Annual Program Report
2009-2010

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-11-P

Period Covered: July 1, 2010 – August 31, 2010

Grant Title: State Wildlife Grants 07-Wildlife Management

Project Title: Priority Species Data Management

Objective:

Efficiently collect, manage, and catalog data on sensitive species across the state in form that is readily accessible, scientifically sound, and useable in maintaining the Wildlife Action Plan.

A. Activity

This year we have been progressing on several long-term projects:

1. Project Tracking Database: This database is designed to track performance on WRC programs to the Wildlife Action Plan. The database was placed into production and biologists began using the database in June 2010. After a period of 6 months, we plan to evaluate usage of the application and develop the appropriate reporting mechanisms.
2. 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 the 14 existing databases are being incorporated individually.
    a. Colonial Waterbird Database: This database is in production and stores all existing data on colonial waterbird species. It will be the main repository for any future data collected.
    b. Aquatics Database: The database has been moved into production and is currently in use by biologists. The database is now accessed through the internet (rather than through Microsoft Access), allowing more flexibility. It also conforms to the BIODE data structure.
3. We have completed training for and installed ESRI's ArcSDE software. This will allow us better centralized storage of spatial data. In the coming year, we plan to use the software to improve distribution of Aquatic and Green Growth Toolbox data.
4. We have completed mapping Wildlife Action Plan Habitats using the newer Southeast Gap Analysis Program (SE GAP) habitat layer. This updated SE GAP layer was not available when the Wildlife Action Plan was developed. This provides an updated look at the location and quantity of priority habitats throughout the state.
5. Ad hoc cartographic services: Developed maps for the Green Growth Toolbox program.

6. We provided technical support for currently deployed GPS/GIS hardware and software to field biologists in the Wildlife Diversity program.
7. 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 on schedule and all accomplishments have been met within target date of achievement.

C. Significant Deviations

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

D. Remarks

None

E. Recommendations

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

- Deploy a Wildlife Resources Commission portal on the Conservation Registry website (www.conservationregistry.org). This innovative partnership with Defenders of Wildlife will allow collection of outside partner accomplishments towards the Wildlife Action Plan.
- Deploy a better mechanism for distributing Green Growth Toolbox data.
- Develop an improved version of the Aquatics Listed Species Project, at dynamic map of listed species occurrences throughout the state.
- Complete conversion of 1-2 other species-specific databases to the BIODE format.
- Complete the reporting element of the Project-Tracking Database.
- Continue to provide technical support for GPS/GIS hardware and software to field biologists

F. Estimated Cost

$ 32,507

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

Final Performance Report

State: North Carolina **Project Number:** T-11-P

Period Covered: July 1, 2009 – August 31, 2010

Grant Title: State Wildlife Grants 07-Wildlife Management

Project Title: CURE Surveys for Early Successional Species

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

A. Activity

Introduction

With the sun-setting of the CURE program on private CURE areas in December 2009, biological surveys have stopped on Benthall Plantation and Rowland CURE areas. The last surveys conducted on these areas were covey counts and useable habitat evaluations in the fall of 2009.

All of the CURE Game Lands have completed or are nearing completion of their initial timber management prescriptions and are entering a habitat maintenance phase. Data collection has been completed for several surveys designed to evaluate initial habitat and wildlife population response to management, including vegetation surveys and winter bird surveys. Quail and songbird point count surveys and useable habitat evaluations will be continued on all CURE game lands for the indefinite future, with each game land site refining their own long-term monitoring needs.

The research project on Western Piedmont CURE native warm season grass fields continued through this year and is scheduled to be completed by spring of 2011. All surveys on Murphy Brown corporate CURE site will continue through fall of 2010 when current grant funding will end, and surveys may be refined to meet the needs of future grants.

Methods

Surveys conducted during the 2009-2010 year included breeding songbird point count surveys, breeding Bachman's sparrow point count surveys, useable habitat evaluations, and winter songbird strip transect surveys. In this report we refer to the CURE I management period (2001-2006) and the CURE II management period (2007-2009) for private land CURE areas, representing periods with different program rules and implementation. The game lands and Murphy Brown have been under just a single administrative and management plan.

Breeding Bird Surveys – Private Lands. From 2007-2009 focal songbirds (Table 1) were counted during the same 5 minute, unlimited distance 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 surveyed on the same morning as the CURE area. We used paired 2 sample t-tests to compare average bird counts between CURE and control routes.

Table 1. CURE II breeding songbird/quail focal bird 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 Game Land. 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 2009). 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. Simple linear regression was used to compare the slope of the trend line between CURE and reference routes.

Bachman's sparrow point counts. Survey points were located $\geq$0.4 miles apart using a modified gird system. Four routes of approximately 25 points each were established on each of the CURE and Control areas and were surveyed 3 times each. In 2010, only 2 of the routes on each of the CURE and control areas were surveyed due to manpower limitations. Surveys began at first light and ended ~5 hours after sunrise on days with little wind and no precipitation. Observers recorded the estimated location of each bird on aerial photos. We used playback of Bachman's sparrow song recordings to increase detection rates. From 0-3 minutes the observer listened passively with no playback stimulation. From 4-6 minutes, the observer played recorded Bachman's sparrow vocalizations.

Bachman's sparrow territory mapping. Territory mapping was used to determine territory establishment rates and sizes (Robbins 1970, Ralph et al. 1993). Territory mapping was conducted for a random sample of Bachman's sparrow sighting locations from the point count

surveys. Bird locations were visited at least once every 10 days on mornings without heavy precipitation or strong winds, and spot-mapped for a minimum of 15 minutes. If the target bird was not detected within ~10 minutes the MP3 caller was used to stimulate a response. Observers recorded age (adult vs. juvenile), behavior, location, and movement of each bird observed. Locations and behaviors of all neighboring Bachman's sparrows and bobwhite quail were also recorded. At the end of the field season, all observations were transferred to one map. A territory was designated if the target bird was observed at least 3 times within a 21-45 day period. Territory size was determined using the least convex polygon method in ARC GIS. Each territory was given a Vickery score (Vickery 1992), a reproductive index based on observed behaviors.

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*

Winter Bird Surveys. 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. In 2010 winter bird surveys were conducted on Caswell CURE and Frogsboro (control) areas, Suggs Mill Pond, and Murphy Brown. As of the writing of this report, the 2010 winter bird data has not yet been analyzed or summarized.

Useable Habitat. To track the quantity of early successional 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 measured useable habitat available during both the breeding and non-breeding seasons. A stand was classified as useable for the non-breeding season if it was available in five of the seven months from October through April. A stand was classified as useable for the breeding season if it was useable in at least two of the five months of the breeding period from May through September. "Not useable" habitat was all areas without suitable cover for quail.

Results- CURE private lands

Benthall Plantation

Breeding Songbirds. The Benthall Plantation survey route consisted of 21 survey points on the CURE area and 23 points on the control. Indigo bunting, common yellowthroat, prairie warbler and yellow-breasted chat were more abundant on the CURE area than the control, suggesting the CURE area provided better shrubland habitat than the control. Counts of several grassland-associated species such as eastern kingbird, eastern meadowlark, and grasshopper sparrow were significantly lower on CURE than on the control area.

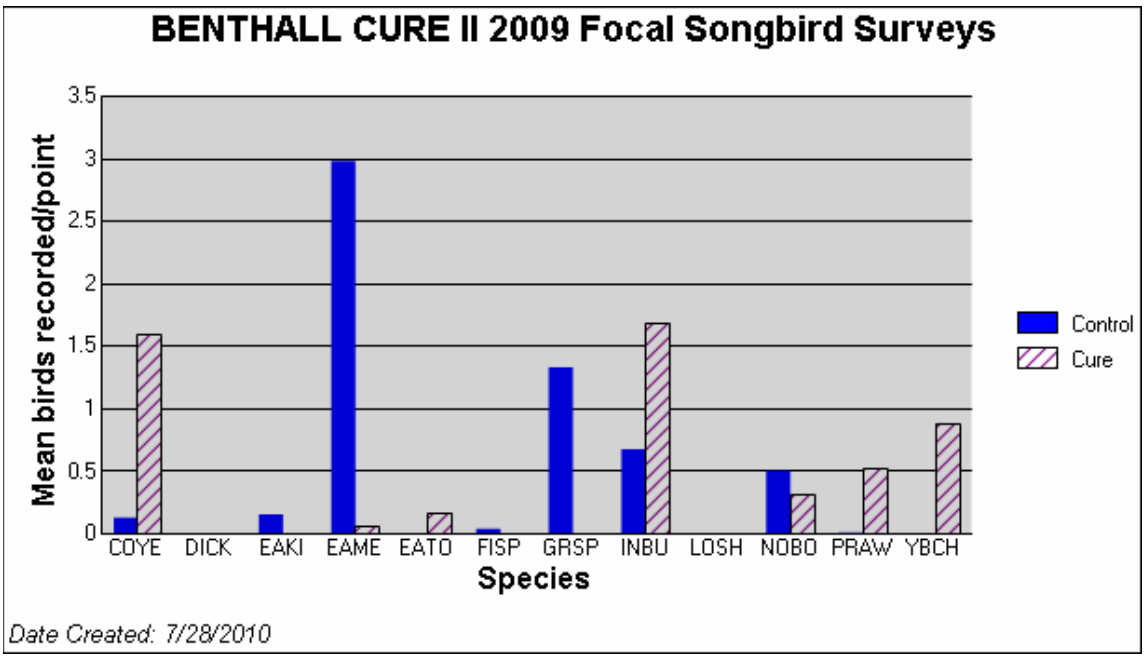


Figure 1. Relative abundance of focal songbird species on Benthall CURE II, 2009, based on unlimited distance, five minute counts. Key to species codes can be found in Table 1.

Useable Habitat. The amount of useable habitat remained relatively constant during the CURE II period at Benthall Plantation (Fig. 2). In 2009 58% of the landscape was useable for quail during the breeding season while 21% of the landscape was useable in the non-breeding season. The greater abundance of breeding habitat is primarily because of the large acreage of annual

row-crops which provide some habitat in the breeding season but have insufficient cover after harvest. CURE habitat enhancements did not significantly increase the quantity of breeding habitat, though the quality was likely improved with the conversion of row crop to fallow habitats. The greatest improvement was seen in the quantity of non-breeding habitat, where CURE treatments almost doubled the amount of winter cover available to quail since the inception of CURE in 2002. The Benthall control area had 78% useable breeding habitat and only 2% non-breeding habitat.

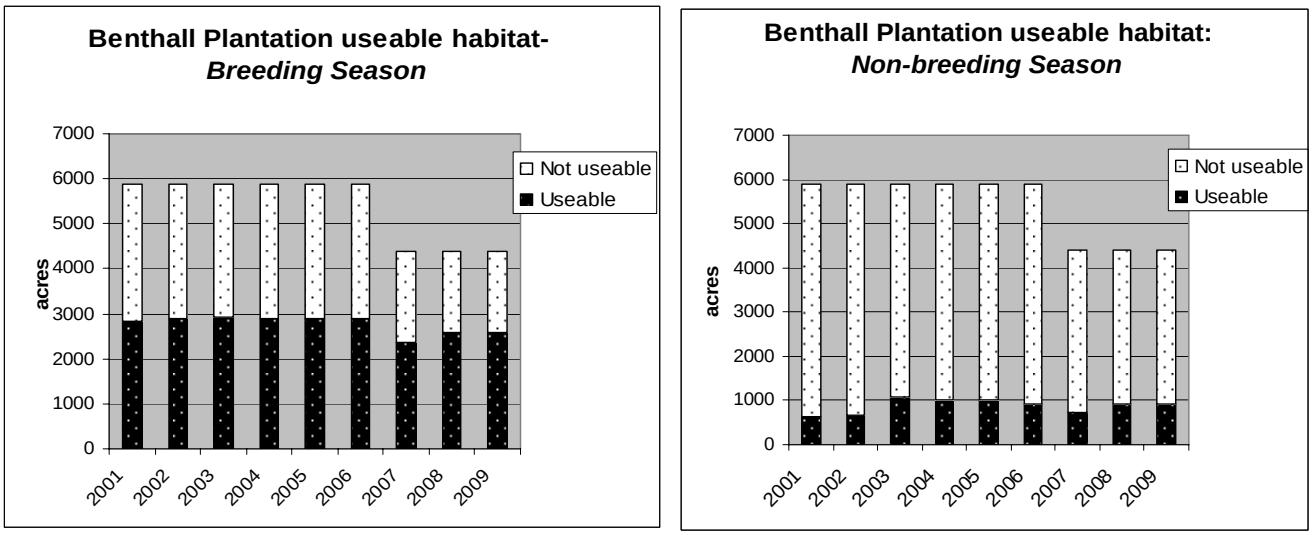


Figure 2. Acres of habitat suitable for quail use at Benthall Plantation, 2001-2009, during the breeding season (left graph) and the non-breeding season (right graph). Note that the total acreage of the CURE area was reduced in 2007 with the transition to CURE II.

Rowland

Breeding Songbirds. This survey route consisted of 16 survey points on the Rowland CURE cooperative and 18 points on the control area. Across all 3 years of CURE II, there was a significantly greater abundance of field sparrow ($P = 0.02$) and northern bobwhite ($P = 0.01$) on the CURE area than the control. During CURE II there were no significant differences in abundance for any other focal species between CURE and control. Worthy of note, the Rowland cooperative was the only CURE area with observations of loggerhead shrikes.

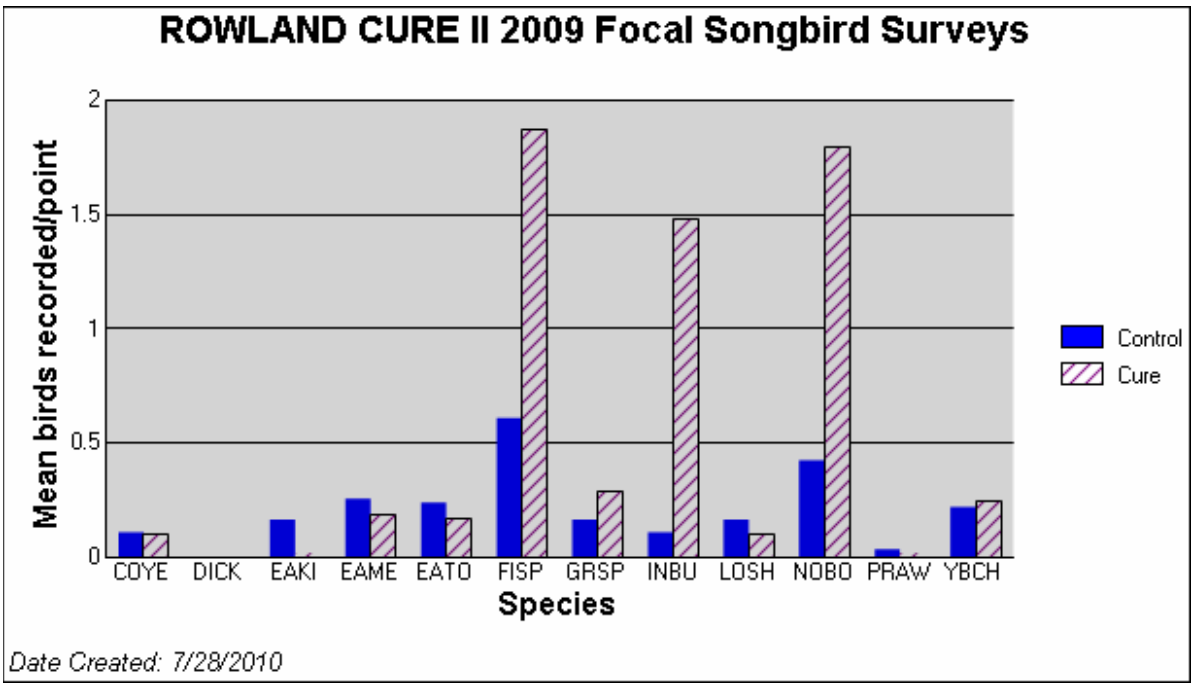


Figure 3. Relative abundance of focal songbird species on Rowland CURE II, 2009, based on unlimited distance, five-minute counts. Key to species codes can be found in Table 1.

Useable Habitat. The total amount of useable habitat remained relatively constant during the CURE II period at Rowland (Fig. 4). Over the past several years there has been a decrease in the amount of useable breeding habitat, in part due to the canopy closing on young pine stands and thinned pine stands, reducing the herbaceous understory. At the start of the program 51% of the landscape was useable for quail as breeding habitat and in 2009, 55% of the area was useable for breeding. Non-breeding habitat has been more limiting at Rowland and this is where the greatest improvements were realized early in the CURE program. In 2001 only 7% of the landscape was useable for quail in the non-breeding season and in 2009, 19% of the area was useable in the winter. The Rowland control area had 61% useable breeding habitat and 6% non-breeding habitat in 2009.

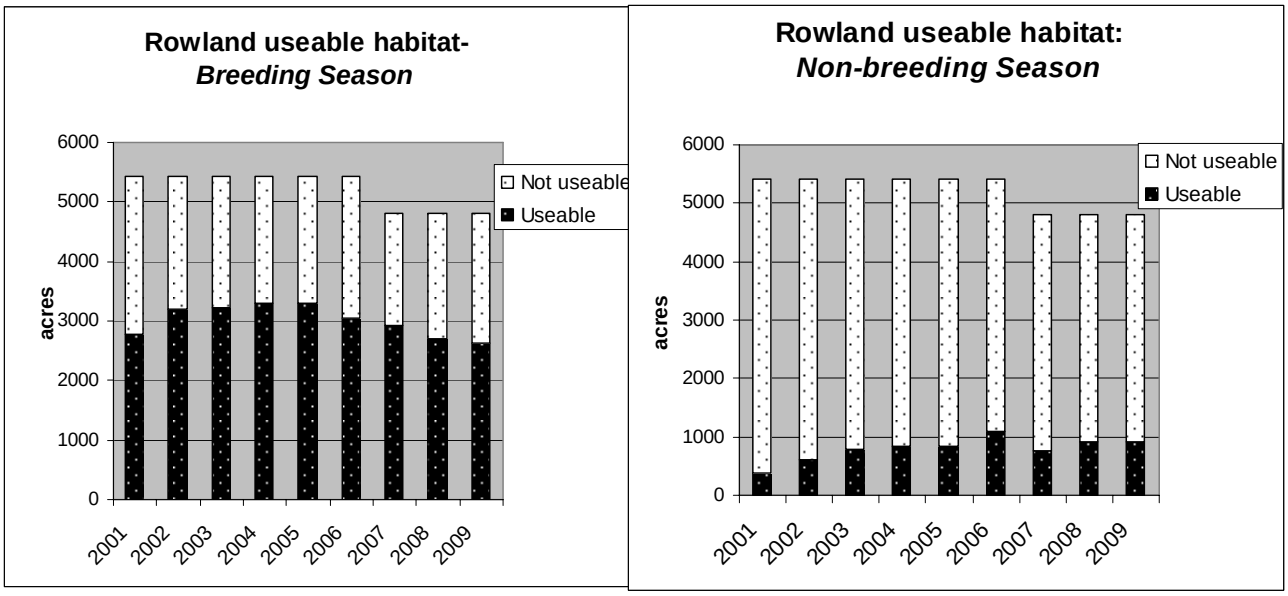


Figure 4. Acres of habitat suitable for quail use at Rowland, 2001-2009, during the breeding season (left graph) and the non-breeding season (right graph). Note that the total acreage of the CURE area was reduced in 2007 with the transition to CURE II.

Turnersburg

Breeding Songbirds. Breeding season point count surveys were conducted on 9 CURE contracted warm season grass fields which were paired with 9 nearby (1-3 km) non-CURE fescue pastures. The indigo bunting was the most abundant focal species on all fields (Fig. 5). There were no significant differences (all P values ≥ 0.24) in mean abundance of focal birds between CURE and control fields across all 3 years of CURE II.

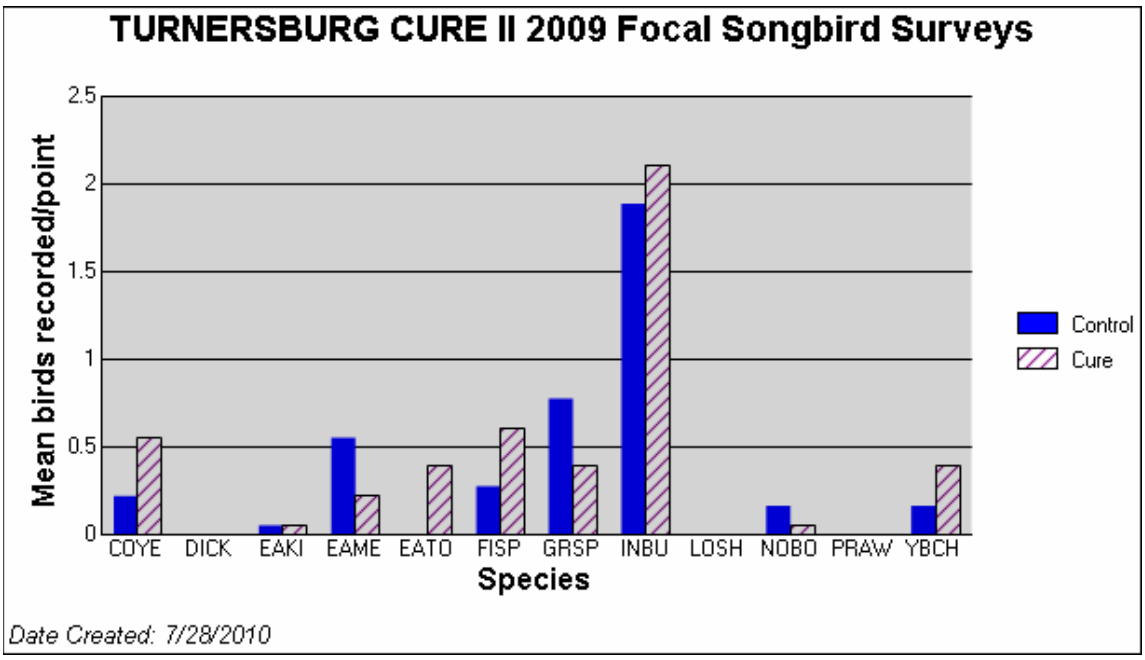


Figure 5. Relative abundance of focal songbird species in the Piedmont focal area, 2009, based on unlimited distance, five-minute counts. CURE points were located in fields planted to native warm season grasses while control points were located in fields planted to exotic cool season grasses. Key to species codes can be found in Table 1.

Native Warm Season Grass Research project. A graduate research project with NC State University began in April 2009 to evaluate the wildlife benefits of grassland management techniques in the western Piedmont. Methods include songbird territory (spot) mapping, small mammal trapping, and vegetation surveys. Objectives are to compare use and benefits to wildlife populations of native warm season grass (nwsg) fields under agricultural management, native warm season grass fields managed exclusively for wildlife ("wildlife fields"), and exotic cool season grass (ecsg) fields managed for agriculture.

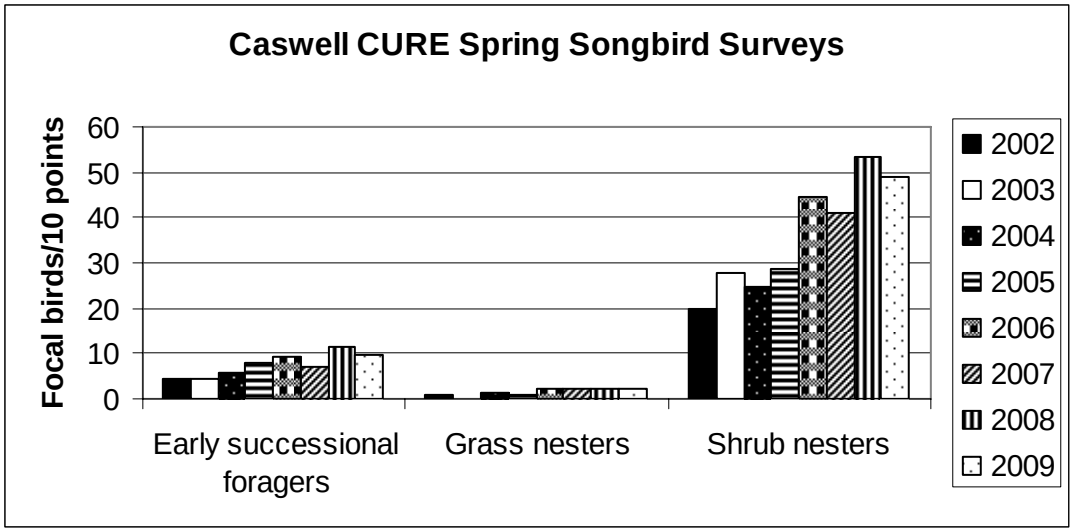
Songbird and small mammal surveys were conducted in 7 nwsg forage fields, 7 ecsg forage fields, and 4 "wildlife" fields that contained a mix of nwsg and forbs. At least 9 spot mapping visits were made to each field in 2009, and these surveys were repeated in the summer of 2010. Analyses will compare songbird territory density and reproductive effort between each field type.

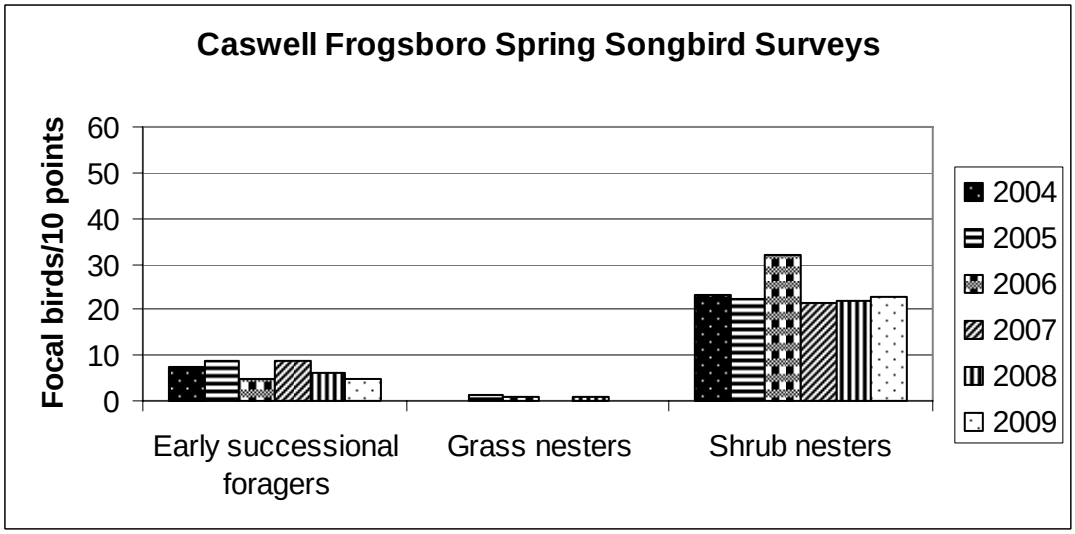
In 2009, a total of 338 small mammals were captured: 217 *Sigmodon hispidus*, 71 *Peromyscus leucopus*, 46 *Mus musculus*, 3 *Zapus hudsonius*, and 1 *Blarina brevicauda*. Small mammal captures differed (p=0.002) among the three field types. More small mammals were captured in wildlife fields ($\bar{x}$=50.3±10.0/1000 trap nights) than in ecsg ($\bar{x}$=4.5±2.9/1000 trap nights) and nwsg ($\bar{x}$=20.6±4.0/1000 trap nights) fields. Although captures were higher in nwsg fields than in ecsg fields, capture numbers did not differ significantly. Based on preliminary data, ecsg and nwsg forage fields do not provide the same habitat quality for small mammals as the diverse plant communities in wildlife fields. Vegetation measures were collected in 2009 and expanded in 2010 to relate bird and mammal survey results to habitat quality and vegetative structure.

Results- CURE Game Lands

Caswell Game Lands

Breeding Songbirds. At Caswell Game Land shrubland nesters were the most abundant guild. Indigo bunting was by far the most common shrub nesting species detected on Caswell, followed by yellow-breasted chat and prairie warbler. The early successional forager group was dominated by chipping sparrows and brown-headed cowbird. The grassland nester group was entirely represented by northern bobwhite.





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. Caswell Frogsboro (control) surveys were initiated in 2004.

Since the initiation of CURE there have been significant increases in early successional foragers (+0.94 birds/10 points per year, $P = 0.004$), grassland nesters (+0.31 birds/10 points per year, $P = 0.004$), and shrub nesters (+4.73 birds/10 points per year, $P = 0.0007$) on the CURE area. From

2004-2009 there has been no trend (*P* values $\geq$ 0.33) in counts for any of these guilds on the Frogsboro route control (Fig 6 & 7). Within the shrub nesting group, yellow breasted chat showed the greatest increase on the CURE area since the start of management. Field sparrow (Fig 8), eastern towhee, and common yellowthroat also had increases in counts from 2002-2009. By 2009 there were higher counts for every species in the shrub nesting guild on the CURE area compared to the Frogsboro route. Within the early successional forager guild, brown-headed cowbird had the greatest increase in relative abundance on the CURE area since the initiation of management. There were significantly more eastern wood-peewees detected on the CURE area compared to the control, and red-headed woodpeckers were only detected on the CURE area.

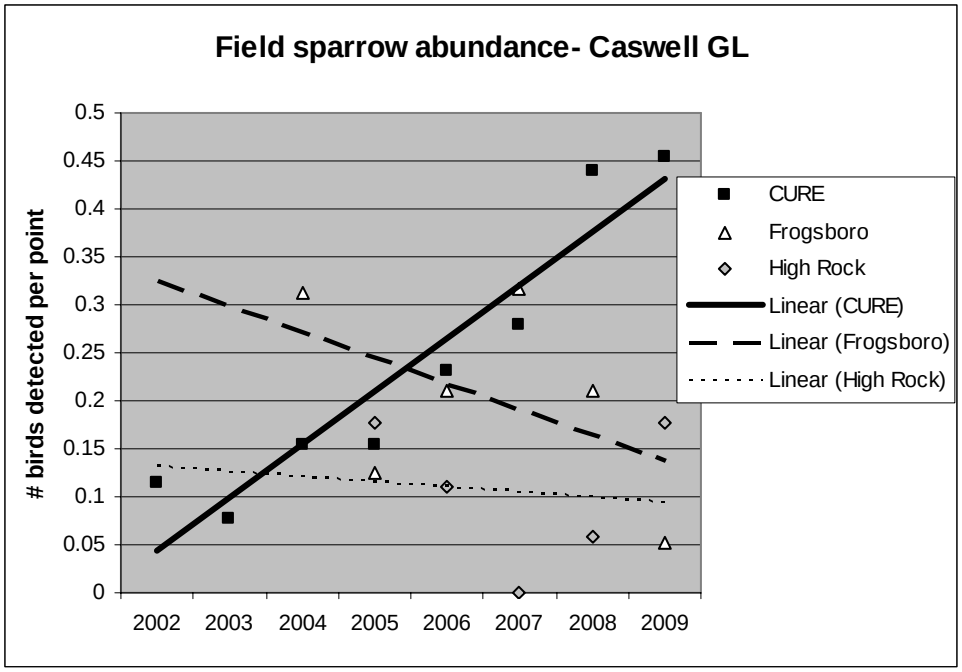


Figure 8. Field sparrow relative abundance from point count surveys, Caswell Game Land, 2002-2009. Lines represent linear regression trend line. Frogsboro and High Rock routes are located on Caswell Game Land but off the CURE area.

While timber cutting had negative effects on mature forest breeding species such as wood thrush and ovenbird at the scale of the stand (Marcus unpublished data), the count trend for these species across the entire CURE area is similar to the trends on the reference routes (Fig 9), suggesting that the more intensive timber management is not negatively affecting populations of forest species at the scale of the CURE area.

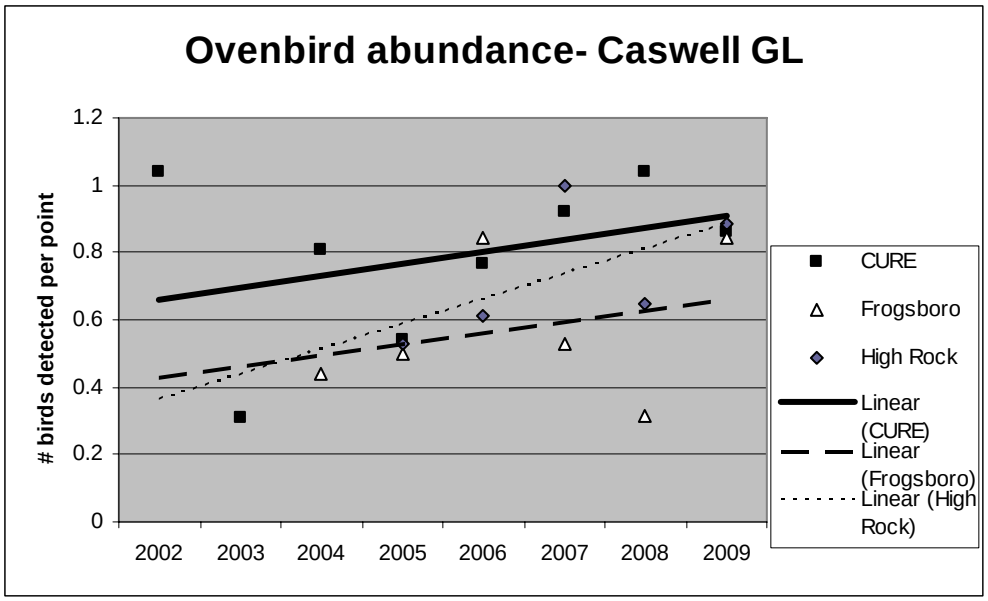


Figure 9. Ovenbird relative abundance from point count surveys, Caswell Game Land, 2002-2009. Lines represent linear regression trend line. Frogsboro and High Rock routes are located on Caswell Game Land but off the CURE area.

Winter Songbirds. In 2010 we surveyed 44 stands on the CURE area in field, hardwood, and pine forest habitats. 2010 was the last year of winter bird data collection on Caswell Game Land because initial CURE timber management operations have been completed. As of the writing of this report the 2010 data has not yet been summarized.

Useable Habitat. There has been a steady increase in acres of useable quail habitat in both the breeding and non-breeding seasons since the inception of CURE. In 2002, only 10% of the Caswell CURE area provided breeding habitat and 11% of the landscape was useable in the winter. Patches of useable habitat were separated by large blocks of closed canopy forest which are not suitable for quail. In 2009, 31% of the CURE area provided useable breeding habitat and 31% was non-breeding habitat. By 2009, most of the stands initially prescribed for thinning or clearcutting had been cut. The majority of the non-useable habitat (66% of the landscape) consists of mature, closed canopy hardwood-dominated stands and recently cut pine stands which have not yet responded with adequate groundcover. Caswell's CURE goal is to establish and maintain ~51% of the area in early successional habitat by 2012.

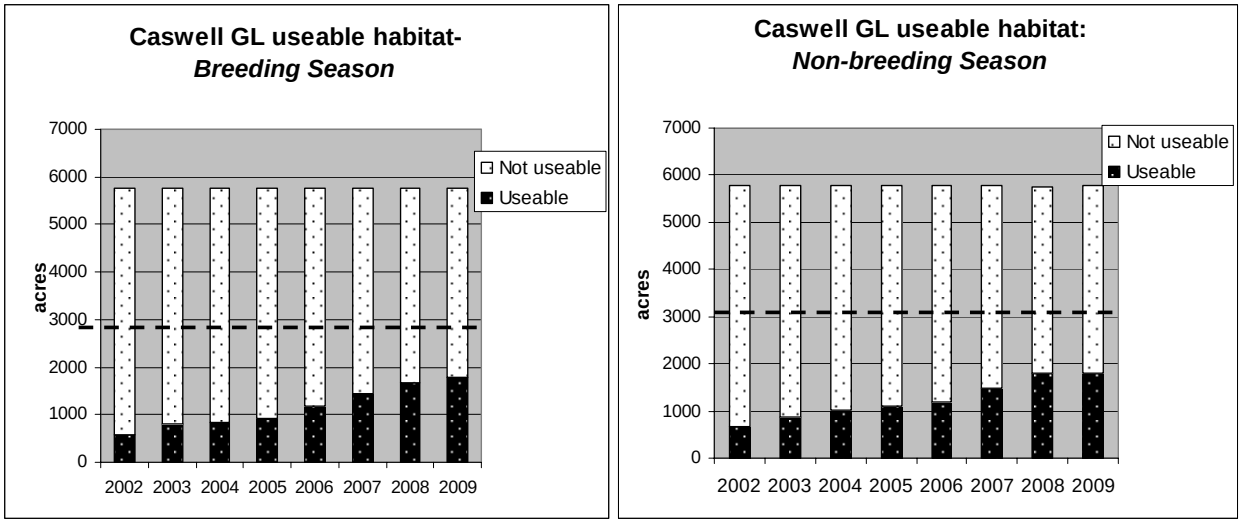
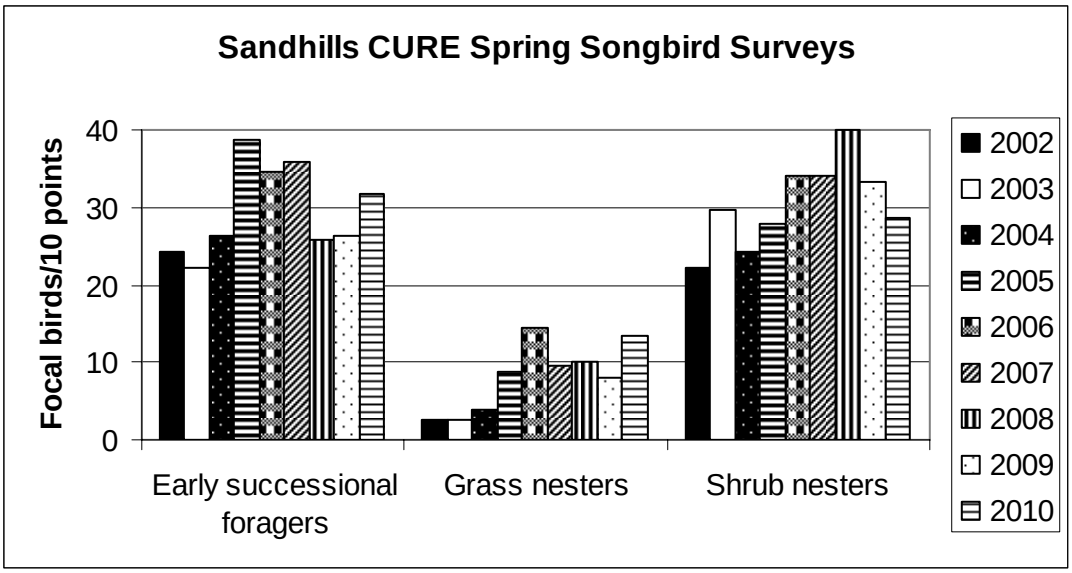


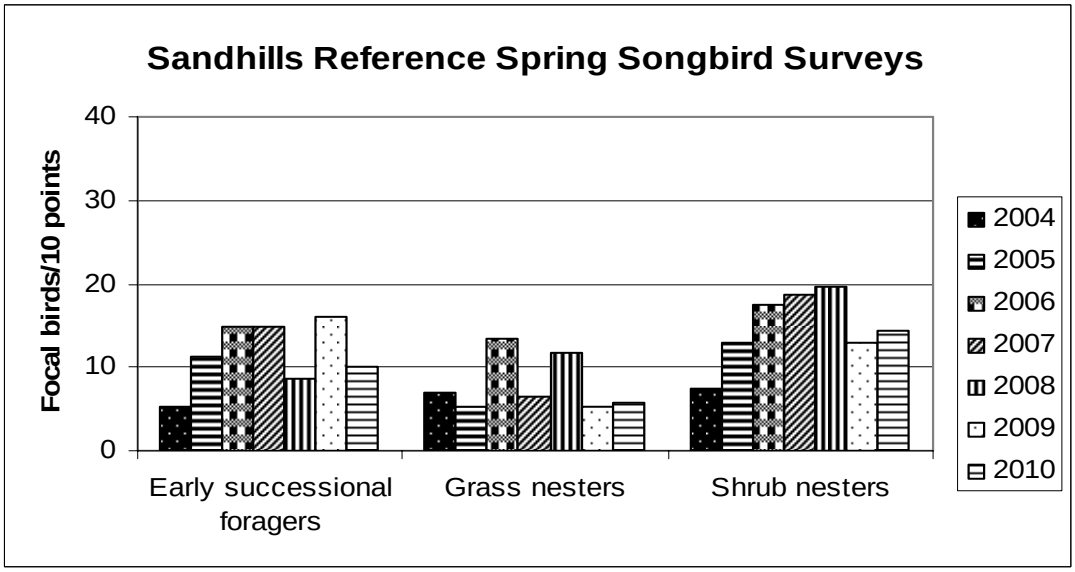
Figure 10. Acres of habitat suitable for quail use on Caswell Game Land CURE area, 2002-2009, during the breeding season (left graph) and the non-breeding season (right graph). (Note: Dashed line indicates early succession acreage goal stated in CURE area management plan.)

