (0.0%)	1 (1.4%)
# (%) Sites w/ Black-crowned night herons	1(2.9%)	0 (0.0%)	1 (1.4%)
# (%) Sites w/ Green herons	1(2.9%)	0 (0.0%)	1 (1.4%)

Wildlife Diversity staff and partners conducted follow-up ground surveys at twelve sites in the Coastal Plain and Piedmont combined. Biologists with Mecklenburg County also located a number of new sites that are not included in the results above. This data will be compiled in future reports. Most of the sites visited supported great blue herons although great egrets and yellow-crowned night herons (*Nyctanassa violacea)* were also observed nesting.

Spring of 2009 marked the second year of inland heronry surveys. To date over half of the Coastal Plain and Piedmont have been surveyed with good numbers of colonies detected both years (Figure 1). Coastal biologists completed surveys along the Cape Fear, White Oak and portions of the Neuse River Basins and flew a total of ten days in 2009. Piedmont biologists conducted surveys along the upper Cape Fear and Lumber River Basins, completing surveys in seven days. A total of 127 new colonies were located during surveys along the Coastal Plain: 101 along the Cape Fear, 9 along the White Oak and 17 along the Neuse. Most of these were great blue heronries although a number of large great egret colonies were also located. Several sites had other small herons that are not easily detected from the air including a site with little blue herons near Riegelwood and a mixed species colony near the mouth of the Cape Fear just south of Town Creek. A total of 37 know heronries were also checked and of these 26 were still

active. Eleven were not relocated and are most likely inactive although it's also possible they were missed.

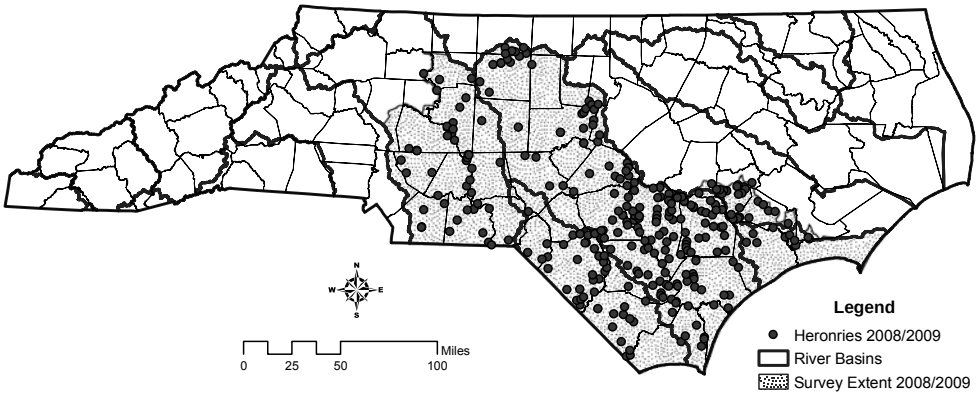


Figure 1. Areas surveyed and heronries detected during 2008 and 2009 flights.

Follow-up ground surveys were conducted at five sites along the Coastal Plain in 2009. These were sites containing habitat where we would expect to find small herons/egrets that are difficult to detect from the air (e.g. open ponds with small cypress). At one such site, we found fifteen little blue heron nests that were completely missed from the air. We were also able to obtain more accurate counts of anhingas at these sites. Unfortunately we were unable to obtain permission from the landowner to conduct ground counts at the mixed colony near Town Creek. NC Audubon staff was able to check it from the water and confirmed nesting by snowy egrets, anhingas, white ibis, yellow-crowned night herons and cattle egrets.

Biologist located 40 new colonies in the Piedmont and a small portion of the Coastal Plain: 39 along the upper Cape Fear River and one along the upper Lumber River. All of the sites contained great blue heron nests although two of the sites also supported anhingas. Thirteen known colonies were also checked and of these six were found to be active. The remaining seven are likely inactive although it's possible some simply weren't detected. An overall report on the inland heronry surveys will be produced when the survey is complete.

Non-breeding Shorebird Surveys

There is 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.

International Shorebird Surveys were conducted at New Drum Inlet in the fall of 2008 and spring of 2009. This marks the sixth consecutive year of surveys at this site. The collection of long-term data at important stop-over sites is critical in detecting changes in timing of migration,

population trends, etc. We attempted to conduct surveys at least once per month during migration and as frequently as three times per month, but we were unable to do as many spring surveys as usual because of boat problems. A total of eight International Shorebird Surveys were completed with the majority (7) conducted during fall migration. Observations of interest include one day counts of 1,104 Black-bellied plovers (*Pluvialis squatarola*), 101 red knots (*Calidris canutus*), 53 marbled godwit (*Limosa fedoa*), 581 short-billed dowitchers (*Limnodromus griseus*) and 35 piping plovers (*Charadrius melodus*). Over 1500 shorebirds were tallied during a single count in late October and undoubtedly many thousands of birds stop at this site during migration.

Staff conducted three American oystercatcher (*Haematopus palliates*) resighting surveys at important wintering sites in Back Bay near Beaufort, NC. The peak count occurred on Feb. 11th with 220 individuals counted. A total of 19 different banded birds were identified. This data contributes to ongoing work along the Atlantic Coast to resight banded birds and track wintering populations. Data will contribute to answering research questions on dispersal, recruitment and survival of oystercatchers.

A coast-wide survey for red knots 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 NC Audubon. A total of 1,466 birds were counted and the largest flocks were observed on Bogue Banks, Onslow Beach and North Core Banks. Good numbers were also seen along Ft. Fisher, Wrightsville Beach and portions of Cape Hatteras National Seashore.

Finally, weekly surveys for shorebirds and colonial waterbirds continued at Bogue Inlet in response to the Channel Relocation Project that was completed in 2004. This project and surveys were completed in December 2008 and final results from those surveys were given in a separate report to the Town of Emerald Isle. We will continue to manage appropriate habitat at this site as outlined in the Waterbird Management Plan (Cameron 2004).

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. A primary objective of the Waterbird Project is to maintain and create suitable nesting habitat on these islands. This fiscal year we continued 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. Four islands received material; Islands MN and L near Oregon Inlet, Cora June Island near Hatteras Inlet and Bigfoot Island near Ocracoke Inlet. Placement of

material is expected to benefit thousands of nesting waterbirds by creating early successional habitat needed by species of greatest conservation concern.

The waterbird biologist participated in and presented data at the American Oystercatcher Working Group meeting and the Wood Stork Working Group meeting. Staff also attended the Waterbird Society meeting where much was learned about waterbird research and conservation efforts nationally and internationally. NCWRC hosted the annual NC Colonial Waterbird Committee meeting held in March. It was well attended with 37 people representing 19 different agencies/organizations participating in the meeting. Lastly, we continued to provide technical guidance as part of the Negotiated Rulemaking Team for the development of an Off-road Vehicle Management Plan for Cape Hatteras National Seashore.

Several programs and workshops were given on colonial waterbirds and shorebirds including presentations to the Lower Cape Fear Birds Club and workshops for staff at Cape Hatteras National Seashore, State Parks and National Estuarine Research Reserve and the NC Center for the Advancement of Teaching on Ocracoke Island. Lastly, we participated in a seabird necropsy training session with NC State University School of Veterinary Medicine. We used birds that were collected from a die-off in July (primarily greater shearwaters) to try to learn more about reasons for mortality events. Tissue samples were sent to the Seabird Ecological Assessment Network (SEANET) at Tufts University for further analysis. 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

It was originally thought that inland heronry surveys along the Coastal Plain and Piedmont would take three years to complete. It now appears a few surveys will need to be conducted during a fourth year to adequately cover appropriate habitat along the Coastal Plain and Piedmont.

C. Significant Deviations

None

D. Remarks

While this 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. Good numbers of species of concern, including black skimmer (*Rynchops niger*), gull-billed tern (*Gelochelidon nilotica*) and common tern (*Sterna hirundo*), nested on New Dump Island in Core Sound and Island D near Oregon Inlet. Common terns and black skimmers also returned to nest on Parnell Island although in smaller numbers that 2005 and 2006 when social attraction was used to lure them to nest at this site. Cora June Island also continues to host a significant mixed tern/skimmer colony.

Wildlife Diversity Program biologists worked to increase awareness and reproductive success of least terns (*Sternula antillarum*) nesting on gravel roofs. First, with the help of staff in Public

Outreach, we issued a press release on the importance of gravel roofs to nesting least terns and offered suggestions on how building owners could help birds have a successful breeding season. We also obtained permission to put chick shelters on the roof at Food Lion in Atlantic Beach to provide much needed shade for least tern chicks. This site had been used by over a hundred pairs the previous year, but unfortunately only a few pairs returned to nest this year and instead it appears these birds relocated to Kmart in Morehead City. We should continue to try to obtain permission from building owners to use chick shelters on rooftops with little shade.

Lay's Lake continues to support a significant heronry. During a site visit in late May, staff counted 134 wood stork nests, 368 cattle egret nests, 61 anhinga nests, 60 great egret nests, 22 little blue heron nests, 14 snowy egret nests and one black-crowned night heron nest.

Lastly, a few additional priority species were observed during inland heronries. Common moorhens (*Gallinula chloropus*) were observed at Warwick Mill Bay, Lay's Lake and a currently unnamed site in Pender County. A nesting pair of least bitterns (*Ixobrychus exilis*) was also observed at the later site.

E. Recommendations

We should work to obtain landowner permission to access the new mixed heronry found during aerial surveys and located south of Town Creek along the Cape Fear River. Given its location, this site should be included in the estuarine surveys next year.

We need to continue to work with USACOE to try to get material to state-owned dredge islands most in need. These include UNI, New River 1 & 2, Sandbag Island, New Dump Island and DOT Island. Sandbag Island supported a colony of royal terns until this year when the birds finally left because of encroaching vegetation. New Dump Island recently received a small amount of sand, but is in need of additional material. This site has supported a large skimmer, common and gull-billed tern colony since material was added and for the first time supported a pair of piping plovers. Additional material at this site will allow for continued use and colony expansion. DOT Island has been eroding for a number of years and is in desperate need of material. Unfortunately this site is not currently permitted to receive material. Both NCDOT and USACOE have indicated they would use the island if a permit is in place. NCWRC staff should work on an EA in order to obtain a permit for this site.

F. Estimated Cost

$ 130,370 (Including in-kind contributions and non-federal partner match)

G. References

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

Prepared By: Susan Cameron
Waterbird Biologist
Wildlife Diversity Program

FINAL PROJECT REPORT

State: North Carolina **Project Number: E-15-HP**

Period Covered: September 1, 2007 – June 30, 2009

Program: Cooperative Endangered Species Conservation Fund-HCP Planning Assistance Grant

Project Title: Habitat Conservation Planning Assistance Grant-Boiling Spring Lakes, North Carolina

Objectives:

The overall objective was to prepare a city-wide Integrated Habitat Conservation Plan/Environmental Assessment (HCP) for the Red-cockaded Woodpecker (RCW) within the city limits of Boiling Spring Lakes (BSL) in Brunswick County, North Carolina.

1. Establish an HCP Steering Committee to oversee the development of the HCP and is responsible for its policy decisions.
2. Establish an HCP Technical Committee to provide the necessary scientific, biological, and technical information to prepare the HCP.
3. Conduct necessary species surveys, monitoring, and research that will provide needed biological knowledge to support management decisions and conservation needs of the HCP.
4. Conduct a mitigation property search.
5. Develop a draft HCP and associated draft National Environmental Policy Act document needed to accompany the incidental take permit application.
6. Educate the citizens of BSL and Brunswick County about RCWs, coastal pine ecosystems, and the HCP planning process through workshops, presentations, field trips, and/or local media outlets.

A. Activity

NCWRC received the planning grant on September 1, 2007. BSL selected and hired a qualified, ecological consultant to assist with development of an HCP on October 2, 2007, and NCWRC approved a contract in November to assist BSL with the cost of purchasing consulting services. An HCP technical/steering committee was established and a kick-off meeting was held on December 11, 2007, during which the consultant compiled available RCW data and resource information from stakeholders and presented a timeline for completing HCP tasks. Beginning in the fall of 2007, the consultant collected RCW population information and conducted a forest inventory of occupied and potential recruitment habitat within the city limits. The resulting foraging habitat data was used to generate a foraging analysis and the results were presented to the Steering Committee for review and discussion at a meeting in January, 2008. The Steering and/or Technical Committee met an additional eight times during the reporting period to receive progress updates, discuss pertinent issues, and make policy decisions regarding key elements of

the HCP. The consultant began work on a preliminary draft integrated HCP/Environmental Assessment in July, 2008, and a draft was completed in September, 2008. The draft document was presented to the city in a public workshop to allow for questions and discussion. A final draft was completed in March, 2009, and presented to the city in a second public workshop. City commissioners requested additional information to guide their decision and a final third public workshop was held in May, 2009. City commissioners are currently reviewing the HCP. Several newspaper articles on the development and progress of the HCP were published during the reporting period to educate citizens and residents about the HCP. Furthermore, the public was allowed to attend and participate in workshops, and committee members responded to all requests for information from residents.

B. Target Dates for Achievement and Accomplishment

All planned activities were completed.

C. Significant Deviation

The project was completed with one extension for 6 months.

D. Remarks

No Remarks.

E. Recommendations

No recommendations.

F. Estimated Cost

$133,001 (including in-kind and partner contributions)

Prepared By: Jennifer Begier - Red-cockaded Woodpecker Biologist
David H. Allen - Coastal Region Wildlife Diversity Supervisor
Division of Wildlife Management

Annual Performance Report

State: North Carolina **Project Number:** E-16-2

Period Covered: July 1, 2008 - June 30, 2009

Grant Title: North Carolina Terrestrial Endangered Species 2008

Project Title: Sea Turtle Nest Surveys, Status, Management and Protection in North Carolina

Objectives:

1. 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 managing 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 sand 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 biologists spend 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 2008, 22 sea turtle nest monitoring and protection projects were active in North Carolina (Table 1). These projects varied in intensity from simply counting turtle 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

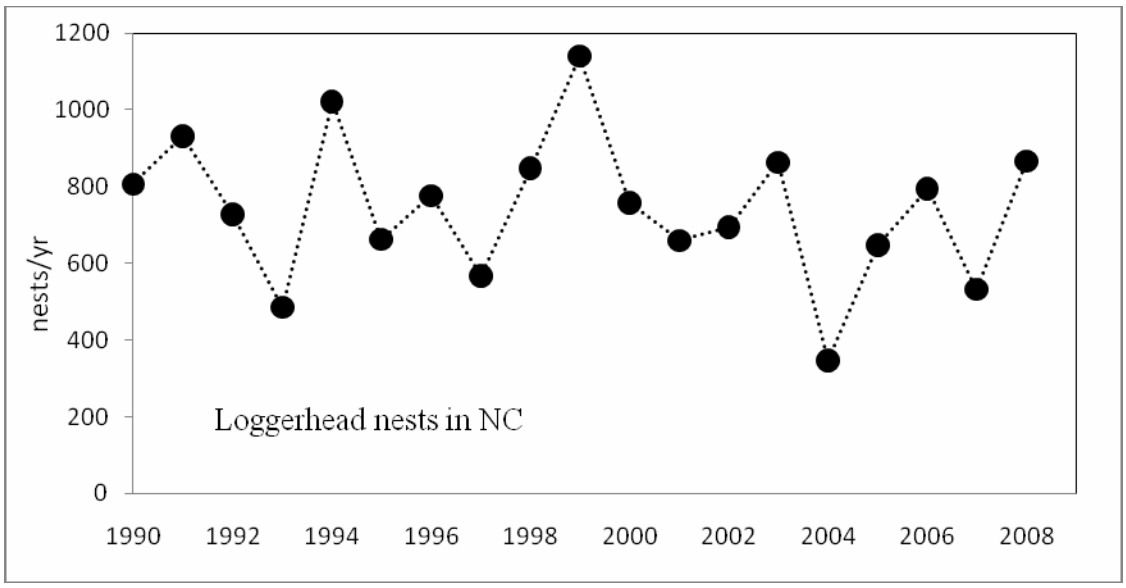
Coordination

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 2008, 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 550 additional individuals who operated under umbrella beach project permits contributed significantly to sea turtle management efforts.

Nest Surveys and Protection

During the 2008 nesting season, there were 1462 sea turtle crawls observed on ocean-facing beaches in North Carolina. Of these, 878 were sea turtle nests (866 laid by loggerheads, 12 laid by green turtles – see Table 1), and the remainder were non-nesting emergences or false crawls. It is likely that some nests and false crawls were not observed by volunteers or collaborators patrolling the beaches, although the actual number is impossible to quantify. The observed nesting total of 866 loggerhead nests is higher than the state average (736 nests/yr), based on the previous 18 years, but annual fluctuation in reproductive activity of sea turtles is common (Figure 1). Note that Brown's Island in Camp Lejuene 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. Similarly, Lea-Huttaf Island (~4 miles) is not monitored daily, although there is regular observer effort several times a week during the nesting season.

Figure 1: Annual numbers of loggerhead nests laid on ocean-facing beaches in North Carolina, 1990-2008.



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 2008, 170 loggerhead nests (19.6%) and 2 green turtle nests (25.0%) were judged to have been laid in a threatened area and were relocated to a more secure location on the same beach. For loggerheads, the mean hatchling emergence success rates of relocated nests (74.5% ±33.3 n=72) and *in situ* nests (53.9% ±42.2 SD, n=369) were significantly different ($p<0.001$, 2-tailed Student's t-test). The lower emergence success of *in situ* nests was likely related to a) the passage of Hurricane Hanna in early September 2008, which inundated or eroded many nests south of Cape Lookout; and b) the relatively high rates of nest predation by foxes on beaches in the southern part of the state. In 2008, 124 loggerhead nests suffered some level of fox predation, ranging in severity from the loss of a few eggs to complete clutch destruction. Emergence success for green turtles was 62.1% (±38.0 n=10) for in situ nests vs. 14% (n=2) for relocated nests. Mean clutch size for loggerhead nests was = 114.6 eggs (range: 56-190), based on relocated nests only, with no prior predation observed. For green turtles, mean clutch size was = 123 eggs (range: 122-124), based on relocated nests only.

On Bald Head Island, four post-nesting females were fitted with Platform Terminal Transmitters (satellite tags) in June and July 2008, to track their migration away from the nesting grounds in North Carolina. Two turtles moved north to the waters near the mouth of Chesapeake Bay, and two moved south, including one that settled in coastal waters of South Carolina and one that swam to Eleuthera Island in the Bahamas. Updated maps are available at: http://www.seaturtle.org/tracking/?project_id=230.

Sea Turtle Rehabilitation and Release (Reported here for informational purposes, though this activity was not funded by this grant)

The STSSN recovered 37 live-stranded loggerheads, 56 green turtles and 12 Kemp's ridley sea turtle during the reporting period. The majority of these turtles suffered cold-stunning related to cooler water temperatures in November-December 2008. Out of the 105 live-stranded sea turtles, 22 loggerheads, 13 green turtles and 8 Kemp's ridley turtles died shortly after stranding. Many of the remaining 62 turtles were treated at either the NEST facility at the NC State Aquarium on Roanoke Island or the Topsail Turtle Hospital, although space limitations at these facilities resulted in several turtles being sent to the following facilities for rehabilitation: Virginia Aquarium, NC Aquarium at Pine Knoll Shores, NC Aquarium at Fort Fisher, South Carolina Aquarium, and the Georgia Sea Turtle Center.

During the reporting period, there were 13 releases of rehabilitated sea turtles coordinated by the Sea Turtle Project. The Coast Guard or private charter boats released 15 loggerheads, 30 green turtles and 3 Kemp's ridleys. In addition, 9 loggerheads, 21 green turtles and 3 Kemp's ridleys were released off of ocean-facing beaches. In addition, a small Kemp's ridley that was found cold-stunned in the United Kingdom in 2006 was transferred to the Topsail Sea Turtle Hospital in May 2009, and was released off Topsail Beach in June 2009.

E. Recommendations

Monitoring of protection of sea turtle nests in North Carolina is vital to sea turtle conservation efforts in the SE USA. It is recommended that these activities continue indefinitely in North Carolina. In 2008, 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

$192,468 (Including in-kind contributions)

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	9
PEA ISLAND NWR	27[a]
CAPE HATTERAS NATIONAL SEASHORE	108[b]
CAPE LOOKOUT NATIONAL SEASHORE	100[c]
FORT MACON STATE PARK	6
BOGUE BANKS	25
HAMMOCKS BEACH STATE PARK	25
CAMP LEJEUNE MARINE CORPS BASE	33
TOPSAIL ISLAND	89
LEA-HUTAFF ISLANDS	9
FIGURE 8 ISLAND	22
WRIGHTSVILLE BEACH	2
MASONBORO ISLAND	15
CAROLINA BEACH	12
KURE BEACH	12
FORT FISHER STATE PARK	47
BALD HEAD ISLAND	104
CASWELL BEACH	91
OAK ISLAND	79
HOLDEN BEACH	37
OCEAN ISLE BEACH	11
SUNSET BEACH and BIRD ISLAND	3
TOTAL	**866**

[a]One green turtle also nested on this beach.

[b]Four green turtle nests were observed on this beach

[c]Seven green turtle nests were observed on this beach

Prepared By: Matthew H. Godfrey - Sea Turtle Project Biologist
Wendy M. Cluse – Sea Turtle Project Assistant Biologist
Division of Wildlife Management

Annual Performance Report

State: North Carolina **Project Number:** E-16-2

Period Covered: July 1, 2008 – June 30, 2009

Grant Title: North Carolina Terrestrial Endangered Species 2008

Project Title: Indiana bat (*Myotis sodalis*) Summer Distribution and Roost Site Selection in Southwestern North Carolina

Objectives:

1. To collect summer distribution data for Indiana bats in the southern Appalachians
2. To measure roost selection criteria at the tree and microhabitat scales

A. Activity

The staff of the North Carolina Wildlife Resources Commission collaborated with numerous other organizations and agencies on this project. A complete report of activities and accomplishments is attached as Appendix A.

B. Target Dates for Achievement and Accomplishment

On schedule.

C. Significant Deviations

None

D. Remarks

This study greatly increased our knowledge of Indiana bat ecology in North Carolina.

E. Recommendations

F. Estimated Cost

$19,163 (including in-kind contributions).

Prepared By: Kendrick Weeks
Mountain Wildlife Diversity Supervisor
North Carolina Wildlife Resources Commission

APPENDIX A

Indiana bat (*Myotis sodalis*) Summer Distribution and Roost Tree Selection in Southwestern North Carolina

Report to:
Kendrick Weeks
North Carolina Wildlife Resources Commission
Raleigh, NC

In partial fulfillment of the requirements in the contractual agreement between Joy O'Keefe and the North Carolina Wildlife Resources Commission

Prepared by:
Joy O'Keefe
Aiken, SC

Scott Bosworth
Tyler, TX

May 2009

Acknowledgements

We thank the following people for their help with mistnet surveys: Michael LaVoie, Ryan Tyree, and Allen Welch (Cherokee Office of Environment and Natural Resources); Dylan Horvath and Victoria Londner (Binghamton University); Ben Laseter (Fish and Wildlife Associates); Robert Currie and Troy Wilson (US Fish and Wildlife Service); Matina Kalcounis Rueppell and Kitty Carney (UNC-Greensboro); James Kiser and Jeff Schwierjohann (Stantec Consulting, Inc.); Lisa Gatens, Ben Hess, Bryan McLean, and Morgan Hightshoe (NC Museum of Natural Sciences); Dottie Brown, Lindsay Green, Chris Kelly, Chris McGrath, Tanya Poole, Karen Resmer, and Lori Williams (NCWRC); Mary Kay Clark (formerly NCWRC); Chris Corben and Kim Livengood (Titley Electronics); Tony Bosworth (TX); Cynthia Kaminski (Asheville, NC); Jessica Smith (Atlanta, GA); Ida Ebretjar; and Mary Frazer, Matt Haney, and Heather Renninger (NC Department of Transportation). Thanks to Steve Lohr and the rest of the staff of the Tusquittee Ranger District for logistical support. We are especially grateful to Cherokee tribe member Steve Coleman (Cherokee Co.) who helped with access and information about Cherokee and Forest Service lands. Thanks also to Gary Sneed (Bureau of Indian Affairs) for help with site scouting, providing maps, and introducing us to landowners.

Summary

Most research on the federally endangered Indiana bat (*Myotis sodalis*) has focused on Midwest populations. Little information exists about the distribution and roost ecology of Indiana bats in the southern Appalachian Mountains, the southern extent of the species range. These data are critical for developing effective management strategies and monitoring programs in the southern Appalachians. Our objectives in this study were to collect summer distribution data and identify the characteristics of summer roosts in southwestern North Carolina. Results presented in this report also include data collected during a previous study funded by the Eastern Band of Cherokee Indians (EBCI). Data were combined because both studies had identical objectives and occurred in the same geographical location during the same bat maternity season. We netted on 49 nights at 38 sites in five counties. We captured 505 bats representing 11 species and transmittered four adult male and four adult female Indiana bats. Characteristics of roost trees and random trees with roost potential and the surrounding habitat (0.1 ha plots) were measured; random trees were ≥50 m from the roost in a random direction. We located two eastern hemlock (*Tsuga canadensis*) roosts for two males and 10 shortleaf pine (*Pinus echinata*) roosts for four females. Hemlock roosts (82.2 cm dbh; 95% bark remaining) were snags in 128–158 year-old northern- or hemlock-hardwood stands. Pine roosts (27.3 cm dbh; <23% bark remaining) were snags in 43–80 year-old mixed pine-hardwood stands. Five variables distinguished pine roosts from random trees (paired two-sample tests, $p < 0.1$). Pine roosts were taller and farther from another tree the same height or greater. Pine roost plots contained a lower proportion of trees taller than the roost, more dead trees, and more dead trees in decay stage two. In southwestern North Carolina, Indiana bats appear to selectively roost in tall conifer snags in close proximity to other suitable snags, which may maximize solar exposure and facilitate roost switching in the event of a disturbance. In 2009, we will collect more roost data in the southern Appalachians and will analyze roost selection at the landscape scale.

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Introduction

The Indiana bat (*Myotis sodalis*) has been federally listed as endangered since 1967 but, until recently, the overall population was thought to be increasing (USFWS 2007). However, since late 2006, tens of thousands of *Myotis* bats have died due to White Nose Syndrome (Veilleux 2008) and it is possible that Indiana bats will go extinct in the northeastern U.S. in five years (Al Hicks, NY Dept. of Conservation, pers. comm.). Indiana bats are long-lived (>20 years) and have low fecundity (one young/year) so recovery from this significant disturbance will be slow. Thus, conserving healthy populations of Indiana bats in the southern part of their range may be critical to the overall survival of the species. Furthermore, peripheral populations may harbor important adaptive genetic variation (Lesica and Allendorf 1995).

The Appalachian Mountains in western North Carolina are the southernmost extent of the range for reproductive Indiana bats, but there are very few data on Indiana bat roost requirements and distribution in the region. Indiana bat maternity colonies were first discovered in the southern Appalachians in 1999 (Nantahala National Forest and Great Smoky Mountains National Park, Britzke et al. 2003); maternity roosts have also been documented on the Cherokee National Forest (CNF) in Monroe County, TN (CNF, unpublished data) and the Cherokee Indian Reservation in Cherokee County, NC (O'Keefe 2008). Primary maternity roosts (Callahan et al. 1997) in the southern Appalachians are often under the sloughing bark of dead southern yellow pines, mainly shortleaf pine (*Pinus echinata)* with >50% bark (Britzke et al. 2003). However, snags are an ephemeral roost type; in the study by Britzke et al. (2003), roosts were unsuitable one year after they were found. The majority of roosts are on mid and upper slopes in mixed pine-hardwood stands, but some non-pine roosts have been found near streams.

In this study, we present new information on Indiana bat maternity habitat characteristics and distribution in southwestern North Carolina; gathering such information is a primary recovery action for the species (USFWS 2007). This information may be valuable to resource managers in the southern portion of the species' range and might enable us to identify adaptive strategies that Indiana bats use to persist in habitat that differs from the core of the species' range. Furthermore, these data can be used to develop management strategies and long-term monitoring programs, to aid in technical assistance, to prioritize land acquisitions, and to assess recovery efforts and status on the state and national levels. We implemented a focused survey effort in southwestern North Carolina, working on the Nantahala National Forest (NNF) and reservation land held by the Eastern Band of Cherokee Indians (EBCI). Our primary objectives were to collect summer distribution data for Indiana bats in the southern Appalachians and to measure roost selection criteria at the tree and microhabitat scales.

Methods

- ***Sampling***

This study built upon previous work (16 May to 30 June 2008) by EBCI in Cherokee, Graham, and Swain counties, NC (Figure 1). We conducted our study on the NNF and the EBCI Reservation from 2 July to 5 August 2008, surveying sites in Cherokee, Clay, Jackson, and Swain counties, NC (Figure 2). Sites were first selected based on existing information about Indiana bat distribution in southwestern North Carolina. We also employed an adaptive sampling strategy by surveying additional sites in areas with high capture success, or by surveying where suitable roosting habitat existed, or where there was some evidence (e.g., echolocation call data) to indicate that Indiana bats might be present.

We conducted mist net surveys at 15 sites on 19 nights; four sites were surveyed twice. For each survey, we set 2–9 net sets; each set consisted of one or two (stacked) 4–12 m nets (38 mm mesh; Avinet, Inc., Dryden, NY) set over roads, streams, or pond margins. Nets were opened at sunset and monitored at 10 min intervals for 3–5 h. Captures were identified to species, sexed, aged, and measured (forearm length and weight). Priority species in North Carolina were banded with unique aluminum forearm bands (Porzana Ltd., East Sussex, UK; NCWRC, USFS-SRS, or USFS-NC). For selected bats (excluding big brown bats, *Eptesicus fuscus*), we collected hair and two wing (3 mm punches) tissue samples to be used in stable isotope and molecular analyses, respectively. For Indiana bats, we trimmed the fur and used surgical glue (Torbot Group, Inc., Cranston, RI) to attach a 0.35–0.42 g radio transmitter (Holohil Systems, Ltd., Ontario, Canada) between the scapulae. Bats were held until the glue dried and were released at the point of capture. For all captures, we adhered to the guidelines of the American Society of Mammalogists for the use of wild animals in research (Gannon et al. 2007). We used a 3-element Yagi antenna and receiver (Wildlife Materials, Murphysboro, IL) to locate the bats at their day roosts. Indiana bats were tracked until the transmitters fell off or the signal was lost.

We collected vegetation data around roost trees we located for Indiana bats tracked during this study and for roosts (n = 4) found during the earlier study by EBCI. We recorded species, diameter at breast height (dbh), and height (measured with a hand-held clinometer) of each roost tree and corresponding random tree (henceforth, 'focal tree'); the first dead tree ≥40 m from the roost in a random direction was used as the random tree. We measured species and dbh for all live and dead trees >10 cm dbh within a 0.1 ha circular plot around focal trees. We used diameter measurements to calculate plot basal areas for live and dead trees. We also calculated basal area and density for trees >22.9 cm dbh and >40.6 cm dbh because the US Forest Service presently identifies suitable or optimal Indiana bat habitat based on those tree classes (Doreen Miller, US Forest Service, personal communication). We measured distance to and height of the closest tree ≥10 cm dbh to focal trees, and closest tree the same height or taller than focal trees. We tallied all saplings (single woody stems <10 cm dbh and ≥2 m in height) in the plot by five diameter classes. We visually estimated percent canopy closure in four cardinal directions 2 m from the focal tree and averaged these values for the plot; we also estimated midstory closure below the roost (2–10 m above ground). Roosts were classified as live-damaged or dead; dead roosts and other dead trees encountered in plots were assigned to one of four decay classes based on branches and bark remaining, condition (hard or soft) and height (Appendix A, Ormsbee 1996); we also noted percent bark remaining on all roosts and dead trees. Most roost trees were in decay

class 2, so we measured density of decay stage 2 trees in each plot. For each focal tree, we measured distance to the closest tree with roost potential (i.e., cavity, crevice, or exfoliating bark present). We used a compass to measure aspect and a clinometer to measure slope in each plot. Anabat detectors and compact flash storage zero-crossing analysis interface modeules (henceforth, "Anabats"; Titley Electronics, Brisbane, Australia) were used to identify high activity areas and to determine presence/absence for Indiana bats. Anabats were set near net sites or roost trees and were turned off when nets were closed.

- ***Statistical Analyses***

We combined tree and microhabitat data for pine roosts located in the EBCI survey and this survey. We tested 27 independent variables (Table 2) for normality using the Shapiro-Wilk W statistic. For normally distributed data, we compared roost and random data using two-tailed paired-sample t-tests. We transformed non-normal data using logarithm or square root transformations and tested the transformed data for normality using the Shapiro-Wilk W statistic. If data were normal after transformation, we used two-tailed paired-sample t-tests to compare transformed data for roost and random sites. Otherwise, we used Wilcoxon signed rank tests to compare untransformed data. We used SAS® (SAS Institute, Inc. 2004) to conduct all statistical analyses outlined above and used $\alpha = 0.1$ to evaluate significance. We report untransformed means ±1 standard error for pine roosts and random trees. We report and compare untransformed means for tree and microhabitat data for Cherokee County trees to data for one Graham County tree and data from two earlier studies in North Carolina and Tennessee.

Results and Discussion

During the 16 May to 30 June 2008 study conducted by EBCI, one pregnant female (Cherokee Co.) and four male (Graham Co.) Indiana bats were captured. In addition, 11 big brown bats (*Eptesicus fuscus*), 25 silver-haired bats (*Lasionycteris noctivigans*), 41 eastern red bats (*Lasiurus borealis*), 5 hoary bats (*L. cinereus*), 2 eastern small-footed bats (*Myotis leibii*), 20 little brown bats (*M. lucifugus*), 53 northern long-eared bats (*M. septentrionalis*), and 9 eastern pipistrelles (*Perimyotis subflavus*) were captured. Ten silver-haired bats were captured in one night at Alarka Laurel in Swain County; ten other sites produced 1–2 silver-haired bats per night. A reproductive female silver-haired bat was captured at Stecoah Creek in Graham County on 3 June 2008. Although there is no information on the ecology of silver-haired bats in North Carolina, a few males have been captured in the mountains every year since at least 2005 (O'Keefe, unpublished data) and the non-breeding population is apparently secure (LeGrand et al. 2006). However, records of reproductive silver-haired bats in western North Carolina are very rare.

During the period from 2 July to 5 August 2008, we captured 1 Rafinesque's big-eared bat (*Corynorhinus rafinesquii*), 88 big brown bats, 2 silver-haired bats, 78 eastern red bats, 1 hoary bat, 1 Seminole bat (*L. seminolus*), 41 eastern small-footed bats, 31 little brown bats, 71 northern long-eared bats, 3 female Indiana bats and 17 eastern pipistrelles. The three female Indiana bats were captured on national forest land in northwestern Cherokee County: two were lactating and one was post-lactating. The male Rafinesque's big-eared bat was captured in Swain County on the EBCI Reservation. In western North Carolina, Rafinesque's big-eared bats have been

captured or observed in Haywood, Graham, Macon and Swain counties (North Carolina Natural Heritage Program 2008), but 2008 was the first time this species was captured on the EBCI Reservation. Thirty three of the eastern small-footed bat captures were from a maternity colony that was roosting under cedar shake siding on an old cabin on the EBCI Reservation on Barnett Knob Firetower Road in Jackson County. This colony appears to be the largest ever documented for this species, as others studying small-footed bats in manmade structures in NC, KY, TN, and NH have reported finding colonies with $\leq$20 bats. The male Seminole bat was captured near Halls Knob in Cherokee County; although this capture was a county record, this species has been documented elsewhere in the southern Appalachians (Susan Loeb, USFS Research Ecologist, personal communication).

We found two Indiana bat maternity trees in western Cherokee County during the EBCI survey (Table 1; Figure 3) and eight maternity roosts in this survey (Table 2; Figure 4). Female Indiana bats used 2–3 trees each and remained in trees for 1–4 days (Table 1 and 2). We confirmed that two females were roosting with other bats; colony counts ranged from 3–14 bats (Table 1 and 2). One female captured in early July was post-lactating; she always roosted alone and her movements led us to believe that she had lost her pup. Females roosted in 13.9–32.2 cm dbh shortleaf pines (Table 1 and 2) in 43–80 year old mixed pine hardwood stands. Yellow pines such as shortleaf pine are used by female Indiana bats in the Great Smoky Mountains National Park (Britzke 2003) and CNF (CNF, unpublished data) and are considered important roost structures for male Indiana bats in Kentucky (Gumbert et al. 2002).

We were unable to locate two males captured in Graham County during the EBCI survey, but the other two males roosted in large recently dead hemlocks. One hemlock was in a 158 year old northern hardwood forest and the other, which held a maternity colony (Table 1), was in a 128 year old hemlock-hardwood forest. Emergence counts at the maternity tree ranged from 9-31 bats; Anabat files recorded under the maternity tree during emergence suggested that the occupants were *Myotis* but we could not use the files to make a specific determination because we recorded few calls and it is difficult to differentiate the calls of *Myotis* bats with acoustical systems. We collected guano from bats using the tree by placing two cotton sheets (274 x 259 cm) under the roost entry/exit at the base of the tree. The guano was not analyzed due to lack of funding but it is being stored for future analyses. An Indiana bat maternity roost was documented in a dead hemlock within 1 km of these trees in 1999 (Eric Britzke, personal communication), but the hemlock appeared to be unsuitable and unused one year later (Britzke 2003).

Five tree and microhabitat variables distinguished pine roosts from random trees (Table 3). Pine roosts were significantly taller than random trees and were almost twice as far from the nearest tree the same height or greater. Only 50% of the trees in pine roost plots were taller than the roost, while 70% of the trees in random plots were taller than the random focal tree. Pine roost plots contained significantly more dead trees and more snags in decay stage 2 when compared to random plots. Basal area and density of 22.9 cm dbh and 40.6 cm dbh tree classes were not good predictors of roost-site selection. It is possible that plot-level variables such as these were not important because we compared roost plots to random plots that were often in the same stand (random trees were 40–50 m from roosts).

We found some similarities in tree and microhabitat characteristics of pine roosts from this study compared to characteristics of trees documented in previous studies in southwest North Carolina and southeast Tennessee (Britzke et al. 2003 and unpublished data from CNF). In this region, Indiana bats typically roost in large diameter snags that are ≥18 m in height (Table 4). Reproductive females may favor large trees because they can accommodate large numbers of bats and canopy trees because they receive more solar radiation, offer protection from predators, and are conspicuous on the landscape (Betts 1998). The amount of bark remaining on the tree varies (Table 4) and variation among studies is likely influenced by differences in how available bark is measured. Canopy closure above the roost is low (~40%; Table 4), which may reflect selection for roosts with greater solar exposure to meet energy demands associated with gestation and lactation (Garroway and Broders 2008). Live and dead tree basal areas differ among the study sites, but dead tree basal area is generally high (Table 4). Females may roost in areas with a greater density of snags to facilitate recurrent roost switching for social or thermal benefits, to avoid ectoparasites, or to make themselves aware of other suitable roosts to which they can switch in the event of a major disturbance that renders a favored roost unsuitable (Barclay and Kurta 2007).

Table 1. Characteristics of roost trees used by female and male Indiana bats on the Nantahala National Forest, Cherokee and Graham counties, North Carolina during a study conducted by the Eastern Band of Cherokee Indians, 16 May to 30 June 2008. All roosts were snags. Exit counts are the number of bats seen emerging or observed under bark. A dash (-) indicates no exit counts were made.

County	Capture date	Bat	Tree species	DBH (cm)	Mininum no. of days used	Exit counts	Dominant tree species in plot
Cherokee							
	5/28/08	F-P	*P. echinata*	45.5	4	14	*Quercus prinus, Oxydendrum arboreum, Acer rubrum, Q. alba, Q. coccinea*
			P. echinata	31.8	1	3	same as above
Graham							
	6/2/08	M-NR	*T. canadensis*	82.2	2	9 - 31	*Tilia americana, T. canadensis, Betula alleghaniensis*
	6/3/08	M-NR	no location	-	-	-	-
	6/10/08	M-S	*T. canadensis*	>80	3	-	no plot
	6/25/08	M-S	no location	-	-	-	-

Table 2. Characteristics of roost trees used by female Indiana bats on the Nantahala National Forest, Cherokee County, North Carolina, during this study from 2 July to 5 August 2008. All roosts were snags. Exit counts are the number of bats seen emerging or observed under bark. A dash (-) indicates no exit counts were made.

Capture date	Bat	Tree species	DBH (cm)	Mininum no. of days used	Exit counts	Dominant tree species in plot
7/2/08	F-PL	*P. echinata*	29.6	2	1	*A. rubrum, O. arboreum, Q. rubra, Q. coccinea*
		P. echinata	28.9	1	-	*O. arboreum, Nyssa sylvatica, Kalmia latifolia, Q. coccinea, Q. prinus*
7/3/08	F-L	*P. echinata*	29.5	1	-	*A. rubrum, O. arboreum, Tsuga canadensis, P. strobus (+ Q. alba, Q. rubra)*
		P. echinata	13.9	1	1	*P. strobus, A. rubrum, L. tulipifera (+ Q. coccinea and Q. prinus)*
		P. echinata	19.8	1	1	*Q. prinus, A. rubrum, O. arboreum, P. strobus*
7/7/08	F-L	*P. echinata*	27.6	1	9+	*P. strobus, A. rubrum, Q. prinus, Liriodendron tulipifera, Q. alba*
		P. echinata	14.6	1	5	*P. strobus, A. rubrum, L. tulipifera, Q. alba*
		P. echinata	32.2	1	-	same as above

Table 3. Mean and standard error (S.E.) values for tree and microhabitat variables for Indiana bat pine roosts and random trees in Cherokee County, NC, located May–July 2008 in a study by EBCI and this study. Roost and random data were compared in paired 2-sample tests. Degrees of freedom (*df*) and P are presented for each paired test.

	Roost (n = 10 trees)		Random (n = 8 trees)			
Plot variables	Mean	S.E.	Mean	S.E.	*df*	*P*
Tree height (m)	18.1	1.3	11.0	1.2	9	0.0012
DBH (cm)	27.3	3.0	32.9	4.4	9	0.1514
Decay stage of focal tree	2.0	0.0	3.3	0.5	-	-
Bark remaining (%)	23.7	6.4	29.4	6.9	9	0.4766*
Canopy closure (%)	41.6	10.6	54.5	11.2	9	0.7598*
Distance to nearest live tree (m)	1.9	0.3	2.4	0.5	9	0.1681
Height of nearest live tree (m)	14.9	1.9	16.3	2.0	9	0.5750
Distance to nearest tree same height or > (m)	5.4	1.1	2.7	0.5	9	0.0514
Height of nearest tree same height or > (m)	20.3	1.7	18.1	2.1	9	0.6312
Distance to nearest potential roost (m)	3.7	0.9	6.6	1.7	9	0.1971
Plot slope (%)	27.1	4.9	26.3	5.2	9	0.8617
Sapling count <2 cm/ha	165.0	39.1	208.6	43.2	6	0.7536
Sapling count 2-4 cm/ha	138.8	45.0	98.6	23.1	6	0.2719
Sapling count 4-6 cm/ha	81.3	26.4	82.9	26.1	6	0.9625
Sapling count 6-8 cm/ha	52.5	13.1	75.7	27.8	6	0.6094*
Sapling count 8-10 cm/ha	41.3	12.7	67.1	30.2	6	0.2012
Live tree basal area (m^2/ha)	18.8	1.6	19.9	1.7	7	0.6665
Live trees/ha	487.5	32.7	506.3	49.4	7	0.7434
Live trees >22.9 cm/ha	136.3	18.8	150.0	14.8	7	0.5082
Live trees >40.6 cm/ha	17.5	6.2	27.5	12.9	7	0.7188*
Number of live trees with roost potential/ha	13.8	5.3	28.8	20.3	6	0.5679
Proportion of plot trees taller than roost	0.5	0.1	0.7	0.1	7	0.0318
Dead tree basal area (m^2/ha)	6.8	0.9	6.9	1.7	7	0.9881
Dead trees/ha	186.3	24.8	108.8	17.9	7	0.0108
Dead trees >22.9 cm/ha	61.3	9.3	57.5	11.5	7	0.7318
Decay stage for all dead trees	2.2	0.1	2.3	0.2	7	0.4390
Number of trees in decay stage 2/ha	93.8	13.4	28.8	9.1	7	0.0050

*Tested with Wilcoxon signed-Rank Test

Table 4. Characteristics of roosts trees used by Indiana bats in Cherokee and Graham counties in 2008 (this study and EBCI study), NNF and Great Smoky Mountains National Park (GSMNP; Britzke et al. 2003), and Monroe Co., TN on the Cherokee National Forest (CNF; unpublished data from CNF).

	Study area and year(s)			
Tree and plot variables	Cherokee Co. NNF 2008 (n = 10 roosts)	Graham Co. NNF 2008 (n = 1 roost)	NNF & GSMNP 1999-2001 (n = 9 roost)	Monroe Co. CNF 2006-2008 (n = 9 roosts)
Tree height (m)	18.1	37.0	18.3	18.3~
DBH (cm)	27.3	82.2	47.0*	35.2
Decay stage of focal tree	2.0	1.0	.	.
Bark remaining (%)	23.7	95.0	41.9	<10~
Canopy closure (%)	41.6	0.0	.	39~
Distance to nearest live tree (m)	1.9	5.0	1.8	.
Height of nearest live tree (m)	14.9	20.7	.	.
Distance to nearest tree same height or > (m)	5.4	8.0	.	.
Height of nearest tree same height or > (m)	20.3	37.0	.	.
Distance to nearest potential roost (m)	3.7	8.0	.	.
Plot slope (%)	27.1	55.0	.	.
Sapling count <2 cm/ha	165.0	880.0	.	.
Sapling count 2-4 cm/ha	138.8	210.0	.	.
Sapling count 4-6 cm/ha	81.3	110.0	.	.
Sapling count 6-8 cm/ha	52.5	130.0	.	.
Sapling count 8-10 cm/ha	41.3	70.0	.	.
Live tree basal area (m^2/ha)	18.8	18.8	17.4	10.4^
Live trees/ha	487.5	260.0	343.8	.
Live trees >22.9 cm/ha	136.3	110.0	56.3	.
Live trees >40.6 cm/ha	17.5	50.0	31.3	.
Number of live trees with roost potential/ha	13.8	0.0	.	.
Proportion of plot trees taller than roost	0.5	0.0	0.4	0.3
Dead tree basal area (m^2/ha)	6.8	23.2	3.5	7.2^
Dead trees/ha	186.3	50.0	81.3	.
Dead trees >22.9 cm/ha	61.3	50.0	37.5	.
Decay stage for all dead trees	2.2	1.4	.	.
Number of trees in decay stage 2/ha	93.8	0.0	.	.

*Mean dbh is 37.9 when 1 exceptionally large roost is excluded

~Estimated or reported in categories

^10 factor prism was used to identify plot trees; data were converted to ha

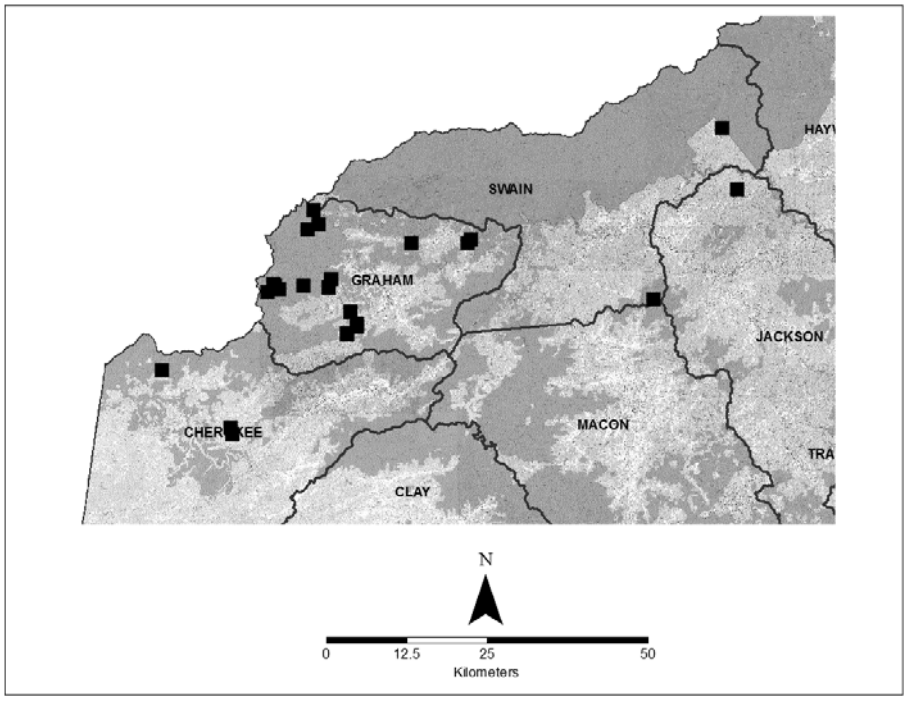

Figure 1. Indiana bat survey sites on the Nantahala National Forest and Cherokee Indian Reservation in southwestern North Carolina for a study by the EBCI, 16 May to 30 June 2008.