Sandhills Game Land

Breeding Songbird. On Sandhills Game Land, shrubland nesters and early successional foragers were the most abundant guilds on the CURE area (Fig. 11 & 12). Indigo bunting was the most abundant shrub nester, followed by eastern towhee and common yellowthroat. The early successional forager group was dominated by chipping sparrow followed by eastern bluebird and red-headed woodpeckers. The grassland nester group was composed almost entirely of Bachman's sparrow and northern bobwhite.

On the Sandhills CURE area there was a significant increase in grassland nesters (+1.22 birds/10 survey points per year, $P = 0.02$) and a marginally significant increase in shrub nesters (+1.26 birds/10 survey points per year, $P = 0.07$). There were no significant trends for guilds on the Block B reference route. Within the early successional forager guild, eastern kingbird and orchard oriole showed the greatest increase on the CURE area since CURE management began. Within the grass nesting guild, both quail and Bachman's sparrows (Fig 13) increased significantly on CURE. Within the shrub nesting guild, prairie warbler and yellow-breasted chat increased the most with CURE management.





Figures 11 and 12. Relative abundance (# focal birds per 10 survey points) of early succession habitat songbird guilds on Sandhills Game Land CURE and reference areas, based on unlimited distance, five minute counts. Habitat enhancements were initiated in the summer of 2003. Surveys on reference area were initiated in 2004.

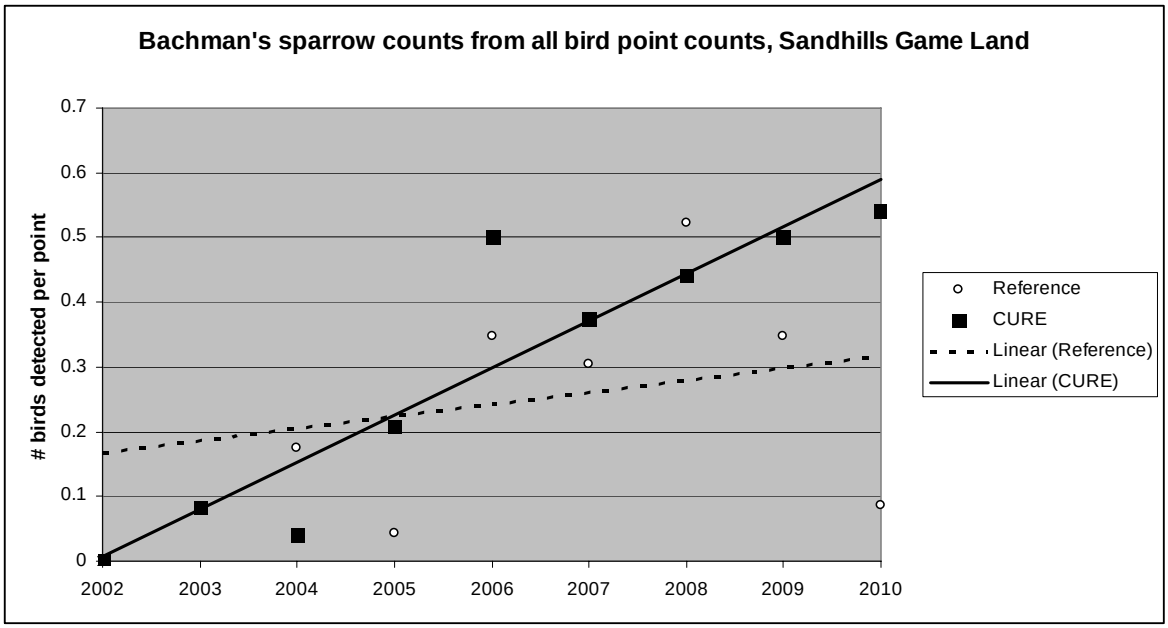


Figure 13. Bachman's sparrow relative abundance from point count surveys, Sandhills Game Land, 2002-2009. Lines represent linear regression trend line. The reference route is located on Sandhills Game Land but off the CURE area. Surveys on the reference route started in 2004.

Bachman's Sparrows. In 2006 we initiated surveys focused specifically on Bachman's sparrows to monitor populations of this priority species after observational data indicated an increase throughout CURE-managed areas. In 2010 point count surveys with song playback were continued on 2 of the 4 routes on each of the CURE and control areas, providing coverage of half of these areas. Surveys were repeated 3 times each. Since 2006, counts from this survey on the CURE area have been relatively stable and decreasing on the control area. There is no significant difference ($P = 0.68$) in the average counts on the CURE area compared to the control area, 2007-2010 combined.

From 2006-2008, we spot-mapped 157 randomly selected Bachman's sparrows. Ninety five of the 157 (61%) sparrows established a breeding territory (defined as at least 3 repeat observations of a sparrow within 162m over a 3-6 week period during the breeding season). 14 of 31 (45%) sparrow locations became territories on the control areas and 81 of 126 (64%) locations on the CURE area became territories. The territory establishment rate in longleaf stands with native groundcover (71 of 119- 60%) was similar to thinned plantations planted to Atlantic coastal panicgrass (20 of 30- 61%).

The overall average territory size (using least convex polygon method) was 3.94 acres (range 0.34-11.6 ac). Average territory size did not differ between stands with native groundcover and stands planted to Atlantic coastal panicgrass (ACP). Stands with native groundcover were occupied (presence of at least 1 sparrow during point count surveys) at a similar rate to stands planted to ACP.

About 2/3 of all established territories were given a Vickery rank of 1- meaning only a territorial male was observed. In about 15% of territories we were able to document the presence of both a

male and a female but observed no evidence of nesting. In about ¼ of established territories we observed evidence of nesting (adults carrying food or fledglings observed). There was no significant difference in the distribution of Vickery scores between birds with territories in native groundcover and ACP.

Thirty seven of 99 (37%) territories were established immediately adjacent to a field or included part of a field within the territory. Fields comprise only 4% of the acreage in the study area, primarily in small (<1ac) blocks, so Bachman's sparrows may be selecting the small openings to include in or adjacent to their territory.

The majority of territories (49 out of 80 territories with fire information) were established in stands which had been burned 1 year previously. Only 7 of 80 territories were established in stands burned in the same year. Territory size appeared to be slightly smaller in stands burned 1 or 2 years previously compared to territories in stands burned in the same year or 3 years ago.

In summary, Bachman's sparrows appear to have expanded their distribution on the Sandhills CURE with management. The data suggest that Bachman's sparrows use thinned plantation stands planted to ACP in a similar way to "natural" stands with native wiregrass and other groundcover. Fields or other small openings may be a valuable habitat component. Bachman's sparrows may prefer stands burned 1-2 years previously over stands with a longer or shorter burn history.

Useable Habitat. Useable habitat continued to increase on Sandhills Game Land. At the initiation of CURE in 2002, only 11% of the CURE area was useable as breeding habitat and 20% non-breeding. In 2009, 50% of the CURE was useable breeding habitat and 52% of the landscape was suitable for quail in the non-breeding season. Most timber thinning and herbicide applications were completed in 2007, and habitat management has entered the "maintenance" phase, primarily with the use of prescribed fire. The location of useable habitat shifts throughout the year, with nearly half the acres burned on the CURE area each year. The majority of the "not useable" acres (44% of area was not useable during either season) consisted of uplands with sparse wiregrass cover. Sandhills' CURE goal is to maintain 74.7% of the CURE area in early successional habitat by 2009.

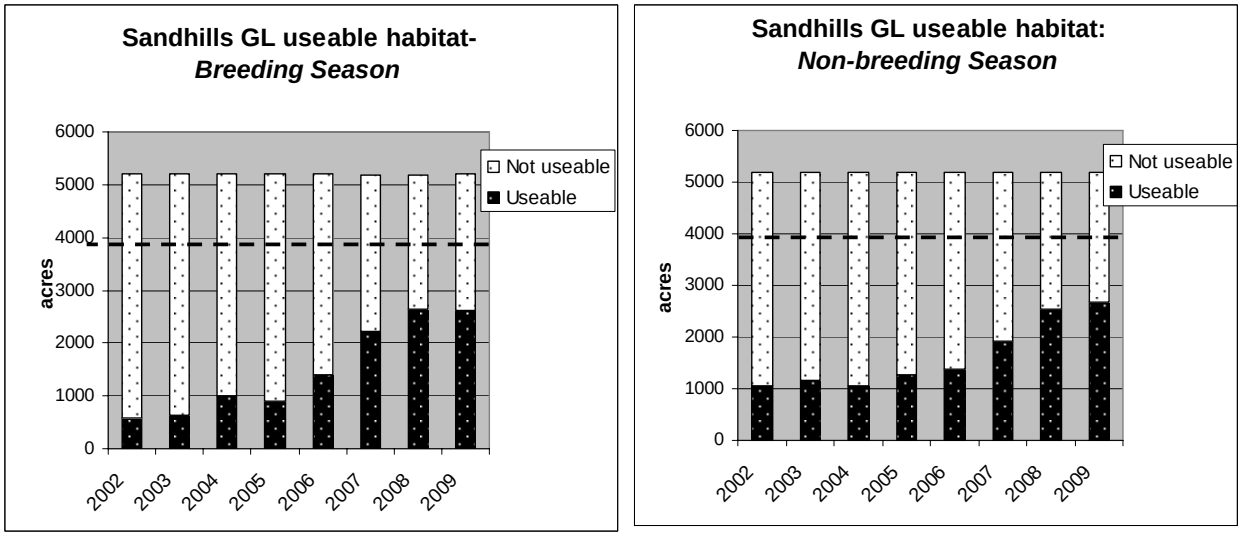
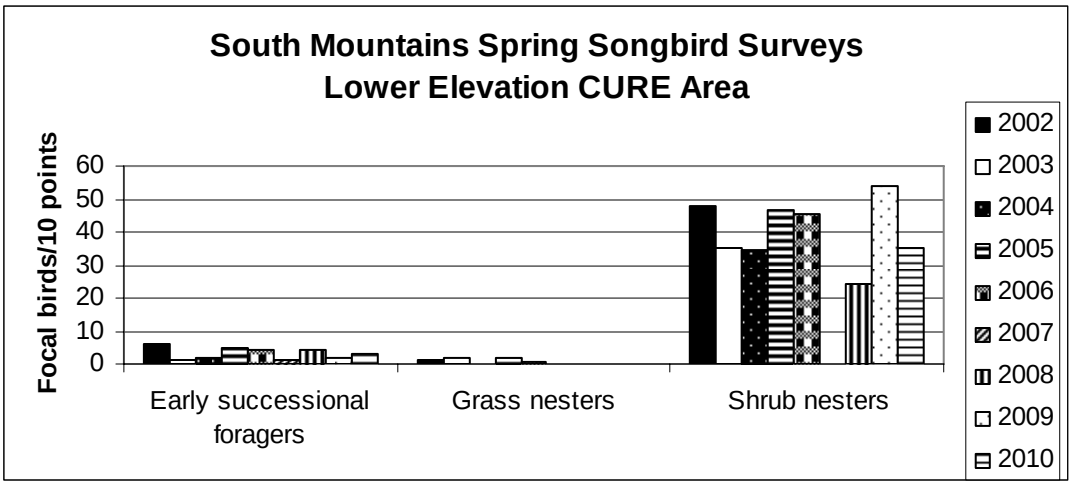


Figure 14. Acres of habitat suitable for quail use on Sandhills Game Land CURE area, 2002-2009, during the breeding season (left graph) and the non-breeding season (right graph). Note: Dashed line indicates early successional acreage goal as stated in CURE area management plan.

South Mountains Game Land

Breeding Songbirds. On the South Mountains lower elevation CURE area shrub nesters were by far the most abundant guild (Fig. 15). Very few early successional foragers and grassland nesters were detected. The most abundant shrub nesters were indigo bunting, yellow-breasted chat, prairie warbler and eastern towhee. Wild turkey was the most commonly detected early successional forager. No grassland nesting species were recorded since 2007. There were no significant trends in counts for shrub nesters or early successional foragers on either the CURE area or BBS reference route. Counts of grassland nesters (predominantly quail) showed a marginally significant decline on both the CURE area (-0.20 birds/10 survey points per year, P = 0.068) and reference route (-0.78 birds/10 survey points per year, P = 0.053).



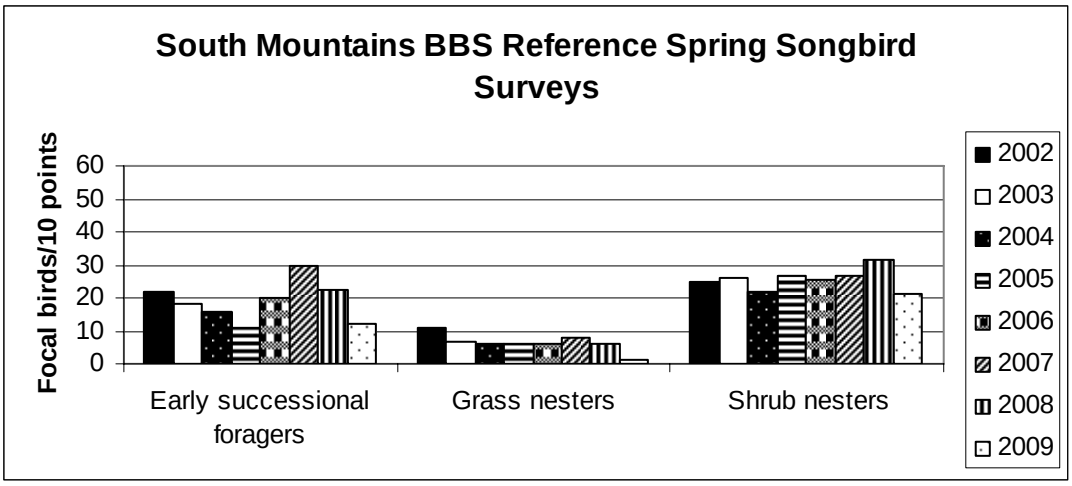


Figure 15 and 16. Relative abundance (# focal birds per 10 survey points) of early succession songbird guilds on South Mountains Game Land CURE area (Quail area), based on unlimited distance, five minute counts. BBS counts are based on unlimited distance, 3 minute counts. Comparisons between BBS and CURE should be made only for count trends. Habitat enhancements on CURE were initiated in the summer of 2003.

Useable Habitat. There has been a steady increase in the amount of breeding season habitat since the inception of CURE management, and substantial gains in non-breeding habitat over the past three years. South Mountains started in 2002 with no useable breeding habitat and 15% of the area in non-breeding habitat provided by shrub-dominated regenerating clearcuts. In 2009, 16% of the area provided breeding habitat and 22% was useable wintering habitat. The non-useable habitat (77.5% of CURE area), consisted of closed canopy mature pine and hardwood stands and stands in which the understory had not yet responded to prescribed burning.

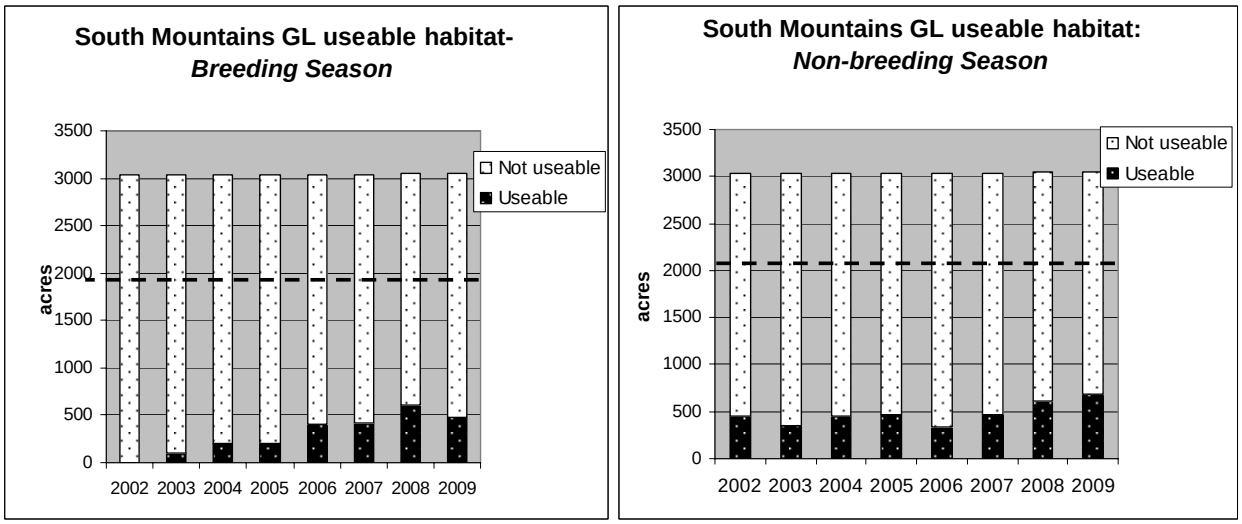
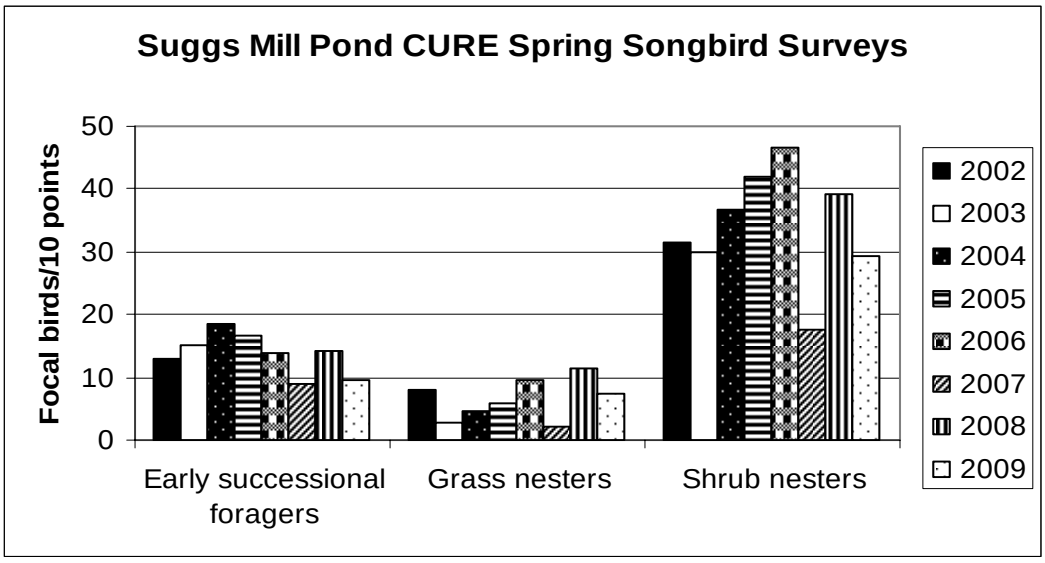
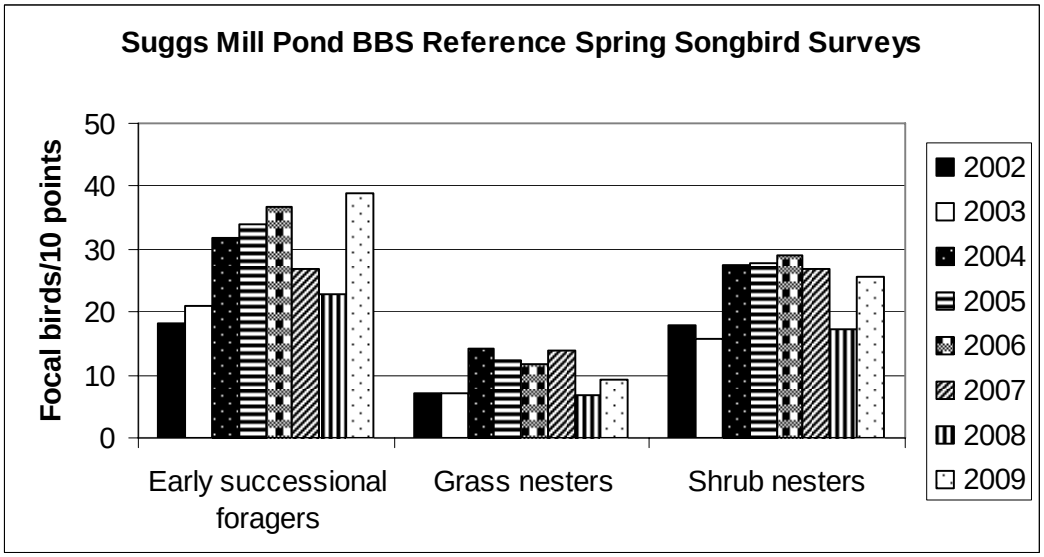


Figure 17. Acres of habitat suitable for quail use at South Mountains Game Land lower elevation management area, 2002-2009, during the breeding season (left graph) and the non-breeding season (right graph). Note: Dashed line indicates early successional acreage goal as stated in CURE area management plan.

Suggs Mill Pond Game Land

Breeding Songbirds. On Suggs Mill Pond Game Land CURE area shrub nesters were the most abundant guild (Fig 18). The most frequently detected shrub nester was eastern towhee followed by common yellowthroat and prairie warbler. The most common early successional forager was eastern wood peewee followed by chipping sparrow and yellow-shafted flicker. The grassland nester group was almost entirely represented by northern bobwhite. Notable was the observation of a Bachman's sparrow in 2004 and 2007. There were no significant trends in counts for any of the guilds on either the CURE area or BBS reference route (Fig. 18 & 19). There was an apparent increase in brown-headed cowbird and eastern towhee and an apparent decrease in chipping sparrow on Suggs CURE from 2002-2009.





Figures 18 and 19. 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.

Winter Birds. In 2010 we surveyed 16 stands on Suggs Game Land in linear opening and pine forest habitats. As of the writing of this report the 2010 data has not yet been summarized.

Useable Habitat. In 2009 there were substantial gains in the acreage of useable habitat available during the breeding season. In 2009 20% of the total acreage (66% of upland acres) was useable for quail while 14% of the total acreage (48% of upland acres) was useable in the non-breeding season. Breeding habitat was gained in thinned pine stands which developed suitable herbaceous understory. The majority of the non-useable acres consist of 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.

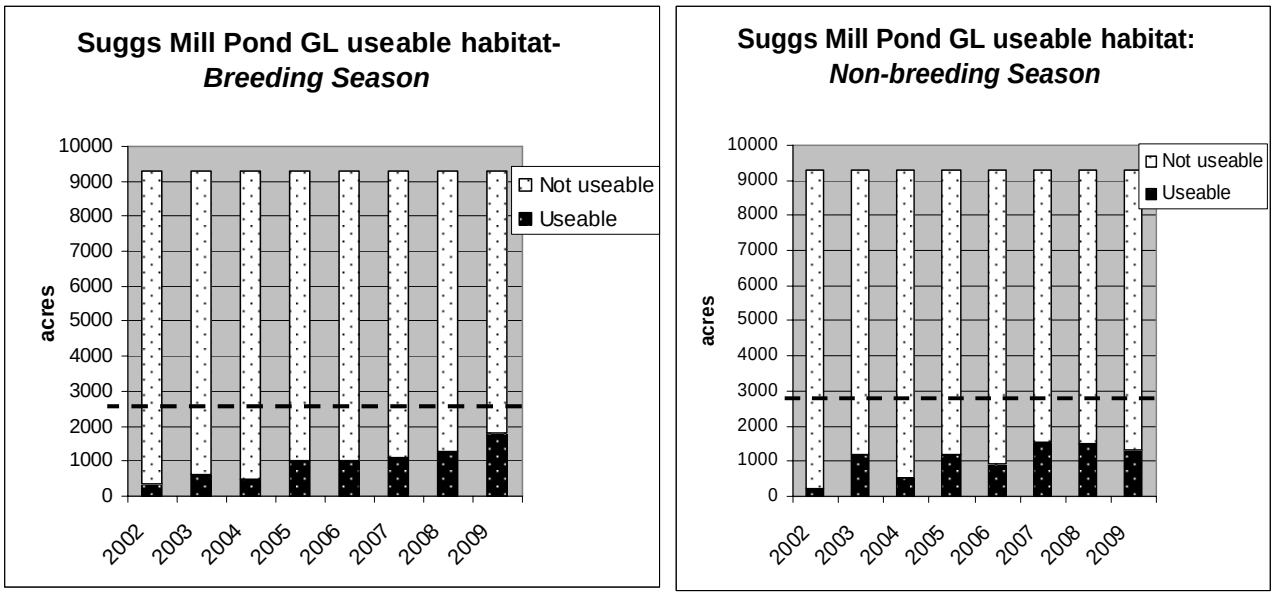


Figure 20. Acres of habitat suitable for quail use at Suggs Mill Pond Game Land, 2002-2009 during the breeding season (left graph) and the non-breeding season (right graph). Dashed line indicates early succession acreage goal stated in CURE area management plan. Note that only ~2800 acres of Suggs Game Land is upland with potential for CURE management.

Results - Corporate CURE

Breeding Songbirds. The Murphy Brown CURE area supported very high numbers of grassland nesters and shrub nesters. Relatively few early successional foragers were detected during point count surveys and this guild appeared to be relatively less abundant on the CURE area than on the BBS reference route (Fig. 21 and 22). The most commonly detected shrub nester on the CURE area was common yellowthroat, followed by indigo bunting, eastern towhee, and blue grosbeak. Murphy Brown supported greater numbers of grey catbirds than any other CURE area. The grassland guild was dominated by very high numbers of quail, red-winged blackbird, and eastern meadowlark. A few grasshopper sparrows were detected on Murphy Brown. CURE management was initiated in 2006 and the 2003-2006 counts can be considered pre-treatment baseline conditions while 2007-2010 can be considered post treatment. Counts of

northern bobwhite ($P = 0.03$), red-winged blackbird ($P = 0.05$), brown thrasher ($P = 0.04$), indigo bunting ($P = 0.04$), prairie warbler ($P = 0.01$), and eastern towhee ($P = 0.05$) were all significantly lower in the post-treatment years than the pre-treatment years. One part of the explanation for this may be a change in point count observers between the pre and post treatment periods.

Winter Songbirds. Winter bird surveys were initiated on the Murphy Brown Ammon farm in 2004. In 2010 strip transect surveys were conducted in 36 stands in cropped agricultural fields, fallow fields, field borders, grazed pasture, managed woods, and unmanaged woods. As of the writing of this report the 2010 data has not yet been summarized.

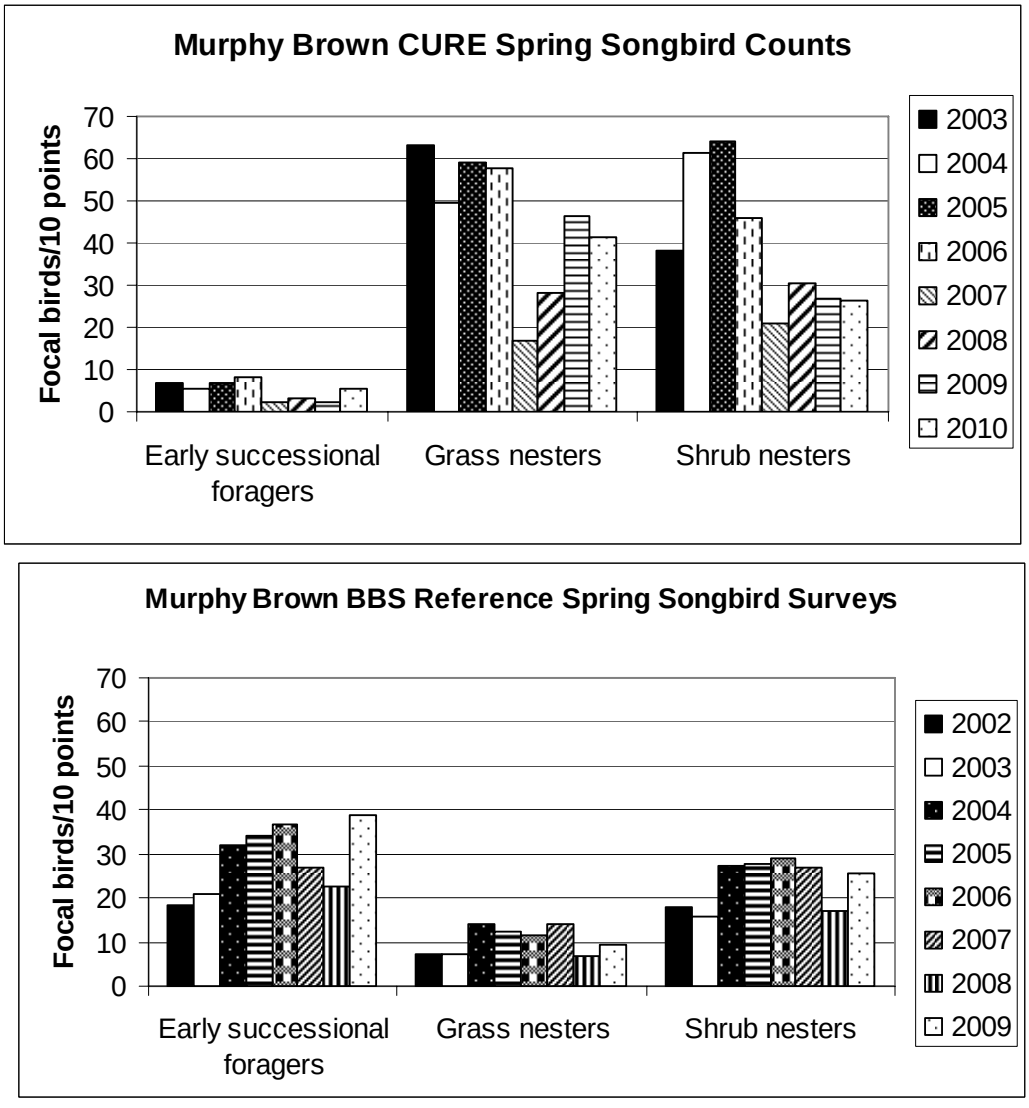


Figure 21 & 22. Relative abundance (# focal birds per 10 survey points) of early succession habitat songbird guilds on the Murphy Brown Ammon Farm, based on unlimited distance, five minute counts. BBS data based on unlimited distance 3 minute counts. Habitat enhancements were initiated in 2006 on the CURE site.

Useable Habitat. Murphy Brown Corporate CURE cooperative consists of 4,315 acres under various management regimes. Stands are 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. This site started with the highest baseline useable habitat of all the CURE areas, with over half the landscape useable in the breeding season and a third of the landscape useable in the non-breeding season. In 2009 there was an increase of 266 acres of breeding habitat and a decrease of 307 acres of non-breeding habitat. Overall there have been modest changes in the total amount of useable habitat on Murphy Brown.

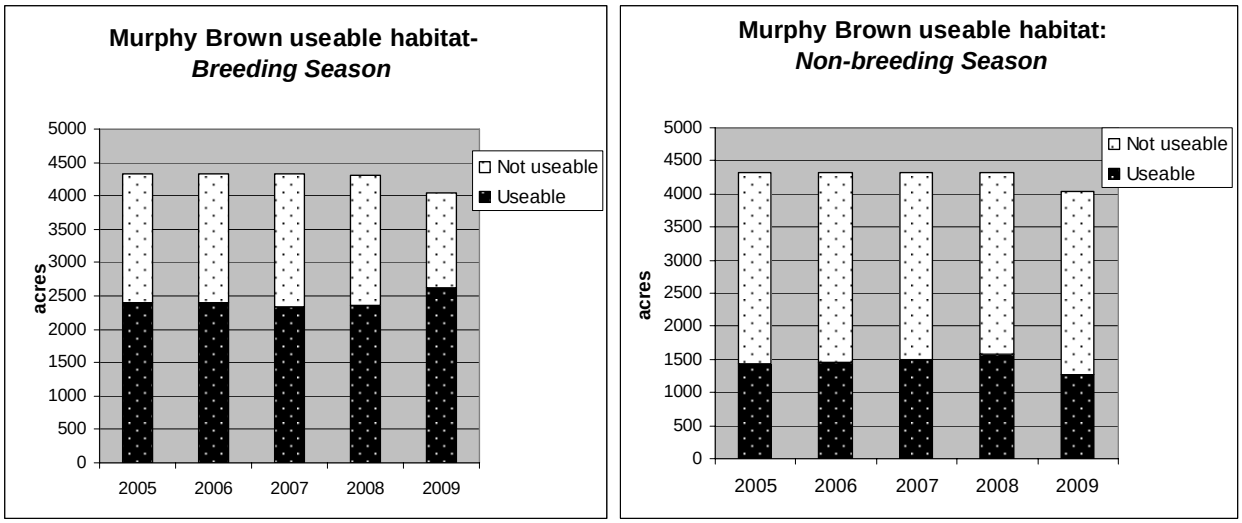


Figure 23. Acres of habitat suitable for quail use on Murphy Brown - Ammon CURE area, 2005-2009, during the breeding season (left graph) and the non-breeding season (right graph).

B. Target Dates for Achievement and Accomplishment

Many of the surveys designed to evaluate the impact of habitat establishment and enhancement on bird populations have been completed. Useable habitat evaluations, songbird point count surveys, and Bachman's sparrow surveys will be continued for the foreseeable future to provide long term monitoring data. In the coming year the focus will be on sharing results with relevant audiences. This project will be combined with the Piedmont Game Lands Songbird Survey project because the long-term monitoring objectives and methodologies are similar for the 2 projects.

C. Significant Deviations

None

D. Remarks

The greatest benefits of the CURE program on private lands have been realized for shrub-nesting songbirds and wintering sparrows (see 2005-2006 CURE annual report for winter songbird results). While most landowners wish to control shrub growth in fallow areas and shrubs were not an explicit management objective for most CURE treatments, enough emergent shrubs developed in habitat areas to provide sufficient nesting and foraging cover. Field sparrow is the

only Wildlife Action Plan priority species to show a positive response to CURE on private lands. The NC State research project should provide useful insights on the response of grassland birds and mammals to warm season grass establishment.

In December 2009 the results of the Caswell CURE surveys and other related survey projects were presented to 26 land managers, technical guidance staff, researchers, and other stakeholders both inside and outside WRC. In August of 2010 these results were shared with an additional 6 WRC land managers and were used to inform future management decisions.

E. Recommendations

This project should be continued as described above during the next period.

F. Estimated Cost

$92,713 (including in-kind and other non-federal match)

G. Literature Cited

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Prepared By: Jeffrey Marcus, Piedmont Wildlife Diversity Supervisor
Wildlife Diversity Program, Division of Wildlife Management
NC Wildlife Resources Commission

Final Performance Report

State: North Carolina **Project Number:** T-11-P

Period Covered: July 1, 2009 – August 31, 2010

Grant Title: State Wildlife Grants 07-Wildlife Management

Project Title: Urban Wildlife Project

Objective:

The main goal of the Urban Project is to help North Carolina's communities proactively conserve important species, habitats, and ecosystems while continuing to grow. Project objectives include:

- To provide proactive technical guidance to local governments on how to design land use planning methods that will conserve important species and habitats alongside development.
- 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.
- To participate in partnership efforts to achieve conservation of species and habitats in urbanizing areas.
- To assist with inventorying natural resources to help better inform land use decisions.
- To provide technical guidance to developers on how to create wildlife-friendly development projects.