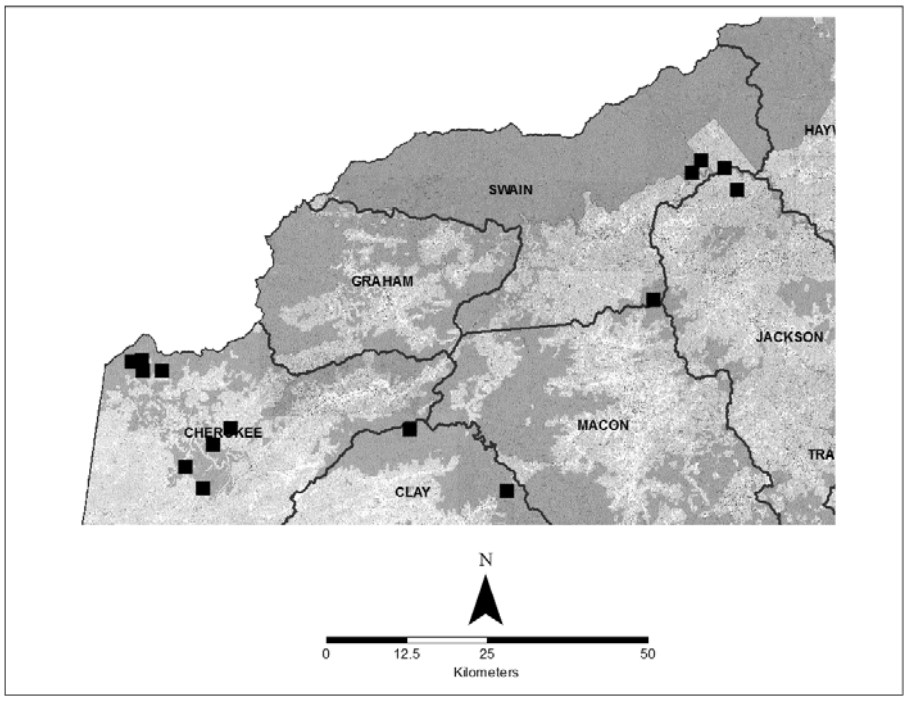

Figure 2. Indiana bat survey sites on the Nantahala National Forest and Cherokee Indian Reservation in southwestern North Carolina from this study, 2 July to 5 August 2008.

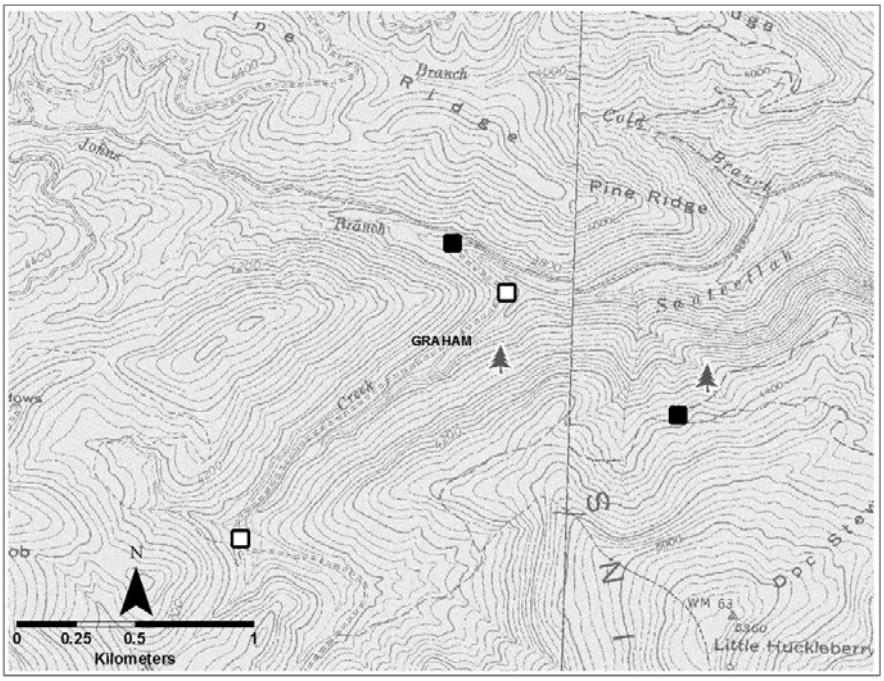

Figure 3. Net sites (squares) and Indiana bat roost (trees) near FS Rd. 81C in western Graham County, North Carolina. White squares denote sites where Indiana bats were captured during the EBCI survey, 16 May to 30 June 2008.

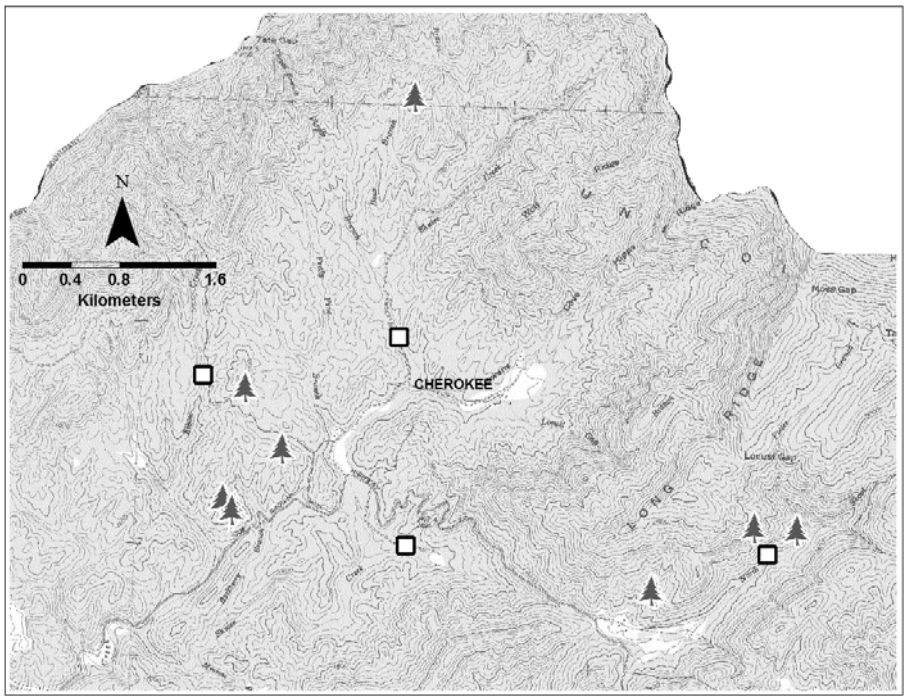

Figure 4. Net sites (squares) and Indiana bat roosts (trees) in northwestern Cherokee County, North Carolina. A female Indiana bat was captured at the easternmost site in the study during the EBCI survey. In this study female Indiana bats were captured at all sites in this part of Cherokee County, 2 July to 5 August 2008.

Recommendations

Although conifers were not considered an important roost type for Indiana bats in the biological opinion issued by the US Fish and Wildlife Service in 2000, combined data from this study and previous studies indicates that yellow pines and eastern hemlocks are important roost types in the southern Appalachians. Females are likely to benefit from retention of large (>25 cm dbh) yellow pines and, even if snags are not created, large trees left may later develop into suitable roost structures. Land managers should consider that density of suitable roosts is likely important (Foster and Kurta 1999) and Indiana bat maternity colonies may require a large roost area; roost areas for other female *Myotis* species range from 5–11 ha (Ormsbee 1996, Broders et al. 2006, O'Keefe 2009). Furthermore, there is evidence from studies in Cherokee (O'Keefe 2008) and Graham (Britzke et al. 2003) counties that maternity colonies make annual movements to new roosting areas in response to changes in roost availability. Because we collected information on only a small sample of bats and roosts, and we worked in a relatively small area, we caution that conclusions based on the limited data presented in this report may be tenuous.

We still know very little about the distribution and ecology of Indiana bats, so we recommend additional studies on the roost ecology of Indiana bats in mixed pine-hardwood forests throughout the southern Appalachians. Roost ecology studies should focus on forests with recent pine beetle kills or hemlocks killed by woolly adelgids, as these may be important roost sites for Indiana bats. Genetic analysis of guano collected under roosts can be used to determine the species composition of maternity colonies (Puechmaille et al. 2007) that are located in future studies. Future studies should also examine the foraging ecology of Indiana bats, as such data are necessary to facilitate the development of a comprehensive management plan for this species.

Appendices

- ***Appendix A***
- ***Decay Classes (From Ormsbee 1996)***

Typical Attributes	Decay class			
	1	2	3	4
% Dead	100%	100%	100%	100%
Branches	80 - 100%	few - no branches	limb stubs to none	none
Bark	80 - 100%	varies	varies	0 - 50%
Condition	hard	hard/soft	soft	soft
Height	full - broken top	broken top	upper bole gone	> 50% full

- ***Appendix B***
- ***Mist Net Sites for EBCI Study, 16 May to 30 June 2008***

County	Location	Easting	Northing	Coordinate System/Datum	Survey Date(s) 2008	Indiana bat capture?
Cherokee						
	North Shoals Creek/FS 408	755142	3900304	NAD 83/16	28 May	Y
	Haven Lane Rifle Range	766871	3892624	NAD 83/16	19, 21, 27 May	N
	McDonald Lane at Hanging Dog Creek	767187	3891635	NAD 83/16	31 May, 1 June	N
Graham						
	Barker Creek	233818	3924559	NAD83/17	3 June	N
	Bear Creek	232223	3923740	NAD83/17	3 June	Y
	FS 81C ~1.5 mi W of gate	227409	3914443	NAD83/17	9 June	N
	John's Branch	772143	3915265	NAD 83/16	2, 3, 17 June	Y
	Laurel Branch/FS 2537	257155	3921681	NAD83/17	3 June	N
	Little Snowbird Creek Park	238342	3907468	NAD83/17	2 June	N
	Lower Cornsilk/FS 2385	238869	3911041	NAD83/17	2 June	N
	ORV Road/Santeetlah Creek	235495	3914838	NAD83/17	2 June	N
	Rattler Ford	235810	3916133	NAD83/17	2 June	N
	Santeetlah Creek (4.7 mi from Hwy 143)	231481	3915057	NAD83/17	3 June	N
	Santeetlah Creek 1 (0.3 mi from Hwy 143)	235781	3916112	NAD83/17	2 June	N
	Santeetlah Rock	772382	3915070	NAD 83/16	12 June	N
	Stecoah Creek/FS 2537	257634	3922272	NAD83/17	3 June	N
	Tapoco Trail	233028	3926816	NAD83/17	2 June	N
	Upper Long Branch	239881	3909233	NAD83/17	3 June	N
	Whigg Branch/FS 81C	772366	3914785	NAD 83/16	10, 25, 30 June	Y
	Yellow Creek Gap	248379	3921698	NAD83/17	18 June	N
Jackson						
	Jenkins Creek Rd at Jenkins Creek Crossing	299143	3930025	NAD83/17	7 June	N
Swain						
	Alarka Laurel	286088	3912904	NAD83/17	8 June	N
	Tribal Hatchery @ border to GSMNP	296799	3939602	NAD83/17	6 June	N

- ***Appendix C***
- ***Mist Net Sites for This Study, 2 July to 5 August 2008***

County	Location	Easting	Northing	Coordinate system/Datum	Survey date(s) 2008	Indiana bat capture?
Cherokee						
	FS 307 on E side of Persimmon Creek	760189	3886034	NAD83/16	28 July, 1 Aug.	N
	North Shoals Creek/FS 408	755142	3900304	NAD83/16	2 July, 3 Aug.	Y
	FS 50 0.5 mi W of Evans Rd, at Shuler Creek	752410	3902381	NAD83/16	3 July	Y
	FS 6105 0.8 mi from gate	764270	3889845	NAD83/16	9 July	N
	FS 6263 0.4 mi from gate	752567	3900663	NAD83/16	7 July	Y
	FS 82 1.2 mi from the east gate	750807	3901975	NAD83/16	22 July	N
	FS 85A, east of Halls Knob	763148	3882981	NAD83/16	17 July	N
	Haven Lane Rifle Range	766871	3892624	NAD83/16	8 July	N
Clay						
	FS 340C ~ 2 mi from split with FS 340	248120	3892711	NAD83/17	2 Aug.	N
	FS 71 1 mi south of Hwy 64	263274	3883270	NAD83/17	30 July	N
Jackson						
	Barnett Knob Firetower Rd	297186	3933407	NAD83/17	10, 11 July	N
	Jenkins Creek Rd at creek crossing	299143	3930025	NAD83/17	14 July	N
Swain						
	Alarka Laurel	286088	3912904	NAD83/17	5 Aug.	N
	Sewer Line Road	292117	3932805	NAD83/17	15 July, 4 Aug.	N
	Sherill Cove Rd.	293500	3934601	NAD83/17	16 July	N

- ***Appendix D***
- ***Indiana Bats Captured During EBCI Study, 16 May to 30 June 2008***

Date	Sex	Reproductive Condition	Mass (g)	Forearm (mm)	Band	County	Location
5/28/2008	F	P	8	37.7	USFS-NC 1063	Cherokee	North Shoals Creek/FS 408
6/2/2008	M	NR	6.5	38	NCWRC A0995	Graham	John's Branch
6/3/2008	M	NR	6.5	37.5	NCDOT 1009	Graham	Bear Creek
6/10/2008	M	S	7.6	38.7	USFS-NC 1086	Graham	Whigg Branch/FS 81C
6/25/2008	M	NR	8.0	36.4	NCWRC A0598	Graham	Whigg Branch/FS 81C

- ***Appendix E***
- ***Indiana Bats Captured During This Study, 2 July to 5 August 2008***

Date	Sex	Reproductive Condition	Mass (g)	Forearm (mm)	Band	County	Location
7/2/2008	F	PL	6.8	38.8	USFS-SRS 1581	Cherokee	North Shoals Creek/FS 408
7/3/2008	F	L	7.4	36.7	USFS-SRS 1631	Cherokee	FS 50 0.5 mi W of Evans Rd, at Shuler Creek
7/7/2008	F	L	-	37.9	USFS-NC 1077	Cherokee	FS 6263 0.4 mi from gate

A dash (-) indicates no measurement was recorded

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Annual Performance Report

State: North Carolina **Project Number:** E-16-2

Period Covered: July 1, 2008 – June 30, 2009

Grant Title: North Carolina Terrestrial Endangered Species 2008

Project Title: Bog Restoration and Management in Western North Carolina

Objectives:

The primary goal of this project is to restore and maintain important habitat for bog turtles. Methods by which to accomplish this goal include:

1. Selective removal of trees and shrubs so as to stall succession (e.g., including use of prescribed burning, manual removal, and introduction of grazers)
2. Removal of manmade drainage devices
3. Maintenance of wetland hydrology through use of berms and other necessary structures
4. Removal of exotic and invasive plants when feasible

A. Activity

Habitat management continues to be a vital part of bog turtle conservation. In 2008-2009, 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, removing and treating invasive plants, conducting prescribed burns, and taking measures to discourage trees from resprouting.

A prescribed burn was conducted at the NCWRC owned Mulberry Mill bog site in Wilkes County in February 2009, with the help of 3 volunteers. The objective was twofold: 1) to suppress some of the invasive plants growing in the bog, and 2) to maintain an open habitat by reducing growth of shrubby plants in main bog area. When the site was visited in June 2009, the main bog had less dense vegetation and many of the multiflora rose plants had been (at least temporarily) killed and showed no sign of re-growth thus far (Figures 1, 2, & 3).

Figure 1. Mulberry Mill site in February 2009 before the prescribed burn was conducted.

Figure 2. Mulberry Mill site in February 2009 immediately after the prescribed burn was conducted.

Figure 3. Mulberry Mill bog in May 2009 (3 months post prescribed burn). Note that Figure 1 and 2 were taken during the winter and Figure 3 was taken in the summer growing season. Most differences are only visible when viewed at close range.

In February 2009, a prescribed burn was also conducted on the upper portion of the Ima's bog site in Wilkes County, with the help of 3 volunteers. The main objective was to continue to increase the area of the bog with patchy sunlit habitat openings in the area that is not grazed by cattle. This was the 3rd time this section of Ima's bog had a prescribed winter burn and it continues to look better each year. The burns have kept saplings from taking hold, has decreased the density of the vegetation, and helped to maintain some patchy sunlit openings. We plan to continue prescribed burns of this area with the goal of further improving this area for the bog turtle and greater bog community. Photos were taken before and after the work was done to document the changes (see Figures 4 & 5).

Figure 4. Ima's bog site in November 2008 before the prescribed burn was conducted.

Figure 5. Ima's bog site in February 2009 immediately after the prescribed burn was conducted.

In June 2009, a group of NCWRC staff and volunteers spent a day working at the Mulberry Mill bog in Wilkes County. With a total of 14 people, we were able to accomplish a lot in one day. There were two main objectives: 1) identifying, removing or cutting, then treating invasive plants in the bog and the stream corridor that drains the bog; 2) thinning out the maples and

alders in the main bog area (SW corner of bog) that is wet and yet quite dense with vegetation. The main invasive plant present at the site was multiflora rose, although there was some non-native honeysuckle and privet. For large thickets of multiflora that were far enough from the water, a foliar spray was used, and when close to the creek, Rodeo was sprayed directly onto cut stems of invasive plant species. In the bog area that was thinned of trees, a dense thicket of multiflora was removed and several maples and alders were selectively removed to create a more patchy and open habitat. This site will be monitored in the future to determine the degree of success of the invasive species removal effort and to manage for possible resprouting of the cut maples and alders in the bog area. Photos were taken before the work was completed and on the next visit to this site a photo will be taken to document the changes (see Figure 6).

Figure 6. Mulberry Mill site in April 2007 before the June 2009 habitat management work day.

In June 2009, a group of NCWRC staff and volunteers spent a day working at the Ima's bog in Wilkes County. With a total of 10 people, we were able to accomplish a lot in one day. Effort was focused on the southern (i.e., lower) portion of the bog, on the downstream side of the paved road. There were two main objectives: 1) identifying, removing or cutting, then treating invasive plants in the bog and immediate surrounding area; 2) thinning out the maples and alders in the wettest portion of the bog. The hope is that once it has been thinned, the cattle will be more likely to graze in there and maintain it as a patchier, open habitat. There were relatively few invasive plants present in this area, so the bulk of the work was in cutting, removing, and treating (with Rodeo) the cut maples and alders. Although it is a huge site and a lot of work remains to be done, we did make good progress on this area. It is much more open and sunlit now. This site will be monitored in the future to determine the degree of success of this effort and to manage for possible resprouting of the cut maples and alders in the bog area. Photos were taken before and after the work was done to document the changes (East of creek: Figures 7-8; West of creek: Figures 9-10).

Figure 7. Ima's bog site (East of creek) in April 2007 before the June 2009 habitat management work day. Note that this photo was taken before leaf-out whereas Figure 9 was taken in mid-summer.

Figure 8. Ima's bog site (East of creek) in June 2009 immediately after the June 2009 habitat management work day.

Figure 9. Ima's bog site (West of creek) in June 2009 before the June 2009 habitat management work day.

Figure 10. Close up view of Ima's bog site (West of creek) in June 2009 immediately after the June 2009 habitat management work day. Note that the alders are less densely packed.

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. This project was described in detail in the 2007-2008 Annual Report. Although no additional habitat management work has been done at this site, an additional photo documents the changes in habitat over time (Figures 11 and 12). The site will require additional management efforts to keep tree stumps from re-sprouting and to monitor the long-term effects on habitat and the bog turtle population.

Figure 11. Franklin bog on March 12, 2008 after habitat management work was completed.

Figure 12. Franklin bog on October 9, 2008, approximately seven months after habitat management work was completed.

In partnership with The Nature Conservancy, steps outlined in the new management plan were carried out at 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 2009 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. Efforts to remove invasive plants by hand are also ongoing at this site. Partners in this project include The Nature Conservancy, the Atlanta Botanical Garden, US Fish and Wildlife Service, the Wildlife Resources Commission, and various volunteers. 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 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

$4,954 (including in-kind contributions).

Prepared by: Gabrielle J. Graeter
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Division of Wildlife Management

Annual Performance Report

State: North Carolina **Project Number:** E-16-2

Period Covered: July 1, 2008 – June 30, 2009

Grant Title: North Carolina Terrestrial Endangered Species 2008

Project Title: Golden-winged Warbler Monitoring and Productivity Survey

Objectives:

A collaborative effort between North Carolina Wildlife Resources Commission and Audubon North Carolina addressed two project objectives.

1. Establish baseline monitoring of the golden-winged warbler (GWWA) population in western North Carolina.

2. Characterize territory and nesting habitat and measure productivity at a macro site in western North Carolina.

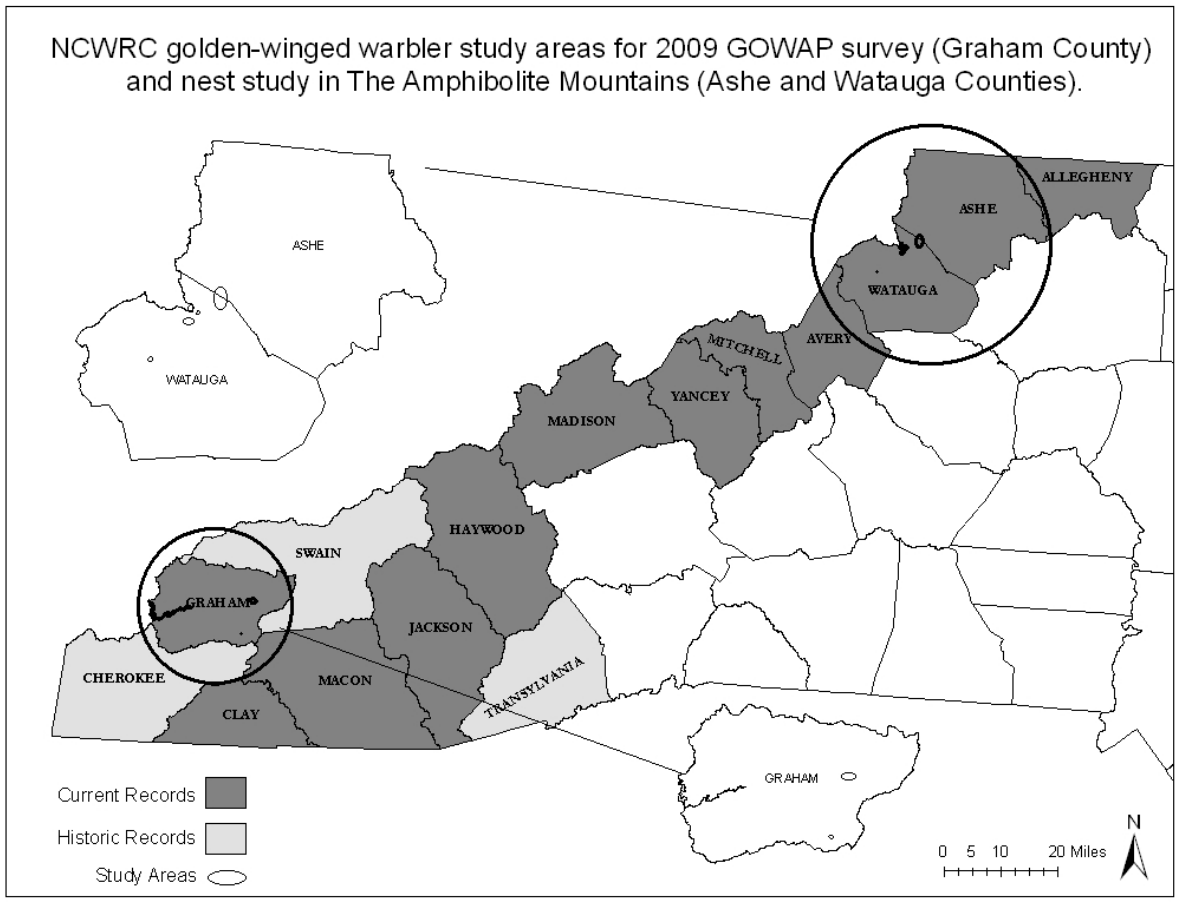
A. Activity

Inventory and Monitoring-
Inventory and monitoring efforts involved re-visiting a subset of historic locations that were initially surveyed during the original Golden-winged Warbler Atlas Project (GOWAP) in 2001-2002, and establishing new survey locations to fill in gaps. The survey network consists of 20 survey points on each page of the North Carolina DeLorme map in western NC. The 20 points are distributed with five points in suitable habitat in each of the four quadrants of a map page (Cornell 2009). This year, five historic locations were surveyed in the northeast quadrant of DeLorme map page 50. This included four points along NC-143 between Robbinsville, NC and the intersection with NC-28, and one point in Tallulah Bog. The five new locations within the northwest quadrant of DeLorme map page 50 were established in suitable habitat along the Cherohala Skyway. All sites were located in Graham County, NC, part of the Fontana/Nantahala National Forest GWWA macro site (Figure 1).

The revised GOWAP protocol combines a standard passive point count with audio playback that includes conspecific and mobbing sequences interspersed with silent listening periods (Cornell 2009). Observers note the time of first detection (song and visual) and sex of a GWWA, blue-winged warbler (BWWA), or hybrid, and also note the presence of a select few associated species. Because GWWAs can be challenging to detect, data collected this year will also be used by the Cornell Laboratory of Ornithology to test the effectiveness of these three methods (passive point count, conspecific, and mobbing playback). A habitat assessment was conducted at each point, assigning a habitat code, habitat descriptor, elevation, successional stage, and extent of potential habitat.

Nesting Study- The Amphibolite Range, a GWWA macro site dominated by farmland (rather than forest), was selected for the productivity study (Figure 1). In May, 2009, NCWRC assisted Audubon NC in the initial three weeks of the survey. Study sites included Elk Knob Game Land (Watauga County, NC, privately owned, under management lease by NCWRC), Elk Knob State Park (Watauga County) and adjacent land owned by Conservation Trust for North Carolina, Long Hope Valley (Ashe County), Cove Creek farm (Watauga County, privately owned), and Sunalei (Watauga County, private housing development on western slopes of Snake Mountain). Male birds captured in mist nets with the aid of an audio lure were color-banded to aid territory mapping and nest searching. Territories were mapped by observing and geo-referencing locations of unmarked and color-banded individuals. Nest searching and subsequent nest monitoring and vegetation surveys were carried out by Audubon NC.