A. Activity

The 2009-2010 fiscal year was the Urban Wildlife Project's fifth year of working to minimize the impacts of rapid urbanization on wildlife populations and habitats. 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 provide proactive technical guidance to local governments. During the reporting period, the WRC staff provided technical guidance on the following projects:

- 1 development project in Currituck County
- 1 development project in Stokes County
- 1 development project in Orange County
- A local planning issue in Whiteville, NC
- A new park site in the Town of Holly Springs, NC
- Park master plan for a City of Raleigh park site
- 2 park planning documents for the City of Raleigh
- 1 Wake County open space property site plan

- Stanly County land use plan update
- Montgomery County land use plan
- Anson County Zoning ordinance

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

- Comments on the 2 City of Raleigh park planning documents were included in final versions of the park "system integration plans," and will be used to guide future management of these park sites.
- Comments on the City of Raleigh Park Master Plan for Horseshoe Bend Park are being used to guide management activities on the site. As a result of comments, the City plans to establish early successional habitat in the park. In addition, for the first time in City history, the parks department plans to use prescribed fire to help manage the early successional habitat.
- More than half of all Green Growth Toolbox recommendations were incorporated into the Stanly and Montgomery County land use plans.

2) Participation in conservation partnership efforts--The Urban Wildlife Biologist continued to participate in and support regional conservation partnership efforts. During the 2009-2010 reporting year, the Urban Wildlife Project:

- Participated in meetings of the Chatham Conservation Partnership
- Participated in the Chatham Conservation Plan focus group
- Participated in activities of the Wake Nature Preserves partnership
- Participated in meetings of the Johnston County Green Infrastructure partnership
- Participated in meetings of the Reality Check Greenspace task force.

Outcomes from these partnership efforts include:

- Public workshop in Johnston County that brought together citizens to discuss draft maps for the "green infrastructure" plan for Johnston County.
- Publication of a book chapter on the Wake Nature Preserves partnership
- Consultant hired by the Chatham Conservation Partnership to develop the first countywide Comprehensive Conservation Plan in North Carolina
- Development of new GIS data layers mapping the location of Wildlife Action Plan priority habitats in Chatham County
- Development of an application process for local governments in Wake County to apply for park sites to become designated as "nature preserves"
- Completion of a draft "Green Infrastructure Plan" for Johnston County
- Neared completion 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.
- Developed and administered survey for local governments in the 16 county "Reality Check" region to identify needs for assistance related to green space planning.

3) Implementation of the Green Growth Toolbox (GGT)—One of the Urban Wildlife Project's focal projects during the past year has been coordinating implementation of the Green Growth Toolbox. The Green Growth Toolbox 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 the website was released in January 2009. During the past year, the Urban Wildlife Project:

- Received and administered a $200,000.00 grant from the Wildlife Conservation Society's Wildlife Action Opportunities Fund to expand implementation of the Green Growth Toolbox across the state of North Carolina over 2 years.
- Delivered a Green Growth Toolbox "train the trainer" workshop to staff with the NC Coastal Land Trust, Land of Sky Regional Council, and Sustainable Sandhills.
- Delivered another train the trainer workshop for external partners interested in implementing the GGT but who will not be receiving direct funds to do so. This workshop was attended by 15 individuals.
- Provided support to staff with the NC Coastal Land Trust, Land of Sky Regional Council, and Sustainable Sandhills to develop regional GGT datasets and appendices, develop regional GGT training workshops, and deliver GGT technical guidance in their regions.
- Developed and printed an executive summary brochure to communicate with elected officials and the public about the Green Growth Toolbox.
- WRC lead Green Growth Toolbox workshops in Orange, Anson, and Stanly Counties, and assisted external partners with a workshop in Moore County and another for 5 municipalities in the southern coastal plain.
- Delivered presentations on the Green Growth Toolbox to approximately 260 stakeholders (planners, elected officials, developers, resource professionals) around the state in the following venues:
    - Community Conservation Standing Committee meeting of the Division of Soil & Water Conservation
    - North Carolina Association of Soil & Water Districts annual meeting
    - 2nd annual North Carolina Urban Forestry Conference
    - SE Lakes Management conference
    - Anson, Stanly and Montgomery County commissioners and planning boards
- Responded to inquiries and communicated with various stakeholders about the project.

Outcomes from the activities listed above include:

- Staff from three partner organizations (NC Coastal Land Trust, Land of Sky Regional Council, and Sustainable Sandhills) have been trained to implement the Green Growth Toolbox in the coastal plain, sandhills, and the mountain region of North Carolina.
- Regional GGT appendices and datasets were developed for the Coastal Plain, Sandhills, and 4 counties in the Mountain region.
- Green Growth Toolbox technical guidance is being provided in every eco-region of North Carolina.
- Conservation data and training on how to use the Green Growth Toolbox in local planning was given to 87 individual planners and other professional staff from 4 county governments, 15 municipal governments, 5 councils of government, 4 state agencies, 4 federal agencies, 1 land trust, 4 consulting firms, and 6 non-governmental organizations.

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. This past year, technical guidance included:

- WRC staff contributed to the development of the Wildlife Friendly Development certification program.
- The Urban Wildlife Biologist provided technical guidance to one developer in Danbury, NC.

5) Terrestrial Conservation Recommendations project—During the 2009-2010 fiscal year, the Urban Wildlife Project produced the document entitled "Conservation Recommendations for Priority Terrestrial Wildlife Species and Habitats in North Carolina." A research technician conducted most of the literature review, and guidance was provided by a multi-agency advisory committee. Steps taken to produce this document included:

- Comprehensively reviewing the scientific literature to identify science-based conservation thresholds for groups of terrestrial species in the North Carolina Wildlife Action Plan
- Developing conservation recommendations for local governments/developers based on what was found in the scientific literature
- Compiling findings into a series of documents.
- Coordinating an extensive peer review process with biologist and policy experts
- Editing and producing final drafts of the document
- Working with a graphic designer to produce an attractive primary publication that can be shared with our target audience.

The document will be released in the coming fiscal year.

6) Collaborative projects with conservation partners—WRC collaborated closely with Coastal Land Trust, Sustainable Sandhills, Army Environmental Command, US Fish and Wildlife Service, and Land of Sky Regional Council to expand implementation of the Green Growth Toolbox statewide. This collaboration is discussed further in the Green Growth Toolbox section above.

WRC collaborated with the Wake Nature Preserves Partnership to provide biological data and management recommendations to county and municipal parks in Wake County. Partnership members contributed time and expertise in conducting biological inventories, crafting management plans, and assisting with habitat management activities.

WRC also initiated a partnership with Duke University and Chatham County to develop a model upland habitat protection ordinance. This effort will provide counties and municipalities with a starting point to enact an ordinance to protect priority upland habitats in a way that is compatible with state and federal laws. Duke University is researching the legal basis and constraints for such an ordinance and will draft model language. Chatham County is providing input to the process and intends to propose to enact this ordinance for Chatham County when it is completed.

7) Other activities—During the past year, the Urban Wildlife Project delivered presentations on urbanization and wildlife to approximately 250 individuals (planners, developers, elected officials, resource professionals, and others). Presentation venues included:

- Development with Trees workshop hosted by Guilford County Cooperative Extension in Greensboro, NC
- Conservation Based Design workshops hosted by NCSU FEOP in Wilmington and Greensboro, NC
- Triangle Conservation Symposium hosted by Triangle Land Conservancy in Durham, NC
- Forestry Issues Teleconference Series hosted by NCSU FEOP in Raleigh, NC

In addition, a master's student at North Carolina State University created a draft "Rapid Urban Habitat Assessment" template for the Urban Wildlife Project.

B. Target Dates for Achievement and Accomplishment

Project objectives were addressed and all activities proceeded as planned.

C. Significant Deviations

None

D. Remarks

None

E. Recommendations

We recommend that this project be continued for the coming year.

F. Estimated Cost

$202,280 (including in-kind and other non-federal match)

Prepared By:

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

Final Performance Report

State: North Carolina **Project Number:** T-11-P

Period Covered: July 1, 2009 – August 31, 2010

Grant Title: State Wildlife Grants 07-Wildlife Management

Project Title: Piedmont Songbird Surveys and Management

Objective:

The objectives of this project include:
1. Continue established long-term monitoring surveys on Sandhills and Caswell Game Lands.
2. Initiate new surveys for priority species to determine distribution and population status in areas and in habitats with the greatest information needs.
3. Analyze and share information from the Songbird Surveys on Piedmont Game lands project.
4. Conduct technical guidance and habitat management activities to benefit priority species.

A. Activity

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 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 other 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. Data collection for the territory mapping and productivity studies was completed in 2008. The breeding songbird point count surveys will be continued for the foreseeable future to provide long-term trend information.

Point Count Surveys
In 2010, point count surveys were conducted on the Sandhills Block B south, Block C, and CURE routes and the Caswell Frogsboro & CURE routes. The Sandhills field trial route and Caswell High Rock route were not surveyed in 2010 due to manpower constraints. 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.

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 for this project were conducted in 2010 at Caswell Game Land on 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 initially. We continued to survey the same stands each year after the initial selection. At Caswell we surveyed pine forest, hardwood forest, and field habitats. 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.

B. Target Dates for Achievement and Accomplishment

The emphasis in the coming year will be on sharing results with relevant stakeholders and guiding future management decisions. Point count surveys and migration observations will be continued for the foreseeable future to provide long-term monitoring data.

C. Significant Deviations

None

D. Remarks

Point Counts
The most frequently detected birds on Sandhills Game Land include pine warbler, indigo bunting, eastern towhee, mourning dove, chipping sparrow, Bachman's sparrow, American crow, eastern bluebird, Carolina wren and blue jay. 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 the number of Bachman's sparrows detected, particularly on the CURE area (Figure 1).

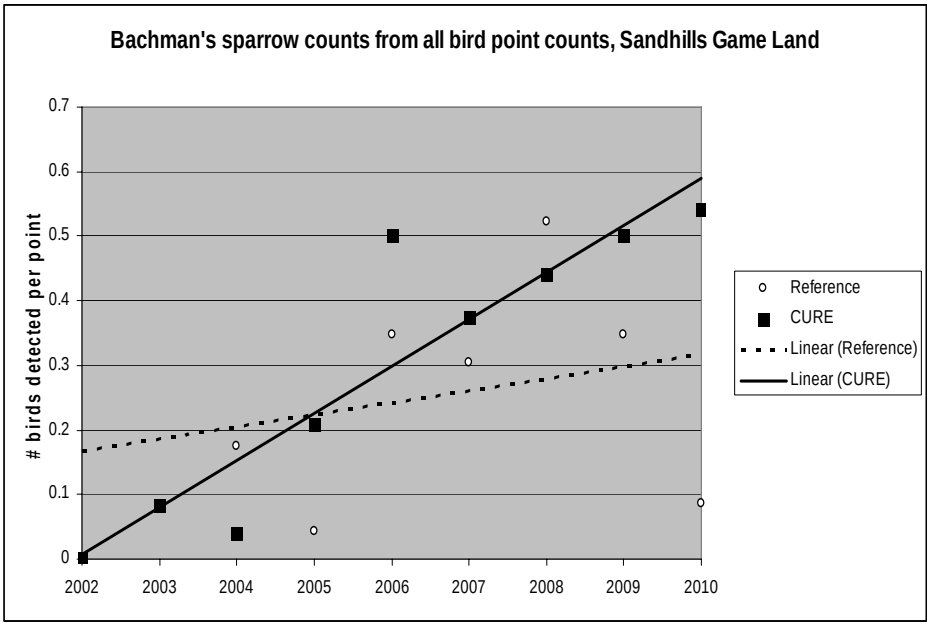

Figure 1. Bachman's sparrow count trends from Sandhills Game Land CURE and Block B (Reference) routes. Note that the reference route was initiated in 2004.

Red-eyed vireo, indigo bunting, and northern cardinal were the most frequently encountered species on Caswell Game Land across all routes and years. Species of conservation concern detected on Caswell point count routes include brown-headed nuthatch, hooded warbler, and Kentucky warbler. Shrub nesting birds have increased in abundance on Caswell Game Land since the inception of CURE. Counts of indigo bunting, yellow-breasted chat, and field sparrow have all increased significantly. While timber operations have negatively impacted wood thrush, ovenbird, and Acadian flycatcher at the stand level (see 2008-2009 report for this project for full results), counts of these species have remained steady at the scale of the Game Land. With CURE management, brown-headed cowbirds have increased their distribution and relative abundance on the Caswell CURE area. Cowbird parasitism rates at Caswell are modest (see 2008-2009 report).

The results from point count surveys conducted for this project have been used as comparison and reference information for surveys conducted by the "CURE Survey for Early Successional Species" SWG project. Please see the 2009-2010 CURE annual report for a more thorough treatment of the results from both of these inter-related projects.

Sandhills Migration Results

Of the 104 sightings of 39 "pass through" migrant bird species in the Sandhills region between fall of 2003 and fall of 2010 (Table 1), 27 sightings were in drain habitats, 31 were associated with lakes or drained impoundments, 9 were associated with fields, and 31 were in forested

upland habitats, primarily longleaf pine (Figure 2). 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. Notable observations from the past year include an unusual number of great egrets observed in the Sandhills in the late summer of 2010 and a juvenile wood stork which was observed foraging in the mud flats within a drained impoundment on Sandhills Game Land for about 2 weeks in August 2010.

Table 1. Pass-through migrants (birds that neither breed nor over-winter) observed in the Sandhills region, fall 2003 – fall 2010.

Warblers	Shorebirds/waterbirds	Other species
Bay-breasted warbler	Great egret	Bank swallow
Blackburnian warbler	Greater yellowlegs	Baltimore oriole
Blackpoll warbler	Lesser yellowlegs	Blue-headed vireo
Black-throated blue warbler	Semipalmated sandpiper	Broad-winged hawk
Cape May warbler	Snowy egret	Bobolink
Chestnut-sided warbler	Solitary sandpiper	Grey-cheeked thrush
Magnolia warbler	Spotted sandpiper	Merlin
Palm warbler	Wood stork	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

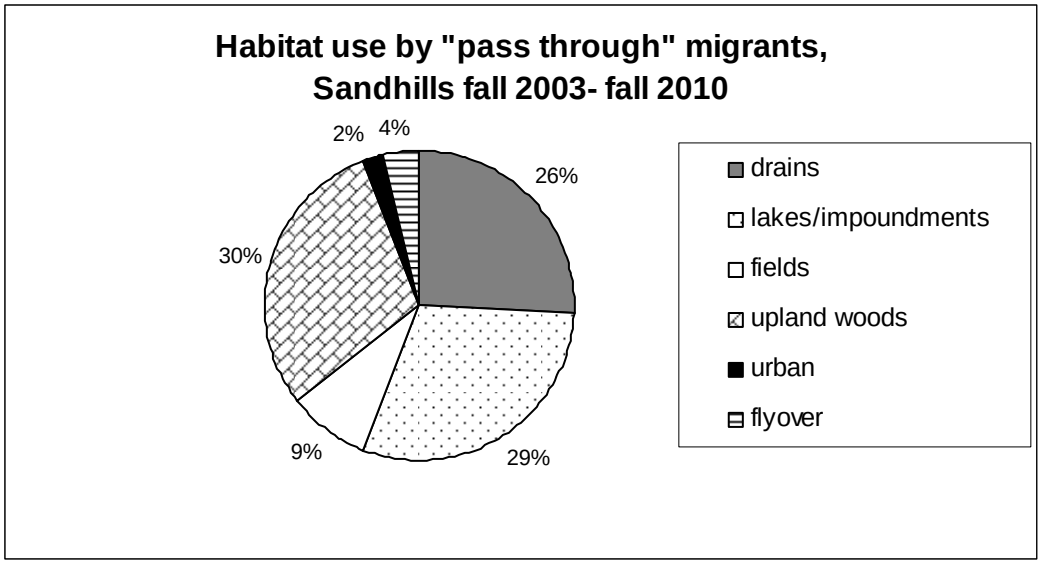

Figure 2. Habitats in which migrants were observed, Sandhills region 2003-2010.

Winter Songbirds
In 2010 we surveyed 38 stands on the Frogsboro tract in field, hardwood, and pine forest habitats. 2010 was the last year of winter bird data collection on Caswell Game Land because initial CURE timber management operations have been completed. As of the writing of this report the 2010 data has not yet been summarized.

Communicating Results
In December 2009 the results of the Caswell Game Land songbird surveys and other related survey projects were presented to 26 land managers, technical guidance staff, researchers, and other stakeholders both inside and outside WRC. In August of 2010 these results were shared with an additional 6 WRC land managers and were used to inform future management decisions. Project information and results were shared with 20 members of New Hope Audubon in December 2009. Other information sharing included communicating with 30 people during the grand opening of the Jordan Lake eagle observation platform and sharing info with ~60 people during International Migratory Bird Day at the NC Museum of Natural Sciences.

E. Recommendations

This project should be combined with the CURE Surveys project and continued during the next period.

F. Estimated Cost

$8,406 (including in-kind and other non-federal match)

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NC Wildlife Resources Commission

Final Performance Report

State: North Carolina **Project Number:** T - 11 - P

Period Covered: July 1, 2009 – August 31, 2010

Grant Title: State Wildlife Grants 07-Wildlife Management

Project Title: Priority Amphibian and Reptile Surveys in the Piedmont and Sandhills

Objectives:

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 monitor reptile and amphibian populations to determine population trends.
3. To conduct research on movements, habitat use, and relationship to land use to better elucidate factors which may be limiting populations.
4. To provide technical guidance to governmental agencies and private entities based on findings from surveys and research.
5. To conduct management activities on public lands to enhance reptile and amphibian habitats and populations.

A. Activity

Projects completed during the grant period included 1) Study of the movements and habitat use of Gopher Frogs in the NC Sandhills; 2) Monitoring of a Tiger Salamander population in the NC Sandhills and determination of the relationship between egg mass surveys and breeding adult populations; and 3) Restoration and/or enhancement of 6 isolated wetlands and concurrent monitoring of project success. Other surveys of targeted species and habitats were also conducted throughout the Piedmont and Sandhills, including surveys for priority amphibian and reptile species in the Uwharries region. Because of the loss of a Coastal Wildlife Diversity Biologist, the Piedmont wildlife diversity staff also worked on several projects in the Coastal Plain, as well as projects that straddle both the Coastal Plain and Piedmont. See the Coastal Herpetology 2009-2010 report for information about related projects.

Gopher Frog Movements and Habitat Use in the Sandhills of NC

A study on the movements and habitat use of the Gopher Frog, *Rana capito*, was started in FY 2008-09 and completed during 2010. Following is a manuscript documenting the project, recently submitted to *Journal of Wildlife Management* for publication. In addition to this study, a status assessment of Gopher Frogs in North Carolina was also begun during the last year. Results of that project are presented in the Coastal Herpetology annual report.

Movements and Habitat Use of the Carolina Gopher Frog, *Rana capito capito*, in the Sandhills of North Carolina: Implications for Longleaf Pine Conservation and Management

Understanding how animals use landscapes is essential for managing habitat and guiding land conservation, preservation, and use. This is especially important for amphibians that need upland habitat as well as isolated wetlands for breeding, and that may travel long distances year after year to the same site to breed. Recent advances in radiotelemetry technology have allowed biologists to track the movements of smaller amphibians, and to get closer to answering the questions: 1) How much upland habitat is necessary to preserve populations of amphibians that breed in isolated wetlands? and 2) How should landscapes be conserved and managed? For instance, Semlitsch and Bodie (2003) summarized available literature on movements of amphibians and reptiles that rely on both isolated wetlands and surrounding upland habitat. Based on available data for numerous species, they proposed "core areas" of protection around wetlands of approximately 350 m from the edge of an isolated wetland in order to protect a given population. They also pointed out that the typical level of "buffer" protection around isolated wetlands in most states ranges from 15-30 m.

The gopher frog (*Rana capito*) is listed as Endangered, Threatened, or of Special Concern in all states where it occurs, including North Carolina, South Carolina, Georgia, Florida, and Alabama. Additionally, the genetically distinct, but closely related Mississippi gopher frog (*Rana sevosa*) now only occurs at three sites and is listed as Federally Endangered (Federal Register 2001, Federal Register 2010). In North Carolina, only seven extant populations of gopher frogs are currently known to exist, all on publicly managed land (Braswell 1993, 2001; WJH and MAS unpublished data). Populations of gopher frogs have been lost to the destruction or degradation of upland, fire-maintained pine habitat in addition to the loss or degradation of suitable breeding sites (Bailey 1990, Moulis 1995). Gopher frogs are medium-sized frogs that spend most of the year in sandy, upland habitat, remaining very close to a single burrow or a group of gopher tortoise (*Gopherus polyphemus*) burrows; mammal burrows, especially those made by pocket gophers (*Geomys pinetis*); or tree stumps that have holes associated with them (Wright and Wright 1949, Franz 1986, Jackson and Milstrey 1989, Gentry and Smith 1968, Lee 1968, Blihovde 2006, Roznik 2007, Roznik et al. 2009). These frogs have very specific breeding site requirements, consisting of open-canopied upland ephemeral depression ponds, sinkhole ponds, or borrow pits with herbaceous vegetation and a relatively long hyrdoperiod lasting from fall/winter through mid-summer of the following year (Bailey 1991, Moler and Franz 1987, Jensen and LaClaire 1995). Besides outright destruction, much upland and wetland habitat once used by the gopher frog has been degraded due to lack of appropriate fire regimes, leading to encroachment of hardwoods into wetlands and canopy closure of uplands (Thurgate and Pechmann 2007).

Movement patterns of gopher frogs have been reported by multiple researchers, with very different results. Richter et al. (2001) examined the Mississippi gopher frog and reported post-breeding movements of <300 m from the breeding pond. Other telemetry or mark-recapture studies in Florida and Georgia have found movement distances ranging from 100–700 m from breeding ponds (Roznik et al. 2009, Roznik and Johnson 2009, Phillips 1995, Greenberg 2001). Observational reports of gopher frogs found in upland habitat suggest gopher frogs are capable

of moving 800 m–2 km from breeding sites (Carr 1940, Franz et al. 1988, Roznik 2007), but these reports were based on where frogs were found compared to the closest known breeding site. Information about the movements of the Carolina gopher frog in the northern part of its range does not exist. Given the limited and somewhat conflicting information about the post-breeding movements and habitat use of gopher frogs, it is difficult to develop plans aimed at properly managing habitat or guiding conservation efforts in parts of the Southeastern Coastal Plain where gopher frog populations still remain. Our goal was to study the movement patterns and landscape use of gopher frogs in order to inform sound management and conservation of areas within the range of this species.

METHODS

Study Site Description

We studied gopher frogs on a 6,000 ha block of the Sandhills Game Land (SGL), a property owned and managed by the North Carolina Wildlife Resources Commission, in Scotland County, NC. The property consists mainly of longleaf pine (*Pinus palustris*)–wiregrass (*Aristida stricta*) sandhills dissected by numerous drainages. The ecosystem is maintained on a 2-3 yr controlled burn cycle, with much of the area around our study pond burned during the growing season (Apr-Jul). Gopher frogs on the SGL were captured at a single ephemeral upland depression pond referred to by many names, including 17 Frog Pond, Grassy Pond, and Bog Hole. The pond is approximately 1-3 ha in size, depending on rainfall during a particular year, and is completely open canopied with an abundance of herbaceous wetland vegetation. About one quarter of the forest southeast of the pond, between it and two sand roads (Figure 1), was thinned using logging equipment in 2009.

Trapping and Tracking Techniques

Gopher frogs were captured in a drift fence that completely encircled the pond. We walked the drift fence during every rainy night from Nov-Apr to capture frogs. Frogs were selected for radiotelemetry if they were leaving the pond post-breeding and if they weighed more than 45 g (to keep the transmitter weight under 5% of the frog's body weight). Each frog captured was measured for total length (TL), weighed, sexed, and photographed. Males were identified by visible paired vocal pouches and enlarged thumbs. Females did not have visible vocal pouches or enlarged thumbs and were obviously thin after just having deposited eggs. We identified each individual frog by taking a photograph of the left side of its face and comparing the spotting patterns to other captured or trapped frogs. Transmitters (Holohil Systems, Ltd; Model BD-2; 2 g weight) were attached to 14-mm plastic beaded chains (Identisys, Inc.) and clasped around each frog's waist so that the transmitter sat just above the urostyle and the antenna faced posterior to the frog. Belts and transmitters were painted brown to maintain the frogs' camouflage. Fitting of transmitters took only a few minutes and frogs were released just outside the drift fence after attachment.

Frogs were tracked using a digital receiver (Advanced Telemetry Systems, model R410) and a 3-element Yagi antenna. With few exceptions, telemetered frogs were tracked daily, and in all cases frogs were tracked immediately prior to and following rainfall events. Frogs were also often tracked at night during heavy rains to ensure that they did not travel beyond our tracking range. When frogs were located, their location was recorded with a GPS unit (Trimble GeoXM)

accurate to within several meters. Distances moved by frogs were measured from the center of the breeding pond.

Refugia Characteristics

We also recorded data on each frog's position (surface or underground), as well as vegetation characteristics within a 1 m^2 area around each summer refugium. Vegetation characteristics included 1) general habitat (upland longleaf pine, pine-hardwood, woody drain, herbaceous drain, field); 2) tree basal area; 3) canopy cover; 4) percent of vegetation within a 1 m^2 area around each frog, including, wiregrass, leaf/needle litter, bare ground, other vegetation; 5) type of refugium, including mammal burrow, stump hole, or refugium dug by the frog. Gopher frogs maintain a small area adjacent to their refugium that is cleared of debris, exposing a "pad" of mineral soil (e.g., Richter et al. 2001). We recorded whether a maintained pad existed at a refugium the first day a frog was tracked to that location. Finally, we used homemade single-ended funnel traps constructed of hardware cloth to capture frogs at their refugia so we could remove the transmitters at the end of tracking. Traps were placed adjacent to refugia and burlap was wrapped around the refugium so the frogs would have to enter the trap when they emerged.

Stumps that frogs used as summer refugia were characterized by measuring maximum diameter of the hole associated with the stump, as well as the diameter of the base of the stump. Most of the stumps our frogs used were decayed to the point where only a ring of bark remained, with or without a standing section of heartwood in the center. We measured the diameter of these stumps from bark to bark, on the surface of the ground. Others had only a crater where the original stump had been; for these we measured the diameter of the crater. Several stumps could not be accurately measured because the edges of the original stump could not be discerned. For stump bases that we were able to measure, we estimated the size of the once-standing tree by correlating stump diameter to diameter at breast height (DBH) using methods similar to Bylin (1982). We measured the diameter of the base at ground level and the DBH of 10 longleaf pines nearest to each summer refugium used by a frog. Using simple linear regression, we found a strong relationship ($R^2 = 0.88$) between stump diameter and the DBH of the original tree that formed the stump. We then used the linear regression equation to estimate the size of the pine tree that formed each stump used by a gopher frog. We estimated the age of the tree that formed each stump based on DBH and tree cores or ring counts from sites with similar characteristics. We attempted to age stumps with obvious saw marks by obtaining timber sale records for the property.

RESULTS

Post-breeding Movements

We successfully tracked 17 gopher frogs away from the breeding pond (5 in 2009 and 12 in 2010). Twelve tracked frogs were released the night they were captured and immediately migrated away from the pond; 3 were released the morning following being captured, and 2 were released in the morning after being held in the lab for 7 days. The 5 frogs that were released in the morning stayed within a few meters of their release location immediately outside of the drift fence until the next rainy night. We treated this movement as the first tracking day.

We tracked 9 gopher frogs (5 females and 4 males) to their final summer refugia. An additional 8 frogs (4 males and 4 females) were tracked, but their belts were lost, their transmitter signals were lost, or they were killed (Table 1 and Figure 1). We also documented the breeding and summer habitat locations for 1 frog in 2 consecutive years. Frogs were tracked for 5 days (a frog that was killed by fire) to 69 days, with an average tracking period of 39 days per frog. Frogs that were tracked to their final summer refugium (n = 9) average straight-line migration distances of 1.3 km from the breeding pond, with distances ranging from 505 m–3.5 km. Of all frogs tracked (n = 17), the average straight-line distance traveled away from the breeding pond was 1.1 km, with a range of 300 m–3.5 km (Table 1).

Frogs made major migrations only on rainy nights, with few exceptions (4 frogs shifted their locations by 5-22 m during dry weather, and another moved 60 m during dry weather after being handled). Single-night migrations averaged 743 m and ranged from 263 m–1.2 km. Thus, frogs were capable of migrating at a rate of 100 m/hr. Of the 9 frogs that were tracked to their final summer refugia, 5 traveled directly to their refugium in a single night (the night they were captured and fitted with a transmitter), and their refugia ranged from 505 m–1.2 km from the pond. The remaining 4 frogs took 9–27 days to reach their final refugia, encompassing between 2 and 6 different rainy nights; these frogs mostly traveled to refugia >1.4 km from the breeding pond (Table 1). Gopher frogs used a variety of refugia while they were migrating from the breeding pond to summer refugia. Two frogs used shallow small mammal burrows in fallow fields. We also observed 2 frogs that dug their own shallow holes while in transit. In these instances, a shallow, angled depression was excavated sufficient to cover the entire frog immediately below the surface. Three frogs used shallow holes of unknown origin while in transit to summer refugia. Though these small depressions were similar in size and shape to holes that were constructed by gopher frogs during this study, they had not been recently excavated. One frog sheltered in holes associated with the stumps of oaks (*Quercus sp.*) on 2 separate occasions while traveling to a summer refugium.

Summer Refugia Habitat

Eight of 9 (89%) frogs tracked to their summer refugium used holes associated with tree stumps (Fig 3) in longleaf pine stands (Table 2). The remaining frog used a large burrow created by an unknown animal in a sparsely vegetated, former military parachute drop zone. Though most frogs used stump holes, characteristics of the forest and vegetation around refugia varied widely among frogs tracked (Table 2). Basal area around summer refugia ranged from 0–120 ft^2/ac (mean = 74.4 +/- 12.0). Canopy cover ranged from 0–92% (mean = 71.0 +/- 9.5). Wiregrass cover ranged from 0–80 % (mean = 23.3 +/- 9.8). Leaf/needle cover ranged from 0–95 % (mean = 57.8 +/- 12.6). Bare soil ranged from 0–70% (mean = 12.4 +/- 7.6). Total vegetation cover ranged from 5–90% (mean = 42.2 +/- 10.9).

Stump holes used for summer refugia were very similar, with regard to size, among all frogs. The mean diameter of the base of stumps used by frogs was 72.1 cm (range = 68.6–78.7). Estimates of the mean DBH of the tree that created the stump used by frogs was 42.9 cm (range = 41.4–45.7). Holes used by gopher frogs, associated with stumps and one mammal burrow, ranged from 5.1–17.8 cm (mean = 9.3). We were unable to determine the year that several of the stumps used by gopher frogs were created during forestry operations. Logging in these stands took place prior to 1994 (16 years before this study).

We incidentally trapped several commensal species with which gopher frogs shared their summer refugium while we were trapping frogs to remove their transmitter belts. One refugium was shared with an adult black racer (*Coluber constrictor*), 1 was shared with a subadult cornsnake (*Elaphe guttata*), and another was shared with an adult northern pine snake (*Pituophis melanoleucus*) and a southern toad (*Bufo terrestris*).

Site Fidelity

Site fidelity was verified for one frog (# 325) that was captured at the breeding pond during both seasons and returned to the same stump hole, 3.5 km away from the pond, 2 consecutive summers. Additionally, 5 of 8 frogs were tracked to stumps which had previously maintained pads associated with them.

Vulnerability to Early Season Prescribed Fire

Tracked frogs spent an average of 10 days sitting on the surface during dry periods as they migrated to summer refugia (Table 1). In these instances, they were either completely exposed at the base of a clump of vegetation or situated just beneath leaf litter (Fig 2), leaving them vulnerable to fire. Frogs were on the surface during Mar, Apr, and early May during migrations away from the breeding pond. All frogs successfully tracked to their summer refugia reached these protective refugia by early May, though this could vary from year to year, depending on temperature and precipitation.

A controlled burn was initiated on the morning of 13 Apr 2010 in an area that contained four telemetered frogs. Two of the frogs were in their summer refugia (stump holes), while the other 2 were on the surface—1 beneath a small pile of oak leaves on a slope adjacent to a small stream (frog # 046), and the other beneath mixed hardwood leaf litter near the head of a small, dry tributary (frog # 902). The positions of all four frogs were verified immediately prior to the onset of burning, and the condition of each of the two frogs on the surface was monitored regularly as the fire approached their respective positions. Frog # 046 was exposed to a backing-fire that moved slowly through the sparse fuels associated with a scrub-oak habitat, and was able to move 20 meters into the nearby stream to escape the fire. The line of fire that passed over frog # 902 was a light head-fire with an approximate flame length of 1 m. Immediately after the fire had moved past the frog's location it was found burned and dead on the surface 45 cm from its pre-fire location. Subsequent trapping of the two frogs located in stumpholes verified that they had survived the fire without harm. This was the only instance in which our telemetered frogs were exposed to fire.

DISCUSSION

Migrations

The migration distances we observed for several gopher frogs (maximum of 3.5 km) are the longest ever recorded for a pond-breeding amphibian (see Appendix 1 in Semlitsch and Bodie 2003 for an overview of published amphibian movement studies). The migrations we documented were also substantially longer than has been reported for gopher frogs in other areas (Richter et al. 2001, Roznik and Johnson 2009, Carr 1940, Franz et al. 1988). For instance, Richter et al. (2001) tracked gopher frogs in Mississippi using similar techniques to ours and observed post-breeding migrations of <300 m for all individuals. Some of the frogs we tracked

traveled six to 10 times that distance and all traveled >500 m from the study pond, except for 1 that was eaten by an unknown predator while migrating. Gopher frogs in Florida are known to travel up to 691 m based on a telemetry study (Roznik and Johnson 2009), and observational data suggest possible migrations of up to 2 km in Florida (Carr 1940, Franz et al. 1988, Blihovde 2006, Roznik 2007, Greenberg 2001). Gopher frogs clearly use landscapes differently, including migration patterns, depending on the geographic location and perhaps the type or condition of upland habitat. We also suspect that refugium (stump hole or gopher tortoise burrow) availability may be a limiting factor on the landscape that influences migration distances.

Gopher frogs in our study used a variety of habitats as they migrated to their summer refugia. Three frogs used field habitat and they readily crossed steep drainages that supported first-order streams surrounded by thick vegetation. The only barrier to migration appeared to be an impounded lake and an associated upstream beaver pond complex (Fig 1, upper left). A very small proportion of frogs caught at the fence entered or left the pond from the direction of the lake (unpublished data) and the tracked frogs that traveled in that direction crossed the drainage just upstream from the beaver impoundment. The recently thinned forest to the east of the pond did not appear to have an effect on gopher frog movements. Four of our frogs traveled through the thinned area without changing course and most of the frogs captured at the fence came from the side of the pond that had recently been thinned (unpublished data). The final post-breeding locations of all tracked gopher frogs were in fire-maintained, open longleaf pine forest, with the exception of 1 frog that used a mammal burrow associated with a fallow field.

Refugia Use and Fidelity

Gopher Frogs used a variety of refugia while migrating away from the pond; however, pine stumps with associated holes were used for summer refugia by all but 1 of the frogs we tracked to a summer refugium. The importance of stump holes for gopher frogs was also reported by Richter et al. (2001), but other studies have found that gopher frogs mainly use the burrows of gopher tortoises and pocket gophers (Blihovde 2006, Roznik et al. 2009, Roznik and Johnson 2009). Where gopher tortoises or pocket gophers do not occur, or where their populations have severely declined, stump holes are the most commonly used underground refugia. Additionally, we hypothesize that useable stump holes can be a limiting factor for gopher frog populations. The frogs we studied mainly used the remnants of large pine trees with at least 5-cm diameter holes at the base of the stump. Stump holes of this type in upland habitat appear to be extremely rare in the North Carolina Sandhills and they may remain on the landscape for several decades or longer. Our vegetation data suggest that frogs were not choosing summer locations based on a specific vegetative component (e.g., basal area, wiregrass cover, etc. varied widely among refugia locations), but instead chose summer habitat based on where a useable stump hole was available. We also suggest that the availability of suitable stump holes in upland habitat may influence the distances that gopher frogs travel to find summer refugia (*i.e.,* frogs may have to travel farther in landscapes with few suitable stump holes).

In addition to the likelihood that stump holes are a limiting resource on some landscapes, we also found that gopher frogs will use the same stump year after year, and are capable of returning to the same stump several kilometers away from the breeding pond. When frogs were tracked to a stump hole (summer refugia), it was evident that some of them already had a cleared "pad" where a gopher frog had been using the stump previously. We suspected that this was evidence

of site fidelity to summer refugia. We documented one case of confirmed multi-year site fidelity to a summer refugium, where a frog traveled over 14 km, from a summer refugium, to the pond, and back over two consecutive seasons. Our findings also show that gopher frogs have a strong sense of direction, able to travel in a nearly straight-line (see Fig 1) across several km from the breeding pond to their summer refugium.

Vulnerability to Early Season Prescribed Fire

Literature about direct mortality of amphibians during prescribed burning is sparse and difficult to measure (see Russell et al. 1999 for an overview). The death of a telemetered frog during a prescribed burn demonstrated the vulnerability of migrating gopher frogs to fire. We note that the weather conditions on the day of the burn were typical of those regarded as appropriate for the use of prescribed fire, and that the fire itself did not demonstrate any exceptional qualities in regards to intensity, rate of movement, or temperature. We also note that though one frog was able to escape into a stream, many of the burn blocks that our animals entered did not contain surface water that could be used as refugia during fire events, and that most of the surface positions used by our telemetered frogs were considerably further from bodies of water than the 20 m used by the frog that escaped. Further, we assume that if underground refugia were available in the area of a frog's position, it would use it rather than sit on the surface for extended periods during dry weather. The potential for gopher frogs to escape prescribed fire is even more unlikely when strip-firing and spot-firing techniques are employed, as these methods result in two or more opposing lines of fire. Most importantly, the short distance (45 cm) moved by the frog that was killed in the prescribed fire suggests that in cases of moderate fire intensity, gopher frogs may not be capable of attempting an escape. Like many other endemic species of the southeastern Coastal Plain, gopher frogs are adapted to, and restricted to, upland pine forests that have historically been maintained by fire. However, prescribed burning represents a paradox for gopher frogs where the necessity of fire for maintaining an open pine ecosystem can also result in direct mortality if it occurs when frogs are away from the safety of their refugia. Because of the risk of direct mortality, as well as the loss of cover used by migrating gopher frogs, and because we assume that gopher frogs exhibit similar behavior while migrating to breeding sites, we recommend that prescribed burning in areas that support populations of gopher frogs only be conducted after mid-May.