Figure 1. NCWRC golden-winged warbler study areas for 2009 GOWAP survey and nesting study.



B. Target Dates for Achievement and Accomplishment

On schedule.

C. Significant Deviations

None

D. Remarks

Inventory and Monitoring- Golden-winged warblers were detected at six of ten GOWAP survey points in Graham County, with a total of eight birds found in early and mid successional habitat in locations with larger areas of suitable habitat (Table 1). This included five GWWAs at four of the historic sites and two GWWAs at two new sites on the Skyway. No blue-winged warblers or hybrids were observed. A GWWA nest with four nestlings was found at the Tallulah Bog site. Of the list of five potential associated species (brown thrasher, field sparrow, prairie warbler, eastern towhee, and willow flycatcher) only eastern towhee was observed and at just two of the sites with GWWAs. Predominant trees at points with GWWAs included red maple, tulip poplar, black locust, black walnut, and black cherry.

Table 1. NCWRC Golden-winged Warbler Atlas Project (GOWAP) survey results at old and new sites in Graham County, NC, 2009.

Point	Location	# GWWA	Habitat[1]	Success-ion	Extent (acres)	Elev. (feet)
50NE-1	NC-143 billboards	1 male	Upland shrubby field	Early	3	2590
50NE-2	NC-143 Stecoah Gap	1 male	Upland clear cut	Early	6	3178
50NE-3	Tallulah Bog	2 males 1 female	Wetland utility right of way	Early	8	2670
50NE-4	NC-143 shoulder	0	Upland utility right of way	Middle	<1	2981
50NE-5	NC-143 utility row	1 male	Upland utility right of way	Early	5	2930
50NW-1 new	Cherohala Skyway-Hooper Cove overlook	0	Other upland habitat	Early	2	3103
50NW-2 new	Cherohala Skyway-Shute Cove overlook	1 male	Other upland habitat	Middle	3	3467
50NW-3 new	Cherohala Skyway-Obadiah Gap overlook	1 male	Other upland habitat	Middle	4	3672
50NW-4 new	Cherohala Skyway-mile 10	0	Other upland habitat	Early	<1	4294
50NW-5 new	Cherohala Skyway-FR81-217	0	Other upland habitat	Middle	<1	4303

[1]Definitions of Habitat terms and Successional stages from Golden-winged Warbler Monitoring Protocol 2009 (Cornell 2009).

Nesting Study- Over the course of the study, 25 adult male GWWAs, 13 adult female GWWAs, and at least one Brewster's warbler were detected via spot mapping. This included returns of two banded male GWWAs at Elk Knob Game Land and Long Hope Valley and one banded male Brewster's warbler at Cove Creek. One new male GWWA was color-banded at Elk Knob Game Land. Weather conditions were unsuitable for capturing and banding additional birds. Due to several factors described below, no nests were found. Fledglings were found at several sites, but these data do not provide an accurate measure of productivity. For example, low fledgling counts at some sites simply reflect lack of survey effort due to limited field staff or access, and not low productivity (e.g., Long Hope, Sunalei) (Table 2).

Table 2. Golden-winged warblers detected via spot mapping in the Amphibolite range, 2009

Site	Male GWWA	Female GWWA	Sets of fledglings
Elk Knob Game Land	6	4	2 sets
Cove Creek	3	2	1 sets
Elk Knob State Park and CTNC property	4	3	2 sets
Long Hope Valley	7	1	0 sets
Sunalei	5	3	0 sets
Totals	25	13	5 sets

Based on consultation with a species expert, it was apparent that three factors conspired to hamper our ability to locate nests: constant rain, insufficient number of observers, and terrain (L.Bullock, pers.comm). Steady rain and below normal temperatures for the first 17 days in May hampered efforts to locate nests. In fact, males were back on territories approximately one week later than usual, with females arriving later as well. Singing rates were low on rainy days in occupied territories making it difficult to accurately delineate territory boundaries, and some territories occupied in previous years were vacant through mid May. Males in adjacent territories expanded their territories into some of the vacant territories in the absence of competition, but were apparently unsuccessful in attracting mates by mid May when NCWRC's involvement ended. Previous observations suggest that these birds will move downslope out of their territories during extreme weather events or will entirely relocate to more protected sites, often downslope (C.Smalling, pers.comm). In contrast to our efforts, similar studies in the Cumberland Plateau entail a minimum of five technicians searching for a nest and more gentle terrain. The birds often move away from the nest when approached, requiring multiple observers to track their movement simultaneously along the slopes without losing track of their locations. At a minimum, two observers should focus on one pair or territory at a time. However, due to limited staff and time, we were forced to spread out, with one observer spot-mapping in each territory.

Despite the lack of nests, fledglings were spotted later in the season by the Audubon NC biologist. Also, the vegetation work and the accuracy of the spot-mapping was an improvement this year compared to Audubon NC's efforts last year (C.Smalling, pers.comm). Observations this year were successful in identifying habitat variables associated with territory delineation. The vegetation analysis was conducted fully by Audubon NC and the results were not available at the time of reporting. A summary of territory sizes is also forthcoming from Audubon NC.

It is expected that this dataset will provide important information for the unique categories of GWWA habitat found in the Amphibolites and a few other locations in western NC: agricultural landscapes maintained in part by grazing, utility line right of ways, and wetlands. Existing datasets are restricted to forested tracts managed with silviculture (Klaus and Buehler 2001). Information will be used to guide habitat management practices on government lands (including lands managed as North Carolina game lands) as well as private property (e.g., for the Wildlife Conservation Land Program).

E. Recommendations

Monitoring at permanent survey sites may be needed every 5 years given the rapid rate that GWWA habitat becomes unsuitable due to succession. As a side benefit, surveys will allow biologists to assess management needs at occupied sites before habitat unsuitability results in local extirpations. Standardized GOWAP protocol is the preferred survey method.

Surveys completed by NCWRC and Audubon NC in the 2009 nesting season will be used to ground truth a Duke University habitat model for GWWA in western North Carolina. To improve inferences in other areas of potential habitat, ground-truthing efforts will focus on sites modeled as high and medium probability of GWWA occurrence. NCWRC should lend support in future efforts by Audubon NC and the Appalachian Mountains Joint Venture to obtain productivity and nesting microhabitat data and manage habitat for this declining species.

F. Estimated Cost

$5,016 (Including in-kind contributions)

G. References

Cornell Laboratory of Ornithology. 2009. Golden-winged Warbler Monitoring Protocol 2009. Cornell Laboratory of Ornithology, Ithaca, NY. 4pp.

Klaus, N.A. and D.A. Buehler. 2001. Golden-winged warbler breeding habitat characteristics and nest success in clearcuts in the Southern Appalachian Mountains. Wilson Bull. 113(3):297-301.

Smalling, C. 2007. The status and distribution of the golden-winged warbler and their hybrids in Western North Carolina. Unpublished. Audubon NC. 4pp.

Prepared By: Chris Kelly
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Division of Wildlife Management

Annual Performance Report

State: North Carolina **Project Number:** E-16-2

Period Covered: July 1, 2008 – June 30, 2009

Grant Title: North Carolina Terrestrial Endangered Species 2008

Project Title: Northern Flying Squirrel Habitat Management

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 include:

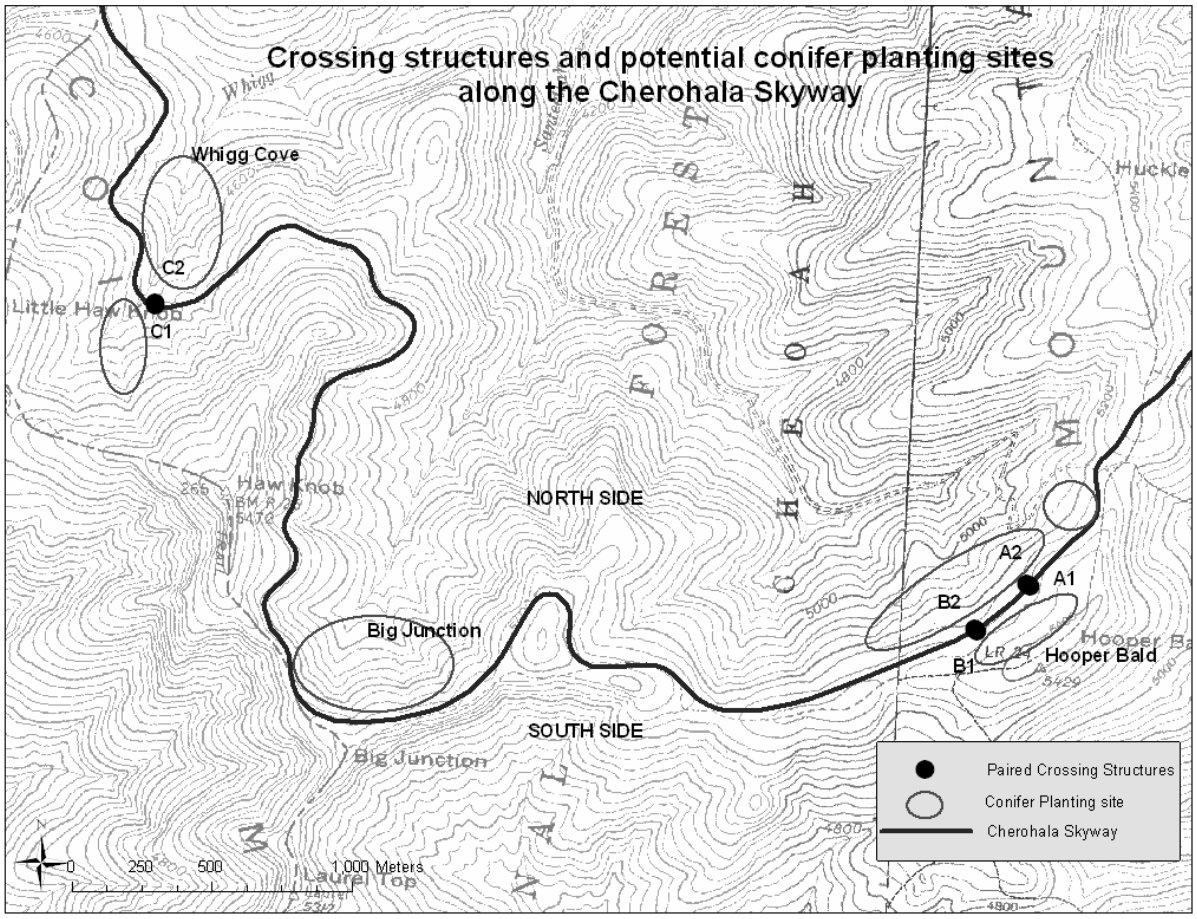
- Conifer habitat: Work with the U.S. Forest Service (USFS) to engage appropriate management to stave-off complete loss of hemlocks and to enhance the conifer component with planted red spruce and Fraser fir.

- Crossing structure evaluation: Evaluate squirrels' use of modified utility poles posted in June 2008 using wildlife cameras, radio telemetry, and other techniques.

A. Activity

This year's activities consisted of a preliminary evaluation of the crossing structures and a collaborative effort with the U.S. Forest Service to roll the conifer proposal into a forest management proposal. The NCWRC conifer planting proposal coincided with the development of the Nantahala National Forest Upper Santeetlah forest management proposal. NCWRC provided technical guidance on preferred locations and methods for establishing red spruce and Fraser fir in the Unicois to address two objectives: to establish roadside vegetation in order to narrow the width of this corridor and to supplant dying hemlocks in order to maintain a conifer component within this recovery area. Technical guidance consisted of two meetings and a field trip with U.S. Forest Service staff and submission of agency comments in response to scoping. NCWRC made recommendations on specific locations for conifer plantings: in forested areas with and without hemlocks and along the road shoulder in proximity to crossing structures (Figure 1).

Figure 1. Locations of three pairs of NCWRC road crossing structures and proposed conifer planting sites in the Unicoi Mountains recovery area, Graham County, NC.



The preliminary evaluation of the crossing structures involved selecting and posting cameras on the poles for photo-monitoring, developing a method for climbing the poles to check the cameras, capturing squirrels for experimental releases onto the poles, and post-release monitoring of squirrels. NCWRC enlisted an undergraduate intern supported by a student award from North Carolina State University to assist in selection and acquisition of cameras. Six Scoutguard 550 trail cameras were provided to NCWRC on temporary loan. Duke Energy assisted with installation of cameras and hardware components for a pole climbing system using ropes and ascenders. One camera was attached to a vertically oriented 2x4 bracketed to the horizontal launch beam, at the top of each pole (Figure 2). In this position, cameras could capture images of an animal moving down the 6-8 feet of the launch beam, where it was oriented over the road gap. Cameras were posted March 11 and 17, 2009 and programmed to take still images 24 hours a day to evaluate use of the structures by any animals. Camera checks are a significant undertaking, requiring the assistance of several staff and volunteers to manage traffic, set up equipment, climb the poles, and program the cameras; thus they are checked infrequently. Cameras were checked on April 4 and May 30, 2009; all images were downloaded and batteries were changed as needed. Settings were reprogrammed to video mode on May 30th.

The evaluation was delayed until spring due to lack of squirrel captures from boxes during initial winter surveys. In March, 2009, three Northern flying squirrels were captured from squirrel boxes near the poles, fitted with radio transmitters, and experimentally released onto poles on the opposite side of the road from the capture site (Table 1). A fourth squirrel was discovered denning in a shelter on a pole and was radio-collared and released onto the same pole. Their response following release was monitored via the cameras and, when possible, radio-telemetry. We attempted to document whether squirrels (1) *could* climb the poles, (2) *would* climb the poles on their own volition outside of an experimental release scenario, (3) cross the road using the poles, or (4) cross the road by some other means. Thus, evaluation of crossing structure use is derived from a combination of camera images, radio-telemetry readings synchronized with time-stamped images *during* an experimental release, and locations of dens with respect to the release location *after* an experimental release.

Figure 2. Scoutguard 550 camera posted on launch beam and accessed by climbing via ropes and ascenders.

Table 1. Summary of experimental releases and evidence of Northern flying squirrels' use of crossing structures, Spring 2009.

Squirrel ID	Capture Date	Capture location. Side of Skyway	General area	Radio-collared?	Release site. Side of Skyway	Crossed road upon release?	Crossed road again at later date	Evidence of squirrel climbing pole	Evidence of squirrel using pole to cross Skyway
Male 260	3/17/09	Pole A1 escape shelter. South side	Hooper Bald	Yes	Pole A1. South side	No	Yes, at least 4 times (telemetry)	Observed upon release	No
Female 160	3/18/09	Whigg Branch box 9. North side	Whigg Cove	Yes	Pole C1. South side	Yes	No	Observed upon release	No
Male 040	3/18/09	Whigg Branch box 9. North side	Whigg Cove	Yes	Pole C1. South side	Yes	No	No	No
Male 130	3/21/09	Hooper box 22. North side	Hooper Bald	Yes	Pole A1. South side	Yes	No	Camera & Telemetry 3/21/09	Camera & Telemetry 3/21/09
untagged squirrel 1	Not captured	Not captured; 2 images from pole A1	Hooper Bald	No	n/a	n/a	Unknown	Camera 3/25/09	No
untagged squirrel 2	Not captured	Not captured; 1 image from pole A1	Hooper Bald	No	n/a	n/a	Unknown	Camera 5/24/09	No

The six images of Northern flying squirrels were obtained from the camera posted on pole A1, on the south side of the Skyway in the Hooper Bald section. An experimentally-released squirrel (#130) was documented, via cameras and telemetry, using pole A1 to glide across the road. The time stamp on the images of this animal perched on the end of the launch beam (21:07) corresponds with the time when the telemetry signal shifted from the south side of the road to the north side (Figure 3). Photo-monitoring alone documented exploration of pole A1 and the launch beam by two previously uncaptured Northern flying squirrels outside of an experimental release scenario (referred to as "untagged squirrel 1 and 2") (Figures 4 and 5). Because these two sets of images are from separate nights and because we can not see ear tags or radio-collars, we are unable to determine if these are images of one individual or two separate individuals.

Figure 3. Squirrel #130 preparing to jump from pole A1 during an experimental release that was accompanied by radio-telemetry monitoring, March 21, 2009.

Figure 4. Untagged Northern flying squirrel 1 on pole A1, March 25, 2009.

Figure 5. Untagged Northern flying squirrel 2 on pole A1, May 24, 2009.

Road crossings by three squirrels, documented via telemetry, were not documented with photo-monitoring, suggesting that these squirrels jumped from below the level of the camera lens or crossed via another means (#160, 040, and 260). Female 160 climbed pole C1 in Whigg Cove, then retreated to a tree den adjacent to the pole until dark. Male 040 was released onto pole C1 and dropped to the ground, ran up a tree, and remained in a den until dark. The female crossed at

dark; the male crossed later that night. These two squirrels were captured together, released onto a pole together, and found the next day again denning together. Female 160 was tracked for six months in 2008, so we have extensive data on her home range. The two remained together for several more weeks and were captured for removal of transmitters on April 16, 2009, when the female was found pregnant and near parturition, denning with this same male. It is not clear if this is her mate or older offspring. She was captured denning without the male one more time on June 9, 2009. It was difficult to determine if there were pups in the nest with her, but she appeared to be pregnant. The third squirrel, male 260, was captured from a birch bark nest it had constructed in a pvc escape shelter on pole A1 (Figure 6). Upon release, this squirrel retreated to the escape shelter and remained there until dark. It used a tree den on the south side for approximately one week, but eventually crossed to the north side of the Skyway. While we have not been able to obtain a contiguous history of movement and den data, we have subsequently tracked this squirrel to three dens on the south side of the Skyway and one den on the north side. It has crossed the road a minimum of four times since March 17, 2009.

Figure 6. Shredded birch bark nest in pvc escape shelter on pole A1 where squirrel #260 was captured on March 17, 2009.

The Scoutguard cameras, powered by lithium batteries, performed well as a means of passive monitoring. Other species photographed in April and May include an American robin using the beam as a song perch, a pair of bluebirds, and a red squirrel (Whigg Cove). An indigo bunting has been using camera B2 as a song perch, triggering the camera to misfire and max out the memory card and batteries. There have been no images of Southern flying squirrels on the poles in Whigg Cove and there have been no images of aerial predators such as barred owls.

B. Target Dates for Achievement and Accomplishment

On schedule.

C. Significant Deviations

None

D. Remarks

This is the first attempt in the U.S. to use wood poles to help a gliding mammal cross a road barrier. The preliminary results are encouraging, demonstrating that flying squirrels will climb the poles, den in escape shelters, use the pole to cross the road during an experimental release, cross the road by some means, and explore the poles on their own volition.

Evidence is lacking to explain six crossings that were not captured by cameras or telemetry at the time of crossing. One limitation of the cameras is that they can only capture images of animals up on the launch beam in line with the camera sensor; a squirrel jumping from the pole below the level of the launch beam and camera would not be photographed. It is also possible that squirrels have discovered another means to cross. Snowfall in winter 2009 provided an opportunity to search for squirrel tracks in the thick briars along the road shoulder and woodland edge. Flying squirrel tracks were found in and around the log piles at the woodland edge but not in the briars, suggesting that they do not regularly disperse through the briars to attempt a crossing on foot. While experimental release of animals to the opposite side of the road to monitor response *prior* to pole installation might have been worth testing, our main interest is in whether or not squirrels will cross on their own outside of such an experiment. Their behavior during an experimental release is altered by stress and a strong instinct to return immediately to their home range. Furthermore, the home range of a male Northern flying squirrel captured in the small, isolated patch of habitat on the south side of the Skyway below Hooper Bald was long and narrow, extending to the east and west and limited to the south side by the Skyway; that individual did not cross the road. Prior to installation of the poles in 2008, we have not documented any squirrels crossing the road, despite long distance excursions on one side of the road.

Squirrel #260 is the only individual known to have crossed the road on its own volition (i.e., outside of an experimental release scenario) in the history of the two telemetry studies that have been conducted in the Unicoi Mountains. Furthermore, it is the only individual captured on the south side of the Skyway since 1995, although this may also be an artifact of less sampling on that side (Kelly 2008; Weigl et al. 2002). This squirrel exhibited unusual behavior in two ways: by constructing a birch bark nest in a pvc escape shelter on pole A1 and by crossing the road to dens on either side of the Skyway at least four times.

In the years since the Skyway was widened, the road has influenced the shape of squirrels' home ranges, with many home ranges in close proximity to the Skyway and segments of the home range boundaries delineated by the right-of-way. (Weigl et al. 2002; Kelly 2008). It remains to be seen if the crossing structures will effectively re-connect habitat and populations, but evidence provided by this research is encouraging.

Efforts to reconnect and enhance habitat with conifers are vital to maintaining healthy Carolina Northern flying squirrel populations. This is especially imperative in Whigg Cove, where there is overlap with Southern flying squirrels and impending loss of Eastern hemlocks. The first evidence of hybridization between Northern and Southern flying squirrels has been documented in Ontario and Pennsylvania where Southern flying squirrels have encroached into degraded Northern flying squirrel habitat (Garroway et al. 2009), posing a threat of local extinction by gene dilution through genetic introgression. The timeline for implementation of the conifer

planting project is now contingent upon progress of the environmental review process for the USFS Upper Santeetlah forest management project. The crossing structures may mitigate for the road barrier until roadside vegetation matures.

E. Recommendations

Long term success in reconnecting this bisected population is contingent upon trees regenerating on the shoulder to narrow the gap between woodland edges. NCWRC will provide technical guidance to the USFS and NC Department of Transportation to accomplish this objective by two means: by planting conifers along the road shoulder and near the crossing structures, and by posting "no mow" signs in areas with crossing structures, conifer plantings, or existing woody saplings in order to allow trees to mature near known crossing points.

Further evaluation of squirrels' use of the crossing structures is needed to address several unanswered questions. Additional monitoring with cameras, telemetry, and other means is recommended to determine if additional squirrels will use the poles on their own volition. Preliminary evidence of a squirrel using a pole to cross is limited to one experimental release, and evidence of squirrels climbing poles on their own is limited to just three instances on the same pole. We would also like to determine if use peaks at certain times of the year, such as the breeding or juvenile dispersal seasons, or if predation by owls is a problem. If possible, we would like to test other means of detection (acoustic sampling) around known occupied dens, then set up acoustic equipment at poles to monitor squirrel activity near crossing points.

NCWRC should remain actively engaged with the USFS in the conifer planting proposal to ensure that it is implemented correctly and that the USFS considers treating hemlocks. Finally, the high profile crossing structures have piqued the curiosity of visitors to the Skyway. The temporary interpretive sign and brochure should be updated with the encouraging results we have gathered to date.

F. Estimated Cost

$9,031 (Including In-Kind contributions)

G. References

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Prepared By: Chris Kelly
Division of Wildlife Management

Semi-Annual Progress Report
North Carolina Sea Turtle Stranding and Salvage Network
1 July 2008 – 31 December 2008

A. Grant Number: NA08NMF4720513

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 2008 – 30 June 2009

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 Bald Head Island, Morehead City, Beaufort, Cape Hatteras, and Manteo. Additionally, the on-line reporting function for stranded turtles continued to be improved and streamlined and volunteers were encouraged to use it to upload data and photos to the centralized state database. In the reporting period, there were 74 on-line reports of observed stranded turtles.

3. During this reporting period, GPS units, digital cameras and PIT tag scanners were distributed to permitted volunteer members of the North Carolina STSSN.

4. Efforts continued to standardize methods on a regional level. The National STSSN meeting was held in July where all Atlantic Coast state coordinators discussed all aspects of the program. As a follow-up, the Assistant Coordinator attended a regional meeting in South Carolina in November with veterinarians and the stranding coordinators from Florida, Georgia and South Carolina, to coordinate and improve data collection. In addition, the North Carolina STSSN continues to work with seaturtle.org and NMFS Southeast Fisheries Science Center to enhance online reporting tools.

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 64 live cold-stunned turtles that were found stranded between 12-November and 10-December. They were comprised of 45 greens, 14 loggerheads, 4 Kemp's ridleys, and 1 likely hybrid (green/loggerhead). The majority of the turtles (57) were found within 1 week beginning 18-November along the inshore (soundside) beaches in Carteret and Dare counties. An additional 16 greens, 4 Kemp's ridleys, and 1 loggerhead stranded dead and were classified as part of this cold stunning event given the proximity in time and location to the live strandings and their lack of severe decomposition. The event required the cooperation from not only the North Carolina STSSN participants and rehabilitation centers, but also all three NC Aquariums, NC State University, the Virginia Aquarium, the South Carolina Aquarium, the Georgia Sea Turtle Center, and private individuals.

Job 3 Title: Post-Mortem Examinations and Collection of Biological Samples

1. There were 272 strandings reported by the STSSN during this period: 88 loggerheads, 141 green turtles, 34 Kemp's ridleys, 2 leatherbacks, 1 likely hybrid (green/loggerhead) and 6 unidentified species. Of these, 30 loggerheads, 22 green turtles, 7 Kemp's ridleys, and 1 leatherback were necropsied by NCWRC staff and permitted volunteers. These examinations revealed 29 females, 17 males, and 14 turtles with unclassifiable gonads. Of those necropsied, 3 loggerheads showed signs of illness and infection, including low muscle and fat loads, high parasite counts, and paleness. Three greens revealed numerous plastic pieces in the gut,

and 1 additional green had ingested pieces of yarn and monofilament. One loggerhead had severe fractures to the carapace and plastron and multiple abrasions. The cause of these injuries was undetermined. The leatherback that stranded had a fish hook and lure in its front flipper, but it was not determined as a probable cause of mortality. No other abnormalities were found. All other specimens appeared healthy or were otherwise inconclusive. Many of the greens had seagrasses in their digestive tracts whereas the loggerheads and Kemp's ridleys appeared to be feeding on crab parts (horseshoe, stone, or blue crab), whelk, moon snails or fish.

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 and leatherbacks for DNA analysis. All four flippers were collected from Kemp's ridleys that stranded dead. Most samples related to skeletochronology work were transferred to the Sea Turtle Ageing Team at the NOAA-Beaufort Laboratory for their use.

Job 4 Title: Facilitate the Recovery and Release of Live Stranded Sea Turtles

1. The STSSN recovered 72 live-stranded sea turtles during the reporting period: 19 loggerheads, 46 green turtles, 6 Kemp's ridleys, and 1 hybrid. Two loggerheads and 1 Kemp's ridley died during transport to a rehab facility. Four cold stunned greens were euthanized due to extensive injuries suffered from predators between the time when the turtles stranded and when they were observed and picked up. Twenty-six turtles were brought to the NEST facility at NC Aquarium on Roanoke Island. Two loggerheads and 1 Kemp's ridley died shortly after being admitted. One loggerhead and 1 green turtle that were found lethargic have been successfully released. Four loggerheads, 14 greens, and 3 Kemp's ridleys were admitted for cold stunning. Two of the loggerheads were transferred to the VA Aquarium; one loggerhead, 10 greens, and 2 Kemp's ridleys have been released. Twenty-eight turtles were sent to the Karen Beasley Sea Turtle Rescue and Rehabilitation Center on Topsail Island. One loggerhead was emaciated and lethargic. Four loggerheads, 22 greens, and 1 hybrid were cold stunned. One cold stunned green died a few weeks after being admitted, and the others remain in the rehabilitation center. An additional 11 cold stuns were sent for rehabilitation at the NC Aquarium-Pine Knoll Shores (2 greens, 1 Kemp's ridley),

NC Aquarium-Fort Fisher (1 loggerhead), SC Aquarium Sea Turtle Hospital (2 loggerheads, 2 greens), and the GA Sea Turtle Center (2 loggerheads, 1 green). One loggerhead, 3 Kemp's ridleys, and 1 green have been subsequently released.

2. Five releases of rehabilitated turtles occurred during the reporting period. Seven green turtles and 1 Kemp's ridley from the Topsail Turtle Hospital were released off of Topsail Beach. With the help of the Coast Guard, NC Aquariums, UNC-Wilmington, and a local charter boat captain, 4 offshore trips to the Gulf Stream aided in the release of 4 loggerheads, 3 Kemp's ridleys, and 13 green turtles. The majority of these turtles had earlier suffered from cold stunning.

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 2009 – 30 June 2009

A. Grant Number: NA08NMF4720513

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 2008 – 30 June 2009

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, Swansboro, and Bald Head Island.

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. The cold stunning event that began in late 2008 continued into the first part of 2009. Twenty-two turtles (3 loggerheads, 8 greens, 11 Kemp's ridleys) were determined to be associated with this event, with the majority of the stranded turtles observed between 7-27 January. All were found along soundside beaches, from Salvo to Cape Lookout Bight. Necropsies revealed characteristics indicative of cold stunning. Six turtles were alive; one died but the remaining 5 have been released.

Job 3 Title: Post-Mortem Examinations and Collection of Biological Samples

1. There were 221 stranded turtles reported by the STSSN during this period: 111 loggerheads, 63 green turtles, 41 Kemp's ridleys, 1 leatherback, and 5 unidentified species. Of these, 41 loggerheads, 21 green turtles, 22 Kemp's ridleys and 1 leatherback were necropsied by NCWRC staff and permitted volunteers. These examinations revealed 48 females, 14 males, and 23 turtles with unclassifiable gonads. The majority of the turtles necropsied had no remarkable findings. Two loggerheads had horseshoe crab parts puncturing their gastrointestinal tract; 5 loggerheads were found to be in poor body condition. These turtles were emaciated and covered in epibiota. Four 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 17 loggerheads and 19 green turtles for ageing. Muscle tissue was collected on an opportunistic basis from green turtles for DNA analysis. Front flippers were collected from 13 Kemp's ridleys that stranded dead for coded wire tag scanning and ageing. These specimens are in storage at NOAA-Beaufort Laboratory for later use. Two carapaces and one skull from loggerheads were collected and prepared as teaching aids. Ten green turtle carcasses, 2 loggerhead carcasses and 7 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 33 live-stranded sea turtles during the reporting period. These included 18 loggerheads, 9 green turtles, and 6 Kemp's ridleys. Twelve loggerheads, 3 greens, and 4 Kemp's ridleys died shortly after rescue. These turtles had succumbed to boat strike injuries, cold stunning, or severe emaciation. Two loggerheads and 3 greens were treated for cold stunning and have been released. The NEST facility at the North Carolina Aquarium on Roanoke Island is currently caring for an emaciated green turtle. Four loggerheads, 2 greens, and 1 Kemp's ridley, all suffering from emaciation are being held at the Karen Beasley Sea Turtle Rescue and Rehabilitation Center. Another Kemp's ridley, with signs of possible net entanglement, is also being treated at the Center.

2. Eight releases of rehabilitated turtles occurred during the reporting period. Eleven loggerheads and 17 greens were released into the Gulf Stream with the help of the US Coast Guard, local charter boat captains, and the South Carolina Aquarium in 5 separate releases. Three beach releases were held, sending 9 loggerheads, 14 greens, and 2 Kemp's ridleys back to the ocean.

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

Project Number: I-1
Segment Number: 2, 3

Period Covered: July 1, 2008 - June 30, 2009

Program: 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 The Nature Conservancy to conduct prescribed burning on 1,407 acres of longleaf pine savanna on their Shaken Creek tract in Pender County. NCWRC also amended the agreement to extend the ending date and allow for prescribed burning of an additional 1,500 acres of coastal pine forests through June 2010. This management will restore and/or maintain suitable and occupied RCW habitat. The Shaken Creek tract 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. This property will be managed long-term for restoration of the natural communities.

NCWRC also developed a cost-share management agreement to conduct prescribed burning on the Fort/Sledge properties in Brunswick County and the Hilton Properties LTD tract in New Hanover County both managed by David Fort. The Brunswick County property encompasses approximately 3,100 acres of pine in various age classes, and the New Hanover County tract totals approximately 4,108 acres of which 1,190 acres are in pine. Two additional cost-share agreements are in review for a Girl Scout camp in Brunswick County and private property in Northampton County.

B. Target Dates for Achievement and Accomplishment

All management activities were either completed or are continuing.

C. Significant Deviation

No significant deviations.

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

$ 49,245 (including landowner cost)

Prepared By: Jennifer Begier, Red-cockaded Woodpecker Biologist
Wildlife Diversity Program

Annual Performance Report

State: North Carolina

Project Number: I-5
Segment Number: 1

Period Covered: July 1, 2008 – June 30, 2009

Program: Landowner Incentive Program Tier 1

Project Title: Statewide Red-cockaded Woodpecker Safe Harbor Program for North Carolina

Objectives:

1. 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.
2. 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, technical assistance, or networking.
3. 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.
4. 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

During the reporting period, North Carolina Wildlife Resources Commission (NCWRC) signed three SHMAs for properties in Northampton, Brunswick and New Hanover Counties. These properties encompass approximately 8,500 acres and will provide suitable RCW habitat on approximately 3,870 acres of pine. Baseline surveys for properties in Brunswick and New Hanover Counties were also completed during the reporting period. The RCW Biologist met or spoke with several additional potential applicants and conducted four site visits of which one of those applicants has property suitable for Safe Harbor. The RCW Biologist also continued to meet 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. Annual compliance monitoring reports were received from three existing Safe Harbor properties and an annual report summarizing all 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 wrote an article for the Upland Gazette newsletter highlighting the RCW Safe Harbor Program. The RCW Biologist also conducted an RCW educational workshop for Girl Scouts at Camp Pretty Pond.

Another important component of the NC Statewide RCW Safe Harbor Program is to provide technical assistance and participate in professional meetings. 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 three regular meeting of the Forum, chaired one RCW Subcommittee meeting, and attended a workshop of the Onslow Bight Fire Learning Network. In addition, technical assistance was provided to federal, state, and private partners to further RCW recovery efforts in the Onslow Bight region. Similarly, the Cape Fear Arch Conservation Collaborative (CFA) represents the southern coastal plain of North Carolina. The RCW Biologist attended one regular meeting of the CFA and provided technical assistance to state and private/nonprofit partners regarding RCW habitat management, population management, and regulatory compliance. The RCW Biologist also responded to numerous requests for help from citizens regarding a variety of woodpecker issues.

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

Administration of the North Carolina Safe Harbor Program is currently funded by the Landowner Incentive Program. Therefore, we recommend continued funding of this or other comparable programs to ensure that NCWRC can continue to provide this service to North Carolina property owners and manage the program.

F. Estimated Cost

Year	Job	Cost
2008-2009	Implement RCW Safe Harbor Program	$44,597.51

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, 2008 - December 31, 2009

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 priority foci, the partners selected 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 try 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.

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 would serve as the funding obligation instrument between the landowner and the Forest Landbird Legacy Program, detailing the activities that would be performed and the reimbursements associated with them. Brad Gunn of the Wildlife Resources Commission is Project Administrator and disperses requested funds plus handles grant financial reporting. Through 2008 Mark Johns of the Wildlife Commission was the Project Officer and handled grant reports, with assistance from other partners as needed.

Previous annual reports (2004-2007) detail FLLP activities in those years.

Project Activities 2008-2009 (June 2008 – December 2009)

Since the last project report submission, Mark Johns, Partners in Flight Coordinator and the NCWRC Project Leader for FLLP left his position. Although he stills serves on the FLLP committee in his new capacity with the Town of Cary, he is no longer the Project Lead. Those duties have been distributed among the group and the official lead is Chris McGrath (NCWRC). Due to this transition and understaffing at the Wildlife Commission this report is begin submitted late, but is modified to include activities from June 2008 through December 2009.

Landowner Agreement and FLLP Management Plan Activities

To date there are 13 FLLP projects, with five of those completed and eight active. Each project is summarized in the attached spread sheet which provides the agreement number, cooperator, date and life of agreement, county, costs, habitat type, targeted priority birds, project practices, contacts, and other information. A status report on each project is being developed by the principal contact with each landowner project to provide more details on the activities conducted thus far, remaining activities, and/or modifications of the plans for each project and we anticipate having them available early in 2010.

Site Visits: (to determine suitability of sites for inclusion in the FLLP):

Over the last year and half at least 4 site visits were made by members of the FLLP working group to potential FLLP sites. Those included: Hogan, Horseshoe, Dupont, and Sweeny.

In the last year and a half, two new agreements were started. (Sigmon and Hogan)

FLLP Baseline Bird Inventory Work:

In this period no additional inventory work has been conducted.

Program Organizational Activities:

FLLP Annual Meeting

The 2009 annual meeting of FLLP was held at the WRC building on December 3, 2009. There the recognition/certification process was described and shared. All projects were reviewed. A financial report of the program was presented and the group discussed options on how to proceed with the program. Specifically the group will decide upon a strategy to use the remaining funds in the program before September 2011. Chris Moorman of NCSU presented pertinent research findings to the group.

FLLP Recognition

The FLLP Recognition and Certification procedure has been defined and documented for all members to use. A recognition/certification was presented to the Oates Family for their contribution to bird habitat on their Yancey County property.

Final Report
Bogue Inlet Waterbird Monitoring and Management
2003 -2008

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 a centrally located position in the winter/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). Prior to this project the North Carolina Wildlife Resources Commission (NCWRC) had 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. During NCWRC surveys, shorebirds, including Wilson's Plovers (*Charadrius wilsonia*) and American Oystercatchers (*Haematopus palliatus*), both state listed as species of special concern, were also found nesting 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. Habitats associated with inlets are particularly valuable to coastal birds (Harrington 2008) 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).

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. Channel relocation projects are relatively new and there is a need to monitor changes within inlet complexes. This project afforded us the opportunity to study the waterbird and shorebird communities at Bogue Inlet and monitor changes in response to the project. Pre-project monitoring was conducted by CZR, Incorporated for one year prior to channel relocation. NCWRC conducted during-project and post-project monitoring and management beginning in the winter of 2005. This report provides some information from 2008, the final year of monitoring, as well as a summary of data collected from 2003-2008. Detailed results from each year of during and post-project monitoring from 2005-2007 can be found in the Annual Reports.

2. Objectives

NCWRC was contracted to manage and survey important bird areas within the Bogue Inlet complex. 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. Methods and Activities

3.1 Protection of breeding, foraging and roosting habitat

Management along Bogue Inlet continued through 2008 as described in the Bogue Inlet Waterbird Management Plan (Cameron 2004). Management of habitat on the west end of Bogue Banks included posting important foraging, roosting and nesting habitats to preclude disturbance by people and pets. Posted areas were maintained with detailed signs explaining closures. 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 time, it was necessary to adjust posted areas in response to changing conditions on the spit. In addition, NCWRC posted habitat on state-owned Island #2 and Hammocks Beach State Park (HBSP) posted nesting areas on Bear Island.

3.2 Research and Monitoring

Regular surveys for colonial waterbirds and shorebirds were conducted along four transects as outlined by CZR, Inc. (2004). The transects included 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 (Figure 1). Habitat within the inlet complex changed dramatically over the course of the project (Figure 2) and transects shifted with the changing habitat. CZR, Inc. conducted one year of pre-project monitoring from April 2003 – April 2004 with surveys conducted during low tide. Biologists with NCWRC conducted some additional pre-project surveys during high tide in 2004. Beginning with construction in 2005 and continuing through October of 2008, alternating high and low tide surveys were conducted. Tide is a major factor influencing shorebird distribution, abundance and activity (Burger et al. 1977, Connors et al. 1981, Ruiz et al. 1989) and high tide surveys were added in order to better understand habitat use within Bogue Inlet. The total number of pre and post-construction surveys conducted during high and low tide is outlined in Table 1. Transects were surveyed using a flat-bottomed boat and by walking throughout the designated areas. Counts were completed within two hours of high and low tide during respective surveys. 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.

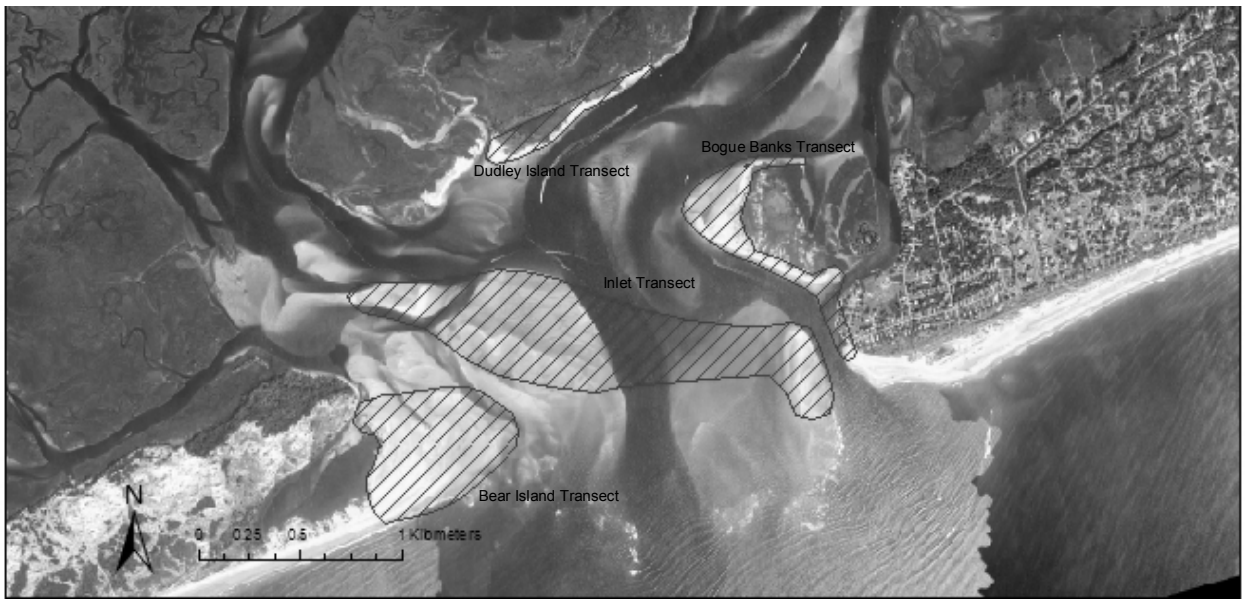
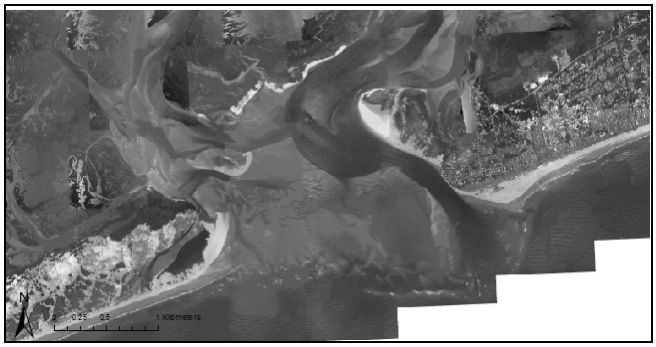


Figure 1. Approximate location of four transects surveyed for waterbirds and shorebirds from 2003-2008 at Bogue Inlet in Carteret Co., NC (base photo from Coastal Planning & Engineering, Inc., 2005). Size and configuration of transects changed with changing inlet features.

a. 2003

b. 2004



c. 2005

d. 2006

e. 2007

f. 2008

Figure 2. Habitat changes at Bogue Inlet 2003-2008 (channel relocation occurred during the winter/spring of 2005). Aerial photos from Coastal Planning & Engineering, Inc.

Table 1. Number of surveys conducted pre and post-construction.

	Total # surveys	Low Tide Surveys	High Tide Surveys
Pre-construction	52	37	15
Post-construction	148	70	78
Total	200	107	93

Count data was summarized by providing seasonal averages by year for all shorebirds and waterbirds and for the most abundant species. Data on shorebirds and waterbirds was treated separately because of differences in behavior and habitat use. Counts along individual transects were summarized and compared as relative abundance (mean # birds/km). Waterbird and shorebird communities were further described in appendices displaying total and peak counts by species and year. Bird activity and habitat use was calculated as percentages during given years. Additional details were given on two species of concern: the Piping Plover, listed as federally threatened and Red Knot (*Calidris canutus*), recently listed as a candidate species.

Changes in bird abundance and species richness were examined by constructing a generalized linear model (GLM) in Statistical Program R (version 2.8.0). GLMs provide an alternative to nonparametric statistics or data transformation for data that is not normally distributed, which is often the case with count data (McCullagh and Nelder 1989). The model included effects of construction (Pre. vs. Post), season and tide on total bird abundance and species richness. Since the number of low tide surveys outweighed high tide surveys during pre-construction monitoring, an additional variable (Pre. vs. Post – low tide surveys only) was created to compare birds observed during low tides. Year was not a tested variable due to the nature of the comparison (i.e. numerous years are nested within pre and post). For the purposes of this analysis, pre and during-construction surveys conducted between April 2003 and April 2005 were classified as pre-construction surveys while those conducted between May 2005 and October 2008 were classified as post-construction surveys.

Lastly, colonial waterbird and shorebird nesting activity was monitored from early April through the end of each nesting season. Intensive monitoring was done on Bogue Banks and consisted of counting nesting pairs and locating and monitoring nests every three to four days to estimate reproductive success. Nest success was calculated as the percentage of nests to hatch at least one egg and fledgling success as the number of chicks fledged divided by the number of nesting pairs. Efforts were also made to determine causes of nest and chick losses. Less intensive monitoring of breeding birds was conducted at other sites with numbers of breeding birds estimated on Dudley Island, Bear Island and along the Inlet transect during weekly surveys with notes taken on reproductive success. Lastly, appropriate habitat on Bogue Banks and within the inlet complex was surveyed for breeding Piping Plovers during the annual coast-wide Piping Plover survey. 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. Nesting data is summarized as the peak number of nesting pairs observed each year.

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. Advertised guided bird walks were provided free for the public during summer months starting in 2005 and continuing through 2008. Walks highlighted birds nesting on North Carolina beaches and also provided an opportunity to look at migrating birds. Walks were initially conducted along the western-most point of Bogue Banks, but the opening of the Coast Guard Channel in the fall of 2005 made this area inaccessible. As a result walks were moved to Fort Macon State Park (located on the east end of Bogue Banks) for 2006 and 2007.

Nourishment at Fort Macon in the fall of 2007 lead to the loss of an ephemeral pool that attracted many shorebirds and as a result, walks were again moved in 2008, this time to South Topsail Beach (adjacent to New Topsail Inlet). This area is easily accessible and provides ample opportunity for people to view breeding and non-breeding waterbirds.

In addition to scheduled walks, other educational opportunities were provided to the public when possible. In 2008, an NCWRC biologist participated in an Earth Day Fair in Swansboro, providing information to fair-goers on beach-nesting birds. Previous educational opportunities involved working with the Emerald Isle Summer Camp and the Outdoor Service Club at West Carteret High School. As children are our future conservation stewards, imparting them with these opportunities at a young age will hopefully provide an understanding of the natural world and an eagerness to protect it. Other informative outlets included newspaper articles in local papers including Tideland News and Carteret News-Times. The recently created brochure entitled "Sharing the Shore with North Carolina's Beach-Nesting Birds" was also distributed annually throughout the area. Finally, important nesting areas within the Bogue Inlet complex were patrolled on holidays and weekends during the summer seasons. 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 visitors a chance to observe the birds in their natural habitat without disturbing them. Over 100 people participated in walks and other educational activities and biologist spoke with many beach-goers over the years.

4. Results and Discussion

4.1 Non-breeding waterbirds

A list of annual total and peak counts of individual species of waterbirds can be found in Appendix A. The total number of waterbirds observed during the 2003/04 pre-construction surveys was 32,225 individuals represented by 37 species. Numbers in subsequent years were considerably lower even though survey effort increased. The most abundant species in Bogue Inlet were Laughing Gull (*Larus atricilla)*, Royal Tern (*Sterna maxima)*, Black Skimmer *(Rynchops niger),* Herring Gull *(Larus argentatus)*, and Brown Pelican (*Pelecanus occidentalis*) (Table 2). These species totaled 56.6% of the waterbird observations from 2003 through 2008. Peak counts for four of the top five species occurred prior to the inlet relocation. These four species were still readily observed in Bogue Inlet post-construction, but not at such high numbers as seen in the first two years of the project. Laughing Gulls, Royal Terns and Black Skimmers were most abundant during fall migration. There was no clear pattern of seasonal abundance for Herring Gulls and Brown Pelicans.

Table 2. Seasonal averages (S=Spring Migration, F=Fall Migration, W=Winter) of five most common waterbird species observed in Bogue Inlet, 2003-2008.

	2003/04 (pre)			2005 (during/post)			2006 (post)			2007 (post)			2008 (post)		
	S	F	W	S	F	W	S	F	W	S	F	W	S	F	W
Laughing Gull	40.17	345.00	26.17	16.53	24.05	7.10	5.07	84.45	0.17	15.87	31.25	0.00	3.80	43.38	0.00
Royal Tern	33.33	150.63	1.17	43.29	79.89	0.00	11.40	119.70	0.00	20.33	63.68	0.17	14.80	29.75	0.00
Black Skimmer	5.58	83.21	9.17	3.47	62.63	0.60	0.93	104.25	0.00	8.13	98.70	0.00	2.07	87.38	0.00
Herring Gull	37.67	153.95	244.00	25.53	15.47	28.70	20.53	27.45	4.50	9.40	4.90	33.50	16.80	32.63	16.50
Brown Pelican	7.83	120.63	47.17	5.18	21.16	43.20	22.67	60.45	7.67	11.00	25.25	16.00	9.73	47.31	40.75

The average number of all waterbird species by season in each year of the project is shown in Figure 3. Numbers were higher for each season during pre-construction surveys in 2003/04. The average number of waterbirds using the inlet during spring migration was relatively consistent from 2005-2008 and varied each year during fall migration and winter months. In general, the highest numbers of waterbirds were observed during fall migration.