MANAGEMENT IMPLICATIONS

Semlitsch and Bodie (2003) suggested that 'core areas' and buffer zones around wetlands aimed at preserving habitat for amphibians should encompass a diameter of approximately 340 m around each wetland, based on an overview of previously published literature. The maximum distances gopher frogs traveled away from breeding ponds in our study was 3.5 km, more than 10 times the suggested core area and buffer zone protection distance. Ironically, a 340 m buffer zone around the pond we studied would likely provide summer habitat for very few, if any, gopher frogs. We realize the recommendations by Semlitsch and Bodie (2003) were not aimed to be "one size fits all," and our data only illustrate the importance of learning more about the movements of different animals across various landscapes.

Gopher frogs in the North Carolina Sandhills clearly need very large tracts of land for summer habitat. If we use the maximum movement of gopher frogs we tracked from the breeding pond to

their summer refugium (3.5 km [2.2 mi]), an area of 3,739 ha (9,239 ac) would be needed to provide for gopher frog breeding and summer habitat. Even if we were to exclude the frog that moved the longest distance, the average movement (1.3 km) and the second longest movement (2.1 km) still suggest that a core area of 538 ha (1,329 ac) to 1,308 ha (3,232 ac) would be required to provide habitat for the majority of frogs in our study population. However, we do not believe that our longest observed movement of 3.5 km is an outlier. First, it seems unlikely that we would have tracked the longest-moving frog in the population, given our small sample size. Additionally, recent drift fence studies conducted on the Sandhills Game Land found 6 gopher frog adults at 4 different traps, located from 1.5-5.2 km from our study pond (Ron Sutherland, personal communication). The pond we studied is the only pond in the area that has recently supported successful gopher frog reproduction, so it is highly likely that all gopher frogs in the area originated from our study pond. This suggests that gopher frogs may migrate even longer distances than what we found in our telemetry study.

In addition to quality open-canopied breeding ponds (Bailey 1990, Thurgate and Pechmann 2007), our study shows that in some areas gopher frogs need extremely large areas of intact upland forest for adult frogs to migrate to summer refugia that may be limited on the landscape. Because these frogs are making such long-distance migrations between upland and wetland sites, development and fragmentation of landscapes (e.g., roads), even if not occurring directly adjacent to breeding sites, has and will continue to negatively impact populations of gopher frogs. We recommend a push toward the preservation of large areas of habitat around remaining gopher frog populations, including efforts to connect upland habitat among multiple breeding sites. In areas where wetland and upland habitat restoration is underway, large, contiguous areas of habitat surrounding breeding sites need to be preserved and managed well. Landscapes need to be managed intensively with prescribed fire to maintain open-canopied wetlands and uplands, but we caution against early-season prescribed burning regimes where gopher frogs still occur. Fire management should include summer burning starting no earlier than mid-May in the vicinity of gopher frog populations in order to avoid the loss of adults, especially considering that many gopher frog populations are now isolated and may consist of relatively small numbers of breeding adults. We also reiterate the importance of retaining large pine stumps on landscapes, as stump holes can be an important and limiting resource for gopher frogs and other species of wildlife. If logging or other ground-disturbing activities are unavoidable in areas that support gopher frogs, we recommend that these activities be initiated when gopher frogs are unlikely to be on the surface or in shallow refugia. In theory, the types of summer refugia used by gopher frogs will afford them increased protection from heavy equipment. Further, in the vicinity of exceptionally vulnerable populations of gopher frogs (e.g., isolated populations, or those with low numbers of breeding adults), we suggest there may be some value in attempting to identify and avoid all stump holes in the areas of impact.

Table 1. Movement patterns of Carolina gopher frogs (*Rana c. capito*) on the Sandhills Game Land, Scotland County, NC during 2009 and 2010. Frogs were originally captured and fitted with transmitters at their breeding pond. Dashes indicate unknown or non-applicable data. "Surface" indicates frog was above ground and not associated with a refugium.

ID	Sex	Days Tracked	No. of Moves	Dist. Moved from Pond (m)	Days to Reach Summer Refugium	Date at Summer Refugium	Latest Date on Surface	Days on Surface during Travel	Fate
563	F	11	2	300	-	-	3 Apr	1	Killed by Predator
129	F	67	1	505	1	13 Mar	-	0	Tracked to Hole
902	M	5	1	524	-	-	9 Apr	4	Killed by Fire
338	F	58	4	698	-	-	6 May	2	Lost Signal
228	M	39	3	813	-	-	9 Apr	10	Belt Failure
375	M	67	1	738	1	11 Apr	-	0	Tracked to Hole
046	F	23	4	751	-	-	25 Apr	15	Belt Failure
150	M	28	1	780	1	29 Mar	-	0	Tracked to Hole
110	F	33	2	798	9	21 Mar	20 Mar	9	Tracked to Hole
090	F	27	1	808	1	13 Mar	-	0	Tracked to Hole
028	M	29	1	1,108	1	29 Mar	-	0	Tracked to Hole
203	F	65	4	1,237	-	-	14 Apr	3	Tracked to Hole
191	F	30	3	1,436	25	-	8 Mar	25	Belt Failure
270	M	19	3	1,659	-	-	30 Mar	13	Belt Failure
208	M	35	4	1,833	-	-	9 Apr	35	Belt Failure
164	F	69	3	2,053	27	9 Apr	8 Mar	26	Tracked to Hole
325	M	61	6	3,470	25	6 May	5 May	25	Tracked to Hole

Table 2. Characteristics of final refugia locations of Carolina gopher frogs (*Rana c. capito*) tracked on the Sandhills Game Land, Scotland Co., NC during 2009 and 2010. Dashes indicate data that could not be obtained accurately.

ID	Refugia Type	Stump Dia (cm)	Original Tree Dia Estimate (cm)	Hole Dia (cm)	Basal Area (ft^2 / ac)	Canopy Cover (%)	Wire Grass Cover (%)	Leaf / Needle Cover (%)	Bare Soil (%)	Total Veg Cover (%)
028	Stump Hole	-	-	12.7	120	90	40	90	0	45
129	Stump Hole	71.1	42.4	8.9	70	84	5	95	2	5
150	Stump Hole	71.1	42.4	5.7	100	65	80	80	0	90
090	Stump Hole	78.7	45.7	10.2	100	84	10	80	10	15
164	Stump Hole	68.6	41.4	5.1	40	76	0	5	10	90
325	Stump Hole	-	-	7.6	70	62	10	50	20	30
203	Stump Hole	71.1	42.4	5.1	80	86	60	30	0	65
375	Stump Hole	-	-	10.2	90	92	5	90	0	10
110	Mammal Burrow	-	-	17.8	0	0	0	0	70	30
	Mean (+/- SE)	72.1 +/- 1.7	42.9 +/- 0.7	9.3 +/- 1.4	74.4 +/- 12.0	71.0 +/- 9.5	23.3 +/- 9.8	57.8 +/- 12.6	12.4 +/- 7.6	42.2 +/- 10.9

*Percentages of wiregrass, litter cover, bare soil, and total vegetation were measured within a 1 sq. m plot around each refugium.

We thank J. Beane, W. Kalinowsky, J. Marcus, D. McCloy, J. Reynolds, L. Sadler, and J. and L. Watschke for assistance with setting up the drift fence and providing materials and their time. We also thank the staff of Sandhills Game Land (NC Wildlife Resources Commission), including B. Beck, L. Criscoe, C. Jordan, J. Marcus, J. Marquess, R. Medford, B. Parsons, L. Sadler, J. Sigler, and B. Smith for their assistance and cooperation with maintaining this project for two years. J. Beane and A. Braswell also provided valuable background information and guidance on this project, and we thank J. Beane and J. Marcus for reviewing an earlier version of this manuscript.

Figure 1. Post-breeding movement patterns of 17 adult Carolina gopher frogs (*Rana capito capito*) from the breeding pond to uplands on the Sandhills Game Land, Scotland Co., NC, USA. Circles at the end of frog paths represent animals that were tracked to their summer burrow. Frog paths without circles represent animals that were still traveling when their transmitter belt failed, their signal was lost, or they were killed. The area shown on this map represents 1,900 ha (4,695 ac).

Figure 2. Gopher frogs were often exposed on the surface of the forest floor for days to weeks during dry periods before moving toward their summer refugium location. This behavior made them susceptible to prescribed burning or wildfires during their migration seasons in the fall, winter, and spring.

Figure 3. Longleaf pine stump hole with cleared pad typical of summer refugia used by gopher frogs on the Sandhills Game Land, Scotland Co., NC, USA.

Tiger Salamander Monitoring in the Sandhills

Eastern Tiger Salamanders, *Ambystoma tigrinum*, are known to occur at relatively few sites in central and eastern North Carolina and they are listed as Threatened in the state. On the Sandhills Game Land, Tiger Salamanders are known to use 4 ponds for breeding, however, only one pond, "17 Frog Pond," appears to support regular juvenile recruitment. Egg masses and adults can be found regularly at the other ponds, but the ponds dry too early in most years for larvae to mature to metamorphosis. We began monitoring the adult population at 17 Frog Pond in 2009-10 to 1) establish a baseline on breeding adult use of the pond; 2) determine the relationship between egg mass counts and breeding adult females; and 3) to gather other basic life history information about Tiger Salamanders in the Sandhills. Egg mass counts of 17 Frog Pond during 2008 and 2009 were also compared to counts obtained during this year's study.

This study was conducted in conjunction with research on the movement patterns of Gopher Frogs at the same location. The methods for capturing Tiger Salamanders were the same as those described in the Gopher Frog section of this report (*i.e.*, we used the same drift fence and monitored the fence during rain events from Nov 2009 – May 2010). Tiger Salamanders captured at the fence were not marked, but they were placed on the opposite side of the fence from where they were captured, thus providing a number of animals entering and leaving the pond during breeding. The drift fence surrounding 17 Frog Pond was also sectioned into 8 directions, providing information on the directionality of movements into and out of the pond. Egg mass surveys were conducted in the pond in March 2010, once all breeding was complete. We conducted a total egg mass count by floating the pond with a canoe and counting all egg masses, while flagging areas of the pond that had already been counted.

We are in the process of analyzing data and completing a scientific manuscript on the findings of this study. Preliminary analysis indicates that 17 Frog Pond harbors a robust population of Tiger Salamanders and this study provides a baseline for future monitoring efforts of what may be the best population of the species remaining in the state. Following is an overview of the results of this study:

- 497 adult tiger salamanders were captured at the fence entering the pond
- 633 adult tiger salamanders were captured at the fence leaving the pond
- Therefore, 136 (41 females and 95 males) were most likely already in the dry pond bed before we opened the traps on Nov 11, 2009, though some may have tunneled under the fence and avoided detection.
- Salamanders were in the pond from before 11 Nov and the last ones left the pond on 9 Apr, though the largest migration (exit) occurred on 12 Mar
- Nearly even sex ratio (324 males : 309 females) and a fairly normal size-class distribution, indicating a healthy population of breeding adults (see Fig 1)
- Very similar population demography (size classes) between sexes
- 1,116 egg masses were counted in the pond. Therefore, there were about 3.6 egg masses per breeding female detected.
- Migrations to and from pond are directionally biased; lake and beaver swamps in the NW direction appear to account for bias (see Fig 2)

- Egg mass counts remained relatively constant for 3 years (2008-2010), despite approximately ¼ of the adjacent uplands undergoing a pine thinning operation in 2009. Large numbers of salamanders migrated to and from the area that was recently logged during this study.

Figure 1. Size class distribution of adult, breeding Tiger Salamanders at 17 Frog Pond on the Sandhills Game Land, Scotland County, NC.

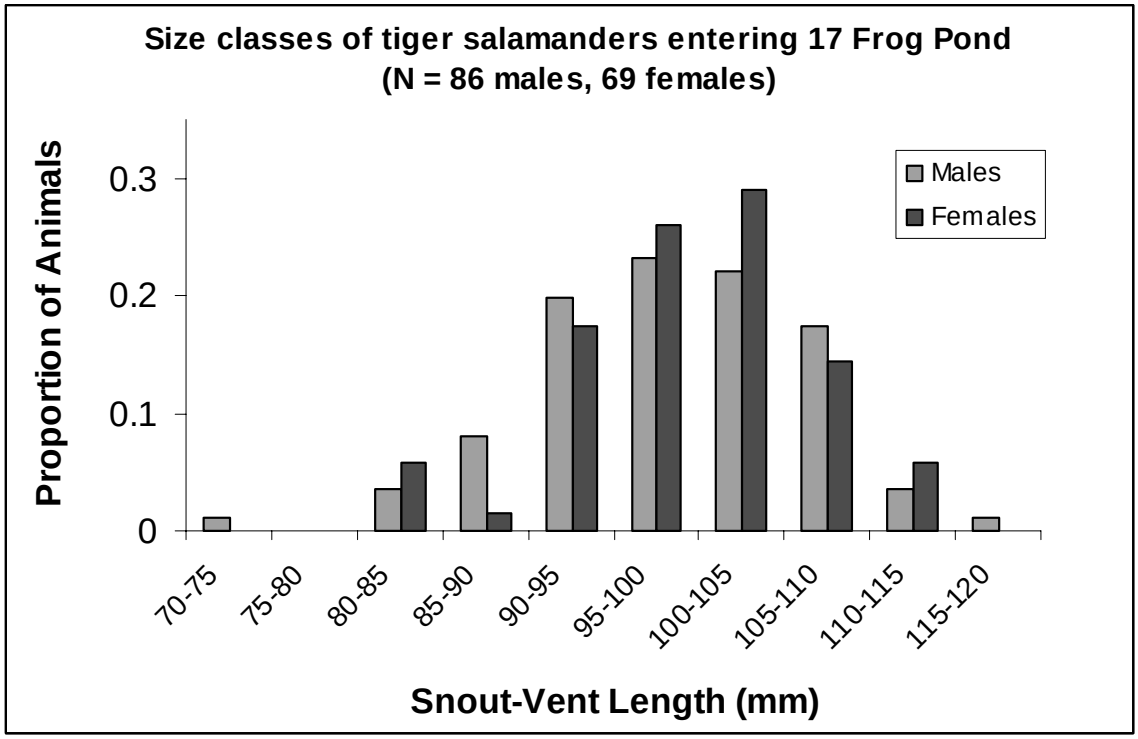
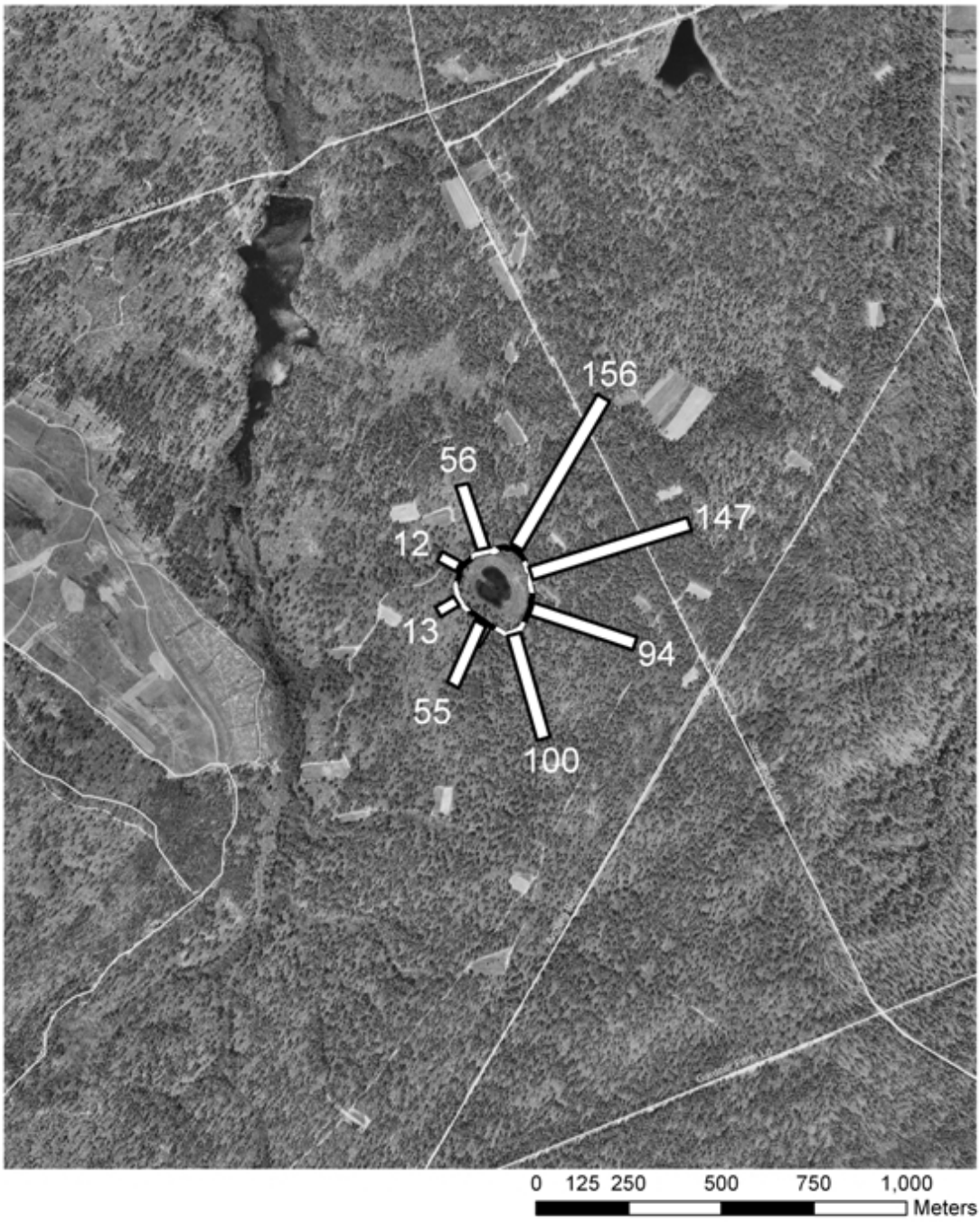


Figure 2. Numbers of adult tiger salamanders leaving the pond in different directions. The length of the bars represents the number of salamanders leaving in each direction.



Isolated Wetland Restoration and Enhancement

Isolated wetlands, or upland ephemeral ponds, support a wide array of amphibian species in North Carolina. Many species in the Sandhills and the Coastal Plain (e.g., Gopher Frog, Ornate Chorus Frog, and Tiger Salamander) require open-canopied, herbaceous ponds for successful reproduction. Because of historic fire exclusion, or problems with the timing of prescribed fire, many isolated ponds that were once open-canopied have become forested. Dense canopy in these ponds reduces herbaceous vegetation needed for amphibian egg attachment and food production, changes the pond's pH, and can drastically alter hydroperiod such that ponds dry too early in the year for larval development to complete.

We are currently in the process of restoring degraded ponds by removing woody vegetation through various means. In consultation with botanists, the state Division of Water Quality, and other partners, we are developing the most effective ways to conduct restoration activities. This project is currently in its early stages, but we have begun restoration work on 3 ponds in the Sandhills and 3 ponds on the Coastal Plain. Sites are being monitored for changes in hydrology, vegetation characteristics, and amphibian use. One restoration site which had not supported any successful amphibian breeding in recent history was used by a large number of Tiger Salamanders and Eastern Spadefoots during the first breeding season after restoration. Some examples of sites where restoration or enhancement work is underway are shown below.

Above: Before (left) and after (right) photographs of an isolated wetland on the Sandhills Game Land that has become forested because of a historical lack of growing season fire. We removed woody vegetation with chainsaws on a portion of the pond and used heavy equipment on approximately one-third of the pond. Tree removal was completed in October, 2009 and the after photo was taken in January 2010. Monitoring is underway to determine how vegetation, hydrology, and amphibians react to the restoration. This was one of our pilot projects to determine the best way to restore open-canopied, herbaceous wetlands.


Above: Before (left) and after (right) photographs of an isolated pond on the Sandhills Game Land where tree removal was completed using chainsaws. Tree removal was completed in September 2009 and the "after" photo was taken in December 2009. This pond supports a population of Mabee's Salamanders and a longer hydroperiod should benefit this species and other amphibians.

Other Activities

In addition to the several large projects listed above, WRC staff also conducted surveys for numerous priority species, including Oak Toad, Pine Barrens Treefrog, and other amphibians and reptiles throughout the Piedmont and Sandhills. New sites for Oak Toad and Pine Barrens Treefrog were discovered on the Sandhills Game Land. See the Coastal Herpetology 2009-2010 report for more information about Gopher Frog surveys that were conducted during the past year. Much of the amphibian survey work conducted this year involved identifying isolated wetlands from aerial and satellite imagery. Numerous previously un-surveyed ponds have been identified and ground-truthed.

The results of research, survey, and restoration projects were presented at meetings throughout the year, reaching 40 people at SE Partners in Amphibian and Reptile Conservation, 30 at Sandhills Natural History Society, 30 at NC Prescribed Fire Council, 25 at NC Climate Change Workshop, 35 at Onslow Bight Conservation Forum and 42 children at 2 different events. Field trips and related meetings informed approximately 50 biologists, managers, regulators, and other stakeholders on pond restoration needs and other aspects of amphibian and reptile conservation and habitat restoration. Additionally, one manuscript was submitted for publication and the results of other projects are currently being written into manuscript form.

B. Target Dates for Achievement and Accomplishment

The Gopher Frog and Tiger Salamander projects were completed this fiscal year. Isolated wetland restoration and enhancement activities will continue over a number of years, and we will monitor the success of each project and adapt our management activities as needed. Surveys for priority amphibians and reptiles in the Piedmont will continue as appropriate.

C. Significant Deviations

The loss of a Coastal Wildlife Diversity biologist position necessitated that the Piedmont Wildlife Diversity staff work on herpetology projects in the Piedmont and Coastal Plain, and some projects that straddled both regions.

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. 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 should continue.

F. Estimated Cost

$105,766 (including in-kind and other non-federal match)

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NC Wildlife Resources Commission

Final Performance Report

State: North Carolina **Project Number:** T - 11 - P

Period Covered: July 1, 2009 – August 31, 2010

Grant Title: State Wildlife Grants 07-Wildlife Management

Project Title: Piedmont Cooperative Land Conservation Project

Objectives:

To implement the Land Conservation and Private Lands Strategies of the NC Wildlife Action Plan collaboratively with conservation partners, particularly through the Greater Uwharrie Conservation Partnership (GUCP) and the Sandhills Conservation Partnership (SCP). Specifically, the project will:

1) Coordinate and focus wildlife habitat protection efforts between land trusts, state agencies, federal agencies, private conservation buyers, industry and other entities through participation in and contributions to conservation partnerships.
2) Provide technical guidance to county and municipal governments and private landowners to develop land use and management plans that will protect important wildlife habitats and other natural resources while promoting sustainable economic growth.
3) Assist with planning and conducting biological surveys for WAP priority species and habitats and assist with updating maps of priority natural resources.
4) Pursue land acquisition and other land conservation projects.

A. Activity

Some of the accomplishments reported on in this report are not due solely to actions by NC Wildlife Resources Commission (WRC) but arose from or were supported by information sharing among WRC and its external partners. The Piedmont Cooperative Land Conservation Project has achieved the following results between July 2009 – August 2010.

1) Improve communication between natural resources agencies and stakeholders and better focus wildlife conservation efforts.

The Piedmont Cooperative Land Conservation Project (PCLCP) helped to coordinate and offer facilitation for the Greater Uwharrie Conservation Partnership (GUCP). The GUCP Working Groups were restructured into 4 new groups: a) Land Protection; b) Conservation Planning, Research and Surveys; c) Stewardship and d) Recreation and Tourism. The Greater Uwharrie Conservation Partnership (GUCP) Forum and Steering Committee met 5 times and working groups met 6 times. The Sandhills Conservation Partnership steering committee met 4 times. The GUCP are communicating more with NC Division of Forest Resources, Natural Resources Conservation Service (NRCS) and NRCS Resource Conservation and Development through

meetings and activities. A web page for the GUCP was completed and is hosted by Central Park NC. Active information exchange occurred on email list serves and to a lesser extent on the GUCP wikispace. A draft Greater Uwharrie Conservation Assessment was created.

2) Promote better land use planning and development ordinances informed by biological data

Land use planning technical guidance was provided through use of the Green Growth Toolbox (GGT), a technical assistance tool for sharing conservation data and recommendations with local governments. GGT implementation efforts were coordinated closely with efforts in association with the Urban Wildlife project, and full results for GGT efforts are included in the Urban Wildlife 2009-2010 report. Here we summarize GGT activities conducted in this focal region.

Training and technical assistance was provided to local governments in Montgomery, Stanly and Anson Counties. Six GGT presentations were made to local governments and planning boards. GGT training workshops were held in Stanly and Anson Counties and were attended by 28 participants from the 2 counties and 6 municipalities, and included 11 planners and planning board members, 3 GIS staff, 7 elected officials, 1 county manager, 1 public works director, 2 NC Extension agents and 3 citizens.

Follow-up technical guidance included two written sets of recommendations submitted about the county Land Use Plan Update, 2 presentations to the Board of Commissioners and 2 presentations to the Land Use Plan Committee. GGT information was included in a joint conference presentation on greenways and recreation by a Stanly County Commissioner and the Land Trust. Fifty percent of GGT recommendations were included in the draft Stanly County Land Use Plan, which still awaits adoption.

We provided technical guidance on 4 occasions in the drafting of the Anson County, county-wide zoning ordinance, which includes a resource protection overlay and a resource conservation district geared to wildlife habitat conservation. We provided 2 sets of written recommendations for proactive wildlife conservation through the zoning ordinance.

We served on the Montgomery County Land Use Plan Stakeholders Committee with 4 other GUCP partners, providing technical guidance at 6 meetings, and one formal written set of recommendations. Sixty percent of GGT recommendations were incorporated into the Montgomery Land Use Plan, which was adopted in July 2010. The GUCP Uwharries Working Group Land Use Plan Forum reported in last year's report led directly to the creation of the Montgomery County Land Use Plan Stakeholders Committee.

3) Provide technical guidance about priority wildlife habitat conservation.

- WRC staff are serving on the Land Trust for Central NC Land Protection and Stewardship Committees. We provided recommendations for their stewardship strategy and management policy which led partially to the consideration of easement stewardship endowment requests to fund habitat management such as prescribed burning.
- WRC staff and partners presented management information at a NC Tree Farm Workshop (100 attendees) and at the Annual Sandhills Society of American Foresters meeting. Landowner contacts (26) were made for controlled burning.

- A prescribed burning coordinator was hired at Montgomery Community College in an initiative endorsed by this project.
- WRC staff and five GUCP partners presented at the Biltmore Forest School, Piedmont Woodland Steward Series to 25 landowners.
- Technical guidance by WRC and 2 GUCP partners to a major local timber company led to habitat conservation planning for G1 and G2 (globally rare) ranked species.
- A landowner contact by WRC led to 1 USFWS habitat restoration agreement on parts of a 500 acre priority private tract adjacent to Morrow Mountain State Park and a connection between that landowner and the land trust.
- We led a workshop for WRC and other conservation partners in the Piedmont to provide information on rock outcrop and small wetland habitats and refine criteria for the Wildlife Conservation Lands Program which provides incentives for landowners to conserve priority habitats and species.
- NRCS provided a conservation plan that will restore 57 acres of early successional habitat at the request of GUCP partners.
- The Land Trust for Central NC accepted a stewardship plan from a certified wildlife biologist for 80 ac. of Piedmont longleaf pine forest restoration.
- Reports to landowners in association with the Uwharrie Wildlife Inventory led to improved relationships and interest from owners of over 10,000 acres of land. These lands include priority habitats such as small wetlands, Piedmont longleaf pine, GUCP priority streams and large blocks (over 50 ac.) of mature hardwood forest.
- The GUCP provided coordination and guidance to support private lands initiatives by US Fish and Wildlife Service and Environmental Defense. Outcomes included restoration projects for 109 acres of Piedmont longleaf, 80 acres of upland hardwood, 125 acres of early successional habitat, a 1 acre bog, and an additional 100 acres under contract to be restored. USFWS spent $12,145 on these restoration efforts and Environmental Defense spent $9000.

4) Land acquisition and other forms of permanent protection.

- The NC Natural Heritage Trust Fund awarded WRC $500,000 toward completing the purchase of 180 acres of the King Mountain Tract.
- $50,000 dedicated by Land Trust donors to prevent cutting of old growth Piedmont Longleaf Pine on the Nichols Tract, while the NC Zoo acquires funding for the 100 acre tract. The Nichols tract was discovered by a local landowner, who introduced GUCP members to it as part of the USFWS and Environmental Defense Piedmont longleaf restoration project.

5) Surveys, data collection and priorities assessment for wildlife species and habitats.

This project coordinated and facilitated wildlife and natural heritage surveys to enhance assessment of conservation priorities, while also building landowner relationships and opportunities for technical guidance and land conservation.

- The NC Natural Heritage Program Assessed pitcher plant moth status in the Uwharries and surveyed for Landscape Habitat Guild Indicators to map core priority habitats and corridors. They also conducted surveys for rare terrestrial invertebrates on 8 high quality habitat sites owned by the NC Zoo, Pee Dee National Wildlife Refuge, and 3 private landowners.

- The scientific expert review of the GUCP conservation priorities was completed.
- The Greater Uwharries Conservation Planning Map (GUCP Map) was used by 3 partners and 1 COG and was used in 2 grant applications.
- GUCP priority species identification training has led to the documentation of a rare, 83 acre wet Piedmont longleaf pine forest on the Pee Dee National Wildlife Refuge.
- Surveys for black-throated green warblers by Catawba College led to documentation of occupancy by the species at 3 of 9 historic sites.

Uwharrie Wildlife Inventory

The goal of the Uwharrie Wildlife Inventory is to inventory potential priority habitats to assess habitat condition and priority species occurrence primarily on private lands. Properties with high potential for occurrence of priority species, as identified by the GUCP map, were contacted for permission to conduct surveys. Survey protocols included fixed effort surveys for birds, reptiles, and amphibians, in addition to habitat evaluations and recording incidental observations of all Wildlife Action Plan priority species. Landowners were provided with a report summarizing survey results and providing them with information on who to contact if they are interested in habitat management or land conservation.

Wildlife surveys were conducted from March until mid-July with the aid of a seasonal technician on 2 rivers and 32 private-owned priority lands. We documented 384 new records for Wildlife Action Plan priority species, including: 41 bird, 2 reptile, 9 amphibian, and 2 mammal species. Ten breeding season records of 4 high priority species were obtained including yellow-crowned night heron, SE crowned snake, Swainson's warbler and worm-eating warbler.

Priority grassland birds were surveyed in mid-June on 50 tracts over 3 occasions in Rowan and Cabarrus Counties using the Breeding Bird Survey protocol. In early July a new population of Swainson's warblers was documented on the Pee Dee River south of the Blewett Falls Dam during 2 river transect bird surveys. During August, the Uwharrie Wildlife Technician set out 32 tin cover board arrays for reptiles. Tin was placed in Piedmont longleaf pine forest and in early successional habitat near records of pygmy rattlesnakes and slender glass lizards on 2 Land Trust properties, one private property and the Uwharrie National Forest. The landowner was trained and is collecting survey data for WRC. The Land Trust will continue surveys as time allows.

Beginning in mid- July WRC staff shared an Anabat detector with the Uwharrie National Forest and conducted bat surveys according to new standard US Forest Service national protocols aimed at measuring bat species status in relation to white-nose syndrome. The USFS will analyze the data. During bat detector surveys reptile and amphibian species records were collected. These road cruising herpetofauna surveys from July to August 30 of 2010 yielded 2 records of timber rattlesnakes and 2 records for scarlet snakes.

One landowner relationship led to the documentation of a 1400 acre Significant Natural Heritage Area on the Pee Dee River in Anson County. We are maintaining periodic contact with the landowner by conducting periodic Uwharrie Wildlife Inventory surveys.

6) Leverage of resources funding for conservation priorities

The following resources and funds have been leveraged partly due to GUCP meetings.

- $12,145 was spent this year by the USFWS and $9,000 by Environmental Defense on longleaf restoration, in partnership with the GUCP partners.
- NC Natural Heritage Trust Fund awarded the NC Natural Heritage Program funds for 80% staff time for invertebrate surveys in the Uwharries from May 2010 – December 2011.
- LTCNC applied for funding for conservation of 3 priority wildlife habitats on over 3000 ac.
- A $450 grant from the North Carolina Department of Tourism was awarded to Central Park NC and the Land Trust to create an information kiosk at Low Water Bridge on the Uwharrie River. The kiosk educates users about the importance of aquatic wildlife and the Land Trust policy on gold panning. This policy prevents mechanical dredging of the river substrate for gold which has become a significant problem with impacts to aquatic species.
- Piedmont Land Conservancy applied for grants to fund a conservation easement on 300 ac. of Camp Caraway (where we are actively surveying for priority wildlife). This project resulted from the "Randolph Camps" meetings, organized by the NC Zoo and supported by the GUCP. It is unlikely at this time that the Camp Caraway Board will accept a conservation easement as they do not favor any restrictions on their land. We will continue to build a relationship with Camp Caraway and their Board in attempts to build on the momentum of this funding application to conserve part of the Camp in some way.

<u>Summary of Measures of Success</u>

- 25 priority conservation projects were conducted in collaboration with 12 GUCP stakeholders and 10 partners
- 3 partners and 1 stakeholder used the Greater Uwharrie Conservation Planning Map in grant applications or in conservation planning
- 10 priority landowner relationships formed in GUCP priority areas resulting in 315 acres of habitat restoration activities by the USFWS.
- 2 new landowners of 15,000 acres engaged in collaboration with partners in areas of high conservation priority.
- 180 acres permanently protected at King Mountain through fee simple purchase.
- 163 acres of priority Piedmont longleaf forests wildlife habitat restoration projected to occur on permanently conserved properties in next 2 years.
- 2 GGT workshops attended by 25 local decision-makers including 11 planners and 3 GIS staff of 2 counties and 6 municipalities.
- 16 presentations, meetings and other information exchanges with local decision-makers
- 2 local governments downloaded Green Growth Toolbox GIS data with technical guidance
- 4 local government staff have received one-on-one technical guidance and written recommendations in 11 technical guidance requests.
- 2 land use plans incorporated 50 and 60% of GGT recommendations
- 1 draft County-wide zoning ordinance in process is including GGT recommendations.

- 1 new local government working relationship formed
- Presentations on priority wildlife conservation given to over 125 landowners
- 1420 additional records added to the GUCP Map database
- 95 new sites surveyed
- GUCP Measures of success are reported biannually and will document acres conserved that resulted from GUCP collaboration for 2 partner fiscal years during 2009 - 2011.

Personnel changes- In November 2010, the Piedmont Land Conservation Biologist left the position to become the NCWRC Land Conservation Biologist, coordinating the Green Growth Toolbox project and other land conservation efforts statewide.

B. Target Dates for Achievement and Accomplishment

All activities on schedule and conducted as planned.

C. Significant Deviations

None

D. Remarks

None

E. Recommendations

In the coming year, the GUCP Map and layers should be updated and distributed to the GUCP via wiggio.com and by ESRI's new Community Maps free mapping web service. The GUCP needs to work more closely to put landowners in contact with appropriate partner agencies or organizations and programs based on landowner conservation objectives. Follow-up with local governments on use of the GGT needs to be high priority and should improve now that the Uwharrie Wildlife Technician is trained to take over almost all responsibilities of the Uwharrie Wildlife Inventory.

F. Estimated Cost

$100,765 (including in-kind and other non-federal match)

Prepared By:

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

Final Performance Report

State: North Carolina **Project Number:** T - 11 - P

Period Covered: July 1, 2009 – August 31, 2010

Grant Title: State Wildlife Grants 07-Wildlife Management

Project Title: North Carolina Partners in Flight (NCPIF)

Objectives:

1. Continue to develop and participate in partnerships that will benefit bird conservation in the state and region through increased communication, cooperation, and collaboration.

2. Provide technical assistance to local, state and federal agencies, private business, conservation groups and private citizens on matters related to bird conservation.

3. Coordinate the Breeding Bird Survey in North Carolina and run several BBS routes; assist with other ongoing monitoring and research initiatives.

4. Coordinate the development and dissemination of informational materials to help create and improve awareness about the status and needs of migratory birds for citizens and natural resource professionals.

5. Train and recruit natural resource professionals and volunteers to help survey bird populations; and assist agencies, non-governmental organizations, academia and private industries to implement bird monitoring and research programs.

A. Activity

For the period, the Wildlife Resources Commission staff has been attempting to address the staffing deficiency created when the NC Partners in Flight Coordinator left the agency. There has been no dedicated staff pursuing the objectives of this project during the reporting period. However, other staff of the agency have conducted activities pursuant to objectives 1-3 of this project. Multiple wildlife Diversity Program staff participated in bird conservation partnerships during the year, including the Forest Landbird Legacy Program, the Southeast painted bunting cooperative with UNC Wilmington and the NC State Museum of Natural Sciences, coordination with the NC Birding Trail Steering Committee, and a partnership with New Hope Audubon for management of a birding site at Jordan Lake.

Staff of the Wildlife Diversity Program provided technical guidance to the NC Scientific Council on Birds, Croatan National Forest, the Division of Wildlife Management on bird conservation priorities in western North Carolina, and to North Carolina State Parks. In addition, staff participated in Breeding Bird Survey activities and Christmas Bird Counts at certain locations across the state.

Finally, staff of the NC Wildlife Resources Commission represented bird conservation needs and priority conservation efforts at a small number of bird conservation related events including International Migratory Bird Day events at the NC State Museum.

B. Target Dates for Achievement and Accomplishment

Since there was no dedicated staff, there were no specific target dates or achievements for this project during the period; however coordination and communications related to bird conservation were undertaken.