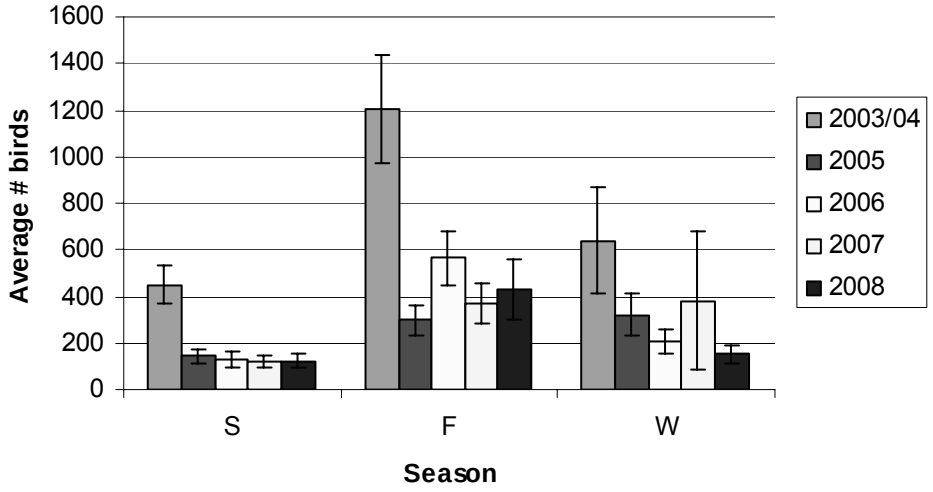


Figure 3. Average number of waterbirds (+/- SE) by season (S=Spring Migration, F=Fall Migration, W=Winter), 2003-2008.

Use of the four transects was also examined by comparing the relative abundance of waterbirds (avg. # birds/km of shoreline) (Table 3). The Bear Island and Inlet transects got the highest use during all years of the project. Fewer birds were seen on Bogue, especially following inlet relocation and Dudley Island had the lowest relative abundance. Overall, relative abundance along transects has decreased following channel construction.

Table 3. Relative waterbird abundance (avg. # birds/km) along the four transects, 2003-2008.

	2003/04 (pre)	2005 (during/post)	2006 (post)	2007 (post)	2008 (post)
Bear	400.30	98.17	122.88	48.44	53.93
Bogue	97.53	34.85	30.02	21.69	38.59
Dudley	22.56	8.53	16.18	7.76	5.48
Inlet	300.98	41.09	49.31	72.95	43.53

Changes in waterbird abundance and species richness pre vs. post-construction were analyzed using a GLM. Waterbird numbers were significantly different between pre and post-construction surveys (Table 4, p=0.006). Figure 4 shows the observed average number of waterbirds in pre and post-surveys. The overall averages illustrate waterbirds were more abundant pre (684.33) versus post-construction (301.29). Similarly, waterbirds were more abundant pre-construction when comparing only low tide surveys (p=0.020). Tide was an important factor in the model with significantly more birds observed during high tide surveys (p=0.002), which makes sense given that waterbirds often congregate in large numbers at high tide roost sites. Season was also important in the model with more waterbirds observed during fall migration (p<0.001).

Table 4. Generalized linear model (quasi-Poisson distribution) results comparing waterbird abundance. * indicates terms significant at α=0.01.

Parameter	Estimate	SE	P-value
Intercept	5.21	0.18	< 0.001
Pre vs. Post - all surveys	0.64	0.23	0.006*
Pre vs. Post - low tide surveys only	0.68	0.30	0.020*
Season - Fall	1.12	0.18	<0.001*
Season - Winter	0.36	0.25	0.140
Tide	-0.62	0.19	0.002*

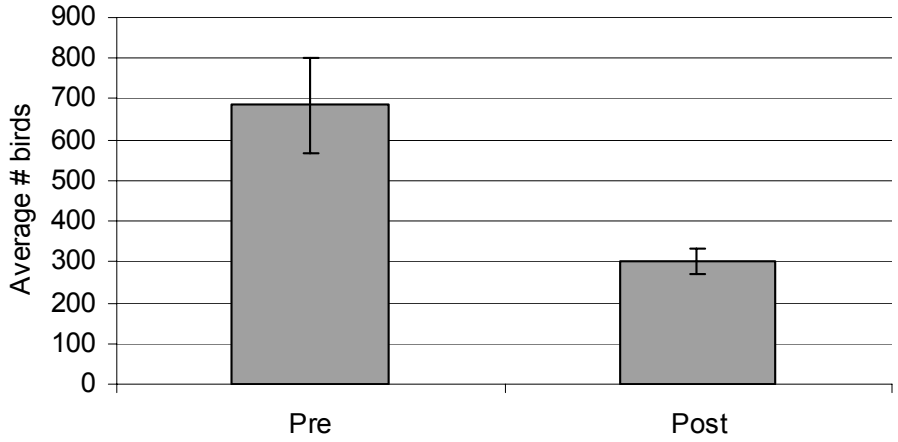


Figure 4. Comparison of average waterbird abundance (+/- SE) observed pre and post-construction.

Similar numbers of species were observed during pre and post-construction surveys with no significant differences detected (Table 5, p=0.710). However, when only low tide surveys were analyzed, species richness was significantly higher pre vs. post-construction (p=0.001). The average number of species observed during pre low tides was 12.35 while the average number observed post low tides was 9.59 (Figure 5). Waterbird species richness was highest during high tide (p=0.001). Seasonal comparison indicate a higher species richness in fall migration than spring migration (p=0.005) and spring migration than winter (p<0.001).

Table 5. Generalized linear model (quasi-Poisson distribution) results comparing waterbird species richness. * indicates terms significant at α=0.01.

Parameter	Estimate	SE	P-value
Intercept	2.38	0.04	< 0.001
Pre vs. Post - all surveys	-0.03	0.08	0.710
Pre vs. Post - low tide surveys only	0.33	0.10	0.001*
Season - Fall	0.12	0.04	0.005*
Season - Winter	-0.41	0.07	< 0.001*
Tide	-0.15	0.05	0.001*

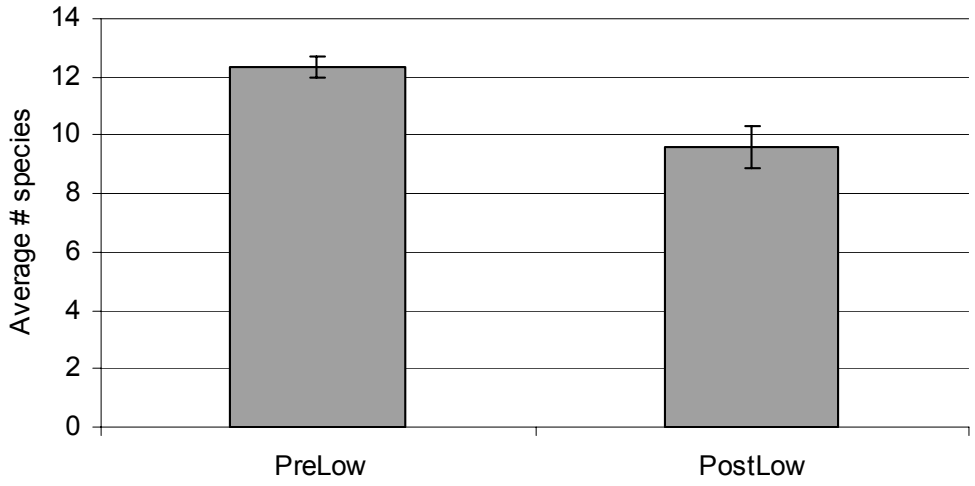


Figure 5. Comparison of average waterbird species richness (+/- SE) observed at low tide pre and post-construction.

A summary of waterbird habitat use and activity is presented in Table 6. During all years, the majority of waterbirds used the inlet complex for roosting. In 2003/04 most birds were observed along the intertidal zone, while in later years most were observed on the beach. Higher percentages of birds were observed foraging and flying in 2003/04 compared to later years. This might be at least partially explained by the fact that fewer high tide surveys were conducted pre-construction.

Table 6. Percentages of total waterbirds observed by activity and habitat, 2003-2008.

	Habitat			Activity		
	Intertidal	Beach	Surf	Roosting	Foraging	Flying
2003/04 (pre)	77.6	12.1	10.3	66.9	11.6	21.5
2005 (during/post)	41.8	49.2	9.0	83.5	6.7	9.8
2006 (post)	22.7	69.7	7.6	79.5	2.8	17.7
2007 (post)	23.8	69.5	6.7	89.1	3.2	7.7
2008 (post)	32.8	56.4	10.8	84.5	3.6	11.9
All years	49.0	41.8	9.2	77.0	7.1	15.9

4.2 Non-breeding shorebirds

A list of yearly total and peak counts of individual species of shorebirds can be found in Appendix B. The numbers of birds observed dropped nearly 50% from 18,121 to 9,292 during the first couple of years following channel relocation, but have rebounded in recent years with 13,464 observed in 2007 and 14,800 in 2008. Numbers of species were similar all years. Table 7 lists seasonal averages of the six most common shorebird species, which were Dunlin (*Calidris alpina*), Short-billed Dowitcher (*Limnodromus griseus*), Sanderling (*Calidris alba*), Semipalmated Plover (*Calidris pusilla*), Black-bellied Plover (*Pluvialis squatarola*) and Western Sandpiper (*Calidris mauri*). These species made up 84.9% of all shorebird observations throughout Bogue Inlet. Dunlin and Short-billed Dowitchers were most abundant during winter months. Semipalmated Plovers and Black-bellied Plovers were generally most abundant during fall migration, but good numbers were also observed in spring and winter. Numbers of Western Sandpipers and Sanderlings varied by season and year, but were generally higher during fall and winter months.

Table 7. Seasonal averages (S=Spring Migration, F=Fall Migration, W=Winter) of six most common shorebird species observed in Bogue Inlet, 2003-2008.

	2003/04 (pre)			2005 (during/post)			2006 (post)			2007 (post)			2008 (post)		
	S	F	W	S	F	W	S	F	W	S	F	W	S	F	W
Dunlin	162.00	230.42	127.00	65.94	58.95	274.00	87.40	22.90	151.67	99.30	62.75	346.00	141.07	11.94	277.00
Short-billed Dowitcher	67.18	93.42	95.50	31.71	22.32	71.00	20.67	26.45	70.67	20.47	57.05	72.17	37.73	77.63	119.25
Sanderling	43.09	103.79	54.50	24.71	30.11	46.20	39.23	38.40	45.33	31.40	59.50	55.67	51.00	95.06	23.75
Semipalmated Plover	16.09	41.00	4.33	24.94	20.68	5.50	15.53	36.45	3.33	27.20	30.35	10.33	40.67	83.31	21.25
Black-bellied Plover	20.82	34.47	18.33	8.59	22.52	11.60	21.00	30.15	30.83	18.80	36.50	38.00	22.07	44.88	19.50
Western Sandpiper	20.18	25.11	10.00	8.00	6.37	17.40	5.73	6.40	5.83	3.87	7.75	41.67	9.47	17.94	17.25

Average total numbers of shorebirds using Bogue Inlet varied seasonally by year, although numbers each year were typically highest during the winter months (Figure 6). The only exception was 2003/04 when numbers were highest during fall migration. During both spring and fall, there appears to have been an initial decline in the numbers of birds using the inlet following construction, although numbers have increased in recent years. Similar numbers of birds were seen following construction during winter months and there has been an increase in use over the last two years of the project. The graph likely minimizes differences since fewer high tide surveys (when bird numbers are typically higher) were conducted during 2003/04.

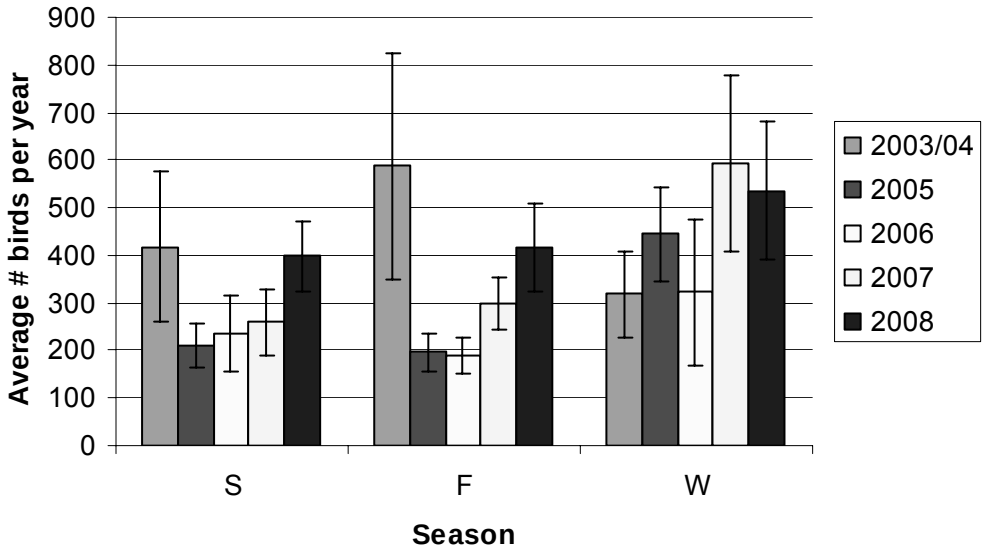


Figure 6. Average number of shorebirds (+/- SE) by season (S=Spring Migration, F=Fall Migration, W=Winter), 2003-2008.

In all years, the Bear Island and Inlet transects supported the highest numbers of shorebirds (Table 8). Relative abundance along these two transects appears to have decreased in the years immediately following channel relocation, but has been increasing in the last couple of years. Relative abundance also decreased along the Bogue and Dudley Island transects and numbers have remained low.

Table 8. Relative shorebird abundance (avg. # birds/km) along the four transects, 2003-2008.

	2003/04 (pre)	2005 (during/post)	2006 (post)	2007 (post)	2008 (post)
Bear	97.13	55.98	69.68	92.23	103.68
Bogue	46.46	30.18	21.74	15.76	17.83
Dudley	62.07	35.61	20.88	24.72	32.92
Inlet	202.67	53.36	29.66	67.23	52.28

Changes in shorebird abundance were analyzed using a GLM (Table 9). The analysis revealed a significant difference in shorebird numbers during low tide surveys pre and post-construction ($p=0.010$). Figure 7 depicts the average number of birds observed during low tide surveys pre-construction (424.30) and post-construction (159.46). There were no significant differences in total shorebird abundance when both high and low tide surveys were combined ($p=0.910$). Tide was an important parameter in the model with significantly more birds observed during high tide ($p<0.001$). Shorebirds are tide dependent and disperse over larger areas as flats are exposed during falling tides. These areas are spread out throughout the inlet complex and surrounding marshes and are not all included in survey areas. As the tide rises and covers these areas, birds congregate in large groups at a few high tide roost sites. Season was not an important variable in the model.

Table 9. Generalized linear model (quasi-Poisson distribution) results comparing shorebird abundance. * indicates terms significant at $\alpha=0.01$.

Parameter	Estimate	SE	P-value
Intercept	5.97	0.16	< 0.001
Pre vs. Post - all surveys	0.03	0.28	0.910
Pre vs. Post - low tide surveys only	0.94	0.37	0.010*
Season - Fall	0.12	0.18	0.520
Season - Winter	0.26	0.23	0.270
Tide	-0.98	0.22	< 0.001*

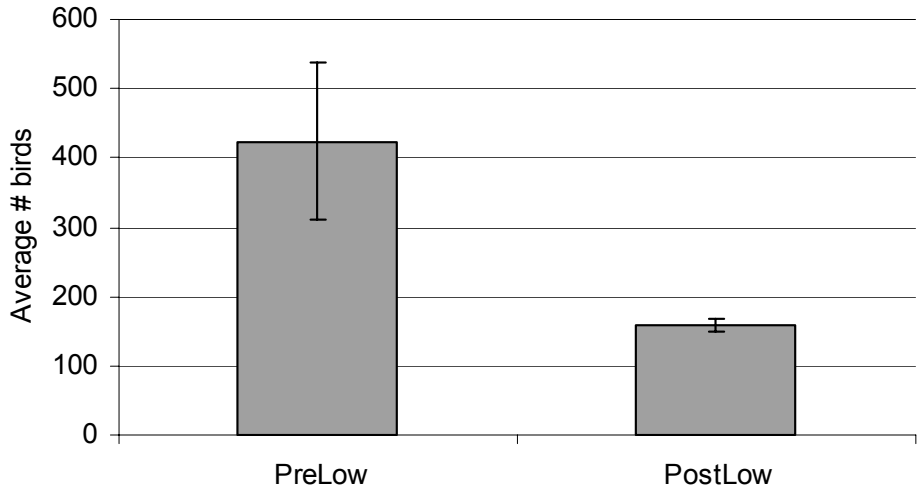


Figure 7. Comparison of average shorebird abundance (+/- SE) observed at low tide surveys during pre and post-construction.

Based on the results from a GLM comparing shorebird species richness, no major differences were observed (Table 10). Similar numbers of species were found during pre and post-construction surveys when all surveys were considered ($p=0.660$) and when low tide only surveys were analyzed ($p=0.960$). There was some seasonal variation in numbers of species

using the inlet complex with fewer species in winter compared to spring ($p<0.001$). This is to be expected as fewer species are typically observed over-wintering along the NC coast when compared to migration periods. A slight difference was observed when comparing overall richness during low and high tide surveys although the difference was not significant ($p=0.060$).

Table 10. Generalized linear model (quasi-Poisson distribution) results comparing shorebird species richness. * indicates terms significant at $\alpha=0.01$.

Parameter	Estimate	SE	P-value
Intercept	2.49	0.04	< 0.001
Pre vs. Post - all surveys	0.04	0.08	0.660
Pre vs. Post - low tide surveys only	0.01	0.10	0.960
Season - Fall	-0.03	0.04	0.510
Season - Winter	-0.31	0.07	< 0.001*
Tide	-0.09	0.05	0.060

Table 11 summarizes shorebird activity and shorebird habitat use within the Bogue Inlet complex. A higher percentage of birds were observed in the intertidal zone and foraging in 2003/04 compared to subsequent years. This might be at least partially explained by the fewer number of high tide surveys during pre-construction versus post-construction. In 2005-2008 birds were observed roosting and flying in fairly equal percentages and birds were typically found in greater percentages using the intertidal zone.

Table 11. Percentages of total shorebirds observed by activity and habitat, 2003-2008.

	Habitat			Activity		
	Intertidal	Beach	Surf	Roosting	Foraging	Flying
2003/04 (pre)	90.7	8.7	0.6	17.7	74.3	8.0
2005 (during/post)	74.1	25.8	0.1	57.9	41.1	1.0
2006 (post)	53.4	45.7	0.9	52.4	45.5	2.1
2007 (post)	60.7	38.7	0.6	50.3	48.2	1.5
2008 (post)	66.9	30.5	2.6	42.1	56.5	1.4
All years	71.4	27.6	1.0	41.4	55.4	3.2

4.3 Piping Plovers

The federally listed Piping Plover was observed along all four transects throughout the length of the project and there has been an increase in the total number of observations in recent years (Table 12). Counts of Piping Plovers initially decreased following the channel relocation, with the lowest number of observations (106) recorded in 2006. Numbers increased in 2007 (181) and again in 2008 (275). Most birds were observed along the Bear Island and Inlet transects. Birds were observed every month of the year with peak counts in September during pre-

construction surveys and in March in years following construction. Bogue Inlet appears to be an important stop-over site during spring migration as birds return to their breeding grounds. It is also important for wintering plovers with between seven and eleven birds found wintering in any given year, representing approximately ten percent of the state's wintering population. The largest one day count during pre and post-construction surveys occurred in March of 2008 when 28 birds were observed on Bear Island. Piping Plover activity and habitat use is presented as percentages in Table 12. In most years, the majority of birds were observed foraging with most observed using intertidal habitats.

Table 12. Summary of total Piping Plover observations, 2003-2008.

	Total	Transect				% Habitat			% Activity			Peak Ct.
	Obs.	Bear	Bogue	Dudley	Inlet	Intertidal	Beach	Surf	Roosting	Foraging	Flying	(Month)
2003/04 (pre)	179	96	23	6	54	73.2	26.8	0.0	16.8	82.1	1.1	16 (Sept.)
2005 (during/post)	149	82	16	30	21	61.7	38.3	0.0	32.2	67.1	0.7	13 (Mar.)
2006 (post)	106	74	7	13	12	51.9	48.1	0.0	28.3	71.7	0.0	16 (Mar.)
2007 (post)	181	81	10	14	76	72.4	26.5	1.1	18.8	79.5	1.7	18 (Mar.)
2008 (post)	275	202	2	27	44	62.9	37.1	0.0	24.4	74.9	0.7	28 (Mar.)
Total	890	535	58	90	207	65.4	34.4	0.2	23.5	75.6	0.9	

The average number of Piping Plovers observed each year along the four transects is depicted in Figure 8. Bear Island proved to be the most important transect for Piping Plovers, followed by the Inlet transect. Along most transects, observations of birds appeared to decrease following channel relocation, but have generally increased in recent years. Only the Bogue transect saw a decline in observations of plovers that has persisted through 2008. This is likely a result of erosion at this site and loss of the soundside mudflat and ephemeral pool, both of which provided important foraging habitat for plovers and other shorebirds.

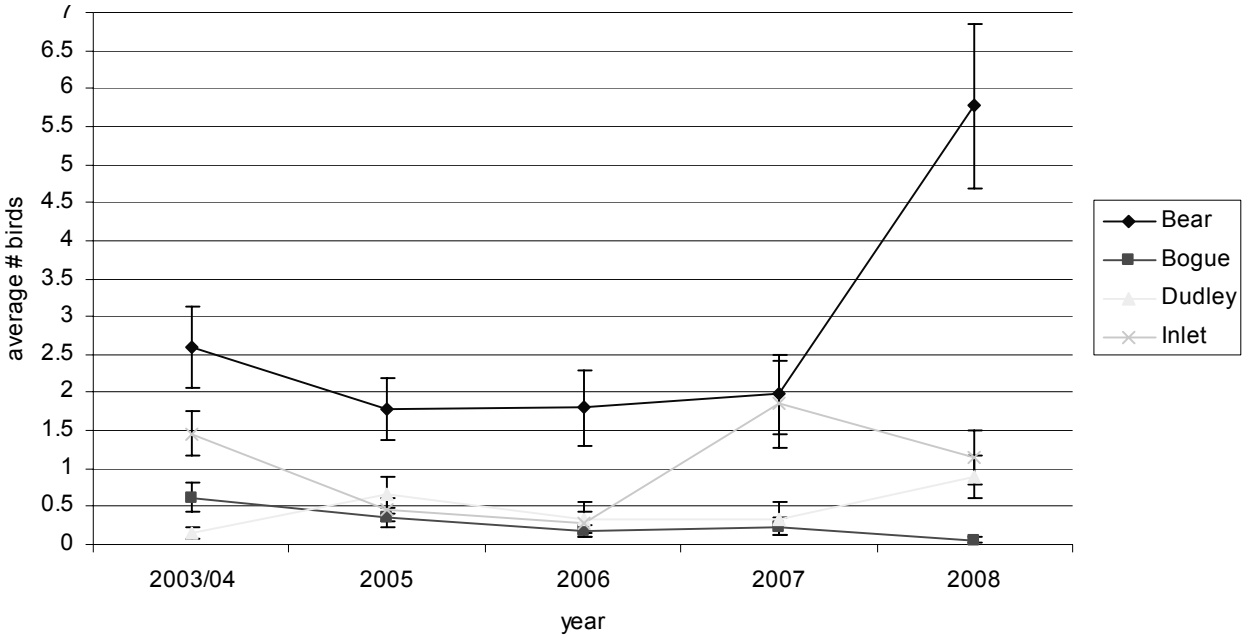


Figure 8. Average number of Piping Plovers (+/- SE) observed per survey by transect, 2003-2008.

A summary of all banded Piping Plovers is given in Appendix C. Birds were observed from all three populations including the endangered Great Lakes population. A few band combinations were observed multiple years along Bogue Inlet indicating that at least some plovers are site faithful and return to Bogue Inlet. The majority of the sightings were along the Bear and Inlet transects, but all four transects had banded plover observations during the project.

4.4 Red Knots

The Red Knot is a medium-sized shorebird that has shown alarming population declines in recent years and is a candidate species for federal listing under the Endangered Species Act. Rising concern of these birds has led to increased banding and monitoring efforts. Appendix C lists observations of Red Knot band combinations and known banding locations. Red Knots were observed in Bogue Inlet during each year of the project with the highest number of observations (409) in 2008 (Table 13). The Bear and Inlet transects provided the most important habitat for this species during most years with the exception of 2005 when birds were equally distributed along the four transects. Overall, most birds were observed roosting and foraging, with the predominant activity varying by year, and most were found using intertidal habitats. Peak numbers were typically observed during spring migration, although there were two years (2004 and 2007) with late winter peaks. These are the same years with the lowest numbers of observations. It's possible that during these years, birds trying to reach breeding grounds in the Arctic might not have lingered for long and instead might have moved through in a few quick pulses that were missed by surveys.

Table 13. Summary of total Red Knot observations, 2003-2008.