C. Significant Deviations

There was significantly less work conducted on this project than was anticipated when it was proposed. Staffing difficulties in the North Carolina Wildlife Resources Commission related to the NC State Budget crisis precluded hiring and left no dedicated staff for this project. While there was no dedicated staff, other division staff did conduct activities in pursuit of objectives (1-3) of this project. No training of natural resources professionals or development of materials occurred during the period. However, senior and administrative staff expended considerable effort planning and working to recreate the NC Partners in Flight position and find a way to address the critical coordination and communication needs of Partners in Flight in North Carolina. While expenditures on this project were far below initial projections, those projections amounted to less than 10% of the grant total and there were efforts undertaken to address the objectives of the project.

D. Remarks

Near the conclusion of this reporting period, steps were taken in the North Carolina Wildlife Resources Commission to address priority actions within this project by combining job responsibilities of this project with those of another vacant position in the agency. Thus, efforts have finally been initiated that will lead to a portion of a staff position dedicated to Partners in Flight activities.

E. Recommendations

Partners in Flight coordination and communication should be re-initiated amongst the numerous bird conservation organizations across North Carolina.

F. Estimated Cost

$4,348

Prepared By: Chris McGrath
Wildlife Diversity Program Coordinator
Division of Wildlife Management

Final Performance Report

State: North Carolina **Project Number:** T – 11 -P

Period Covered: July 1, 2009 - August 31, 2010

Grant Title: State Wildlife Grants 07-Wildlife Management

Project Title: Waterbird Investigations and Management

Objectives:

1. Protect waterbird nesting sites to reduce human disturbance and increase productivity.
2. Provide technical guidance to other agencies and individuals and coordinate with existing and new partners to stabilize declining populations of breeding and non-breeding colonial waterbirds and shorebirds.
3. Collect data on species and relative abundance of non-breeding shorebirds.
4. Collect baseline data on inland heronries (third year).

A. Activities

Protection of waterbird nesting sites. – Before the 2010 nesting season began (March–April), Wildlife Diversity personnel and volunteers posted the perimeter of nesting sites that included 20 state-owned islands in or near Oregon Inlet, Pamlico Sound, Hatteras Inlet, Ocracoke Inlet, Core Sound, and New River Inlet. We obtained permission to post 5 privately-owned barrier and estuarine sites. Nesting sites are posted with informative signs for the public about sensitive nesting species and legal statutes that authorize such protection. Law enforcement officers welcome such signs because they give them authority to enforce temporary closures of property to the general public during the nesting season.

Technical guidance and coordination.— The Wilmington District Corps of Engineers continues to coordinate its activities with the Wildlife Diversity Program, incorporating moratoriums on activities during the shorebirds' and colonial-nesting waterbirds' nesting season.

During the 2010 breeding season for American oystercatchers (*Haematopus palliatus*) and piping plovers (May – 30 Jun 2010), NC Audubon, NC Coastal Reserve and National Estuarine Research Reserve, NC State Parks, Camp Lejeune Marine Corps Base, Currituck and Pea Island National Wildlife Refuges (USFWS), NC State University, Bald Head Island Conservancy, Cape Lookout National Park, and Cape Hatteras National Park each provided data on numbers and locations of nesting pairs. After inclusion of data collected by the Wildlife Diversity Program, we obtained a coastwide estimate of locations and numbers of nesting pairs of American oystercatchers and piping plovers for 2010.

American Oystercatchers.—During the 2010 nesting season, Wildlife Resources Commission (WRC) biologists collaborated with cooperators to obtain numbers of nesting pairs of American oystercatchers for the state. Data were summarized by county and type of habitat

on which American oystercatchers nested. The total estimated number of pairs for 2010 was 369 (Table 1), an increase in number of pairs compared to estimates in 2004 (327 nesting pairs) and 2007 (339 nesting pairs). However, we do not know if the increase in number of nesting pairs is accurate or if increased survey effort and knowledge of nesting areas are affecting the increased estimate. The percentage of nesting pairs on dredged-material islands may be increasing while the percentage on natural barrier island habitats appears to be decreasing. Further analyses will be necessary to determine if these changes in percentages of nests on different habitat types are significant; thus, with our cooperators, we will continue to monitor nesting pairs of American oystercatchers along the North Carolina coast. If the increase in percentage of nests on dredged-material islands is significant, it would indicate the increased importance of these types of habitat, and the possible decline in quality of other sites. Management and conservation actions should address these changes so this species of special concern will continue to contribute to the Atlantic population of American oystercatchers.

Piping Plovers.—WRC biologists and cooperators surveyed the coast of North Carolina for piping plover pairs during the 1-9 June 2010 census window. 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 4-mile long barrier island within a live-fire training range on Marine Corps Base Camp Lejeune.

Fifty-one pairs and 7 individual birds were counted during the 2010 census window (Table 2). The end-of-season best estimate that includes pairs discovered after the census window was 61 pairs and 7 individuals. This estimate is greater than the 54 pairs reported for the 2009 nesting season (Fig. 1). Statewide distribution of nesting pairs was similar to previous years, with most nesting pairs (69%) found along Cape Lookout National Seashore (CLNS). Cape Hatteras National Seashore (CHNS) supported the next greatest number of nesting pairs (12), up from 9 pairs on CHNS in 2009. Productivity estimates for CLNS (0.74 fledglings/pair; down from 0.81 fledglings/pair in 2009) and CHNS (1.25 fledglings/pair; up from 0.67 fledglings/pair in 2009) were the greatest of all locations along coastal North Carolina (other estimates ranged from 0-0.33 fledglings/pair, or no pairs). The 2010 productivity reported for CHNS is much greater than the 29-yr (1989-2007) average (0.54 fledglings/pair) for the NS.

Relative abundance of non-breeding shorebirds.—Many species of shorebirds and colonial-nesting waterbirds use North Carolina's coastal shorelines, islands, sounds, and marshes during their migration from far northern nesting sites to more southerly winter sites. Stop-over sites during migration provide critical resting and foraging locations for these birds. If birds are disturbed during resting or feeding, or if food resources are reduced or unavailable, critical energy reserves may take longer to build up, or may not be met, affecting timing of migration, survival during migration, and survival and reproductive potential.

Population declines of many shorebird species is a significant concern nationally (Brown et al. 2001). North Carolina provides stop-over and/or over-wintering habitat for the piping plover (*Charadrius melodus circumcinctus*, Federally and State listed as endangered; *C. m. melodus*, Federally and State listed as threatened) and red knot (*Calidris canutus rufa*; Federal candidate species), and several species of special concern to North Carolina, including the American oystercatcher (*Haematopus palliatus*), black skimmer (*Rynchops niger*), and Wilson's plover

(*Charadrius wilsonia*). All of the above species are listed as priorities in the North Carolina Wildlife Action Plan (NCWRC 2005) along with the sanderling (*Calidris alba*).

To obtain estimates of numbers of species present (species richness) in North Carolina during fall migration (August – October 2010) and winter (November – February 2010), numbers of individuals of each species, and identification and numbers of banded birds, we participated in the International Shorebird Survey program. Our survey site was New Drum Inlet, the same site from which we have collected data for seven years. Final summary and analysis of these data will be presented once the 2010 winter season surveys are completed.

Inland heronry surveys (Piedmont Inland Surveys).—Herons and egrets are surveyed regularly 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). Because heronries are important biological resources, surveying and monitoring them are listed as priorities in the NC Wildlife Action Plan (NCWRC 2005). Heronries are vulnerable to development and human disturbance; thus, it is important to update our database on the location of new heronries and status of existing heronries.

Aerial surveys for inland heronries began in 2008 during which portions of the coastal plain and piedmont were surveyed. During 2010, piedmont inland surveys continued and WRC biologists detected 147 heronries, including 5 new colonies (Fig. 2). By 30 June 2010, biologists surveyed from I-95 west, covering the eastern part of the Roanoke watershed (beginning just northeast of Durham to I-95), the northern halves of the Tar, Pamlico, and Cape Fear Rivers, and the southern three-fourths of the Yadkin Basin. The Catawba and the eastern half of the Roanoke River were not surveyed due to time and lack of large heronries. The survey of the Piedmont region is complete, although a small portion just north of Durham may have a lower detection rate due to poor flying conditions and visibility. Summary and analysis of inland heronry data will be finalized when surveys of the Coastal Plain region are completed.

B. Target Dates for Achievement and Accomplishment

All planned posting, technical guidance, and most survey activities were on schedule. About half of the counties within the coastal plain still need to be surveyed for inland heronries. We had planned to complete this work in 2010, but personnel turn-over and a delay in hiring prevented completion of the project.

C. Significant Deviation

The Coastal Waterbird Biologist position was vacant for >10 months of this 14-month period; hence, the number of surveys conducted was reduced due to WRC position vacancy.

D. Remarks

None

E. Recommendations

Continue working with landowners to post barrier island, beach-nesting sites before April; continue surveys and mapping of sites with most frequent use by shorebird and colonial-nesting waterbirds; continue enhancement and protection of nesting habitat.

F. Estimated Cost

$106,927 (including in-kind and other non-federal match)

G. Literature Cited

Allen, D. 1996. Inland Colonial Waterbird Survey. Unpublished annual performance report. North Carolina Wildlife Resources Commission, Raleigh, NC. 3 pp.

Brown, S., C. Hickey, B. Harrington, and R. Gill, eds. 2001. The U.S. Shorebird Conservation Plan, 2nd ed. Manomet Center for Conservation Sciences, Manomet, MA.

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

Prepared By: Sara H. Schweitzer
Wildlife Diversity Biologist
Division of Wildlife Management

Table 1. Numbers of American oystercatcher pairs reported during the 2010 breeding season in North Carolina.

		All natural island habitats					
County	**Barrier island**	**Natural island**	**Marsh**	**Shellrake**	**Dredge spoil island**	**Other (rooftop)**	**Total**
Brunswick	5	3		4	40		52
New Hanover	46				13		59
Pender	17				3		20
Onslow	4	10	6	21	3		44
Carteret	62	16	18	11	20	5	132
Hyde	4	1		1	17		23
Dare	17	5	3		14		39
Totals	155	35	27	37	110	5	**369**

Table 2. Numbers of pairs of piping plovers and individual piping plovers counted during the annual "window" survey (1-9 June 2010) along the coast of North Carolina. If individuals were counted, they were assumed to be single, non-nesting adults. Best estimates pertain to the entire nesting season, and the estimate of productivity was obtained by dividing the number of young fledged by the best estimate of number of nesting pairs.

Location	**Number of pairs** (1-9 Jun window survey)	**Number of individuals** (1-9 Jun window survey)	**No. pairs – best estimate** (over entire season)	**No. individuals – best estimate** (over entire season)	**No. young fledged**	**Estimate of productivity**
Currituck National Wildlife Refuge	0	0	0	0	na[1]	na
Cape Hatteras National Seashore	10	4	12	3	15	1.25
Pea Island National Wildlife Refuge	0	0	1	1	0	0
Cape Lookout National Seashore	37	0	42	0	31	0.74
Rachel Carson Reserve (Bird Shoals)	0	0	0	0	na	na
Ft. Macon State Park	0	0	0	0	na	na
Bogue Inlet & west end of Bogue Banks	0	0	0	0	na	na

Table 2. Continued.

Location	Number of pairs	Number of individuals	No. pairs – best estimate	No. individuals – best estimate	No. young fledged	Estimate of productivity
Hammocks Beach State Park (Bear Island)	1	0	1	1	0	0
Camp Lejeune, Onslow Beach	0	2	0	2	na	na
North Topsail Beach, New River Inlet	0	0	0	0	na	na
South Topsail Beach	0	0	0	0	na	na
Lea	2	0	2	0	0	0
Hutaff	1	0	3	0	1	0.33
Figure Eight Island	0	0	0	0	na	na
Wrightsville Beach	0	0	0	0	na	na
Masonboro Island	0	1	0	0	na	na
Ft. Fisher State Recreation Area	0	0	0	0	na	na
Bald Head Island	0	0	0	0	na	na
Oak Island, Caswell Beach, & West end of Long Beach	0	0	0	0	na	na
Holden Beach, east & west ends	0	0	0	0	na	na
Ocean Isle, east & west ends	0	0	0	0	na	na
Sunset Beach and Bird Island	0	0	0	0	na	na
TOTAL	51	7	61	7	47	0.77

[1]na = not applicable because there were no nests. (data compiled by Sara Schweitzer, NCWRC, 2010)

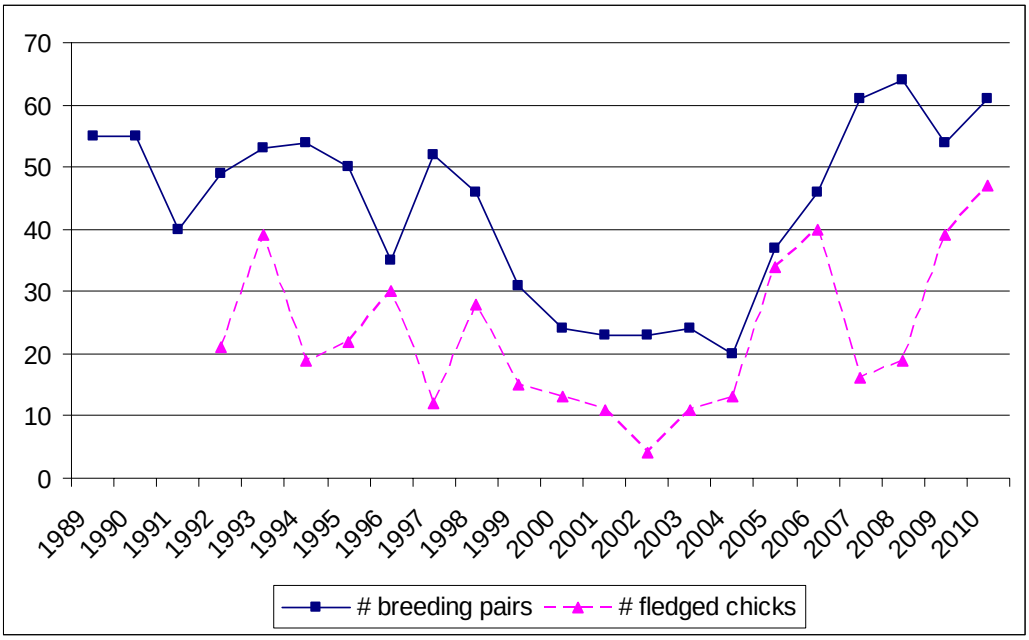

Figure 1. Numbers of nesting pairs and fledglings of Piping Plovers reported in North Carolina from 1989 – 2010. Most nesting pairs are within Cape Hatteras and Cape Lookout National Seashores.

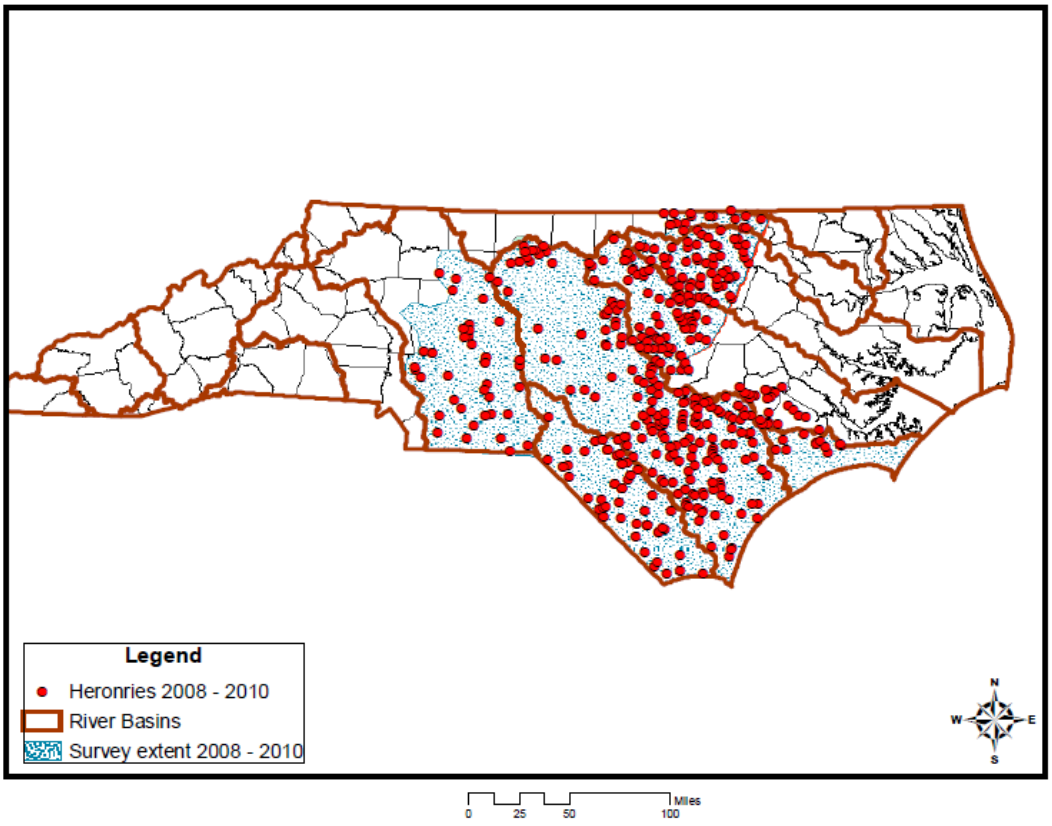

Figure 2. Areas surveyed and heronries detected during 2008 through 2010 flights by NC Wildlife Resources Commission biologists.

Final Performance Report

State: North Carolina **Project Number:** T – 11 -P

Period Covered: July 1, 2009 - August 31, 2010

Grant Title: State Wildlife Grants 07-Wildlife Management

Project Title: Surveys of Priority Amphibians and Reptiles in the Coastal Plain

Objectives:

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

With the loss of a Coastal Wildlife Diversity Biologist position, the Piedmont Wildlife Diversity staff took over some duties associated with this project. Much of the survey, research, and restoration work straddled both the Piedmont and Coastal Plain. Refer to the Piedmont Herpetology 2009-2010 report for information on projects that straddle both regions. The major projects conducted on the Coastal Plain included 1) identifying isolated wetlands (upland depression ponds and sinkhole ponds) that have never been surveyed for their amphibian fauna; 2) initiation of a Gopher Frog status assessment; and 3) restoration or enhancement of upland isolated wetlands at Holly Shelter Game Land and Croatan National Forest. Staff also fostered working relationships with personnel on Croatan National Forest, Camp Lejeune, and Sunny Point Military Ocean Terminal (MOTSU), to address conservation strategies for priority amphibians and reptiles on those highly diverse properties.

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Conservation of the Gopher Frog (*Rana capito*) in North Carolina: Historical versus Current Range and Population Status – Year 1

The gopher frog (*Rana capito*) is a medium-sized frog that is a specialist of upland, longleaf pine forests of the Southeast. It inhabits the Sandhills and Coastal Plain in North Carolina, South Carolina, Georgia, Florida, and Alabama. The closely related and recently recognized Mississippi gopher frog, *Rana sevosa*, inhabits three sites in Mississippi and once also ranged into Louisiana. Gopher frogs live in upland longleaf pine – wiregrass habitat for much of the year, residing in burrows associated with stump holes, gopher tortoise burrows, or mammal burrows. They breed in isolated upland ponds – usually upland depression ponds, Carolina bays, sinkhole ponds, or borrow pits. Breeding ponds need to remain ephemeral with an open canopy and a grassy aquatic structure. The loss and fragmentation of upland habitat coupled with the degradation or outright destruction of quality breeding ponds has led to a perceived dramatic decline of gopher frog populations in many areas, though documentation of declines has yet to be published. We are fortunate in North Carolina to have a report on the status of Gopher Frogs in the state from the 1980s and 90s (Braswell 1993).

In North Carolina, gopher frogs have historically been documented in 13 counties, from the Sandhills in the south-central part of the state, east throughout the Coastal Plain roughly to the Pamlico River in Beaufort County (Braswell 1993). Historically, there were 53 verified site locations from 29 different populations (populations are delineated as separated by 4 km or a major feature such as a river), based on museum records and reports by expert herpetologists.

We visited all historic sites where Braswell (1993) reported active or "unknown status" gopher frog populations. We did not re-visit sites that Braswell reported as destroyed. In addition to historic sites, we visited numerous other ponds near historic sites or in areas where Gopher Frogs have never been documented. Surveys were conducted by egg mass counts and tadpole surveys. Egg mass surveys were conducted in Feb-Mar, 2010 and tadpole surveys were conducted by dipnetting each pond for at least 15 minutes during May and June (Fig 1 and Fig 2). Minnow traps were deployed at Camp Lejeune Marine Corp Base because of high water during the sampling period. We also included drift fence and egg mass surveys conducted by a graduate student at 3 sites on Ft. Bragg (Will Fields, NC State University, personal communication).

Of 29 historic populations of Gopher Frogs known from North Carolina, we found only 7 to be extant during our 2010 surveys (Table 1 and Fig 2). Extant populations found in this study are all on public land, despite surveys having been conducted on historic sites under private ownership. Those sites are: Sandhills Game Land (Scotland Co), Ft. Bragg Army Base (Hoke Co), Sunny Point Military Ocean Terminal (Brunswick Co), Holly Shelter Game Land (Pender Co), Camp Lejeune Marine Corps Base (Onslow Co), and Croatan National Forest (Carteret Co).

Gopher Frogs appear to have been lost from the majority of historical sites where they once occurred. Some breeding ponds have been outright destroyed by development or mining activities, but others have become degraded by changes in fire regimes, reduced groundwater levels, or the loss of upland habitat for adult frogs. There is a possibility of breeding pond and upland habitat restoration at several locations (e.g., Croatan National Forest, Holly Shelter Game Land, and Camp Lejeune) and we are currently in the process of restoration efforts at several

sites. 2009-10 was the first year of at least a 2-year effort to determine the status of Gopher Frogs in North Carolina. A concerted effort will be made in 2011 to re-visit historic sites and to survey recently identified ponds that have never been surveyed. A full report on the status of this species will be provided in the 2010-11 annual report.

Figure 1. Dipnet surveys used to detect Gopher Frog tadpoles in Coastal isolated ponds.

Figure 2. Gopher Frog (top) and Southern Leopard Frog (bottom) tadpoles collected at a historic site in Brunswick County, NC.

Table 1. Historical and current status of gopher frogs in North Carolina.

	Historical	2010 Surveys	Apparent Decline
Known Sites (including road records)	53	9	83 %
Extant Ponds	46	9	80 %
Extant Populations	29	7	76 %

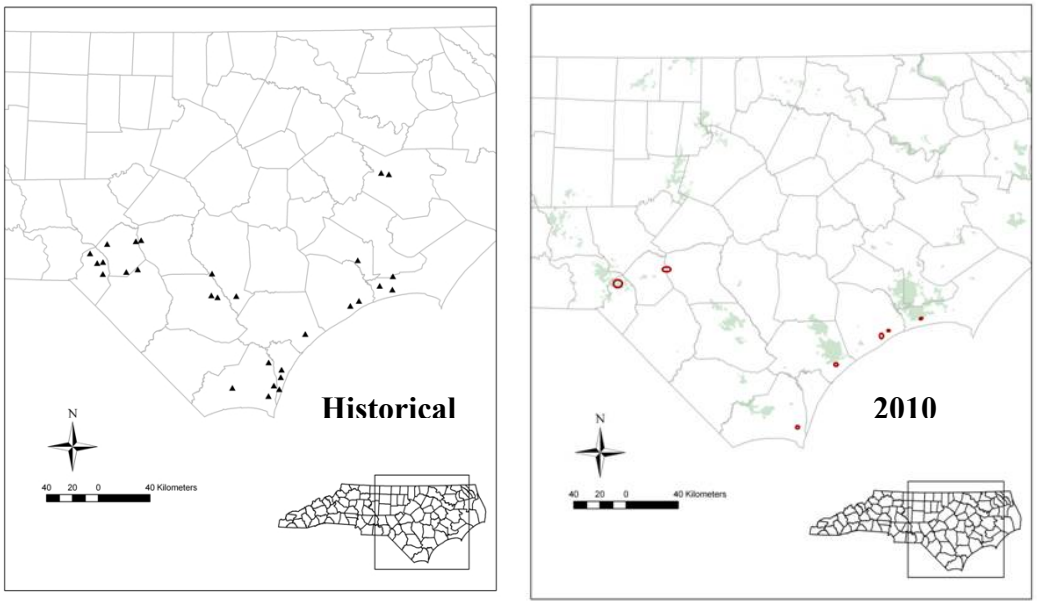

Figure 3. Historically-known gopher frog populations in North Carolina compared to extant populations documented in 2010.

Isolated Wetland Restoration and Enhancement

WRC staff have begun restoration and/or enhancement activities at 6 upland, isolated ponds, including 3 on the Coastal Plain (see Piedmont Herpetology report for details on this project). In 2009-10, restoration work was conducted at one site on Holly Shelter Game Land (Pender Co) and 2 sites on Croatan National Forest (Carteret Co). Holly Shelter Game Land harbors an apparently small, isolated population of Gopher Frogs that uses a small borrow pit for breeding. This work is likely to benefit not only Gopher Frogs, but multiple other amphibian species and

other plants and wildlife in the area. An example of work performed at Holly Shelter is illustrated below.

Holly Shelter Game Land Gopher Frog Breeding Site Enhancement

June 2009

Aug 2010

Dec 2010

This borrow pit is the last known Gopher Frog breeding site in Pender County, NC. Frogs are known to use the pond for breeding every year, but the pond often dries too early for metamorphosis, or tadpoles are left stranded in pools of water created by the uneven pond bottom. The pond supported very little herbaceous, emergent vegetation because of a hard, clay bottom.

Our objectives with this project were to enlarge the pond, remove the berms which isolate water (and developing tadpoles) into separate pools, and to import topsoil so that herbaceous vegetation can establish, providing structure and increased food for developing tadpoles.

Through collaboration with Game Lands staff, we increased the size of the pond and leveled out the pond bottom in order to increase the hydroperiod. We also imported topsoil several inches deep for establishment of herbaceous vegetation. Some locally-native wetland plant seeds were also spread throughout the pond.

By December, 2010, the pond had filled with late fall rains and we will monitor the site for amphibian use, hydroperiod, and amphibian use. This is a pilot project and we will adapt our management based on monitoring results. Borrow pits may be extremely important for mitigating the decline of Gopher Frogs and other amphibian species in areas where natural ponds have been lost or highly degraded.

Other Activities

The results of research, survey, and restoration projects were presented at meetings throughout the year, reaching 40 people at SE Partners in Amphibian and Reptile Conservation, 30 at Sandhills Natural History Society, 30 at NC Prescribed Fire Council, 25 at NC Climate Change Workshop, and 35 at Onslow Bight Conservation Forum. Surveys for priority, pond-breeding amphibians were conducted throughout the region as part of an ongoing survey project. WRC staff are also working with various partners, especially Croatan National Forest biologists and foresters, to guide upland and isolated wetland conservation and restoration activities.

B. Target Dates for Achievement and Accomplishment

Gopher Frog status surveys will continue through 2011 and a final report will be completed late in the year. Pond restoration and enhancement activities will continue on several properties over a period of years. Ongoing surveys for priority amphibians and reptiles, especially for pond-breeding amphibians and Eastern Diamondback Rattlesnakes, will continue over the next several years.

C. Significant Deviations

The loss of a Coastal Wildlife Diversity Biologist necessitated that Piedmont Wildlife Diversity staff work on projects in the Piedmont and Coastal Plain, and some projects that straddled both regions.

D. Remarks - None

E. Recommendations

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. 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 Coastal Plain should continue.

F. Estimated Cost

$23,251

G. References

Braswell, A.L. 1993. Status report on *Rana capito capito* Leconte, the Carolina gopher frog in North Carolina. Report to North Carolina Wildlife Resources Commission. 53 pp.

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

Final Performance Report

State: North Carolina **Project Number:** T – 11 -P

Period Covered: July 1, 2009 – August 31, 2010

Grant Title: State Wildlife Grants 07-Wildlife Management

Project Title: Coastal Region Landbird Conservation

Objectives:

1. Conduct surveys, monitoring, management, and research for priority landbird species occurring in the coastal plain ecoregion of North Carolina.

2. Provide technical assistance to government agencies and private entities regarding status, conservation, and management of priority landbird species in the coastal plain ecoregion and to participate in regional conservation partnerships and planning efforts.

A. Activity

Landbird monitoring

Basic distribution and abundance information is lacking for many of the 42 priority coastal landbird species outlined in the North Carolina Wildlife Action Plan. As a result, point count surveys were initiated at two new locations to begin accumulating baseline data and assist in developing management guidelines. A total of 94 point counts were performed at Holly Shelter Game Land in Pender County and at the Green Swamp Ecological Preserve in Brunswick County. Count stations were spaced at ~1000 m at Holly Shelter along secondary game land roads, and ~500 m at Green Swamp along trails and tertiary roads. All counts were fixed radius (<25, 26-50, 51-100, >100 m) and performed prior to 10:00 am EST once at each location by a single observer in June 2010. Count duration was 5 min. at Holly Shelter and 10 min. at Green Swamp. Time was segmented into 0-3 min., 3-5 min., and 5-10 min. intervals so analysis can be performed on any time-length segment.

Habitat availability in Holly Shelter was modeled for priority species with ≥10 detections using the Mahalanobis distance (D^2) statistic and ArcGIS (Jenness et al. 2010). This technique requires only presence data, thus avoiding the pitfalls associated with classifying habitat as used or unused (Clark et al. 1993). Individual bird detections were relocated in ArcGIS from the count station to their estimated positions using distance and bearing measurements collected during surveys. This provided a more reliable estimate of the habitat actually being used by the bird when it was encountered instead of the habitat associated with the observer's location.

Eight landscape variables were developed for modeling: (1) degree of slope, (2) aspect, (3) elevation, (4) percent canopy cover, (5) percent pocosin, (6) percent longleaf pine, (7) percent non-riverine swamp hardwood forest, and (8) variety of land cover types (i.e. a measure of

habitat fragmentation). Although the first three variables are typically not associated with coastal plain sites, they are included here to test for unknown possibilities/differences. If no differences occur, these variables will be eliminated from future analysis. Each cell value was calculated as the mean of cell values within a one-hundred meter radius. Elevation, slope, and aspect layers were derived from the NC Flood Mapping Program's 6 m digital elevation model. Aspect was transformed to a gradient ranging from 0.0 to 2.0 using the equation:

$$1 + \cos(45\text{-aspect})$$

This distinguished less productive, southwest facing slopes (value = 0.0) from more productive, mesic northeast slopes (value = 2.0) (Beers et al. 1966, van Manen et al. 2005). Canopy and land cover layers were based on the 2001 National Land Cover Database tree canopy and the 2001 southeast Gap Analysis Project classifications, respectively. Mahalanobis distances were rescaled from 0.0-1.0 using Chi-square *p*-values to ease model interpretation: *p*-values close to 1.0 reflect similar habitat and therefore a more ideal combination of predictor variables.

Holly Shelter

A total of 51 species, including 14 priority coastal plain landbirds, were detected at 80 count stations (Table 1). Species richness was significantly higher ($t = -3.60$, $P < 0.001$) in the southern half of the game land, which is likely due to a greater diversity of habitats (Fig. 1).

Predictive maps were created for five priority species: Bachman's sparrow (Fig. 2), eastern wood pewee (Fig. 3), northern bobwhite (Fig. 4), northern flicker (Fig. 5), and prairie warbler (Fig. 6). Mean values of landscape variables for locations where each species was detected are presented in Table 4. This analysis and its results were considered exploratory due to small sample sizes for all species of interest; however, future analyses will include validation sets to test model accuracy.

Green Swamp

A total of 37 species, including eight priority Coastal Plain landbirds, were detected at 14 count stations (Table 2, Fig. 7). Other priority species that were encountered in the Green Swamp but not detected during point counts include: common nighthawk (*Chordeiles minor*), eastern kingbird (*Tyrannus tyrannus*), and yellow-billed cuckoo (*Coccyzus americanus*). Because of the small sample size, no further analysis was performed at this time.

Breeding Bird Survey (BBS)

The BBS is a long-term, large-scale, international avian monitoring program initiated to track the status and trends of North American bird populations. Two BBS routes were completed in Craven/Pamlico/Beaufort Counties and Jones/Onslow, NC in May and June 2010, respectively. Data has been submitted to the USGS Patuxent Wildlife Research Center.

Monitoring Avian Productivity and Survivorship (MAPS)

The MAPS program is a continent-wide network of constant-effort mist netting stations operated cooperatively by public agencies, private organizations, and independent banders (DeSante et al. 2010). The resulting banding data provides critical information relating to the ecology, conservation, and management of North American landbird populations.

In collaboration with The Nature Conservancy, a MAPS banding station was established at the Myers-Clemmons tract within the Green Swamp Ecological Preserve. The station consisted of tens mist nets operated once every ten days from May 14-August 3, 2010. This site is characterized by several limestone ponds bordered by a dense hardwood understory and surrounded by longleaf pine savannah. An additional three nets were set up in five different locations on June 29 and 30 and July 9, 2010 near a borrow pit at the northern extent of the preserve to evaluate capture rates along a pocosin/longleaf savannah ecotone.

Banding effort at the Green Swamp yielded 64 new captures of 20 bird species (Table 3). A total of 39 birds representing 14 species (four priority) were captured at the Myers-Clemmons site, while 25 birds representing six species (one priority) were caught near the borrow pit. The high number of individuals captured near the borrow pit in such a short time period makes this area an attractive, and possibly alternative, site for future MAPS banding.

Red-cockaded Woodpecker (RCW) management and Safe Harbor program

The NC wildlife diversity biologist assisted with RCW cavity tree status surveys, artificial cavity insertion, and pre-burning cavity maintenance at Holly Shelter Game Land. RCW habitat models currently being developed in the Onslow Bight region by an independent consulting firm will be evaluated as a means to identify the most suitable RCW habitat in the southeast coastal plain to seek out for enrollment in Safe Harbor agreements.

Regional conservation partnerships and planning efforts

The Cape Fear Arch Conservation Collaboration and Onslow Bight Conservation Forum are multi-agency partnerships committed to protecting the ecologically rich plant and animal diversity of North Carolina's coastal plain. The NCWRC wildlife diversity biologist attended two Cape Fear Arch committee workshops to discuss focus area champions and conservation agendas, as well as two Onslow Bight RCW sub-committee meetings focused on management decisions related to RCW translocation efforts and habitat models. The wildlife diversity biologist also delivered a presentation of priority NC landbird species to municipality representatives at a Green Growth Toolbox meeting in New Hanover County.

B. Target Dates for Achievement and Accomplishment

Coastal landbird surveys and monitoring were limited in 2010 due to a change in personnel. A full-time wildlife biologist began work on April 15 after an eight month vacancy. A more comprehensive series of surveys is currently being developed for future landbird monitoring in the coastal plain.

C. Significant Deviations

The scale of surveys, monitoring, management, and research conducted during the period was certainly diminished from that which was initially planned, due to loss of personnel; however activities described above demonstrate that the scope of activities was not, nor does the reduction in effort exceed 10% of the grant total.

D. Remarks

None

E. Recommendations

The N.C. Wildlife Action Plan (NCWAP) explicitly states the need for long-term monitoring to establish baseline data for estimating population status and distribution of each priority bird species. Birds are considered one of the most effective indicators of environmental health and biodiversity because they are easy to detect, can be monitored efficiently with a single protocol, and occupy a widely distributed variety of habitat types (Gregory 2003, Hutto 2005). They also represent a taxa admired by a growing group of citizen scientists who are increasingly investing their time to help expand many conservation and research agendas (e.g. Christmas Bird Count, Nightjar Survey Network).

Most bird management and conservation initiatives throughout the United States rely on distribution and status data derived from the USGS North American Breeding Bird Survey (BBS) program. Although the BBS has produced valuable continent-wide population information, the reliability of its scope and methodology has been questioned at smaller scales for secluded habitats not sufficiently surveyed by 3 minute, roadside counts that lack fine-scale habitat measurements. Consequently, land managers concerned with bird populations at local or regional scales are unable to effectively manage habitat for many species.

It is therefore recommended that robust long-term monitoring begin in the Coastal Plain ecoregion to begin accumulating baseline data and provide managers and decision makers with: (1) current landbird breeding and wintering distribution maps, (2) trends in landbird abundance, and (3) identity of areas in need of targeted, in-depth research of imperiled species. This information would be gathered through the implementation of four major activities:

(1) Long-term monitoring at fixed locations
(2) Microhabitat sampling
(3) Land use effects monitoring
(4) Predictive modeling using Geographic Information Systems

Methodologies should be developed from existing long-term monitoring programs (Howe et al. 1997, Downes et al. 2000, Hutto and Young 2002, Young et al. 2006, Lambert et al. 2009), which will help minimize error and bias, increase productivity, and reduce costs. Monitoring locations within Natural Heritage Areas should be randomly stratified within habitats among the 16 coastal plain habitats outlined in the NCWAP to ensure that they are situated in priority areas not currently being monitored by an existing program. Furthermore, surveys must include some measure of detectability, such as distance sampling and repeated visits, to enhance data quality (Fancy and Sauer 2000).

Data derived from this research will help drive specific management decisions, including: (1) setting population or habitat conservation targets, (2) deciding whether to give a species special protection, (3) designing a strategy to reverse undesirable trends, (4) deciding which habitats to

protect, and (4) evaluating and improving existing projects (Bart and Ralph 2005). Lastly, it will serve as the basis for a Coordinated Bird Monitoring (CBM) Program (Bart and Ralph 2005) in the coastal plain, and ideally, North Carolina.

F. Estimated Cost

$37,297 (including in-kind and other non-federal match)

G. References

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TABLE 1. Birds detected at 80 point count stations conducted during June 2010 in Holly Shelter Game Land. Bold type indicates NC Coastal Plain priority species.

Common name	Scientific name	No. detected
Acadian Flycatcher	*Empidonax virescens*	12
American Crow	*Corvus brachyrhynchos*	26
Bachman's Sparrow	***Aimophila aestivalis***	18
Blue Grosbeak	*Passerina caerulea*	5
Blue Jay	*Cyanocitta cristata*	4
Blue-gray Gnatcatcher	*Polioptila caerulea*	2
Brown-headed Cowbird	*Molothrus ater*	31
Brown-headed Nuthatch	***Sitta pusilla***	7
Carolina Chickadee	*Poecile carolinensis*	10
Carolina Wren	*Thryothorus ludovicianus*	59
Chipping Sparrow	*Spizella passerina*	2
Common Nighthawk	***Chordeiles minor***	6
Common Yellowthroat	*Geothlypis trichas*	178
Downy Woodpecker	*Picoides pubescens*	5
Eastern Bluebird	*Sialia sialis*	2

Eastern Kingbird	***Tyrannus tyrannus***	4
Eastern Towhee	*Pipilo erythrophthalmus*	124
Eastern Wood-Pewee	***Contopus virens***	12
Fish Crow	*Corvus ossifragus*	2
Gray Catbird	*Dumetella carolinensis*	33
Great Crested Flycatcher	*Myiarchus crinitus*	32
Green Heron	*Butorides virescens*	6
Hooded Warbler	***Wilsonia citrina***	7
Indigo Bunting	*Passerina cyanea*	38
Louisiana Waterthrush	*Seiurus motacilla*	1
Mourning Dove	*Zenaida macroura*	20
Northern Bobwhite	***Colinus virginianus***	21
Northern Cardinal	*Cardinalis cardinalis*	43
Northern Flicker	***Colaptes auratus***	11
Northern Mockingbird	*Mimus polyglottos*	2
Northern Parula	*Parula americana*	1
N. Rough-winged Swallow	*Stelgidopteryx serripennis*	1
Ovenbird	*Seiurus aurocapilla*	1
Pine Warbler	*Dendroica pinus*	24
Prairie Warbler	***Dendroica discolor***	17
Prothonotary Warbler	*Protonotaria citrea*	2
Red-cockaded Woodpecker	***Picoides borealis***	2
Red-eyed Vireo	*Vireo olivaceus*	3
Red-headed Woodpecker	***Melanerpes erythrocephalus***	4
Red-shouldered Hawk	*Buteo lineatus*	3
Red-tailed Hawk	*Buteo jamaicensis*	2
Summer Tanager	*Piranga rubra*	1
Swainson's Warbler	***Limnothlypis swainsonii***	3
Tufted Titmouse	*Baeolophus bicolor*	4
Turkey Vulture	*Cathartes aura*	7
White-eyed Vireo	*Vireo griseus*	32
Worm-eating Warbler	***Helmitheros vermivorum***	3
Yellow-billed Cuckoo	***Coccyzus americanus***	5
Yellow-breasted Chat	*Icteria virens*	11
Yellow-throated Vireo	*Vireo flavifrons*	1
Yellow-throated Warbler	*Dendroica dominica*	3
	Total	**853**

TABLE 2. Birds detected at 14 point count stations conducted during June 2010 in the Green Swamp. Bold type indicates NC Coastal Plain priority species.

Common name	Scientific name	No. detected
American crow	*Corvus brachyrhynchos*	2
Bachman's sparrow	***Aimophila aestivalis***	8
Blue-gray gnatcatcher	*Polioptila caerulea*	1
Brown-headed cowbird	*Molothrus ater*	1
Brown-headed nuthatch	***Sitta pusilla***	11
Blue grosbeak	*Passerina caerulea*	2
Blue jay	*Cyanocitta cristata*	1
Broad-winged hawk	*Buteo platypterus*	1
Carolina chickadee	*Poecile carolinensis*	1
Carolina wren	*Thryothorus ludovicianus*	14
Chipping sparrow	*Spizella passerina*	1
Common yellowthroat	*Geothlypis trichas*	9
Downy woodpecker	*Picoides pubescens*	2
Eastern bluebird	*Sialia sialis*	2
Eastern towhee	*Pipilo erythrophthalmus*	20
Eastern wood-pewee	***Contopus virens***	7
Fish crow	*Corvus ossifragus*	2
Great crested flycatcher	*Myiarchus crinitus*	8
Green heron	*Butorides virescens*	1
Indigo bunting	*Passerina cyanea*	10
Mourning dove	*Zenaida macroura*	8
Northern bobwhite	***Colinus virginianus***	13
Northern cardinal	*Cardinalis cardinalis*	16
Northern flicker	***Colaptes auratus***	10
Northern mockingbird	*Mimus polyglottos*	3
Pine warbler	*Dendroica pinus*	15
Pileated woodpecker	*Dryocopus pileatus*	6
Prairie warbler	***Dendroica discolor***	1
Prothonotary warbler	*Protonotaria citrea*	4
Red-bellied woodpecker	*Melanerpes carolinus*	4
Red-headed woodpecker	***Melanerpes erythrocephalus***	8
Summer tanager	*Piranga rubra*	1
Tufted titmouse	*Baeolophus bicolor*	6
Turkey vulture	*Cathartes aura*	1
White-eyed vireo	*Vireo griseus*	4
Yellow-billed cuckoo	***Coccyzus americanus***	4
Yellow-throated warbler	*Dendroica dominica*	2
	Total	**210**

TABLE 3. Birds captured at two locations at Green Swamp Ecological Preserve during the 2010 breeding season. BOPI = borrow pit, MYCL = Myers-Clemmons. Bold type indicates NC Coastal Plain priority species.

Common name	Location	New	Unbanded
Carolina chickadee	BOPI	1	-
Carolina wren	BOPI	1	1
Common yellowthroat	BOPI	12	-
Eastern towhee	BOPI	1	-
Northern cardinal	BOPI	1	-
Prairie warbler	**BOPI**	9	-
Bachman's sparrow	**MYCL**	1	-
Blue-gray gnatcatcher	MYCL	1	-
Carolina chickadee	MYCL	3	-
Carolina wren	MYCL	5	-
Eastern bluebird	MYCL	2	-
Eastern towhee	MYCL	1	-
Eastern wood peewee	**MYCL**	1	-
Eastern tufted titmouse	MYCL	3	-
Great crested flycatcher	MYCL	3	-
Northern cardinal	MYCL	9	-
Prothonotary warbler	MYCL	6	-
Red-headed woodpecker	**MYCL**	3	-
Ruby-throated Hummingbird	**MYCL**	-	1
Summer tanager	MYCL	1	-
	Total	**64**	**2**

TABLE 4. Mean values (± SD) of landscape metrics at locations used by five NC Coastal Plain priority species in Holly Shelter Game Land. Landscape metrics were used as predictor variables in Mahalanobis distance habitat modeling of available habitat in HSGL.

Common name	Slope (◦)	Aspect[1]	Elevation (m)	Canopy cover (%)	Longleaf pine (%)	Hrdwd Swamp (%)	Pocosin (%)	Variety[2]
Bachman's sparrow (*n* = 18)	0.8 ± 0.3	1.0 ± 0.0	13.1 ± 2.5	48.0 ± 12.8	59.9 ± 28.0	2.9 ± 4.5	26.9 ± 25.7	5.8 ± 1.8
Eastern wood pewee (*n* = 12)	0.8 ± 0.4	1.0 ± 0.0	12.5 ± 3.4	54.6 ± 15.7	62.7 ± 36.7	1.1 ± 3.2	26.4 ± 39.2	3.9 ± 1.5
Northern bobwhite (*n* = 21)	0.9 ± 0.3	1.0 ± 0.0	13.1 ± 2.7	49.8 ± 19.6	28.2 ± 33.0	6.4 ± 19.9	39.5 ± 44.1	6.1 ± 2.3
Northern flicker (*n* = 11)	0.8 ± 0.2	1.0 ± 0.0	13.8 ± 2.4	48.2 ± 12.0	49.3 ±35.7	5.2 ± 9.6	27.0 ± 31.9	5.4 ± 2.1
Prairie warbler (*n* = 17)	0.8 ± 0.4	1.0 ± 0.0	10.9 ± 1.9	63.0 ± 7.6	12.6 ± 20.9	12.4 ± 29.8	67.3 ± 34.4	5.1 ± 1.7

[1] transformed: 1 + cos(45-aspect)
[2] total number of land cover classes within 100 m radius of cell.

FIG. 1. Point counts conducted in Holly Shelter Game Land, June 2010. Species richness was significantly higher ($P < 0.001$) in the southern half.

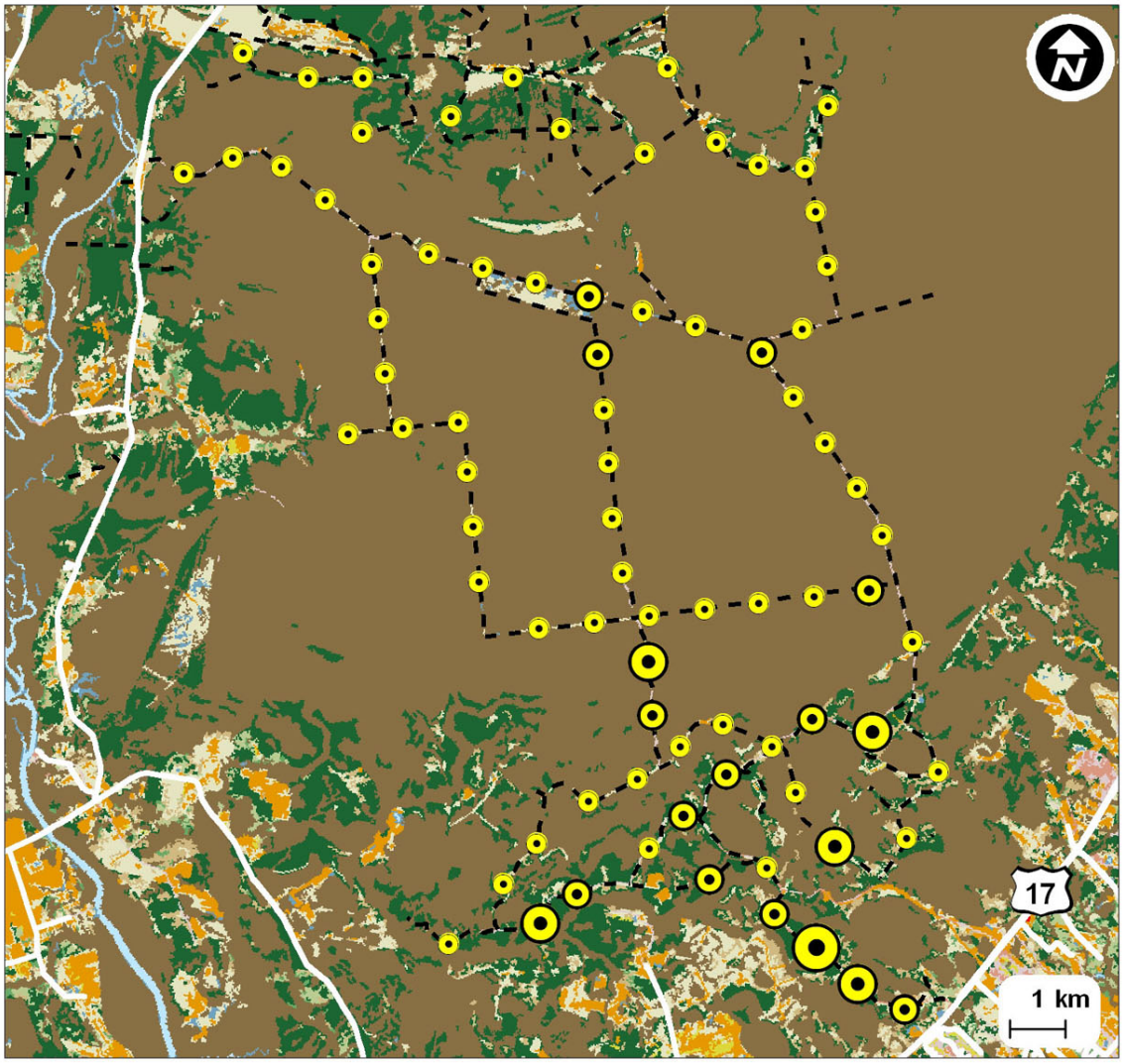


FIG. 2. Predictive model of Bachman's sparrow habitat in Holly Shelter Game Land based on Mahalanobis distance (transformed to Chi-square *p*-values) and presence data derived from point counts. Higher *p*-values indicate more suitable habitat.

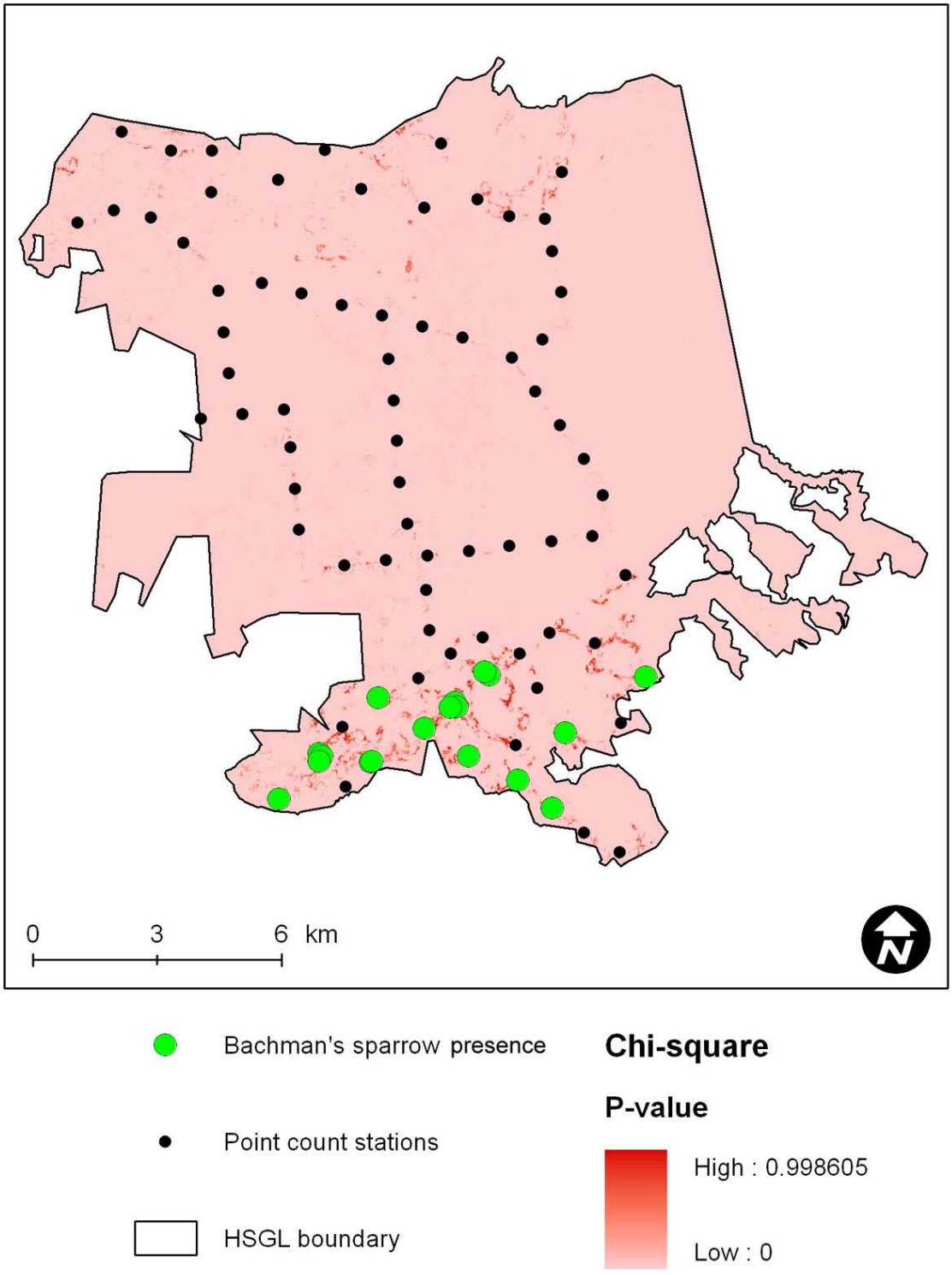


FIG. 3. Predictive model of eastern wood pewee habitat in Holly Shelter Game Land based on Mahalanobis distance (transformed to Chi-square *p*-values) and presence data derived from point counts. Higher *p*-values indicate more suitable habitat.

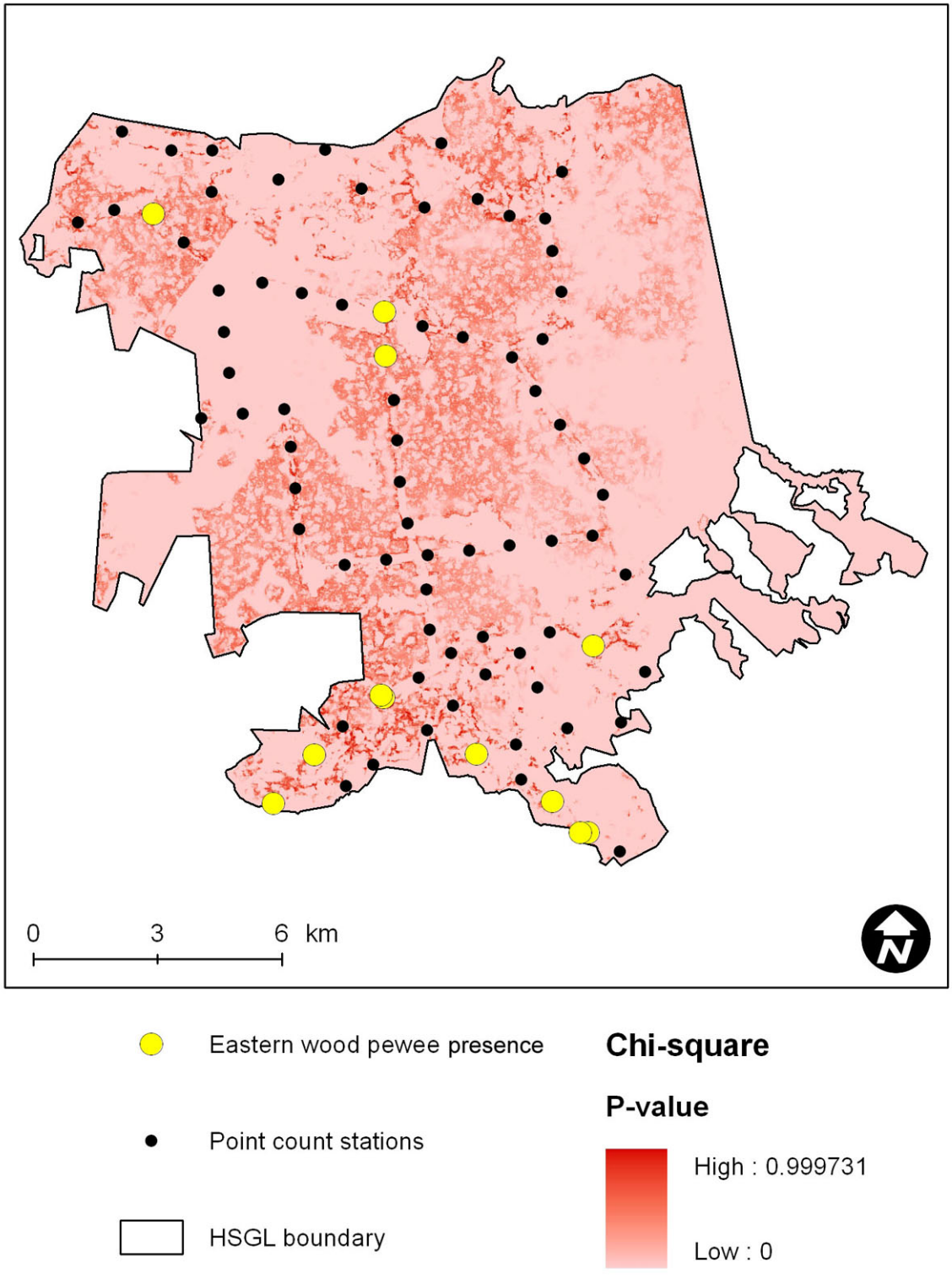


FIG. 4. Predictive model of northern bobwhite habitat in Holly Shelter Game Land based on Mahalanobis distance (transformed to Chi-square *p*-values) and presence data derived from point counts. Higher *p*-values indicate more suitable habitat.

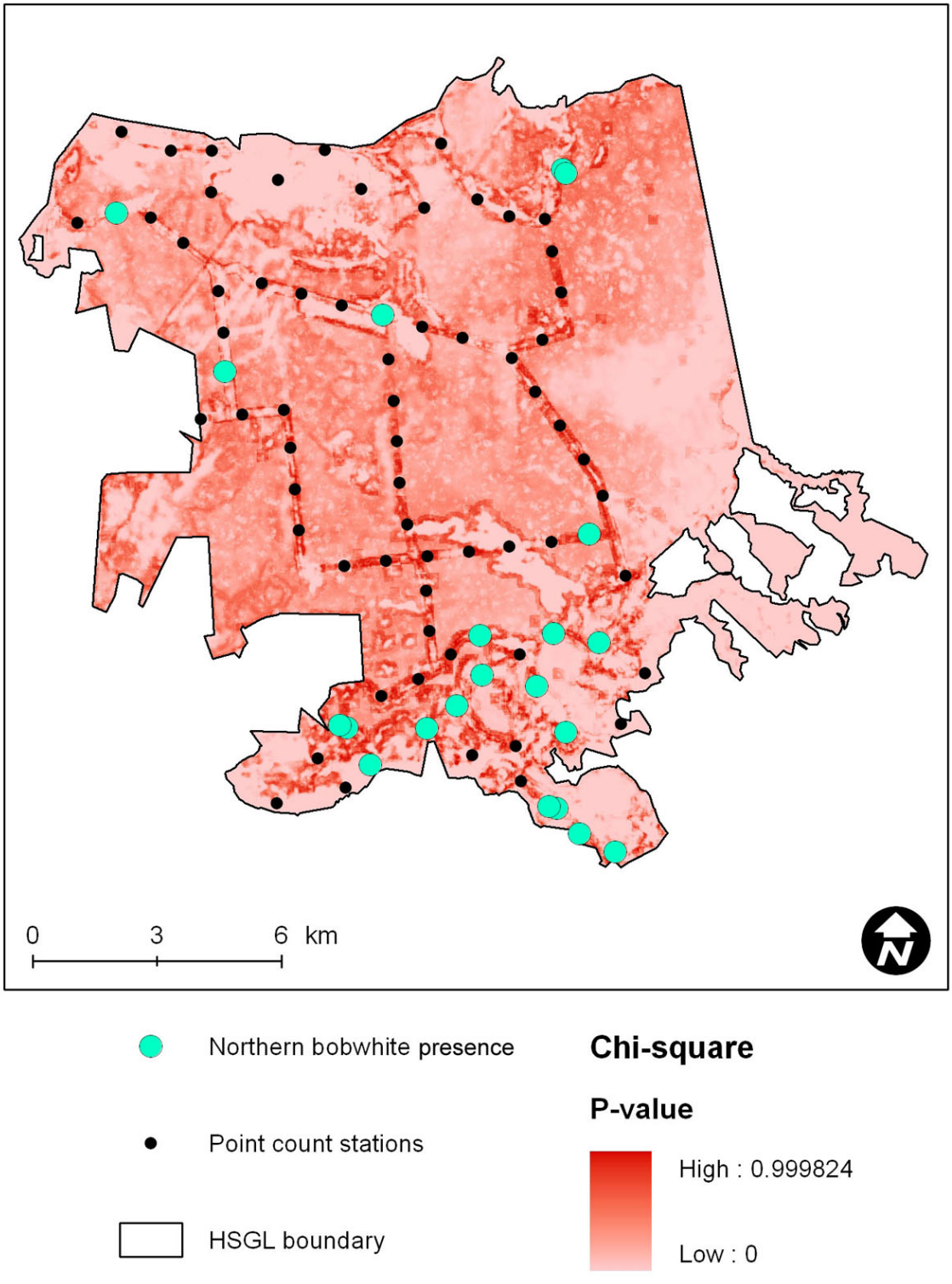


FIG. 5. Predictive model of northern flicker habitat in Holly Shelter Game Land based on Mahalanobis distance (transformed to Chi-square *p*-values) and presence data derived from point counts. Higher *p*-values indicate more suitable habitat.

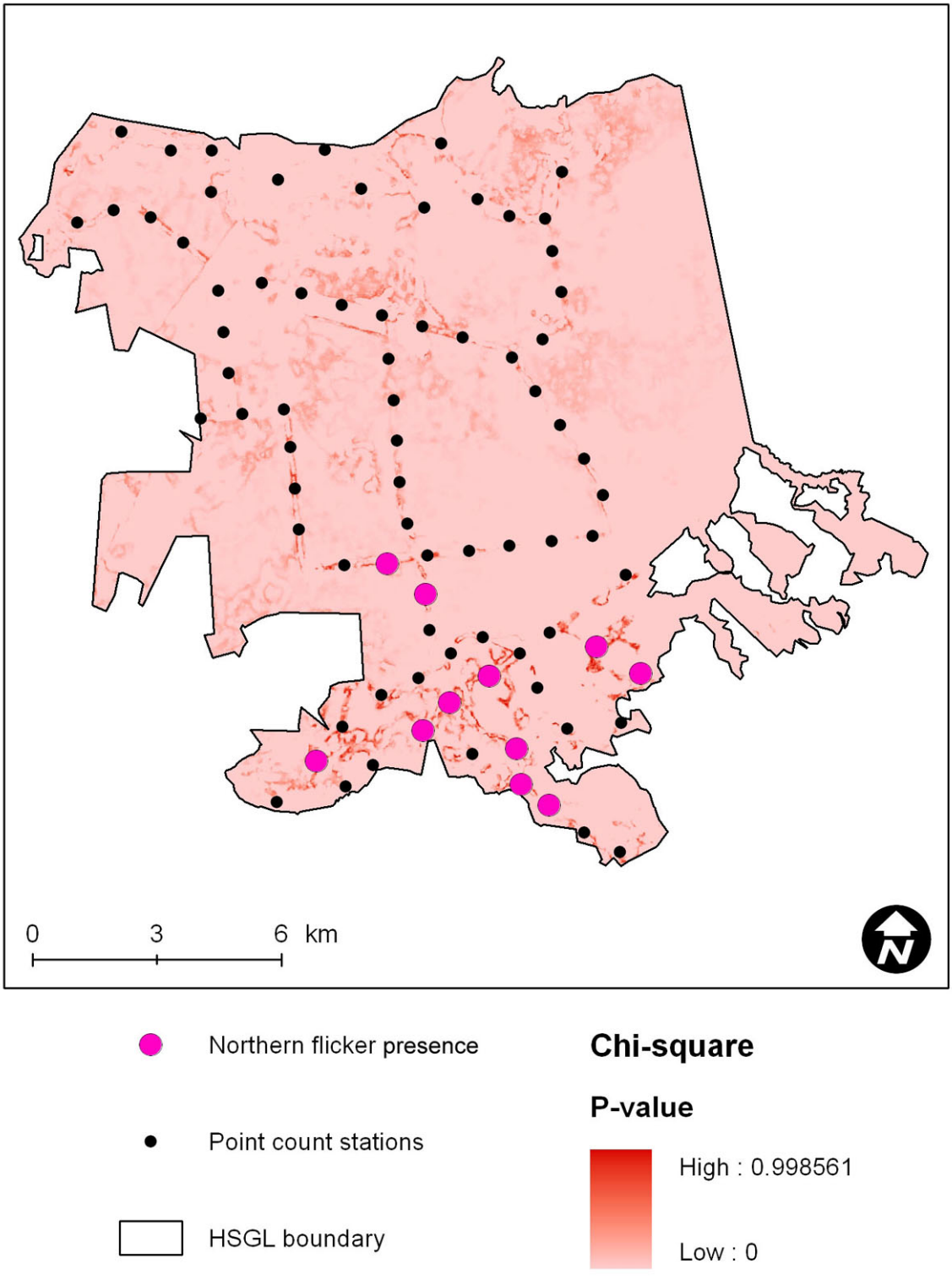


FIG. 6. Predictive model of prairie warbler habitat in Holly Shelter Game Land based on Mahalanobis distance (transformed to Chi-square *p*-values) and presence data derived from point counts. Higher *p*-values indicate more suitable habitat.

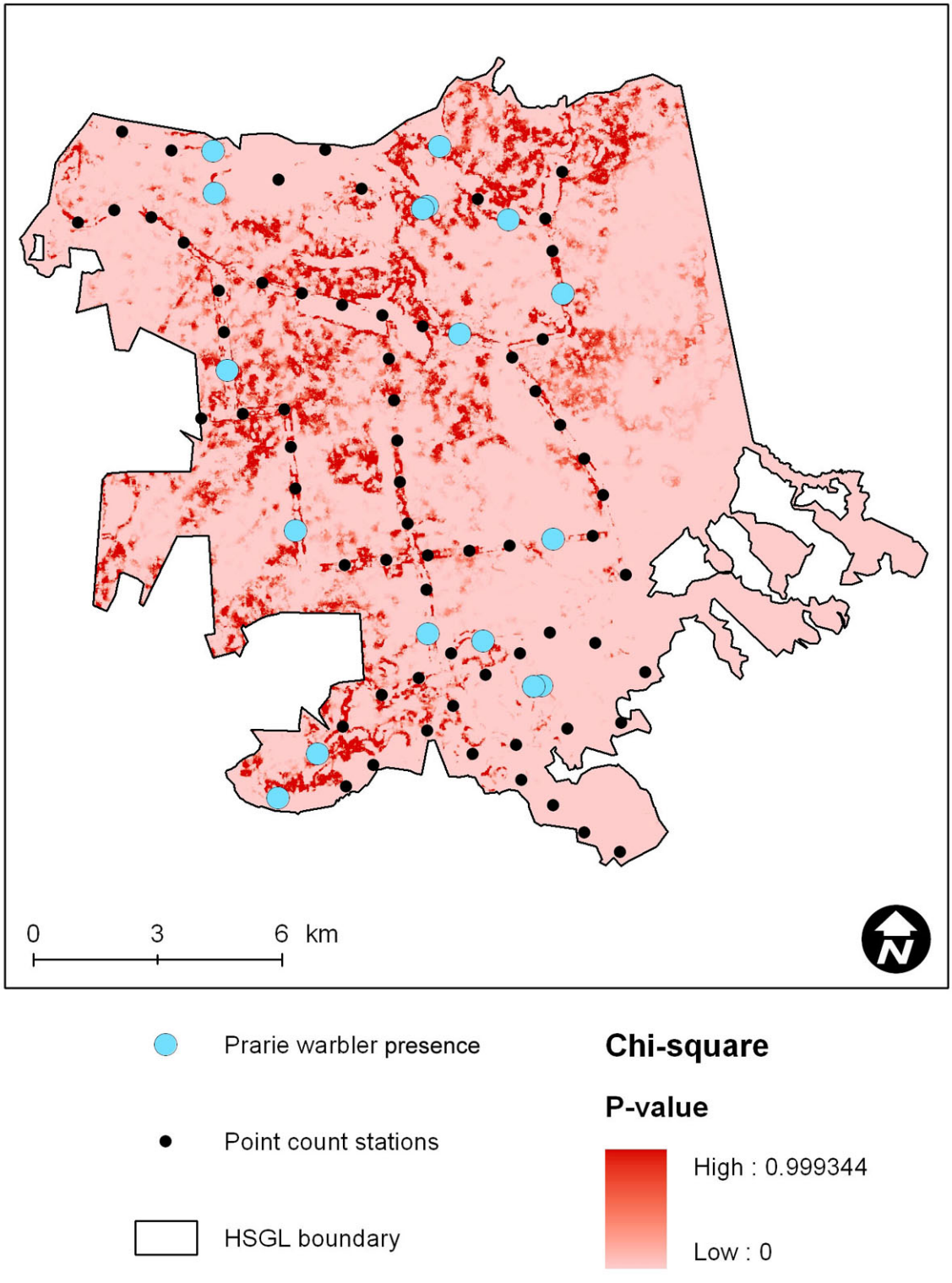
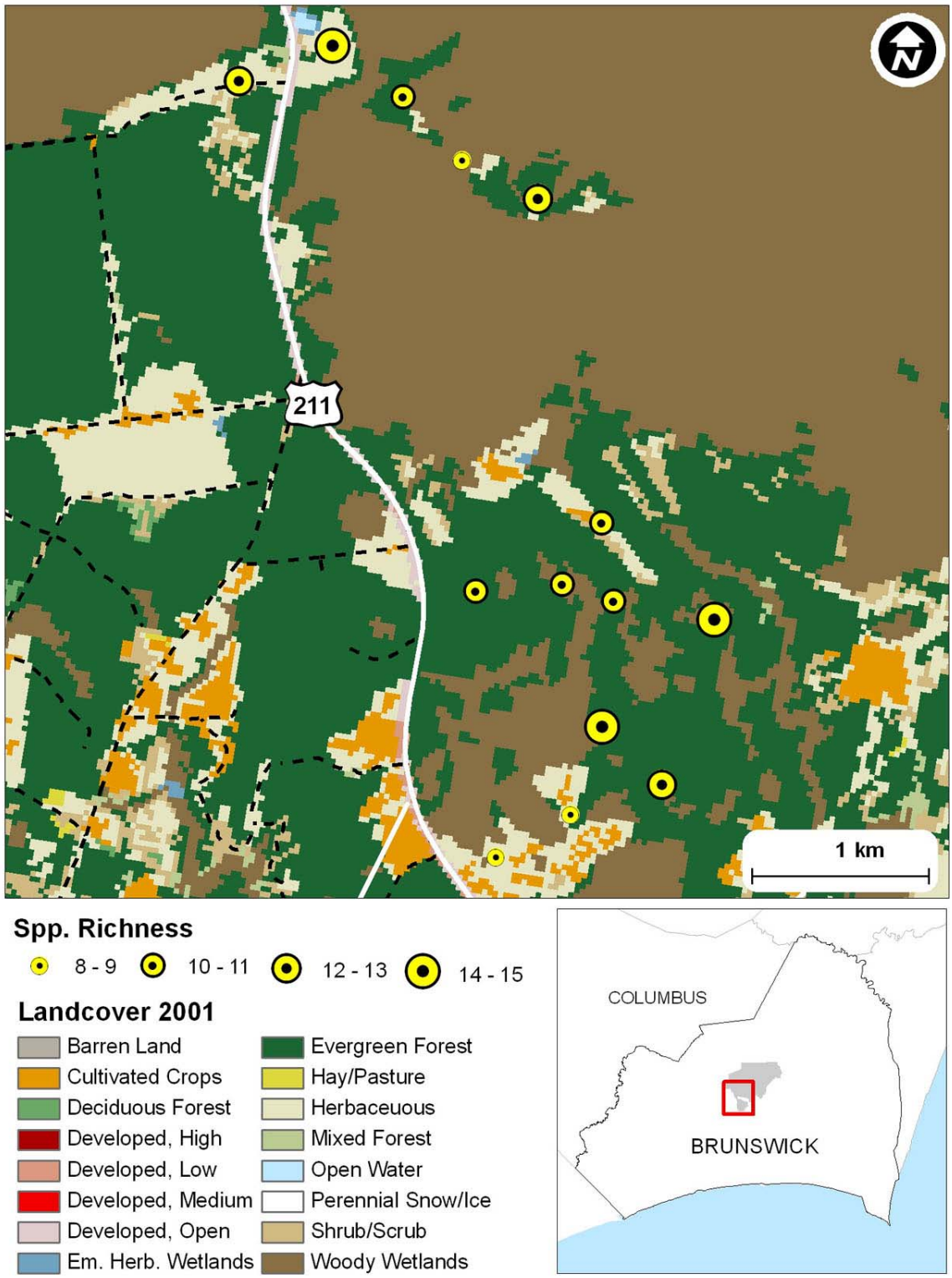


FIG. 7. Point counts conducted in Green Swamp Ecological Preserve, June 2010.



Final Performance Report

State: North Carolina **Project Number:** T – 11 -P

Period Covered: July 1, 2009 – August 31, 2010

Grant Title: State Wildlife Grants 07-Wildlife Management

Project Title: Western Region Amphibian Conservation

Objectives:
Given the need to study the distribution and status of numerous species, this project has the following five primary objectives, as discussed in the NC Wildlife Action Plan (2005):

1. Compile existing, available information from all sources (e.g., state, federal, universities, and private individuals) regarding the current status of amphibian species in western North Carolina (pgs. 457-458, 461-462)
2. Conduct baseline inventories to locate and assess populations of target species (pgs. 457-458)
3. Conduct long-term monitoring and applied research studies of target species communities and their habitats (pgs.457-460)
4. Survey for common, though poorly documented amphibians, to assess their populations and trends (pgs. 457-458)
5. Provide information regarding the status and distribution of amphibians (technical guidance) and habitat conservation priorities to state and federal agencies and other organizations/individuals (pgs. 459-463).

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 currently 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 provide important data and a means to control data acquisition and impacts of collection on local populations. Technical guidance 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 and area-constrained day searches of natural and artificial cover objects in

terrestrial and aquatic habitats, nighttime searches of surface-active salamanders, egg mass counts and nest searches, and auditory surveys (Heyer et al. 1994; Dodd 2010).

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 a. alleganiensis	Eastern 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

During this reporting period, at least 60 aquatic surveys by staff, volunteers, and project partners resulted in a new site and county record for Mole Salamander in a roadside retention pool (Transylvania County), updates of one historical record and documentation of one new record for Common Mudpuppy (Henderson and Ashe Counties), and updates of 19 historical stream records for Eastern Hellbender in eight counties. For hellbender surveys, 50 different survey locations in 26 different river systems represented all five mountain river basins that drain to the Gulf of Mexico. Surveys resulted in documenting three new hellbender streams, two in the New River basin (Ashe County) and one in the Little Tennessee River basin (Macon County). Additionally, trapping efforts by a local high school 4H club resulted in an update of a historical hellbender record in the French Broad River that was over 30 years old (Transylvania County). Despite intensive survey efforts, no hellbenders were found in four streams where they occurred historically (Macon, Swain, Ashe, and Watauga Counties).

Reports of incidental Eastern Hellbender sightings by anglers and private landowners continue to be a valuable source of information. These reports provided four confirmed records (including one new stream that had never been documented for hellbenders). However, surveys conducted in two streams where anecdotal, historical accounts were known resulted in no confirmed hellbender records (Watauga County).