Year	Total Obs.	Transect				% Habitat			% Activity			Peak Count (Month)
		Bear	Bogue	Dudley	Inlet	Intertidal	Beach	Surf	Roosting	Foraging	Flying	
2003/04 (pre)	41	24	0	3	12	97.6	2.4	0.0	4.9	87.8	7.3	17 (Mar.)
2005 (during/post)	250	52	68	65	65	74.0	24.0	0.0	73.2	26.8	0.0	68 (May)
2006 (post)	278	56	3	0	219	88.1	11.9	0.0	87.4	12.6	0.0	204 (May)
2007 (post)	138	40	0	0	98	89.1	4.4	6.5	8.0	92.0	0.0	43 (Feb.)
2008 (post)	409	313	3	3	90	95.1	2.0	2.9	44.5	51.8	3.7	147 (May)
Total	1116	485	74	71	484	88.4	9.7	1.9	55.7	42.7	1.6	

4.5 Breeding waterbirds and shorebirds

The number of breeding pairs of colonial waterbirds and shorebirds were recorded along each transect during the nesting seasons from 2003-2008 (Table 14). In 2008 as in years past, colonial waterbird and shorebird nesting activity was monitored from early April through July with nesting activity intensively monitored along the west end of Bogue Banks. A pair of oystercatchers attempted to nest along the Bogue transect again this year, but the nest was lost to overwash from high tides and the pair did not attempt to renest. Oystercatchers were unable to hatch any chicks at this site over the course of the project. Only one pair of Wilson's Plovers nested along the Bogue transect this year; a loss of one pair from previous years. The loss of a nesting pair may be due to a decrease in breeding and foraging habitat as the beach habitat along the Bogue transect continues to erode and the sound side mud flat that once supported good numbers of fiddler crabs (a favored food for Wilson's Plovers) has disappeared. Only a single nest was found and it was most likely lost to predation as evidenced by raccoon tracks along the beach. In previous years (2005-2007), Wilson's Plovers have had some success along Bogue with 0.50 chicks fledged per pair per year.

The amount of available nesting habitat has also decreased along Dudley Island and the Inlet transect and both have experienced a loss in breeding birds. The numbers of coastal birds nesting along Dudley Island decreased again in 2008, with only one pair of Wilson's Plovers observed, down from a high of seven pairs in 2004. The pair was apparently unsuccessful as no chicks or fledglings were observed. No nesting attempts were made by colonial waterbirds in 2008. The last observed breeding activity along the Inlet transect was in 2004 when 37 pairs of Least Terns and two pairs of Wilson's Plovers nested on Island #2. This island quickly eroded following channel relocation and remains underwater during most high tides. In years following channel relocation, the Inlet transect consisted of primarily intertidal habitat with the exception of a strip of supratidal habitat that formed adjacent to the new channel. There is potential for birds to nest here in upcoming years provided human disturbance can be controlled.

Nesting habitat on Bear Island has increased substantially in recent years, but numbers of nesting colonial waterbirds have declined with the exception of an increase in numbers of Least Terns observed 2008. Black Skimmers no longer nest along Bear Island or elsewhere within the inlet complex. Common Terns numbers have fluctuated between one and two pairs most breeding seasons. Least Tern numbers initially declined along Bear Island but increased in 2008 when

214 pairs were observed nesting along the inlet spit (the largest previous record of 57 nesting pairs was observed in 2004). The dramatic increase in Least Tern numbers can likely be attributed to the loss of habitat at a nearby nesting site. Food Lion in Emerald Isle has supported a large rooftop colony of Least Terns for many years, but construction on the roof during the 2008 breeding season likely caused some birds to move to Bear Island. Chicks of varying ages were observed during the 2008 season but none appeared to survive to fledge. Fox and raccoon tracks were observed leading into and throughout the colony and mammalian predation was likely the primary cause for reproductive failure.

The numbers of shorebirds nesting along Bear Island has increased over the course of the project. Eight pairs of Wilson's Plovers nested in 2008, up from just a single pair in 2003. In addition, a pair of Piping Plovers attempted to nest for the first time on Bear Island beginning in 2006 and returning in subsequent years. In 2008 Piping Plover breeding activity was observed in late April and a partially destroyed nest with one remaining egg was discovered along the beach spit on June 6th. The pair continued to incubate the one egg with a second egg laid by June 10th. On this date, NCWRC placed a predator exclosure around the nest following details in the Piping Plover Recovery Guidelines (USFWS 1996) to protect it from further predation. The device allowed the plovers to successfully hatch both eggs with a chick first observed on July 2nd. Unfortunately, the chicks were lost within a week. This pair has yet to have a successful reproductive season. Wilson's Plovers also appeared to have little success in 2008. Small chicks were observed with adults on a few occasions, but most were not re-sighted in subsequent weekly surveys. Two chicks, close to fledgling age, were observed late in the breeding season, but it is unknown if these chicks survived. As with colonial waterbirds, mammalian predation appears to be an important cause of egg/chick loss.

Overall, the numbers of birds breeding near Bogue Inlet has decreased following channel relocation with changes in habitat and numbers of birds observed varying by transect. A combination of two factors likely led to the observed trend in nesting numbers. First and unrelated to the project, mammalian predation appeared to have increased on Bear Island, decreasing habitat quality at this site. Historically, Bear Island supported a large mixed tern/skimmer colony (NCWRC 2007), but numbers started declining prior to this project while evidence of predation increased. Second, the number of potential nesting sites within the inlet complex has decreased in response to the channel relocation. This means that Bear Island is currently the only site with a good amount of sandy beach habitat for nesting and while the amount of nesting habitat has increased substantially on Bear Island, the habitat quality is low because of predator issues.

Table 14. Total number of breeding pairs along each transect, 2003-2008.

Bear	2003	2004	2005	2006	2007	2008
Black Skimmer	38	0	1	0	0	0
Common Tern	2	1	2	0	0	2
Least Tern	5	57	31	26	2	214
Piping Plover	0	0	0	1	1	1
Wilson's Plover	1	2	2	3	6	8
Total	*46*	*60*	*35*	*30*	*9*	*225*
Bogue						
American Oystercatcher	1	0	1	1	1	1
Least Tern	1	0	0	0	0	0
Wilson's Plover	1	2	2	2	2	1
Total	*3*	*2*	*3*	*3*	*3*	*2*
Dudley						
American Oystercatcher	1	2	1	1	1	0
Least Tern	1	0	5	0	0	0
Wilson's Plover	5	7	5	5	3	1
Total	*7*	*9*	*11*	*6*	*4*	*1*
Inlet						
Least Tern	30	37	0	0	0	0
Wilson's Plover	0	2	0	0	0	0
Total	*30*	*39*	*0*	*0*	*0*	*0*
All Transects						
American Oystercatcher	2	2	2	2	2	1
Black Skimmer	38	0	1	0	0	0
Common Tern	2	1	2	0	0	2
Least Tern	37	94	36	26	2	214
Piping Plover	0	0	0	1	1	1
Wilson's Plover	7	13	9	10	11	10
Total	*86*	*110*	*50*	*39*	*16*	*228*

4.6 Disturbances

One of the greatest sources of disturbance to birds along Bogue Inlet continues to be people using the islands for recreational purposes. Figure 9 illustrates the average number of people seen on each transect throughout the length of the monitoring period. As indicated by the large standard error bars, numbers of people observed during surveys varied greatly, but most disturbances occurred in the summer months during the high tourist season. The Bogue transect experienced the greatest average number of people during the 2003/04 surveys, but human activity declined in 2005 and 2006 corresponding to erosion of the beach on the spit. Some

accretion of sand along the area known as The Point probably lead to the rise in the average number of people observed in 2007 and 2008. Disturbance along Dudley Island remained fairly constant with the average number of people per survey under one. This transect is probably less attractive to recreationists because it is bordered by a large peat bank and has little sandy beach. The average number of people observed along the Bear Island transect has decreased since the beginning of the project. Since the spit has accreted it appears most people prefer to remain near their anchored boats and only small numbers of people were observed walking across the large beach spit. Unfortunately, some people were observed entering posted bird areas and human footprints were often observed in these same areas. The Inlet transect has seen the greatest increase in the average number of people observed per survey with over nine people per survey being observed by 2008. This increase is due to the large accretion of sand along the eastern edge of the transect that is adjacent to the inlet, which has become a popular spot for boaters. Continued education and a presence from biologists and rangers will hopefully alleviate these avoidable disturbances.

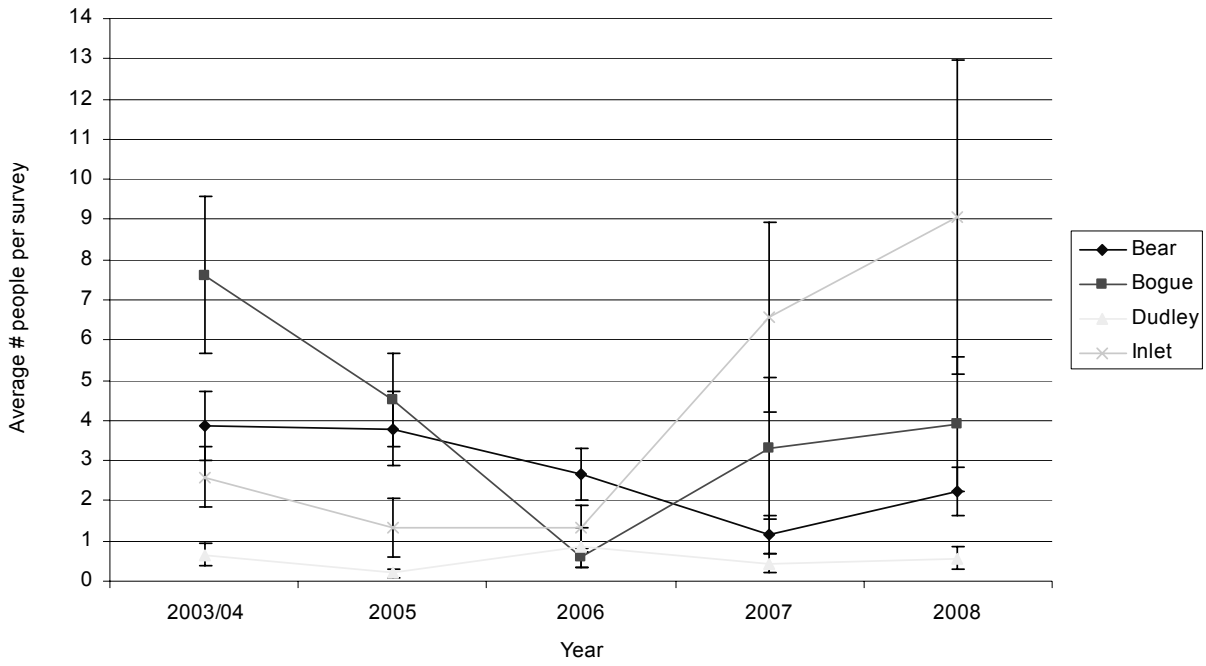


Figure 9. Comparison of average number of people per survey (+/- SE) observed on each transect for each year of the project, 2003-2008.

Other disturbances to breeding birds along Bogue Inlet in 2008 as well as during previous years included early season storms and mammalian predators. Storms producing heavy rains, winds and higher than normal tides contributed to wash out events along many of the transects during the 2008 nesting season. This resulted in loss of nests and chicks and lead to multiple nesting attempts. While weather played a substantial role in the disturbance to nesting birds, a larger threat was that of mammalian predation. The majority of nests and chicks on Bear Island were likely lost to raccoon and fox predation. The continued disturbance from predators threatens

breeding birds along Bogue Inlet. Management practices and perhaps removal of the mammalian predators may prove beneficial for future breeding seasons.

5. Conclusions and Recommendations

This project provided an important opportunity to characterize the colonial waterbird and shorebird communities at Bogue Inlet and to examine impacts of a channel relocation project. It also afforded an opportunity to provide public education on coastal birds and to manage habitat along Bogue Inlet for the benefit of breeding and non-breeding birds. The inlet experienced many changes over the years following channel relocation (Figure 2). Noticeable changes include the sizeable accretion along the east end of Bear Island, which is now connected to most of the Inlet transect during low tide. The accretion of a large beach between The Point and the western tip of Bogue Banks did not occur as predicted and it appears the western tip of Bogue Banks is at risk of becoming a marsh island as the beach habitat continues to disappear. Island #2, part of the Inlet transect, has become little more than an intertidal shoal, no longer suitable for nesting birds. Dudley Island was affected as well with the apparent loss of sandy beach. Although there still appears to be ample foraging habitat, there are fewer high tide roost sites and fewer nesting sites. There have also been some changes in foraging habitat that likely impacted the distribution of birds along the inlet complex. The mud flat and ephemeral pool located on the sound-side of the tip of Bogue Banks disappeared in the years following channel relocation, but there has been an increase in intertidal foraging habitat around Bear Island.

Bogue Inlet appears to be an important migratory stop-over site and wintering site for coastal birds. A total of 28 species of shorebirds were detected in this study. It proved particularly important for several species of shorebirds including Dunlin, Short-billed Dowitcher, Sanderling and Black-bellied Plover with 1,000 – 3,000 birds of each species typically seen over the course of a year. It is also an important staging site for Piping Plovers and Red Knots, especially in the spring. Forty-three species of waterbirds were observed and the inlet was particularly important for several species of colonial waterbirds with thousands of Royal Terns, Black Skimmers, Brown Pelicans and Double-crested Cormorants counted each year as well as good numbers of several species of gulls. The greatest numbers of colonial waterbirds were always observed during the fall months. Birds were most abundant along Bear Island and the inlet shoals and abundance was greatest at high tide.

The channel relocation appears to have had some negative impacts on coastal birds. Negative changes that were observed included a significant decrease in shorebird and waterbird abundance within the inlet complex following channel realignment. Shorebird species richness was the same before and after the project and waterbird species richness declined when comparing low tide surveys. It appears that declines in numbers of shorebirds occurred within the first couple of years following channel relocation and that numbers have rebounded in recent years. Waterbird abundance declined and has remained significantly lower than prior to channel relocation.

It also appears the project negatively impacted nesting birds. Overall breeding activity along Bogue Inlet declined on three of the four transects surveyed during the monitoring project. With a loss of nesting habitat along several transects, there are fewer sites available and the one site with more habitat (Bear Island) is plagued by mammalian predators. It is important for birds to

have multiple potential nesting sites available so when conditions aren't adequate at one site because of predators or disturbance, they can move to more productive sites (Parnell and Shields 1990). Lack of reproductive success at Bear Island suggests the area is acting as a population sink. There is a need to increase the quantity of nesting sites and improve the quality of nesting habitat along Bear Island.

On a positive note, while numbers of observations of Piping Plovers using the inlet initially decreased, they increased substantially in 2008 when more plovers were observed than prior to channel relocation. While it's difficult to say without further analysis if this is a result of the project, there has been an increase in habitat along Bear Island where the expansive flats provide great foraging habitat. Additionally, the first record of nesting Piping Plovers at Bogue Inlet occurred following channel relocation. However it should be noted that the arrival of a breeding pair also corresponds with an increase in the breeding population in NC. With this increase, it is expected that pairs will colonize new sites as previously used nesting areas become saturated.

Management activities likely contributed to the nesting success of Wilson's Plovers along Bogue Banks, but these activities were less productive than we had hoped. This is primarily because of the loss of habitat along the western end of Bogue where intensive management was planned. The Management Plan was developed with the understanding that the amount of nesting habitat would increase substantially on Bogue Banks as predicted by modeling prior to channel relocation. To date, these changes have not been realized and instead the amount of nesting, foraging and roosting habitat has actually decreased on the west end of Bogue Banks. Hopefully there will be an increase in habitat in future years (either naturally or artificially) and NCWRC will continue to manage the area for birds as described in the Waterbird Management Plan.

Several recommendations for this and future studies are provided below. First, it is important to ensure that high and low tide surveys are conducted throughout the length of future projects. The lack of high tide surveys during pre-construction monitoring at Bogue Inlet complicated analysis and made it impossible to compare numbers of birds using the inlet just at high tide. It would also be beneficial to have additional pre-project data and to include data from a control site that wasn't altered during the same time period. In some cases, this data may already exist (e.g. ISS surveys). A large dataset was compiled during the Bogue Inlet project and further analysis, especially related to changes in numbers of specific species and changes in activity and habitat use, would be beneficial. This project did not include money for a biostatistician, precluding more in-depth analysis without additional funding. All of these issues could be addressed if a biostatistician is included from the beginning. It is well known that natural inlets are extremely important to waterbirds and shorebirds including Piping Plovers (Harrington 2008, USFWS 1996) so future studies should investigate cumulative impacts of projects that alter inlets. Finally, it is recommended that future projects build in mitigation measures for unknown impacts that are detected following the completion of the project. In the case of Bogue Inlet and as previously mentioned, we would recommend trying to increase the number of nesting sites (e.g. through beneficial placement of dredged material) within the inlet complex and/or contributing to projects to improve quality of habitat at remaining nesting sites (e.g. predator management on Bear Island).

6. Acknowledgements

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Appendix A. Total waterbird observations and peak counts for each species by year.

Species	2003/04 (n=37)	Peak 2003/04	2005 (n=46)	Peak 2005	2006 (n=41)	Peak 2006	2007 (n=41)	Peak 2007	2008 (n=35)	Peak 2008
Laughing Gull	7194	1711 (Sept.)	809	134 (Jun.)	1766	337 (Sept.)	863	118 (Nov.)	751	198 (Oct.)
Royal Tern	3269	1063 (Sept.)	2254	500 (Aug.)	2565	753 (Sept.)	1516	202 (Oct.)	698	85 (Sept.)
Black Skimmer	1741	635 (Oct.)	1257	290 (Oct.)	2099	870 (Oct.)	2096	884 (Oct.)	1429	621 (Sept.)
Herring Gull	4841	1121 (Feb.)	1015	246 (Feb., Mar.)	884	154 (Mar.)	440	138 (Dec.)	840	296 (Oct.)
Brown Pelican	2669	433 (Sept.)	944	139 (Oct.)	1595	315 (Sept.)	766	126 (Oct.)	1066	244 (Oct.)
Double-crested Cormorant	1821	362 (Mar.)	422	110 (Nov.)	1968	529 (Nov.)	2185	1510 (Dec.)	408	122 (Dec.)
Ring-billed Gull	2484	311 (Feb.)	2069	480 (Jan.)	900	167 (Jan.)	720	175 (Dec.)	452	73 (Sept.)
Least Tern	641	152 (Jul.)	827	152 (Sept.)	251	38 (Jul.)	512	99 (Jul.)	1476	381(Jun.)
Sandwich Tern	1302	180 (Oct.)	264	50 (Sept.)	466	105 (Sept.)	637	77 (Aug.)	673	371 (Oct.)
Forster's Tern	1509	324 (Sept.)	268	57 (Oct.)	251	117 (Sept.)	171	57 (Nov.)	588	228 (Oct.)
Common Tern	776	122 (Aug.)	156	67 (Sept.)	665	215 (Sept.)	422	100 (Oct.)	329	121 (Sept.)
Caspian Tern	491	191 (Oct.)	201	85 (Sept.)	343	195 (Sept.)	425	104 (Aug.)	738	309 (Sept.)
Great Black-backed Gull	969	159 (Oct.)	287	38 (Nov.)	265	35 (Oct.)	137	17 (Oct.)	350	102 (Sept.)
Bonaparte's Gull	1207	424 (Mar.)	175	66 (May)	229	88 (Feb.)	125	35 (Mar.)	196	69 (Feb.)
Red-breasted Merganser	773	304 (Mar.)	34	17 (Mar.)	28	12 (May)	67	25 (Feb.)	65	42 (May)
Northern Gannet	11	8 (Jan.)	423	200 (Jan., Dec.)			54	50 (Apr.)	78	75 (Jan.)
Great Egret	81	9 (Oct.)	53	11 (Apr., Jun.)	95	46 (Oct.)	58	8 (May)	35	6 (Aug.)
Snowy Egret	50	6 (Sept.)	58	9 (Aug.)	44	6 (Jul.)	81	12 (Jul.)	71	11 (Jun.)
White Ibis	6	3 (May)	30	9 (Jul.)	4	2 (Jun.)	54	14 (Nov.)	34	17 (Aug.)
Common Loon	79	42 (Jan.)	5	2 (Nov.)	4	1 (Feb., Mar., May)	6	1 (May, Jul.)	6	4 (Apr.)

Black Scoter	84	84 (Mar.)								
Hooded Merganser	79	38 (Mar.)					2	2 (Apr.)		
Black Tern	8	5 (Sept.)	4	4 (Jul.)	25	22 (Sept.)	3	1 (Jul., Aug.)	37	17 (Aug.)
Lesser Black-backed Gull	40	14 (Sept.)	2	1 (Aug., Oct.)	2	2 (Jan.)	2	2 (Nov.)	19	11 (Sept.)
Tricolored Heron	14	3 (Aug.)	19	13 (Aug.)	10	2 (Jun.)	10	3 (Jul.)	9	3 (Aug.)
Unidentified Gulls	0				45	30 (Sept.)	15	15 (Apr.)		
Canada Goose	19	10 (May)	6	5 (May)	6	6 (Feb.)	28	11 (Mar.)		
Great Blue Heron	23	15 (Jan.)	8	2 (Oct., May)	6	2 (May)	4	1 (Mar., Jun., Nov.)	11	5 (Sept.)
Unidentified Terns									22	22 (Sept.)
Mallard	7	3 (Apr.)	5	2 (May)			4	1 (May)		
Scaup sp.	15	15 (Mar.)								
Glossy Ibis			4	4 (Jul.)			9	9 (Sept.)		
Reddish Egret	1	1 (Jul.)							10	6 (Sept.)
Gull-billed Tern	7	6 (May)					3	2 (Sept.)		
Little Blue Heron	8	2 (Sept.)								
Red-throated Loon	1	1 (Apr.)	5	5 (Jan.)						
Horned Grebe	1	1 (Dec.)					1	1 (Mar.)	3	2 (Mar.)
Parasitic Jaeger									5	1 (Aug., Sept.)
Black-crowned Night Heron			2	2 (Jun.)						
Bufflehead	2	1 (Dec., Jan.)								
Green Heron			1	1 (Aug.)	1	1 (Jul.)				
Clapper Rail					1	1 (Jul.)				
Common Eider	1	1 (Nov.)								
Glaucous Gull							1	1 (Nov.)		

Sooty Tern							1	1 (Mar.)		
Yellow-crowned Night Heron	1	1 (Jul.)								
Total Individuals	32225		11607		14518		11418		10399	
Avg. # Individuals/survey	870.95		252.33		354.10		278.49		297.11	
Total Species	37		30		26		32		27	

Appendix B. Total shorebird observations and peak counts for each species by year.

Species	2003/04 (n=37)	Peak 2003/04	2005 (n=46)	Peak 2005	2006 (n=41)	Peak 2006	2007 (n=41)	Peak 2007	2008 (n=35)	Peak 2008
Dunlin	7297	3115 (Nov.)	4981	576 (Dec.)	2679	460 (Mar.)	4821	771 (Dec.)	3415	510 (Jan.)
Short-billed Dowitcher	3242	962 (Nov.)	1664	280 (Dec.)	1263	237 (Jan.)	1881	290 (Feb.)	2285	267 (Jan.)
Sanderling	2858	305 (Sept.)	1454	100 (Dec.)	1629	176 (Jan.)	1996	233 (Sept.)	2381	284 (Aug.)
Semipalmated Plover	988	239 (Aug.)	872	197 (May)	982	291 (Aug.)	1079	249 (May)	2028	428 (Aug.)
Black-bellied Plover	978	151 (Sept.)	690	105 (Sept.)	1103	126 (Mar.)	1240	127 (Sept.)	1127	155 (Aug.)
Western Sandpiper	759	167 (Mar.)	431	83 (Jan.)	249	33 (Jan.)	463	153 (Jan.)	498	55 (Oct.)
Semipalmated Sandpiper	443	186 (May)	546	110 (May)	95	42 (Aug.)	415	169 (May	425	163 (May)
Wilson's Plover	250	25 (Aug.)	316	28 (Aug.)	246	19 (Aug.)	367	72 (Aug.)	611	108 (Aug.)
Willet	181	25 (May)	120	12 (Apr.)	156	16 (Apr.)	284	40 (Aug.)	389	55 (Aug.)
Red Knot	41	17 (Mar.)	250	68 (May)	278	204 (May)	138	43 (Feb.)	409	147 (May)
Ruddy Turnstone	256	60 (Sept.)	172	22 (Sept.)	124	17 (May)	150	13 (May, Aug., Sept.)	260	38 (May)
Least Sandpiper	395	40 (Aug.)	72	15 (Jul.)	119	23 (Sept.)	123	21 (Sept.)	198	37 (Jun.)
Piping Plover	179	16 (Sept.)	149	13 (Mar.)	106	16 (Mar.)	181	28 (Mar.)	275	28 (Mar.)
American Oystercatcher	76	12 (May)	84	10 (May)	121	15 (Aug.)	138	26 (Aug.)	135	32 (Aug.)
Whimbrel	24	6 (May)	21	3 (May, Jul., Aug.)	36	11 (Jul.)	70	15 (Aug.)	202	26 (Aug.)
Greater Yellowlegs	46	5 (Aug.)	36	7 (Jan.)	28	4 (Sept.)	69	9 (Jul.)	97	14 (Mar., Apr.)
Spotted Sandpiper	32	6 (Aug.)	18	4 (Jul.)	9	3 (Aug.)	30	7 (Aug.)	17	3 (Jul., Aug., Sept.)
Killdeer	36	6 (Oct.)	9	2 (Jan., Mar.)	10	4 (Sept.)	4	2 (Aug.)	12	2 (Mar., Jun., Aug.)