High-Elevation Salamanders

Staff continued efforts started in 2009 to inventory and monitor salamander communities in high-elevation forests. During this reporting period, staff and volunteers documented new sites along the Blue Ridge Parkway and in Pisgah National Forest for two target species: Pigmy Salamander (four sites, Buncombe and Yancey Counties) and Santeetlah Dusky Salamander (three sites, Jackson County). Limited searches for Weller's Salamander in Pisgah National Forest (Yancey County) were conducted at a small site where a privately-owned weather tower is to be constructed, but no target salamanders were found at that location.

Rock Outcrop Salamanders

Several target salamander species dwell in suitable rock outcrop habitat. Three of these species occur in the Hickory Nut Gorge of northwestern Rutherford and northeastern Henderson Counties: Green Salamander, Crevice Salamander, and Blue Ridge Gray-cheeked Salamander (considered rare but not a priority at this time). During the reporting period, staff and volunteers documented eight new sites for Crevice Salamander, one new site for Blue Ridge Gray-cheeked Salamander, and one new site for Green Salamander in the Hickory Nut Gorge.

Green Salamanders also occur in the Southern Blue Ridge area of Henderson, Transylvania, Jackson, and Macon Counties; the population of Green Salamanders in this area is disjunct from that in the Hickory Nut Gorge, but the gap is closing with the addition of 12 "bridge" sites from southwestern Henderson County toward central Henderson County near the town of Flat Rock (Figure 1).

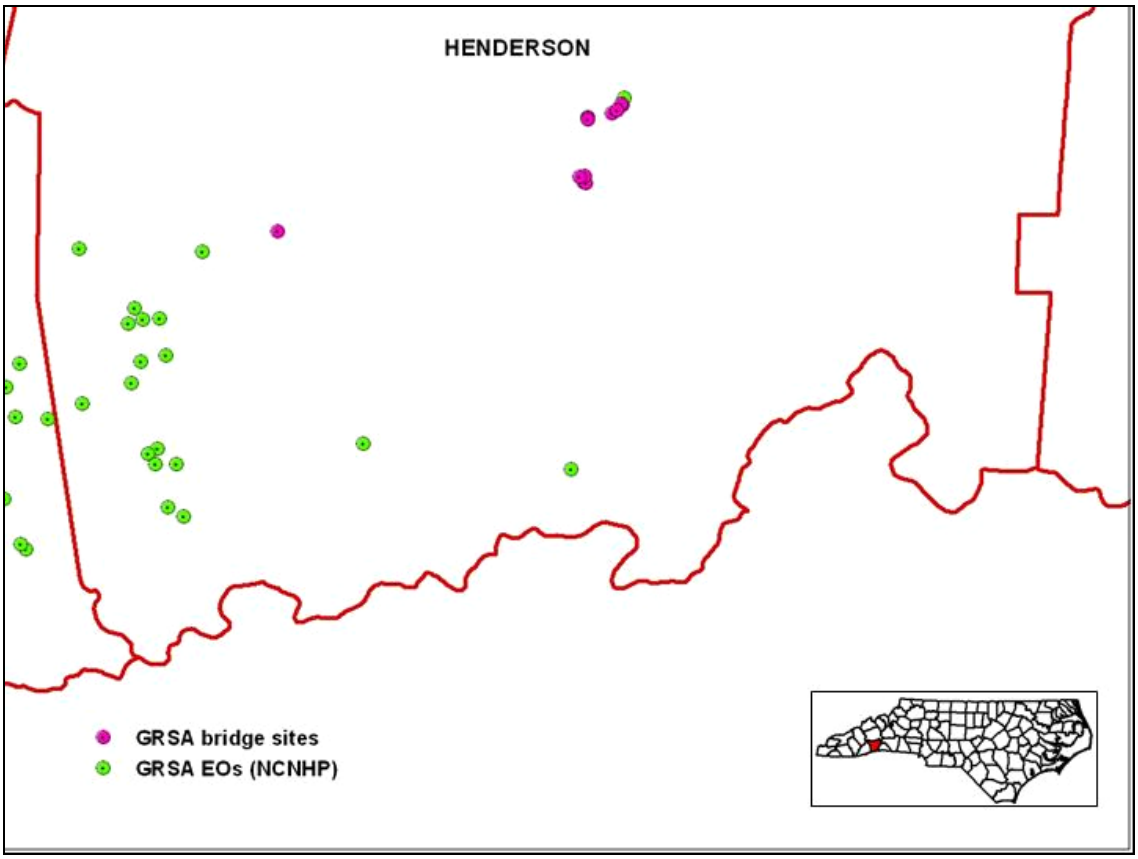


Figure 1. Green Salamander (*Aneides aeneus*) historical NCNHP Elements of Occurrence (EOs) and new "bridge" sites documented in FY 2009-2010, Henderson County, NC.

Southwestern Henderson and southeastern Transylvania Counties continue to demonstrate the greatest concentration of known Green Salamander locations and potential suitable habitat in the state. Over 100 new, occupied patch habitats were documented in this area last year.

Another noteworthy result of Green Salamander surveys came from discovering a new population in southern Transylvania County on what is known as the "Headwaters" tract (~8,000 acres), the largest privately-owned, contiguous forest in the NC mountain region. Staff confirmed three locations of Green Salamanders on a small section of the property last spring, which should help future conservation efforts in this area. These records are significant because they occur in a distribution gap in south-central Transylvania County (Figure 2.)

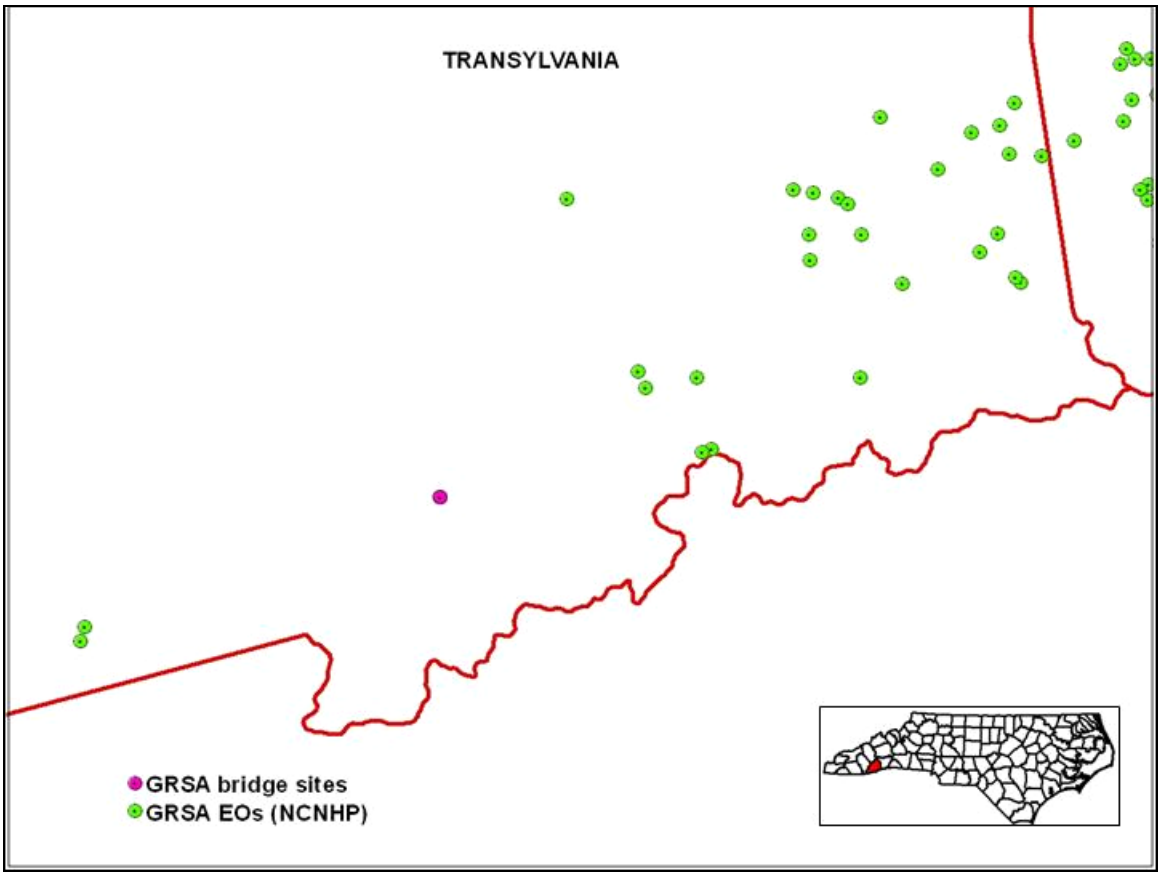


Figure 2. Green Salamander (*Aneides aeneus*) historical NCNHP Elements of Occurrence (EOs) and new "bridge" sites documented in FY 2009-2010, Transylvania County, NC.

Other efforts with Green Salamanders include applied research to examine effects of prescribed fire on Green Salamander habitats and populations on state forest in Henderson and Transylvania Counties. The study consists of examining 80 randomly-chosen Green Salamander sites (40 burn, 40 control), on 11 burn units totaling ~880 acres. Multiple, pre-burn surveys to identify occupied sites in treatment units occurred in 2009 and 2010, resulting in over 50 newly documented sites. In August 2010, staff and volunteers monitored 9 Green Salamander nests found in these study sites; all nests but one contained viable eggs and produced hatchlings. Microclimate and general habitat characteristics were measured such as relative humidity and temperature in suitable rock crevices and overhead canopy cover. Staff and volunteers recorded other general site and landscape-level parameters such as slope, aspect, and forest stand composition, and downloaded on-site weather station data. Initial analyses of these data are on-going.

Multiple surveys at the study sites will take place in October-November each year to assess seasonal occupancy rate and detection probability (Thompson 2004). Salamanders that can easily and safely be extracted from rock crevices will be measured, weighed, and photographed for their unique dorsal color patterns, as a way to "mark" individuals to estimate population size and survivorship (Dodd 2010). Habitat co-variates and environmental data will be monitored

post-burn for several years, along with species detection probabilities and occupancy rates, to examine effects of prescribed fire on this species and its habitat.

In spring 2010 staff initiated a pilot study to track movements of Green Salamanders in rock and arboreal habitat using a harmless, fluorescent powder and a UV lamp ("blacklight") (Graeter et al. 2008). The afternoon before a forecasted evening rain event, staff extracted two salamanders from different sites. The salamanders were marked with the powder and then put back in their crevices. One salamander never demonstrated any noticeable movement (i.e., did not leave any trace of fluorescent powder outside its crevice) in 3 consecutive night surveys (~1-2 hours after dark) and the following mornings (~1 hour before dawn); habitat conditions were moist, humid, and foggy each night, so seemingly ideal for activity. On the first night, the second salamander moved vertically up its rock face approximately 6 feet, then climbed onto a rhododendron branch that was touching the rock, and had continued up the rhododendron stem another 5-6 feet when it was observed after 10 pm (Figure 3). The next morning before dawn, it was found back in its home crevice, where it seemed to remain for the rest of the 3-day study period. This study will be expanded in the future, as time and personnel allow, examining how this species uses available rock and woody stem habitat spatially.

Figure 3. Green Salamander (*Aneides aeneus*) on a rhododendron (12 ft above ground), leaving traces of UV fluorescent powder during nighttime movements, May 6, 2010, Transylvania County, NC.

Other Priority Salamanders

Staff and volunteers documented the continued presence of 7 target species at 11 different historical sites and 3 new, or previously unreported, sites (Table 2). Observations of common species were recorded and will be used in the future to monitor salamander communities over time.

To begin examining Junaluska Salamander upland habitat use in the Cheoah River corridor (Graham County), staff installed new coverboard stations at three locations in spring 2010. No priority species have been found in initial surveys.

Table 2. North Carolina Wildlife Resources Commission selected results for several target salamander species from mountain region surveys, July 2009-August 2010.

TARGET SPECIES OBSERVED	COMMON NAME	SAMPLING METHODS USED	SITE(S) AND COUNTY
Ambystoma maculatum	Spotted Salamander	egg mass counts; coverboard surveys	Sandy Bottom Preserve (Buncombe); DuPont SF pools (Henderson); Talulah bog (Graham); Progress Energy wetland (Buncombe)*
Ambystoma talpoideum	Mole Salamander	coverboard surveys	Sandy Bottom Preserve (Buncombe)
Eurycea guttolineata	Three-lined Salamander	incidental observation	DuPont SF_Flat Rock Trail (Henderson)*
Hemidactylium scutatum	Four-toed Salamander	coverboard surveys	Sandy Bottom Preserve (Buncombe)
Plethodon richmondi	Ravine Salamander	visual encounter surveys	Mt. Jefferson SP (Ashe); Doughton Park (Wilkes)*
Plethodon shermani	Red-legged Salamander	visual encounter surveys	Wayah Crest (Macon)*; Winespring Bald (Macon); Wayah Bald (Macon); Wilson Lick (Macon); Robin Branch (Macon)
Plethodon ventralis	Southern Zigzag Salamander	coverboard surveys	Richmond Hill Park (Buncombe)

* 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 in North

Carolina were known, all in Cherokee County. In spring 2010 staff documented 18 new breeding habitats for this species (2008=8 new sites, 2009=22 new sites) for a total of 48 newly identified locations for Mountain Chorus Frog in the state within the past 3 years (Williams 2009; Williams 2010) (Figure 4). Of particular interest was the first confirmed record of this species on protected National Forest property; all other known Mountain Chorus Frog sites in the state occur on private land or in state-maintained roadside ditches. This species will continue to be monitored each spring with concerted efforts to document new sites in and around Cherokee County, with particular emphasis on National Forest property.

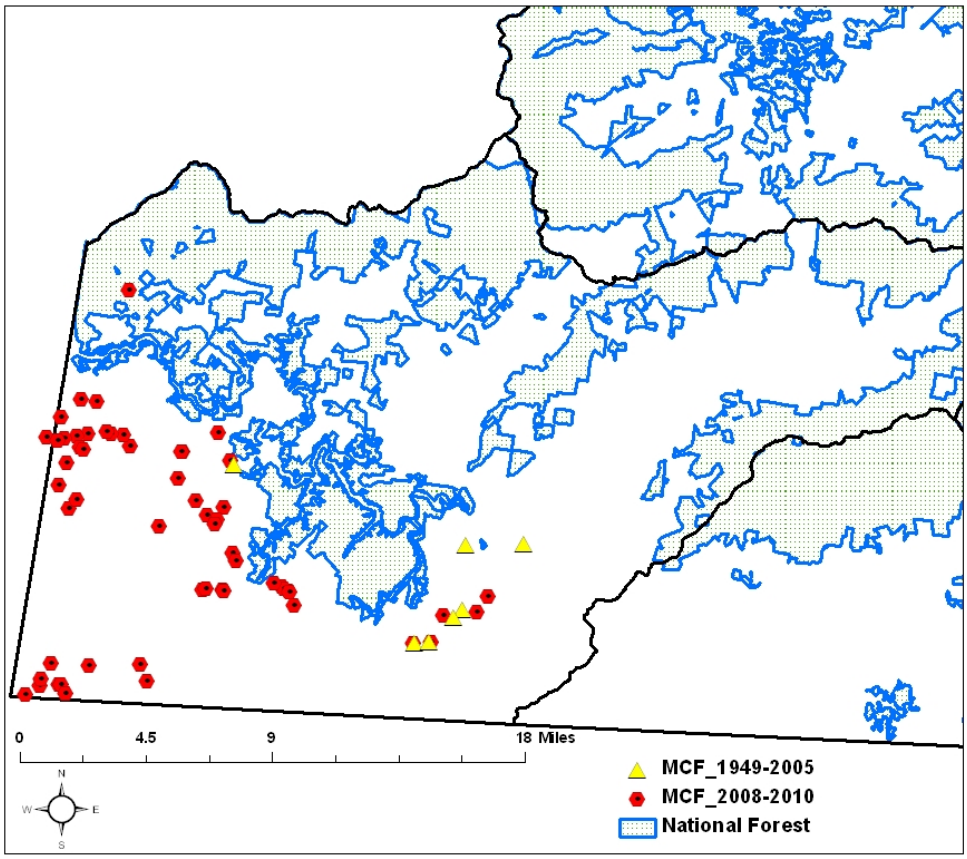


Figure 4. Historical (2005 and earlier) and recently documented occurrences (2008-2010) for Mountain Chorus Frog (*Pseudacris brachyphona*) in Cherokee County, NC, including the state's first record on National Forest.

B. Target Dates for Achievement and Accomplishment

On schedule

C. Significant Deviations

None

D. Remarks

Of increasing importance is access to private lands, particularly areas that have never been surveyed. Many new salamander records were documented during this reporting period simply by having access to private land and conducting baseline inventories. Partnerships within local communities, as well as media outreach, resulted in new connections and relationships with landowners and ultimately new records for priority species like the Green Salamander. The Wildlife Conservation Lands Program (WCLP) continues to provide new opportunities on private land that may have previously been off-limits to biologists.

E. Recommendations

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, coordination, and data sharing among researchers and other conservation partners if we hope to meet long-term project goals and objectives.

As time and resources permit, staff will seek more opportunities to partner with other agencies and other programs within the NC Wildlife Resources Commission to conduct baseline inventories on Game Lands and monitor effects of land management activities such as prescribed fire and/or silviculture on amphibian communities and habitats. Future collaborative efforts will also include creating and/or restoring wetland habitats and ephemeral pools on Game Lands to benefit amphibians and other priority species. These habitats will become much more important (and possibly rare) across the landscape as natural habitats continue to be fragmented, developed, and destroyed. Also, predicted effects of climate change could mean more intense and frequent droughts and/or floods which could alter habitats and impact populations permanently.

Regarding future surveys for Mountain Chorus Frog, efforts in 2011 will focus on the Nantahala National Forest in Cherokee County; objectives will include mapping potential breeding habitats, documenting Mountain Chorus Frog presence, comparing forested habitats to those on private lands, and providing management and conservation strategies to the US Forest Service. Since all but one known occurrence of this species is on private land vulnerable to destruction and development, it is crucial to find additional sites for this species on protected lands to ensure conservation for the future.

Salamander taxonomy continues to change. For example, a recent paper published on Pigmy Salamander taxonomy reports that two separate species exist in the North Carolina mountains: *Desmognathus wrighti* and *Desmognathus organi* (Northern Pigmy Salamander) (Crespi et al. 2010), thus naming a possible 50th salamander species for the western region if this suggested taxonomic change is adopted. 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.

F. Estimated Cost

$110,059 (including in-kind and other non-federal match)

G. References

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Final Performance Report

State: North Carolina **Project Number:** T – 11 -P

Period Covered: July 1, 2009 – August 31, 2010

Grant Title: State Wildlife Grants 07-Wildlife Management

Project Title: Western Region Bird Conservation

Objectives:

To improve our understanding of avian diversity and priority species in western North Carolina, and to enhance our ability to make conservation or management decisions via additional inventories and continued monitoring of birds on public and private lands, and via adaptive management.

A. Activity

Game land Songbird Surveys

To meet the modified project objectives, focus was shifted this year to inventories of newer game lands, while partial monitoring was carried out on other game lands to inform adaptive management. Considerable effort was invested conducting an initial inventory of the Pond Mountain tract (Ashe County), documenting 42 species, including nine Wildlife Action Plan priority species and two NC Special Concern species (Table 1). Informal surveys consisted of five minute counts at half mile intervals along the interior road system, plus woodland observations and recording of all birds seen or heard on the tract in order to develop a species list. Three Top Game Land was surveyed less intensively by noting all birds seen or heard while walking the interior road system. Several locations on Needmore Game Land first surveyed in 2009 were revisited this year. Finally, the bird list for Sandy Mush Game Land was updated with new species records compiled from records submitted by local birders and from a staff Bird Refresher day co-hosted by Wildlife Diversity and Game Lands staff. Surveys of these three game lands documented numerous Wildlife Action Plan priority species (Table 2), including American kestrels successfully nesting in recently posted nest boxes at Sandy Mush.

At Cold Mountain Game Land surveys were conducted, following the established point system layout and protocol. Thurmond Chatham points were surveyed using a 10 minute count. In order to free up time for the inventory work at Pond Mountain and Three Top, a decision was made to survey only key areas of the extensive Green River Game Land point network this year. A subset of points representing actively managed areas (timber harvest, burning) was surveyed by a volunteer and Private Lands biologist. At Green River, an incubating chuck will's widow was flushed off of a nest in thinned woods adjacent to a young clear cut.

Table 1. Species list compiled June 3, 4, and 15, 2010, Pond Mountain tract (Ashe County, NC).

American crow	Indigo bunting
American goldfinch	Least flycatcher
American robin	Mourning dove
Barn swallow	Northern bobwhite[1]
Black and white warbler	Ovenbird
Black-throated blue warbler	Pileated woodpecker
Black-throated green warbler	Red-breasted nuthatch
Blue jay	Red-eyed vireo
Blue-headed vireo	Red-tailed hawk
Brown thrasher	Rose-breasted grosbeak[1]
Canada warbler[1]	Ruffed grouse
Carolina chickadee	Scarlet tanager
Cedar waxwing	Slate-colored junco
Chestnut-sided warbler[1]	Song sparrow
Chimney swift	Turkey vulture
Chipping sparrow	Veery
Common yellowthroat	Vesper sparrow[1,2]
Eastern towhee	Wild turkey
Eastern wood pewee[1]	Winter wren
Field sparrow[1]	Yellow-bellied sapsucker[1,2]
Gray catbird	Yellow-shafted flicker[1]

[1] NC Wildlife Action Plan priority species
[2] NC Special Concern species

Table 2. Wildlife Action Plan priority species documented during *partial* inventories[1] and monitoring[2] of six western game lands, 2010.

Species	Three Top[1]	Needmore and Coweeta Bottoms[1]	Sandy Mush[1]	Green River[2]	Cold Mountain[2]	Thurmond Chatham[2]
American kestrel			X			
American woodcock			X			
Barn owl			X			
Blue winged warbler[3]			X			
Brown headed nuthatch			X			
Canada warbler	X					
Chimney swift			X			
Cooper's hawk			X			
Eastern wood pewee			X		X	X
Field sparrow		X	X	X		
Hairy woodpecker			X		X	
Hooded warbler			X	X	X	X
Kentucky warbler			X	X		
Northern bobwhite			X	X		
Orchard oriole		X	X			
Prairie warbler			X	X		
Rose breasted grosbeak	X					
Swainson's warbler		X				
Whip poor will			X			
Wood thrush	X	X	X	X	X	X
Yellow-billed cuckoo			X	X	X	
Yellow-shafted flicker			X	X		X

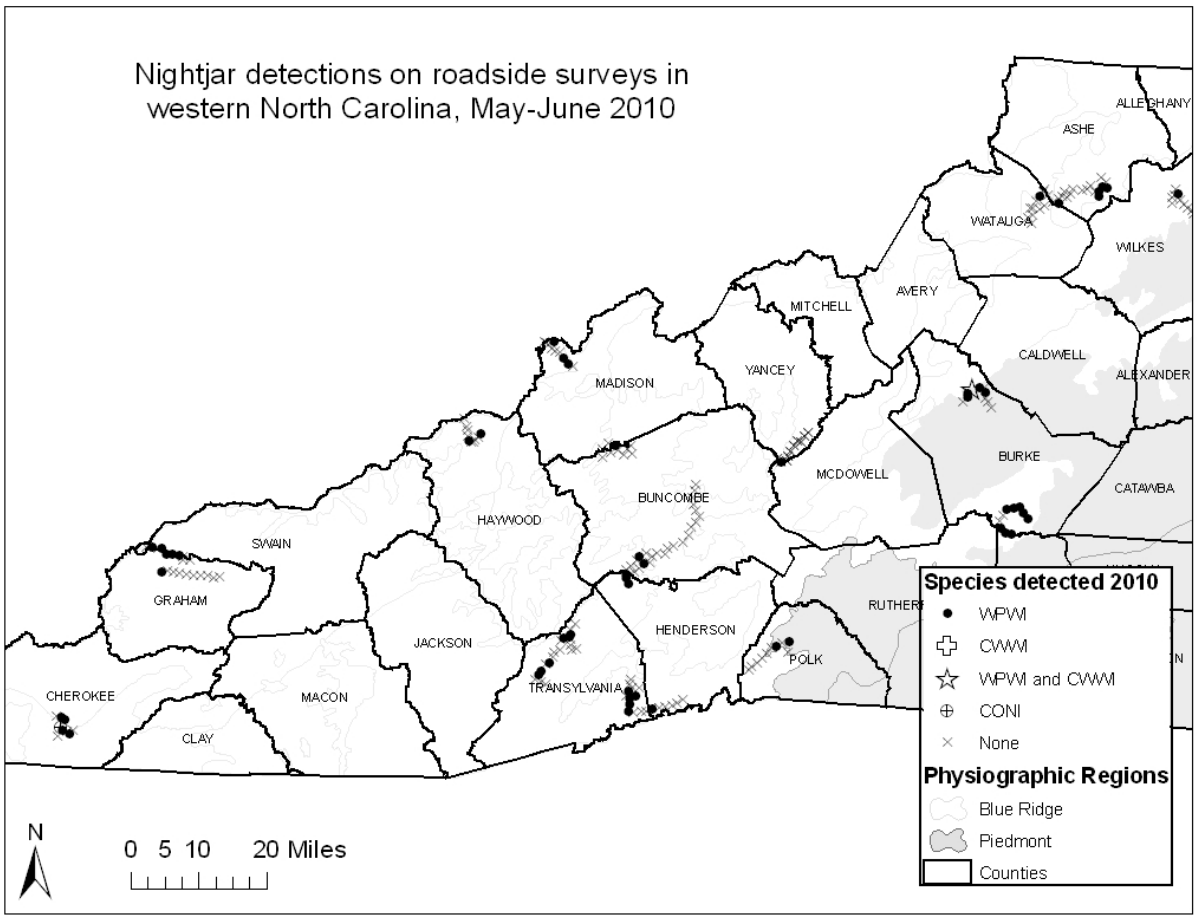
[1] partial inventory. [2] partial monitoring. [3] NC Significantly Rare species

Nightjar Survey

In an effort to address conservation of priority species, the nightjar survey was carried out again in 2010. 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.

We again used methods developed by NCWRC, the Northeast Nightjar Monitoring Program, and the Southeast U.S. Nightjar Survey (Hunt 2007, Kelly 2008). Surveys were conducted once within a 16 day window around the May 27th or June 26th, 2010 full moons. Twenty-six routes were surveyed this year in 16 counties in the Mountains, Foothills, and western Piedmont (Figure 1, Table 3). This included three new routes in the Mountains (Graham, Swain, and Cherokee Counties).

Figure 1. Nightjar detections on roadside survey routes in western North Carolina, 2010[1].



[1] Five routes, from the following counties, are not depicted: Burke, Catawba, Henderson, Macon, and Watauga.

Table 3. Mountain, Foothills, and western Piedmont regions summary of western NC nightjar survey results for June 2010. WPWI = whip-poor-will. CWWI = chuck will's widow.

	Mountains	**Foothills and Western Piedmont**
# routes surveyed	20	6
# routes with WPWI	17 of 20	5 of 6
Max # WPWI	61	33
# WPWI per route (S.E.)	3.05 (0.62)	5.5 (1.7)
# WPWI per route with WPWI (S.E.)[1]	3.58 (0.65)	6.6 (1.6)
# routes with CWWI	0 of 20	2 of 6
# CWWI	0	4

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

Whip-poor-will detections per route were higher on the Foothills and western Piedmont routes than Mountain routes (Table 3). Chuck-will's widows were encountered on two routes in two counties (Burke and Catawba) in the western Piedmont. Both species were detected on the Worry Crossroads route in Burke County. Furthermore, both species were detected at the same stop (stop 7) on the Worry Crossroads route (Figure 1). Only chuck-will's widow was detected on the Johnson Bridge Road route that traverses Burke and Catawba Counties.

Golden-winged Warbler Surveys

In an effort to address conservation of a second priority species, considerable effort was invested in golden-winged warbler surveys in 2010. Efforts included (1) monitoring of official Golden-Winged Warbler Atlas Project (GOWAP) sites in cooperation with Audubon North Carolina and (2) surveys of timber harvest units on the Nantahala and Pisgah National Forest Game Lands, in collaboration with NCWRC Game Land staff, using GOWAP protocol (Cornell 2010) (Table 4). The latter effort was prompted by the under-representation of regenerating forest habitat in the official GOWAP point network for NC (most official GOWAP points are along roadsides, due to ease of access for volunteers and those without permission to drive behind USFS gates). Surveys were conducted in two-age and shelterwood harvest units on the following timber sale areas logged in the last eight years: Hazanet, Stecoah, Trimont, Ray Branch, County Line, Jutts Creek/Goldmine, and Second Look.

Combining both projects, 62 surveys were conducted and staff observed 17 golden-winged warblers (including one female) and three blue-winged warblers in spring 2010. NCWRC's 25 GOWAP surveys were conducted exclusively by Wildlife Diversity program staff. The timber unit surveys were a joint effort between NCWRC's Wildlife Diversity and western region Land Management staff. Crews from three western region wildlife depots attended field training in GOWAP protocol and then independently conducted surveys of portions of seven timber harvest analysis areas (n=36 sampling locations). This effort boosted NCWRC's GWWA survey project by 144 % and resulted in detection of nine GWWAs in harvest units. Detailed silviculture/harvest data for these cutover areas will be provided by the U.S. Forest Service.

Table 4. NCWRC 2010 Golden-winged Warbler Atlas Project (GOWAP) survey results at official GOWAP sites plus timber harvest units on the Nantahala National Forest. GWWA= golden-winged warbler. BWWA= blue-winged warbler.

Point	Location	# GWWA	Habitat[2]	Succ-ession	Extent (acres)	Elev. (feet)	County
GOWAP points							
50NE-1	NC-143 billboards	None	Upland shrubby field	Middle	3	2590	Graham
50NE-2	NC-143 Stecoah Gap	1 male GWWA[1]	Upland utility right of way	Early	6	3178	Graham
50NE-3	Talula Bog	1 male GWWA	Wetland utility right of way	Early	8	2670	Graham
50NE-4	NC-143 shoulder	None	Upland utility right of way	Early	3	2993	Graham
50NE-5	NC-143 utility row	None	Upland utility right of way	Early	5	2930	Graham
50NW-1 new	Cherohala Skyway- Hooper Cove overlook	None	Other upland habitat	Early	2	3103	Graham
50NW-2 new	Cherohala Skyway- Shute Cove overlook	1 male GWWA	Other upland habitat	Middle	3	3467	Graham
50NW-3 new	Cherohala Skyway- Obadiah Gap overlook	1 male, 1 female GWWA	Other upland habitat	Middle	4	3672	Graham
50NW-4 new	Cherohala Skyway- mile 10	None	Other upland habitat	Early	<1	4294	Graham
50NW-5 new	Cherohala Skyway- FR81-217	None	Other upland habitat	Middle	<1	4303	Graham
28SE- 1	NC28-NC-143	None	Other upland habitat	Middle	2	2547	Graham
28SE- 2	Sawyers Creek Church	None	Shrub wetland	Early	1.5	2014	Graham
28SE- 3	Field by tobacco barn	None	Upland utility right of way	Early	1.5	2006	Graham
28SE- 4	Santeetlah Dam Road	None	Upland utility right of way	Early	3	2024	Graham
28SE- 5	Aqueduct	None	Wetland utility right of way	Early	4	2000	Graham
30SE- 1	Wesley Creek Road farm gate	1 male GWWA	Upland abandoned farm	Early	4	3565	Haywood
30SE- 2	Wesley Creek Road- Greenwood gate	1 male GWWA[1]	Upland abandoned farm	Early	3	3730	Haywood
30SE- 3	Max Patch Road- upper	1 male GWWA	Upland abandoned farm	Early	100	3805	Haywood
30SE- 4	Trail at Max Patch proper	None	Other upland habitat	Early	30	4180	Madison
30SE- 5	Harmon Den horse camp	None	Upland successional forest	Middle	0	2825	Haywood
13NW- 18	Big Laurel Road	1 male BWWA	Upland abandoned farm	Early	5	2786	Ashe
13NW- 19	Rich Hill Road	1 male BWWA	Upland utility right of way	Early	20	3387	Ashe
13NW- 20	Big Spring Junction	None	Upland abandoned farm	Middle	1	3886	Ashe
13NW- 21	Flatwoods	None	Upland abandoned farm	Early	3	3464	Ashe
13NW- 22	Flatwoods/Burnt School	None	Upland abandoned farm	Middle	2	3238	Ashe
Other GWWA surveys							
Sandy Mush 1	Sandy Mush Game Land	1 male BWWA	Upland clear cut	Middle	300	2058	Buncombe
Nantahala National Forest Timber Unit surveys							
County Line 1	County Line project	1 male	Upland successional forest- shelter.	Early	50	4407	Swain
County Line 2	County Line project	None	Upland successional forest- shelter.	Early	50	4163	Macon
County Line 3	County Line project	None	Upland successional forest- shelter.	Early	10	4221	Macon
County Line 4	County Line project	None	Upland successional forest- shelter.	Early	20	3750	Macon

County Line 5	County Line project	None	Upland successional forest- shelter.	Early	40	3411	Macon
County Line 6	County Line project	None	Upland successional forest- shelter.	Early	20	3510	Macon
Goldmine1	Goldmine	None	Upland clearcut	Early	5	2080	Graham
Goldmine2	Goldmine	None	Upland clearcut	Early	15	2020	Graham
Hazanet 1	Hazanet project	1 male GWWA	Upland successional forest- two age	Middle	20	3600	Graham
Hazanet 2	Hazanet project	1 male GWWA	Upland successional forest	Early	15	2850	Graham
Hazanet 3	Hazanet project unit	None	Upland successional forest	Early	10	2917	Graham
Hazanet 4	Hazanet project	1 male GWWA	Upland successional forest	Early	10	3650	Graham
Hazanet 5	Hazanet project	None	Upland successional forest	Middle	20	3652	Graham
Hazanet 6	Hazanet project	None	Upland successional forest	Early	20	3560	Graham
Hazanet 7	Hazanet project	None	Upland successional forest	Early	30	3550	Graham
Jutt1	Jutts Creek	None	Upland clearcut	Early	20	3350	Graham
Jutt2	Jutts Creek	None	Upland clearcut	Early	15	3395	Graham
Ray Branch 1	Ray Branch project	1 male GWWA	Upland successional forest	Early	10	3260	Macon
Ray Branch 2	Ray Branch project	1 male GWWA	Upland successional forest	Early	20	3480	Macon
Ray Branch 3	Ray Branch project	None	Upland successional forest	Early		3637	Macon
SecondLook1	Second Look project- Wildcat Creek	None	Upland clearcut	-	-	-	Macon
SecondLook2	Second Look project- Wildcat Creek	None	Upland clearcut	-	-	-	Macon
SecondLook3	Second Look project- Buck Knob	None	Upland clearcut	-	-	-	Jackson
SecondLook4	Second Look project	None	Upland successional forest	-	-	-	Jackson
SecondLook5	Second Look project	None	Upland clearcut	-	-	-	Jackson
Stecoah 1	Stecoah project	1 male GWWA	Upland successional forest- two age	Early	-	3126	Graham
Stecoah 2	Stecoah project	1 male GWWA	Upland successional forest- blowdown	Early	2	3231	Graham
Stecoah 3	Stecoah project	None	Upland successional forest- two age	Early	10		Graham
Stecoah 4	Stecoah project	None	Upland successional forest- two age	Early	10	3440	Graham
Trimont 1	Trimont project	None	Upland successional forest- shelter.	Early	15	3025	Macon
Trimont 2	Trimont project	None	Upland successional forest- shelter.	Early	12	2658	Macon
Trimont 3	Trimont project	1 male GWWA	Upland successional forest- two age	Early	15	3027	Macon
Trimont 4	Trimont project	1 male GWWA	Upland successional forest- shelter.	Early	10	2865	Macon
Trimont 5	Trimont project	None	Upland successional forest- two age	Early	11	3145	Macon
Trimont 6	Trimont project	None	Upland successional forest- two age	Middle	-	2971	Macon
Trimont 7	Trimont project	None	Upland successional forest	Early	20	2742	Macon

[1] Observed during scouting within survey window, but not during official count.

[2] Definitions of Habitat terms and Successional stages from Golden-winged Warbler Monitoring Protocol 2010 (Cornell 2010).

B. Target Dates for Achievement and Accomplishment

On schedule

C. Significant Deviations

None

D. Remarks

Game land Songbird Surveys

Surveys of Pond Mountain revealed this tract's importance to vesper sparrows and numerous early successional species.

Prior to the 2010 golden-winged warbler survey of timber harvest units on the Nantahala National Forest, the last survey of golden-winged warblers in timber harvest units took place in the mid 1990s. Those study areas are no longer suitable due to vegetation succession. Since the late 1980's timber operations that created the habitat used by golden-winged warblers in the 1990s study, the amount of acreage in regeneration on the Nantahala National Forest has declined 90% (D.Miller, pers.comm.).

E. Recommendations

Western region bird conservation efforts should focus future efforts on (1) collecting baseline data on other western region game lands for the development of game land management plans, (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.

Survey efforts at Pond Mountain should evaluate management options for priority species, including golden-winged warbler, vesper sparrow, bobwhite, Appalachian yellow-bellied sapsucker, and other high elevation wildlife of forest and field. Pond Mountain is an optimal site for NCWRC's future spruce restoration efforts, including planting red spruce test plots, transplanting seedlings into hardwood forests, and releasing seedlings from hardwood canopy. Similar survey-management efforts are already underway at Sandy Mush game land, with a focus on barn owl, American kestrel, prairie warbler, field sparrow, and bobwhite.

Following the lead of the golden-winged warbler Working Group's range-wide conservation initiative, North Carolina should begin implementing priority conservation efforts at the state level. Surveys in 2010 were a productive kickoff of this effort, providing needed data about golden-winged warblers in regenerating forests. The shifting mosaic of early successional habitat in the form of regenerating timber units appears to be a viable management option for golden-winged warblers on the Nantahala National Forest. NCWRC will be working closely

with the U.S. Forest Service, Appalachian Mountains Joint Venture, and other partners to implement golden-winged warbler habitat restoration on the National Forests.

F. Estimated Cost

$33,625 (including in-kind and other non-federal match)

G. References

Buehler, D.A., A.M. Roth, R. Vallender, T.C. Will, J.L. Confer, R.A. Canterbury, S. Barker Swarthout, K.V. Rosenberg, and L.P. Bulluck. 2007. Status and conservation priorities of golden-winged warbler (*Vermivora chrysoptera*) in North America. The Auk 124(4):1439-1445.