Marbled Godwit	9	8 (Dec.)	1	1 (Sept.)	24	20 (Oct.)	7	4 (Aug.)	19	6 (Apr.)
Peeps	5	5 (Aug.)	2	2 (May)	32	25 (Jan.)	5	5 (Aug.)	10	9 (Aug.)
Long-billed Dowitcher	23	8 (Mar.)								
Snowy Plover									3	1 (Jul., Sept.)
Unknown shorebird									3	3 (Sept.)
Buff-breasted Sandpiper	1	1 (Sept.)					1	1 (Sept.)		
Pectoral Sandpiper			2	1 (Feb.)						
Stilt Sandpiper	1	1 (Nov.)	1	1 (Jul.)						
White-rumped Sandpiper							1	1 (Apr.)	1	1 (May)
Yellowlegs sp.					2	2 (Jul.)				
European Whimbrel	1	1 (Nov.)								
Ruff					1	1 (May)				
Wilson's Phalarope							1	1 (Aug.)		
Total Individuals	18121		11891		9292		13464		14800	
Avg. # Individuals/survey	489.76		258.50		226.63		328.39		422.85	
Total Species	23		21		20		22		22	

Appendix C. Summary of all banded birds observed during surveys.

Species	Year	Transect	Left Band	Right Band	Banding Location
American Oystercatcher	2005, 2007	Bear, Inlet	UL: yellow; LL: blue/metal	UR:black; LR: none	Cape Romain NWR, South Carolina on 10/16/2003
American Oystercatcher	2007, 2008	Bear	Blue 70	Blue 70	Cape Romain NWR, South Carolina on 9/14/2006
Caspian Tern	2007	Bogue	white w/ alpha code APF	Metal	Gull Island, Lake Ontario, Canada; banded as chick on 6/15/2007
Laughing Gull	2005	Dudley	Metal	Metal	Unknown
Piping Plover	2004, 2005, 2006	Bear, Dudley	None	Metal	Unknown
Piping Plover	2004	Inlet	metal/blue	Metal	Unknown
Piping Plover	2003	Inlet	Metal	Metal	Unknown
Piping Plover	2005	Bear	Metal	Metal	Unknown
Piping Plover	2003, 2004	Bear, Inlet	blue	Metal	Unknown
Piping Plover	2003	Bear	blue/purple	Metal	Unknown
Piping Plover	2003	Bear	blue/metal?	Metal	Unknown
Piping Plover	2004	Inlet	faded bicolor metal	Metal	probably Atlantic Canada
Piping Plover	2003, 2005	Bear, Bogue, Dudley	None	faded bicolor band	probably Atlantic Canada
Piping Plover	2003	Dudley, Bear	None	orange/green/metal	Unknown
Piping Plover	2003	Bear	None	metal blue	Unknown
Piping Plover	2007	Bear, Inlet	None	U: metal, L: split color band light green/orange	Platte River area, Michigan; 2005 or 2006
Piping Plover	2003	Bear	None	U: white, L: yellow/orange	Unknown
Piping Plover	2004	Dudley, Inlet	orange/blue	Metal	Unknown
Piping Plover	2003, 2004	Inlet	orange/blue “OB”	Metal	Unknown
Piping Plover	2003	Bear	orange/metal	Metal	Unknown
Piping Plover	2003	Inlet	orange/red	Metal	Unknown
Piping Plover	2003	Bogue	Red	U: white flag, L: yellow/orange	Saskatchewan Canada
Piping Plover	2003	Bear, Bogue	Red	yellow/orange	Unknown

Piping Plover	2004	Inlet	Red/blue	Metal	Unknown
Piping Plover	2005	Bear	Red/metal	None	Lake Diefenbaker, SK
Piping Plover	2003	Bear	Metal	orange/blue	Unknown
Piping Plover	2008	Inlet, Dudley	none (missing foot)	Metal	Possible Atlantic Canada
Piping Plover	2006	Inlet	U: light blue, L: yellow	U: none, L: red/metal	Unknown
Piping Plover	2007, 2008	Bear, Inlet	U: metal, L: red	U: orange, L: none	Grand Marias area, Great Lakes, Michigan; banded as chick 2005, 2006 or 2007
Piping Plover	2007	Inlet	U: metal, L: yellow	U: none, L: orange/light blue	2 yr. old from North Manitou Island, Michigan
Piping Plover	2008	Bear	split color band light green/orange	U: metal, L: light green	Platte River, MI; 2007 chick
Piping Plover	2008	Dudley	U: orange, L: none	U: metal, L: black	Unknown
Red Knot	2007, 2008	Inlet	UL: lime green flag 05, LL: none	UR: green, LR: metal	Kimbles Beach, NJ on 5/19/03
Red Knot	2008	Bear	UL: lime green flag 19, LL: none	UR: orange, LR: metal	Mispillion, DE 5/28/2003
Red Knot	2008	Bear	UL: lime green flag unk. code, LL: none	UR: white, LR: metal	Delaware 2005
Red Knot	2005	Bear, Dudley	UL: lime green flag unk. code, LL: none	UR: lime green, LR: metal	Delaware Bay 2006/2007 or Virginia 2006
Red Knot	2005	Bogue, Dudley	UL: orange flag C7, LL: white/green	UR: metal, LR: none	Argentina
Red Knot	2008	Bear	UL: metal, LL: green	UR: orange flag MTM, LR: none	Argentina
Red Knot	2008	Bear	UL: orange flag unk. code, LL: white	UR: metal, LR: none	Argentina
Red Knot	2008	Bear	UL: orange flag EPE, LL: yellow	UR: metal, LR: none	Argentina
Red Knot	2008	Bear	UL: orange flag ML, LL: green	UR: metal, LR: none	Argentina
Red Knot	2008	Bear	UL: orange flag unk. code, LL: none	UR: metal, LR: blue/white	Argentina

Red Knot	2008	Bear	UL: orange flag, LL: yellow	UR: metal, LR: red	Argentina
Red Knot	2008	Bear	UL: metal, LL: none	UR: light blue flag, LR: yellow	Brazil
Red Knot	2005	Dudley	UL: green flag, LL: green	UR: metal, LR: orange	Delaware
Red Knot	2005	Dudley	UL: green flag, LL: white/red	UR: metal, LR: green/blue	NJ Shore of DE Bay; May 2, 2005
Red Knot	2005	Dudley	UL: green flag, LL: blue	UR: metal, LR: red/green	Delaware Bay; banded between May 10-17, 2001
Red Knot	2005	Dudley	UL: lime green flag MEM, LL: none	UR: red, LR: none	NJ Shore of DE Bay; May 22, 2004
Red Knot	2005	Inlet	UL: mint green flag, LL: none	UR: orange, LR: metal	Delaware; May 2003
Royal Tern	2007	Inlet	None	green/metal	Unknown
Ruddy Turnstone	2008	Dudley	UL: lime green flag EP5, LL: none	UR: lime green, LR: metal	Gandys Beach, NJ on 5/24/07; USFWS band 1282-00118
Sanderling	2007	Bogue	UL: lime green flag NUO; LL: none	UR: none; LR: metal	Cooks Beach, NJ on 5/15/07, USFWS band 1731-03608
Sanderling	2007	Bogue	UL: green flag LET; LL: none	UR: yellow; LR: metal	Fortescue, NJ on 5/22/05, USFWS band 1621-19524
Wilson's Plover	2008	Inlet	yellow/green	Red	Onslow Beach; banded as chick in 2008
Wilson's Plover	2008	Dudley	Red	green/green	Onslow Beach; banded as chick in 2008

Annual Performance Report

State: North Carolina

Period Covered: July 1, 2008 - June 30, 2009

Project Title: Piping Plover Monitoring and Management in North Carolina

Objectives:

Coordinate piping plover (*Charadrius melodus*) monitoring activities for North Carolina.

A. Activity

Wildlife Diversity Program biologists continued to coordinate piping plover activities and compile data during the 2008/2009 fiscal year. The coast of North Carolina was surveyed for breeding piping plovers during the June 1st through June 9th census window in 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.

Sixty pairs and seven individual birds were counted during the 2008 census window. The end-of-season best estimate, which includes pairs discovered after the census window, was 64 pairs and five individuals (Table 1). This represents a 5% increase from last year's best estimate of 61 pairs and is the highest number recorded along NC in the years that complete surveys have been conducted (Figure 1). Statewide distribution was similar to previous years with the majority of nesting pairs (70%) found along Cape Lookout National Seashore (CLNS). Counts were similar to previous years at most sites with the exception of Cape Hatteras National Seashore (CHNS) where eleven pairs nested. This marks an 83% increase from the six pairs that nested along CHNS in 2007.

Table 1. Total number of piping plover pairs and fledglings by site in NC, 2008.

Site Name	Piper pairs (individuals) Window Census	Piper pairs (individuals) Best Estimate	Young Fledged	Productivity
Sunset Beach/Bird Is.	0	0	--	--
Ocean Isle	0	0	--	--
Holden Beach	(1 ind.)	0	--	--
Oak Is.	0	0	--	--
Bald Head Is.	0	0	--	--
Ft. Fisher	0	0	--	--
Masonboro Is.	0	0	--	--
Wrightsville Beach	0	0	--	--
Figure Eight Is.	0	0	--	--
Lea/Hutaff Is.	3 pr. (1 ind.)	4 pr. (1 ind.)	3	0.75
S. Topsail	2 pr.	2 pr.	0	0.00
N. Topsail	0	0	--	--
Onslow Beach	1 pr.	0	--	--
Bear Is. (Hammocks Beach S.P.)	1 pr.	1 pr.	0	0.00
Bogue Banks	0	0	--	--
Bird Shoals	0	0	--	--
Cape Lookout NS	43 pr. (2 ind.)	45 pr. (2 ind.)*	9**	0.20
Dump Island	1 pr.	1 pr.	0	0.00
Cape Hatteras NS	9 pr. (2 ind.)	11 pr. (2 ind.)	7	0.64
Pea Is. NWR	(1 ind.)	0	--	--
Corolla North to State line	0	0	--	--
TOTAL	**60 pr. (7 ind.)**	**64 pr. (5 ind.)**	**19**	**0.30**

* A total of 46 pairs attempted to nest at CLNS, but it appears one pair from Portsmouth moved to South Ocracoke in late May. That pair was included in the best estimate for CHNS.

** Includes one chick with a deformed wing that was transported to zoo facility at day 37. It later died in captivity.

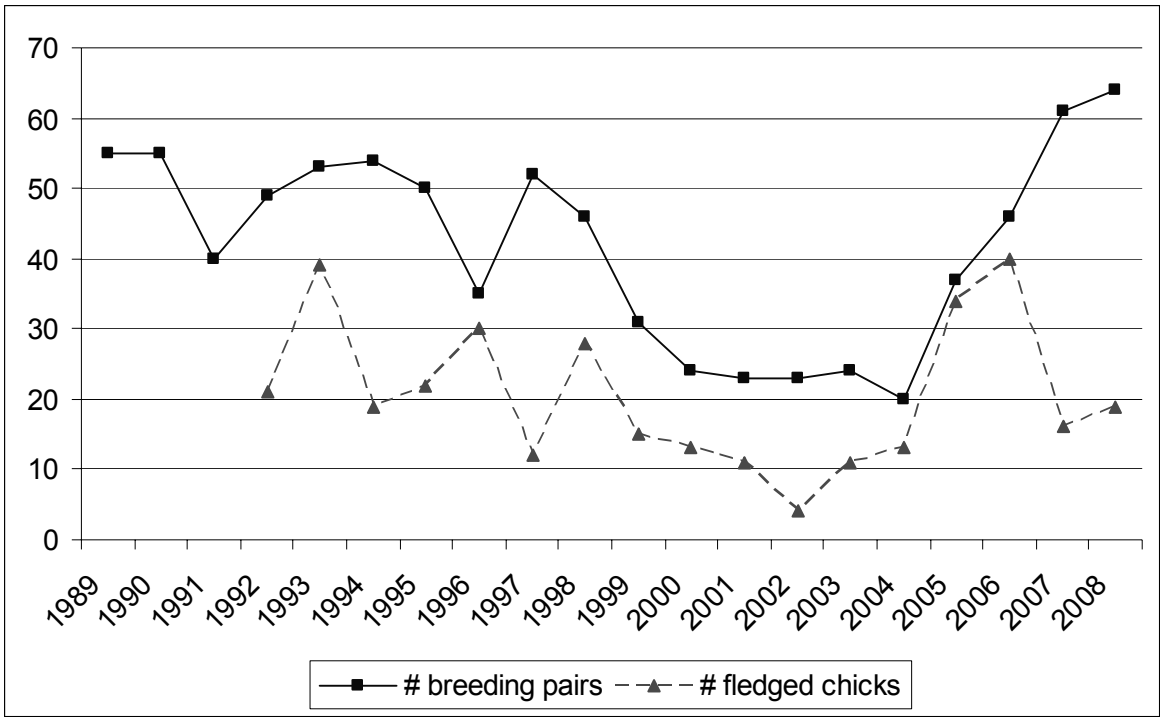

Figure 1. Number of piping plover nesting pairs and fledglings in NC, 1989-2008.

Unfortunately, reproductive success was very low for the second year in a row with only 19 chicks surviving to fledge from the 64 pairs (0.30 chicks per pair). This is similar to productivity of 0.26 chicks fledged per pair in 2007 and is below state's average of 0.50 chicks fledged per pair. Productivity was highest on Lea/Hutaff Island where four pairs fledged three chicks (0.75 chicks per pair) and CHNS where eleven pairs fledged seven chicks (0.64 chicks per pair). Nine chicks fledged from 45 pairs (0.20 chicks per pair) on CLNS. Pairs nesting at Bear Island, Dump Island and South Topsail failed to fledge any chicks.

Several factors or combination of factors likely contributed to the below average productivity observed. Predation, especially by mammalian predators, continues to be an issue along the NC coast. Poor weather early in the season may have delayed nesting in some areas and ill-timed heavy rains later in the season resulted in some nest/chick loss. Lastly, the deterioration of habitat created by Hurricane Isabel, which hit the coast in September of 2003, continues to be a concern. This storm renewed habitat on portions of CLNS and to a lesser extent, CHNS and likely knocked back mammalian 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 revegetating.

Census window surveys were conducted again in early June of 2009 and a total of 53 pairs and eight individuals were counted (Table 2). This is down about 12% from last year's census window count of 60 pairs, seven individuals and it is expected that the end of breeding season total will also be down. This decline comes on the heels of several years of increases, but is not unexpected given the lack of storm events to create new habitat and the continued low reproductive success of North Carolina plovers. Biologists are hopeful that intensive predator

and human disturbance management along Cape Hatteras and Cape Lookout National Seashores this year will increase productivity at the two strongholds supporting nesting plovers in the state. NC State University is currently in the midst of a project that involves removing half of the raccoon population along South Core Banks and it will be very interesting to learn how the shorebird and predator communities respond. It is already shaping up to be a more productive season with 32 chicks fledged from Cape Lookout and Cape Hatteras combined and several unfledged chicks remaining.

Table 2. 2009 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	0
Oak Is.	0
Bald Head Is.	0
Ft. Fisher	0
Masonboro Is.	0
Wrightsville Beach	0
Figure Eight Is.	0
Lea/Hutaff Is.	4 pr. (1 ind.)
S. Topsail	1 pr.
N. Topsail	0
Onslow Beach	1 pr.
Bear Is. (Hammocks Beach S.P.)	1 pr
Bogue Banks	0
Bird Shoals	0
Cape Lookout NS	37 pr. (1 ind.)
New Dump Island	1 ind.
Cape Hatteras NS	9 pr. (4 ind.)
Pea Is. NWR	0
Corolla North to State line	1 ind.
TOTAL	**53 (8 ind.)**

This fiscal year NCWRC biologists monitored nesting pairs at Bear Island, South Topsail and New Dump Island. We also worked with partners to erect predator exclosures around nests that aren't exclosed by other management personnel. This year NCWRC staff exclosed one nest on Bear Island and one on Onslow Beach.

Lastly we continue to update NCWRCs shorebird database with sightings of nonbreeding 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

A pair of piping plovers attempted to nest for the first time on New Dump Island; a dredged material island in Core Sound managed for nesting waterbirds. The nest was found as a completed clutch with only one egg and likely lost additional eggs to extreme high tides. The habitat at this site is ideal for piping plovers and includes sand/shell substrate for nesting and an adjacent algal flat that provides good foraging. The site could use additional material along the western shoreline and care should be taken to avoid the algal flat if/when additional material is added to the island. Given the appropriate habitat and lack of mammalian predators, plovers could be very successful at this site as long as early succession habitat remains.

A piping plover nest was also found for the first time on Onslow Beach, which is part of Camp Lejeune Marine Corps Base. The nest was located by a Virginia Tech student conducting research on Wilson's plovers. This nest successfully hatched and one chick from the brood remained alive at the last observation.

E. Recommendations

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. We should also continue to support predator management activities conducted by partners including Cape Lookout and Cape Hatteras National Seashores.

F. Estimated Cost:

$667.47

Prepared By: Susan Cameron
Wildlife Diversity Program
Division of Wildlife Management

Annual Performance Report

State: North Carolina

Period Covered: July 1, 2008 - June 30, 2009

Project Title: Bald Eagle Monitoring

Funded By: National Fish and Wildlife Foundation Grant #2006-0176-002

Objectives:

We intend 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 will be investigated when reported. Land use, ownership, and potential disturbances around nests are documented. Letters will be sent to inform non-federal landowners with eagle nests about the status of the nests and their responsibilities as landowners to protect the nests under the Bald and Golden Eagle Protection Act. Data on each eagle nesting territory will be 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 136 eagle nesting territories are now known within the state. The Coastal Region continues to have the majority of known nests. There are 82 known nests in the Coastal Region, which includes 10 new nesting territories that were found this year. The Piedmont Region has a total of 47 known nesting territories, which includes 6 new nesting territories found this year. The Mountain Region has 7 known nesting territories.

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. Nests are considered inactive when there are no signs of nesting activities throughout the nesting season.

Across the state, at least 113 of the 136 known nesting territories were occupied this year. At least 105 of the territories were active. At least 91 nests were successful in 2009 and production totaled at least 150 fledglings. This total of fledglings is a new record high for North Carolina and exceeds the previous record set last year by 30. Productivity was up from 1.33 young fledged per active nest in 2008 to 1.42 young fledged per active nest in 2009. However, of the successful nests, 1.64 young fledged per nest in 2009. That is down from the 1.76 young fledged per successful nest in 2008. There were at least 6 inactive nesting territories this year.

Table 1. Summary of regional nesting activities across the state

Region	Occupied	Active	Successful	Chicks Fledged	Chicks Fledged per active nests	Inactive
Coastal	67	63	54	84	1.33	3
Piedmont	39	35	30	53	1.51	3
Mountain	7	7	7	13	1.85	0
Totals	113	105	91	150	1.42	6

Seventeen nesting territories did not have complete monitoring this year for various reasons. Twelve of the nests were in the Coastal Region and five were in the Piedmont Region. Eight nests were not observed due to the unknown nests locations, which includes one nest in each of the following counties; Camden, Chowan, Craven, Currituck, Orange, Pamlico, Vance, and Wayne. Three nests were not found during aerial surveys in Hyde, Northampton, and Tyrrell counties. One nest in Chowan County was not found during an aerial survey but was later located from the ground in August. Since that nest was checked outside of the nesting season, nesting may have already concluded. Three nests on federal lands in Carteret, Dare, and Hyde counties were not checked during the nesting season. Two known nesting territories were not checked in Guilford and Pasquotank counties.

New Nesting Activity

Statewide, 16 new bald eagle nesting territories were found this year. In the Coastal Region, 10 new nests were found. Craven County added three new nesting territories this year. In Craven County, one of the nests was found by a NCWRC enforcement officer, one was found by the bald eagle technician during a field visit to a nearby nest and the other was found by a long time local bird enthusiast. The Mackay Island National Wildlife Refuge staff found a new nesting territory on their lands in Currituck County. A NCWRC biologist found a new nest in Jones County during a heronry flight survey. An employee with the Coastal Land Trust found a nest in New Hanover County. Biologists with the Camp LeJeune Marine Corps Base in Onslow County found their second known territory this year. The bald eagle technician found a new nest in Pamlico County while checking other known territories in the county. Another new nesting territory was found in Pamlico County by a professional wildlife photographer. The last new territory was in Tyrrell County. This nest was an alternate nest from a previously known territory. This year the known territory was active along with the alternate nest. Since both locations were active, a new territory split from the previously known territory.

In the Piedmont Region, six new nesting territories were found this year. The first known nesting territory in Franklin County was found this year and was reported active since 2001. Two new nests were found in Halifax County. The first was found by the volunteer working with the bald eagle technician during an ornithology field trip with East Carolina University. The Center for Conservation Biology (CCB) found the other new nest in Halifax County during one of their flights. A new territory was found in Mecklenburg County this year on the first known artificial nesting structure. A new nesting territory was found in Wake County near the Falls Lake region. The last new territory was also found by the CCB during one of their conservation flights in Warren 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. Three new nesting territories were located during flights this year. Two were found during the CCB flights and one during a heronry survey with NCWRC. There were five new alternate nests locations found for known territories this year during flights. Four were found with one of the NCWRC enforcement pilots: one alternate nest in Beaufort County, two in Pitt County, and one in Washington County. The CCB found the other new alternate nest in Halifax County.

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 Craven (12), Beaufort (11), Pitt (8), Chatham (6) Pamlico (6), Wake (6), Halifax (5), Hyde (5), and Tyrrell (5).

A 350 acre wildfire threatened an eagle nest in Beaufort County in early March. Fire and smoke were observed on March 12th underneath the eagle's nest. No eagles were seen in the nest but an adult was seen flying nearby over the scorched landscape. The nest was checked five times after the fire. Both adults were seen on the nesting tree on March 28th, with one sitting in the nest in an incubation or brooding posture. No eagles were seen on April 23rd, May 13th, June 2nd, or June 19th. However, on May 13th, new nesting material had been added to the nest. There was a burnt limb added to the side of the nest. This nest was classified as active but unsuccessful in producing any fledglings.

Mortalities/Injuries

There were two adult mortalities documented during the nesting season. The first mortality was in early March. A dead adult eagle was found near Laurinburg in Scotland County. This adult died when it was electrocuted by contact with transmission lines. The second mortality occurred

near Wilmington in New Hanover County in early April. An adult was found underneath the nesting tree lying on the ground. The eagle suffered a laceration on the dorsal neck and had considerable hemorrhaging in the oral cavity. The eagle was shipped to the USGS National Wildlife Health Center in Madison, Wisconsin for a necropsy. The preliminary diagnosis from the center was the eagle died of trauma, probable impact during flight. Cloacal swabs and kidney/spleen pool samples were submitted for virulogical tests. Results of those tests were not available at this time.

Two injured eagles were reported during this year's nesting season. A juvenile eagle was found on a back porch in Corolla, Currituck County. The eagle was taken to an animal hospital in Manteo to receive treatment. The eagle was examined and found underweight and heavily infested with lice. After the eagle received treatment it was picked up and taken to a location for release. The juvenile eagle was still unable to fly, thus recaptured and taken to a wildlife rehabilitator near Edenton. A few days later the injured eagle was taken to the Carolina Raptor Center in Mecklenburg County. The eagle was diagnosed with a vision problem and is unable to be released at this time. The second injured eagle was found near Plymouth in Washington County. It was an adult and was also taken to the Carolina Raptor Center to receive treatment. It has a high white blood cell count and is expected to fully recover.

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. 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 August. All data has been presented to the US Fish and Wildlife Service and the North Carolina Natural Heritage Program 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. At this time, a sub sample system should be considered.

F. Estimated Cost (FY-2008-09)

$ 36,287.43

Prepared By: David H. Allen - Coastal Region Wildlife Diversity Supervisor
Fred Jarrett – Bald Eagle Technician
Division of Wildlife Management

Annual Performance Report

State: North Carolina

Period Covered: 1 July 2008 – 30 June 2009

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. A formal Memorandum of Understanding was signed by all six NCBT steering Committee partners in May, 2008.

The North Carolina Birding Trail Steering Committee met several times and conducted conference calls to review the status of projects, develop communications plans, and provide oversight for the birding trail effort.

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 105 sites were approved for the mountain region. The Mountain Trail Guide was published and unveiled at a Grand Opening Celebration held at the North Carolina Arboretum on June 25, 2009.

B. Remarks

Since August 2008, the NC Wildlife Resources Commission has been without a full time birding trail coordinator. NCWRC contracted with the former coordinator through March 2009 to complete the development of the Mountain Region Trail Guide. The former coordinator and volunteer steering committee members have shouldered the burden of maintaining steering committee coordination and planning as well as continuing ongoing efforts including the newsletter (Trail Mail) and completion of the Birder Friendly Business Training Program.

C. Estimated NCWRC Costs (2008-2009)

$56,023.53

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

Annual Report

USFWS Grant Agreement # 401814J011

State: North Carolina

Period Covered: July 1, 2008 - June 30, 2009

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 project helps to fund habitat management of privately owned bogs in North Carolina specifically for the bog turtle by identifying candidate bogs, preparing habitat management agreements, and conducting habitat management. Due to staff changes and limited personnel resources during the period covered, no habitat work was completed and an extension was granted through the next fiscal year.

B. Project Implementation

A select group of bog landowners that were prioritized by several factors, including condition of the bog, were contacted by letter and other means as feasible in June 2009. Work with landowners to sign them up and develop specific management plans continues.

C. Estimated Costs:

$103.48.

D. Conclusions

Work on this project will continue in 2009-2010.

Prepared By: Kendrick Weeks
North Carolina Wildlife Resources Commission