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Prepared By: Chris Kelly
Division of Wildlife Management

Final Performance Report

State: North Carolina **Project Number:** T – 11 -P

Period Covered: July 1, 2009 – August 31, 2010

Grant Title: State Wildlife Grants 07-Wildlife Management

Project Title: Peregrine Falcon Productivity Monitoring

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 2010 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.

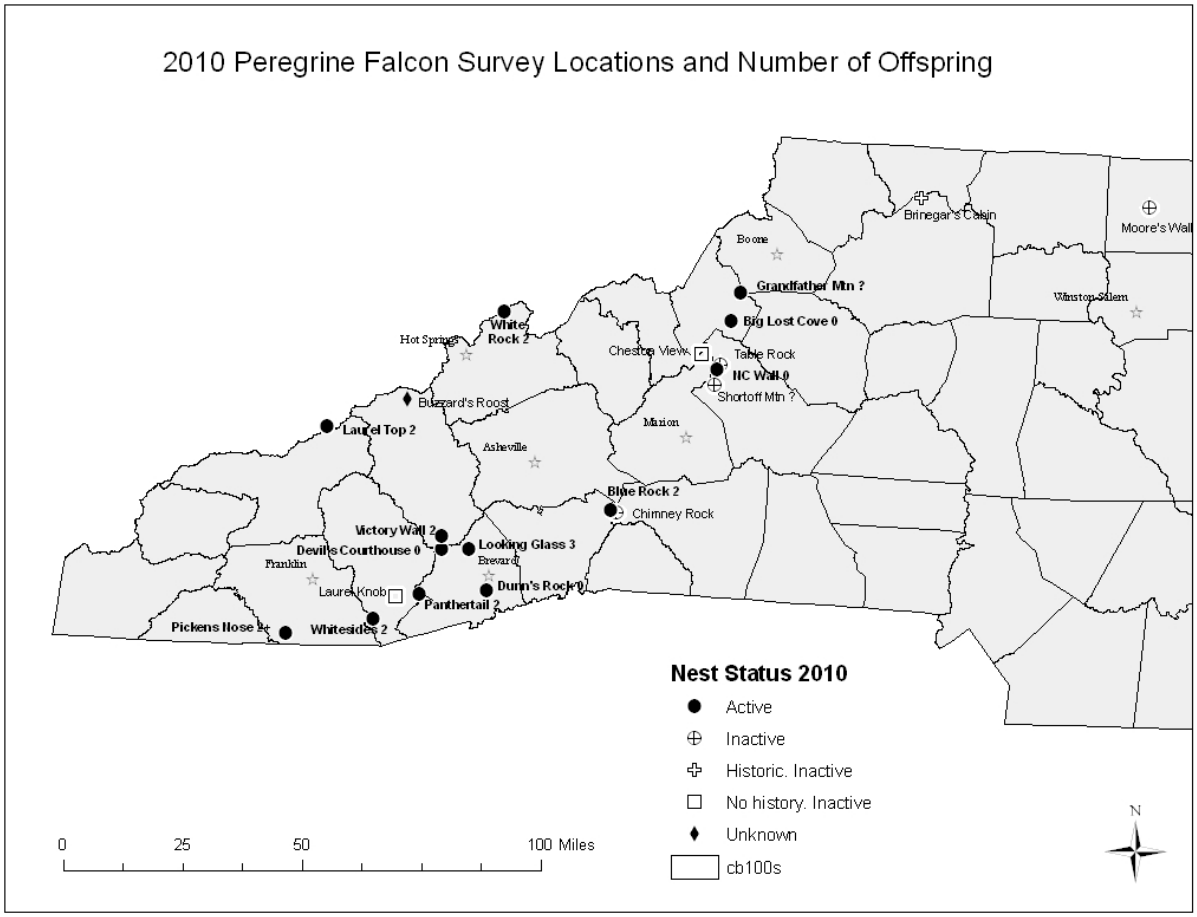
The survey followed protocol set forth in the U.S. Fish and Wildlife Service Monitoring Plan for the American Peregrine Falcon (USFWS 2003). Efforts focused on the 13 territories surveyed in 2009 (NCWRC 2009) with a combined effort of 235 observer hours (Table 1). Nine of the 13 monitoring sites were occupied, and five produced nestlings and/or fledglings (Table 1 and Figure 1). In addition, six secondary sites (Victory Wall, Pickens Nose, Laurel Knob, Brinegar Cabin, The Peak, and Bluff Mountain) were checked for falcons, and nesting was confirmed and successful at Victory Wall and Pickens Nose. Great Smoky Mountains National Park reported fledglings at a third "new" site on Laurel Top.

Table 1. Peregrine Falcon survey efforts at territories in western North Carolina, 2010.

SITE	OBSERVER HOURS	FALCONS OBSERVED	PAIR PRESENT	DETECTED NESTLINGS >28 days old OR FLEDGED
Big Lost Cove	10	Yes	Yes	No
Hickory Nut Gorge (Blue Rock and Chimney Rock)	12	Yes	Yes	Yes[a]- 2
Devil's Courthouse	15.5	Yes	Yes	No
Grandfather Mountain	4	Yes	Yes	No
Hanging Rock State Park	10.5	No	No	No
Shortoff Mountain	24.5	No	No	No
NC Wall	10.5	Yes	Yes	No
Looking Glass Rock	23.5	Yes	Yes	Yes[b]- 3
Panthertail Mountain	7	Yes	Yes	Yes[b]- 2
Buzzard's Roost	10	No	Unclear	No
White Rock Cliff	20.75	Yes	Yes	Yes[c]-2
Whiteside Mountain	44.5	Yes	Yes	Yes[a]-2
Dunn's Rock	2	Yes	Yes	No
Victory Wall	23	Yes	Yes	Yes[c]- 2
Pickens Nose	16.5	Yes	Yes	Yes[a]-2min
Laurel Top	1	Yes	Yes	Yes[a]- 2
TOTAL	235.25	13 Sites	13 Sites	8 sites

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

Figure 1. Peregrine falcon territories in North Carolina, showing number of nestlings detected during the 2010 nesting season. No number indicates nest failure.



Site Summaries- Primary Sites

Nest success greatly improved in 2010 with higher success in the southern and central mountains (Table 2). Due to closure of I-40 through the Pigeon River Gorge for landslide repairs, there was no access to Buzzard's Roost until early May. It was unclear if a pair had been on territory; there was fresh whitewash but birds were not observed during multiple late season visits.
Notable observations included:

- For the first time in 20 years, falcons nested successfully in Hickory Nut Gorge (Blue Wall).
- The eyrie at Shortoff Mountain was unoccupied for the first time in the history of the monitoring program. Falcons were also absent from Hanging Rock State Park (Moore's Wall).
- After three years of nest failure, the Looking Glass nest produced nestlings this year.
- Falcons at Whiteside Mountain shifted to a nest ledge on the east face of the cliff.

Site Summaries- Secondary Sites

Surveys of seven secondary sites by NCWRC and partners resulted in the discovery of three "new" occupied territories. Successful nests were reported at Victory Wall (Haywood County), Pickens Nose (Macon County), and Laurel Top (Swain County). Victory Wall was last used by a pair of falcons in the late 1990s and the pair subsequently relocated to Devil's Courthouse. Pickens Nose was used as a hack site during reintroductions in the 1990s. A birder reported adults and fledglings present in 2009 but it is not clear how long this site has been occupied. Great Smoky Mountains National Park staff reported fledglings flying in and out of an eyrie at Laurel Top, a remote cliff on the North Carolina-Tennessee line in the Park. The Peak and Brinegar Cabin supported nesting common ravens.

Table 2. North Carolina Wildlife Resources Commission initial observation dates of nesting chronology phases for peregrine falcons at 16 sites in western North Carolina, 2010.

SITE	BONDED PAIR	INCUBATION	CHICKS (Number)	FLEDGLINGS Date (Number)	CONFIRMED FAILURE
Big Lost Cove	April 29				July 11
Chimney Rock					
Devil's Courthouse	April 30	April 30			June 6
Grandfather Mountain	May 27				
Hanging Rock State Park					
Shortoff Mountain					
NC Wall	March 15				June 23
Looking Glass	March 31	March 31	May 14 (3) [a]		
Panthertail Mountain	April 14	April 14	May 21 (2) [a]		
Buzzard's Roost					
White Rock Cliff	April 13	April 13	May 28 (2)	June 21 (2)	
Whiteside Mountain	March 19	March 19		May 18 (2)	
Dunn's Rock	April 14*				May 4
Victory Wall	March 31	April 5 (4 eggs)	April 30 (2)		
Pickens Nose	April 12	April 12		May 27 (2)	
Laurel Top				July 6 (2)	

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

Technical Guidance

A new cliff closure was posted at Victory Wall, and the Whiteside Mountain closure was shifted to the east half of the cliff. A closure order was not established at Pickens Nose because there was no evidence of rock climbing on or in the immediate vicinity of the nest ledge; climbing is concentrated on the south end of the ridge where there is exposed rock face.

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, territory occupancy and nest success were just short of the national average, and productivity fell within the range of the national average (Table 3). National averages are based on the USFWS report for the 2006 monitoring season (Green et al. 2008).

Table 3. North Carolina Wildlife Resources Commission peregrine falcon population health indices; western North Carolina 2010 – vs – national average (2006).

	TERRITORY OCCUPANCY	NEST SUCCESS	PRODUCTIVITY
North Carolina (2010)	81% (13 of 16 sites)	61% (8 confirmed of 13 pairs)	*1.3 (17 young/13 nesting pairs)
National Average (recent years)	84%	71%	1.24 – 2.2

* Young fledged at one site where we could not see the nest to count nestlings (Pickens Nose), so productivity may have been higher.

Population Parameters in WNC: 2010 –vs- Past Years

With the addition of three new occupied territories and improved nest success, this season produced the highest number of offspring (Figure 2) since the completion of reintroduction efforts in 1996, and productivity increased after three less productive years. This is despite the unusual absence of a pair at the typically productive Shortoff Mountain eyrie.

Once again, there was evidence of population turnover with young, inexperienced birds on three territories in the northern mountains, where nesting attempts failed. Second year females were present at Big Lost Cove, NC Wall, and Grandfather Mountain. The female at Grandfather Mountain represented the first documented case of a banded falcon on territory in western North Carolina. Though this bird was apparently banded as a nestling with both a U.S. Fish and Wildlife Service aluminum band and colored bands, without being able to read the inscription on the green and black bands, her state of origin could not be determined, since many northeastern states use the green-black band combination.

Table 4. Summary of peregrine falcon territory occupancy, nest success, and productivity in western North Carolina, 1987-2010.

SITE	# years surveyed (1st year)[1]	# years occupied (percent[1])	# years successful (percent)	total # fledglings	# fledglings/ years surveyed	# fledglings/ years occupied	# fledglings 2010
Big Lost Cove	14 (1997)	14 (100%)	6 (42%)	9	0.64	0.64	0
Hickory Nut Gorge	22 (1989)	20 (91%)	3 (15%)	5	0.22	0.25	2
Devil's Courthouse	12 (1999)	12 (100%)	8 (66%)	14	1.16	1.16	0
Grandfather Mountain	21 (1990)	13 (61%)[2]	4 (30%)	9	0.42	0.69	0
Hanging Rock State Park	11 (2000)	7 (63%)	2 (28%)	2	0.18	0.28	0
Shortoff Mountain	13 (1998)	11 (84%)	10 (91%)	24	1.84	2.18	0
NC Wall	17 (1987)	15 (88%)	3 (20%)	5	0.29	0.33	0
Looking Glass	23 (1988)	23 (100%)	13 (56%)	34	1.47	1.47	3
Panthertail Mountain	18 (1993)	18 (100%)	12 (66%)	29	1.61	1.61	2
Pigeon River Gorge	7 (2004)	6 (85%)	3 (50%)	10	1.42	1.67	0
White Rock Cliff	23 (1988)	20 (87%)	8 (40%)	15	0.65	0.75	2
Whiteside Mountain	23 (1988)	23 (100%)	18 (78%)	45	1.95	1.95	2
Dunn's Rock	4 (2007)	4 (100%)	1 (25%)	2	0.50	0.50	0
Table Rock	5 (2006)	2 (40%)[3]	1 (50%)	3	0.60	1.50	0
Victory Wall	1 (2010)[4]	1 (100%)	1 (100%)	2	0.50	0.50	2
Pickens Nose	1 (2010)[5]	1 (100%)	1 (100%)	2	0.50	0.50	2
Laurel Top	1 (2010)	1 (100%)	1 (100%)	2	0.50	0.50	2
Total	-	-	-	212			17
Mean (SE)	-	-	-		0.85 (0.14)	0.97 (0.15)	

[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.

[4] Victory Wall was used at least once in the late 1990s.

[5] Pickens Nose was likely occupied and successful in 2009, based on a birder's report. Data just reflect the initial survey by NCWRC, in 2010.

Figure 2. North Carolina Wildlife Resources Commission data regarding peregrine falcons hacked, pairs observed, and number of offspring in North Carolina, 1984-2010.

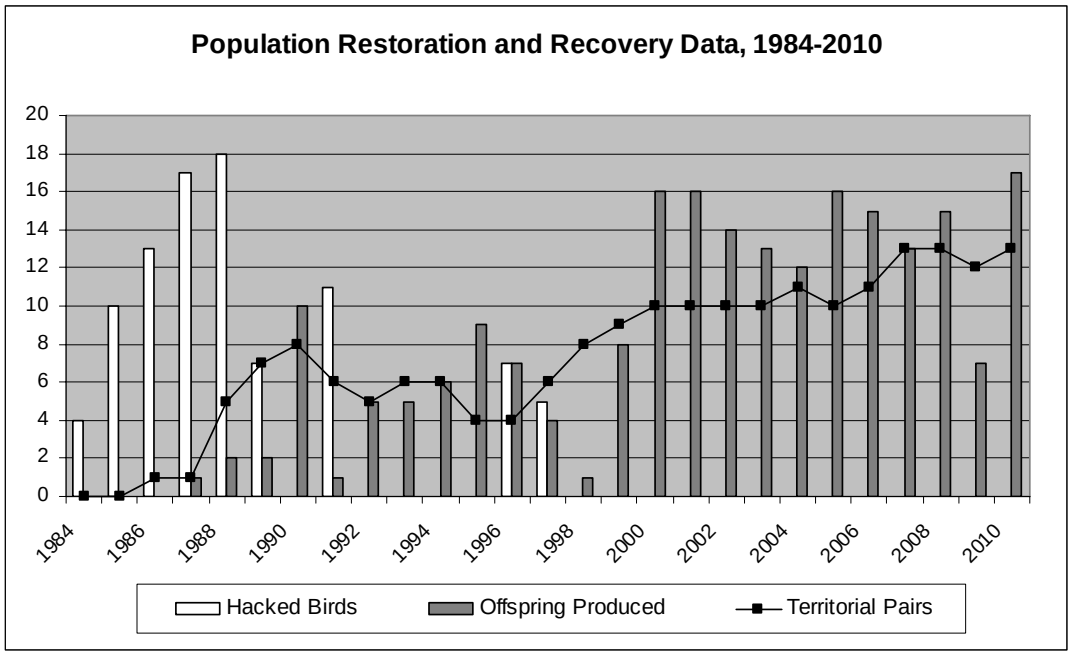
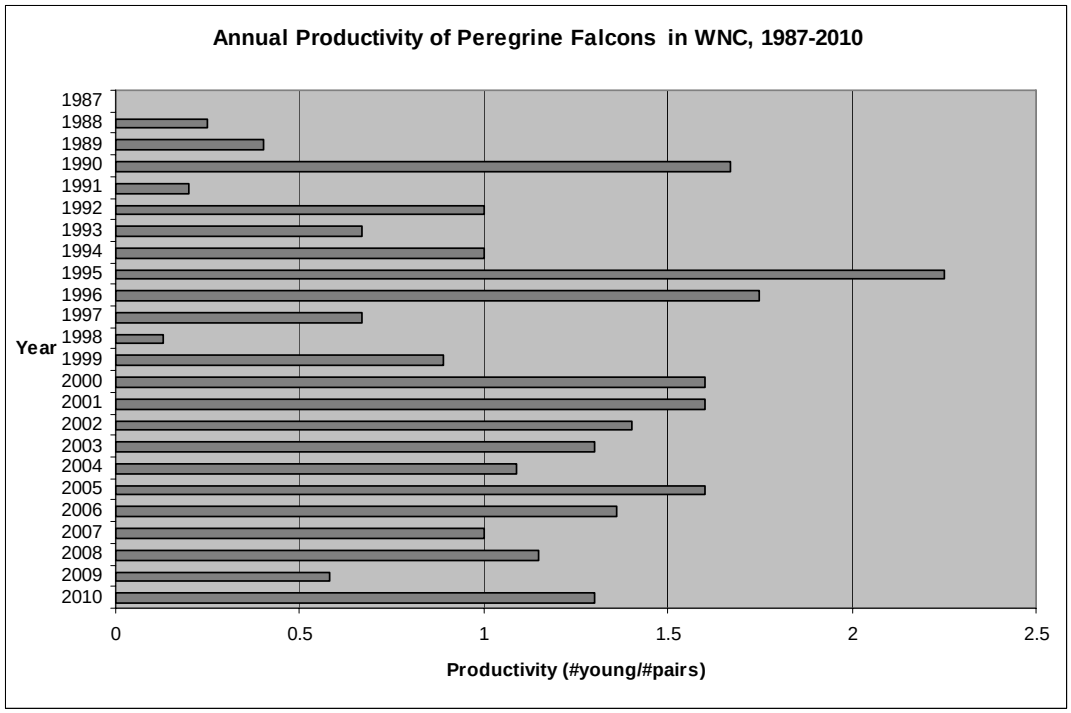


Figure 3. Annual productivity of peregrine falcons, 1987-2010.



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 2011 will again 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 has been rolled into the broader NCWRC Mountain Region Bird Conservation project.

F. Estimated Cost

$21,178 (including in-kind and other non-federal match)

G. References

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

Green, M.G., S. Willey, T. Swem, R. Mesta, P. Delphey, R. Currie, and M. Amaral. 2008. 2006 Monitoring results for breeding American Peregrine Falcon (*Falco peregrinus anatum*). U.S. Department of Interior, Fish and Wildlife Service. Region 1, Portland, OR.

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

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

Final Performance Report

State: North Carolina **Project Number:** T – 11 -P

Period Covered: July 1, 2009 – August 31, 2010

Grant Title: State Wildlife Grants 07-Wildlife Management

Project Title: Carolina Northern Flying Squirrel Conservation

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 GRA's where there are sufficient captures;
4. To assess NFSQ population trends through long-term monitoring in western NC by tracking trends in abundance or site occupancy over time;
5. To provide technical guidance on NFSQ ecology, habitat, and management activities that may affect the squirrel and its habitat to cooperating federal and state agencies and private organizations;
6. To implement conservation actions that improve high elevation (WAP) habitat;
7. To begin developing priority research topics geared toward recovery of the flying squirrel and protection of its habitat.

A. Activity

The Carolina northern flying squirrel (*Glaucomys sabrinus coloratus*) project consisted of both winter nest box surveys as well as acoustic surveys. Considerable time was also spent analyzing data and providing technical guidance to conservation partners.

Productive nest box transects in the Great Balsams, Black-Craggy Mountains, Unicoi Mountains, and Grandfather Mountain were surveyed in winter 2010. Persistent severe weather prevented access to many transects, including 55 % of the historical nest box transects and the relatively new boxes in the lower elevations of the Unicoi range. New transects at Alarka Laurel spruce bog as well as existing nest boxes at Beech Creek and Sugar Mountain Bog were checked. Captured animals were weighed, measured, ear-tagged, and released. In addition, Beech Creek Bog was trapped by NCWRC and NC State Parks staff in October 2009.

In collaboration with Michelle Gilley, a PhD student at Auburn University, an intensive field test of acoustic survey equipment was carried out in December 2009 and July 2010. The goal was to determine if "bat detectors" could be used as a rapid survey technique to document presence of Carolina northern flying squirrels by recording their ultrasonic and sonic vocalizations. Pettersson D240X detectors and iRiver mp3 line-in recorders were used to survey areas with

histories of high captures from nest boxes, low captures, and overlap with southern flying squirrels.

The long term nest box monitoring data were analyzed with assistance from Mark Ford (Virginia Tech) and presented at the 20th Colloquium on the Conservation of Mammals of the Southeastern United States and at the Association of Southeastern Biologists conference.

Technical Guidance

NCWRC provided technical guidance on five proposals from the National Forests in North Carolina. These included recommendations to the Nantahala National Forest on conifer planting, hemlock treatment, and a right of way request in the Unicoi Mountains, and to Pisgah National Forest for balds management at Roan Mountain and conifer planting in the Wolf Knob analysis area. In addition, NCWRC provided technical guidance to the U.S. Fish and Wildlife Service regarding a private residential development and a Biological Opinion for Natural Resource Conservation Service, and to the National Park Service for a hazard tree removal and tree limbing proposal for the Blue Ridge Parkway. NCWRC reviewed one endangered species permit (Eastern Band of Cherokee Indians) and collected blood samples for a genetics study by Dr. Brian Arbogast of UNC-Wilmington.

Results

Nest boxes- Between January and early April, staff conducted checks of boxes in the Unicois, Great Balsams, Black and Craggy Mountains, and Grandfather Mountain. Altogether, 117 CNFSs were detected including 9 previously tagged individuals (Table 1). Ninety-eight of these 117 animals were fitted with ear tags for the first time. Ten of the 117 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, 150 boxes contained CNFS nests, although just 36 of the 150 were occupied by CNFSs. Overall, across the four main GRAs, 47% of boxes were found to contain nest material identified as CNFS nests (Table 2). However, only 24% of those nests and just 11% of all boxes we checked were occupied by CNFSs.

Unusually high captures were documented on a few transects in the Great Balsams. Because access and weather prevented the completion of surveys, data are summarized as number of squirrel detections per box (Figure 1). Late season surveys were unproductive since females had already moved out of boxes for the breeding season. As a result, we do not know if high captures were a phenomenon across the Great Balsams.

Table 1. North Carolina Wildlife Resources Commission northern flying squirrel capture summary, 2010.

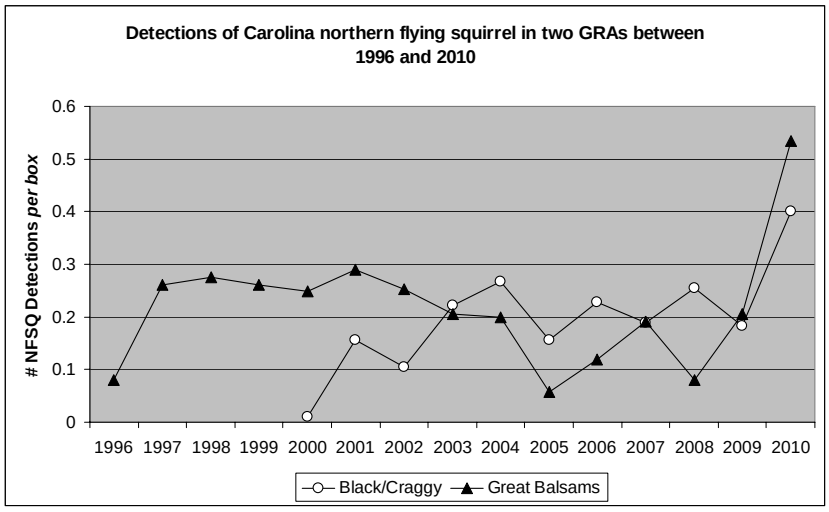
Mountain Range/GRA	# Boxes Checked[1]	# CNFS Detected	# Recaptures	# CNFS Newly Tagged
Black & Craggy Mtns	100	**40**	2	36
Great Balsams	120	**64**	4	53
Unicoi Mountains	57	**4**	1	2
Grandfather Mountain	40	**9**	2	7
Beech Creek Bog SNA	12	**0**	0	0
Sugar Mtn Bog SNA	20	**0**	0	0
Alarka Spruce Bog	7	**0**	0	0
Totals	**356**	**117**	**9**	**98**

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

Table 2. North Carolina Wildlife Resources Commission northern flying squirrel nest summary, 2010.

Mountain Range/GRA	Number Boxes Checked	Number CNFS Nests (occupied and unoccupied)	% Boxes with Nests	% Boxes occupied by CNFSs	% Nests occupied by CNFSs
Black & Craggy Mtns	100	51	51 %	11 %	22 %
Great Balsams	120	68	57 %	17 %	29 %
Unicoi Mountains	57	13	23 %	4 %	15 %
Grandfather Mountain	40	18	45 %	8 %	17 %
Beech Creek Bog SNA	12	0	0 %	0 %	0 %
Sugar Mtn Bog SNA	20	0	0 %	0 %	0 %
Alarka Spruce Bog	7	0	0	0	0
Totals for BC,GB,UN,GF	**317**	**150**	**47 %**	**11 %**	**24 %**

Figure 1. North Carolina Wildlife Resources Commission detections of northern flying squirrels between 1996 and 2010 in the two GRAs with the largest squirrel box networks.



* # boxes = 180 in Black-Craggies and 210 in Great Balsams for 1996-2009. 100 boxes in Black-Craggies and 120 in Great Balsams in 2010 due to limited access.

Trapping- Due to rain, only 70 trap nights were completed at Beech Creek Bog in October 2009, and northern flying squirrels were not documented. One southern flying squirrel was captured.

Occupancy analysis- The long term nest box monitoring data were analyzed at the scale of the nest box transect to calculate occupancy rates and detection probabilities, determine the influence of habitat quality, elevation, and patch size, and evaluate survey needs. Occupancy remained constant ($\psi = 0.51 \pm 0.046$) while detection probability (p) was higher in better quality habitat, with $p = 0.63 \pm 0.029$ in medium to low quality habitat, and $p = 0.75 \pm 0.047$ in high-medium quality habitats.

Acoustic surveys- In July 2010, 42 calls were documented in 18 trap nights, where trap night is represented by an individual recording unit running a single night. The most common calls recorded were "short" and "long" calls. However, we also recorded "upsweeps", "barks", and "juvenile song" (terminology by Michelle Gilley, Auburn University).

B. Target Dates for Achievement and Accomplishment

On schedule

C. Significant Deviations

We were unable to survey 55% of sites due to impassable roads and new access restrictions by the National Park Service. Late season (early April) surveys resulted in lower captures relative to winter capture rates because post mating dispersal of females had already occurred.

D. Remarks

Captures were markedly higher in some areas this year. Unfortunately, severe winter weather and new access restrictions prevented us from completing all transects in the two largest nest box networks (Great Balsams and Black-Craggies). Furthermore, we were unable to access boxes in the Plott Balsams, Roan Mountain, and Smokies. Nests in the Unicoi boxes were frozen, and therefore unavailable for squirrels to use. Occupancy rates based on nest boxes are somewhat low (50%) and detection probability is relatively high, suggesting that a lot of habitat may be unoccupied. Acoustic surveys generated promising results for a new survey technique. We expect to see higher detection probabilities associated with this technique, which could improve the occupancy estimates.

E. Recommendations

The first approximation of the occupancy analysis used coarse data sets, including transect level presence-absence data, patch size based on elevation query (Weigl et. al.), and habitat assignments from past modeling studies and assessment by biologists familiar with the transects. Finer grained occupancy analysis is needed at the scale of the individual nest box and with improved land cover (habitat) data and patch size estimates. U.S. Fish and Wildlife Service has

been assisting NCWRC in developing a CNFS map based on Southeast GAP Analysis land cover data, two "potential vegetation" models, and elevation limits.

The three highest priorities now are to (1) develop a survey protocol using acoustic monitoring equipment, (2) compare occupancy and detection from nest box surveys versus acoustic surveys, and (3) survey "new" sites using acoustic monitoring equipment. The advent of the acoustic monitoring technique should allow NCWRC to shift into a sustainable, long term monitoring plan. For example, acoustic monitoring is appropriate in low captures sites for monitoring presence/absence (Roan, Smokies), while nest box monitoring is more appropriate to continue in high capture sites with larger nest box networks (Great Balsams, Black-Craggies) in order to maintain some tracking of demographic data.

F. Estimated Cost

$39,948 (including in-kind and other non-federal match)

G. References

Gilley, L.M. and T.L. Best. 2010. *Characterization of ultrasonic calls in two species of gliding mammals: Glaucomys sabrinus and G. volans.* 20th Colloquium on the Conservation of Mammals in the Southeastern United States. Asheville, NC.

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Division of Wildlife Management

Final Performance Report

State: North Carolina **Project Number:** T – 11 -P

Period Covered: July 1, 2009 – August 31, 2010

Grant Title: State Wildlife Grant 07 –Wildlife Management

Project Title: Western Region Mammal Inventory and Monitoring

Objective:

1. To collect distribution information on priority mammal species identified in the NC Wildlife Action Plan for western North Carolina.
2. To assess population status of priority mammal species through regular survey efforts throughout the region.
3. To provide technical guidance related to priority mammal populations and their habitats for use by the public, cooperating state and federal agencies and organizations, and in the implementation and revision of the NC Wildlife Action Plan.

A. Activity

From July 1, 2009 – August 31, 2010, Wildlife Diversity staff continued efforts to monitor significant bat roosts, and gather baseline information on species distribution and relative population status of bats throughout western North Carolina. In order to accomplish objectives, a variety of different survey techniques were employed including hibernacula counts, summer mist net surveys at various non-roost sites, summer and transitional roost surveys, and surveillance for signs of White Nose Syndrome (WNS) on bats in all seasons. Due to staffing limitations and WNS priorities, no surveys were conducted for small mammals beyond the occasional incidental observation.

Bat Hibernacula surveys:

Survey efforts for winter roosts were prioritized based on historical significance, recently acquired data, recommendations of regional agencies and bat conservation organizations (e.g. USFWS, USFS, NPS, TNC, EBCI, SBDN), and new concerns about White Nose Syndrome (WNS). 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. In addition to the full counts, we conducted surveillance for signs of WNS at some additional sites.

Hibernacula counts and WNS surveillance took place in January, February, and March 2010. 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, thirteen sites (9 caves and 4 mines) in eight counties were surveyed (Table 1). A total of 6,116 bats were counted, representing nine species (Table 2). Three Rafinesque's big-eared bats (state listed threatened), 48 eastern small-footed bat (state special concern), and 1 Indiana bat (state & federally listed endangered) were observed during these surveys. In addition, 8 sites were visited with the sole purpose of conducting surveillance for White Nose Syndrome (Table 3); WNS was not documented at any sites in North Carolina during these hibernation counts and/or surveillance for WNS.

Table 1. North Carolina Wildlife Resources Commission bat hibernacula survey locations and species assemblages in the mountain region, January – March, 2010.

Site Name	County	Property Ownership	Survey Date	Species	Number
Anthodite Cave	Madison	Unknown	1/11/2010	*Eptesicus fuscus*	2
				Lasionycteris notivagans	2
				Perimyotis subflavus	7
					11
Pilot Knob Caves	Avery	Grandfather Mountain/The Nature Conservancy	1/26/2010	None	**0**
Cooper's Caves	Yancey	Mountain Air Country Club	1/28/2010	*Myotis leibii*	5
				Myotis species	2
					7
Bull Pen Mine	Jackson	USFS (Nantahala National Forest)	2/1/2010	*Corynorhinus rafinesquii rafinesquii*	3
				Perimyotis subflavus	4
				Perimyotis subflavus	12
					19
Upper Whitewater Road Mine	Transylvania	USFS (Nantahala National Forest)	2/1/2010	*Perimyotis subflavus*	**2**
Middle Bat Cave	Rutherford	The Nature Conservancy	2/2/2010	*Eptesicus fuscus*	3
				Myotis leibii	5
				Myotis lucifugus	1
				Perimyotis subflavus	4
				Perimyotis subflavus	16
					29
Breakdown Cave	Rutherford	NC State Parks	2/3/2010	*Myotis leibii*	3
				Perimyotis subflavus	1
					4

Rumbling Bald Cave	Rutherford	NC State Parks	2/3/2010	*Myotis leibii*	1
				Myotis septentrionalis	1
				Perimyotis subflavus	1
					3
Sliding Rock Cave 1 and 2	Rutherford	The Nature Conservancy	2/3/2010	*Myotis leibii*	3
				Myotis lucifugus	2
				Myotis sodalis	1
				Myotis species	1
				Perimyotis subflavus	49
					56
Blowing Springs Cave	Swain	USFS (Nantahala National Forest)	2/4/2010	*Myotis lucifugus*	64
				Myotis septentrionalis	12
				Myotis species	248
				Perimyotis subflavus	1010
					1334
Big Ridge Mine	Haywood	City of Waynesville	2/8/2010	*Eptesicus fuscus*	1
				Myotis leibii	31
				Myotis lucifugus	274
				Myotis septentrionalis	32
				Myotis species	14
				Perimyotis subflavus	3326
					3678
Cranberry Iron Mine	Avery	Waterfront Group	2/12/2010	*Eptesicus fuscus*	7
				Eptesicus fuscus	9
				Myotis lucifugus	37
				Myotis septentrionalis	3
				Myotis septentrionalis	28
				Myotis species	3
				Myotis species	248
				Perimyotis subflavus	276
				Perimyotis subflavus	325
					936
Celo Knob Cave	Yancey	USFS (Pisgah National Forest)	3/1/2010	*Myotis lucifugus*	2
				Myotis species	12
				Perimyotis subflavus	23
					37

Table 2. North Carolina Wildlife Resources Commission summary of bat species observed during hibernacula surveys in the mountain region, January – March, 2010.

Species	Number
Big Brown Bat (*Eptesicus fuscus*)	22
Silver-haired Bat *(Lasionycteris notivagans)*	2
Tri-colored Bat *(Perimyotis subflavus)*	5056
Eastern Small-footed Bat* (*Myotis leibii*)	48
Myotis species	528
Rafinesque's Big-eared Bat** (*Corynorhinus rafinesquii rafinesquii*)	3
Little Brown Bat (*Myotis lucifugus*)	380
Northern Long-eared Bat (*Myotis septentrionalis*)	76
Indiana Bat*** (*Myotis sodalis*)	1
TOTAL	**6116**

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

Table 3. North Carolina Wildlife Resources Commission summary of hibernacula visited solely for surveillance for White Nose Syndrome in the mountain region, February – April, 2010.

Site Name	County	Property Ownership	Survey Date	Signs of WNS?
Big and Little Bat Cave	Rutherford	The Nature Conservancy	2/2/2010	No
Big Ridge Mine	Haywood	City of Waynesville	4/6/2010	No
Limekiln	McDowell	USFS (Pisgah National Forest)	4/7/2010	No
Pseudosaltpeter	McDowell	USFS (Pisgah National Forest)	4/7/2010	No
Wind Cave	McDowell	USFS (Pisgah National Forest)	4/7/2010	No
Cranberry Iron Mine	Avery	Waterfront Group	4/8/2010	No
Radford Cave 1 (Small)	Cherokee	USFS (Nantahala National Forest)	4/9/2010	No
Isom Mica Mine	Yancey	USFS (Pisgah National Forest)	4/12/2010	No

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 this year in an effort to document big-eared bat use. In addition to these two structures, three roost sites in two counties were surveyed (Table 4). A total of approximately 445 bats were observed or captured, representing four species (Table 5). Significant observations included three Rafinesque's big-eared bats (state listed threatened) and 53 eastern small-footed bats (state special concern).

Table 4. North Carolina Wildlife Resources Commission summer and transitional/migratory roost survey locations and bat species assemblages in the mountain region, July 1, 2009 to August 31, 2010.

Site Name	County	Property Ownership	Survey Date	Species	Number
Harmon Den/Hurricane Creek Cinderblock Structure	Haywood	USFS (Pisgah National Forest)	7/22/2010	*Corynorhinus rafinesquii rafinesquii*	**3**
Harmon Den/Hurricane Creek Culvert Structure	Haywood	USFS (Pisgah National Forest)	7/22/2010	None	**0**
Raf Bat Cave	Haywood	USFS (Pisgah National Forest)	7/22/2010	None	**0**
Fontana Lake@Hwy 28	Swain	NC DOT	5/26/2010	*Myotis leibii*	11
				Myotis lucifugus	1
					12
			6/15/2010	*Myotis leibii*	**21**
			7/15/2010	*Myotis leibii*	**15**
			8/4/2010	*Myotis leibii*	6
				Myotis lucifugus	3
					9
T Sandlin Bridge@ Hwy 28	Swain	NC DOT	5/26/2010	*Eptesicus fuscus*	**4**
			6/15/2010	*Eptesicus fuscus*	**30**
			7/15/2010	*Eptesicus fuscus*	**200**
			8/4/2010	*Eptesicus fuscus*	150
				Myotis lucifugus	1
					151

Table 5. North Carolina Wildlife Resources Commission summary of summer roost surveys in the mountain region, July 1, 2009 to August 31, 2010.

Species	Number
Rafinesque's Big-eared Bat** (*Corynorhinus rafinesquii rafinesquii*)	3
Eastern Small-footed Bat* (*Myotis leibii*)	53
Little Brown Bat (*Myotis lucifugus*)	5
Big Brown Bat (*Eptesicus fuscus*)	384
TOTAL	**445**

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

Mist-netting:
Summer mist netting efforts were conducted in June, 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.

Twenty-one sites in 7 counties were surveyed with mist nets (Table 6). Three sites were surveyed twice each. A total of 24 nights of netting yielded 578 captures representing 11 species (Table 7). Significant captures included 6 Rafinesque's big-eared bats (state listed threatened), 1 gray bat (state & federally listed endangered), 10 eastern small-footed bats (state listed special concern), and 2 Indiana bats (state & federally listed endangered).

Table 6. North Carolina Wildlife Resources Commission summer mist net survey locations and bat captures in the mountain region, July 1, 2009 to August 31, 2010.

Site Name	County	Property Ownership	Survey Date	Species	Number
Shiny Creek	Haywood	City of Waynesville	7/8/2009	*Lasiurus borealis*	2
				Myotis septentrionalis	4
					6
Alarka Laurel 1	Swain	USFS (Nantahala National Forest)	6/14/2010	*Eptesicus fuscus*	3
				Lasionycteris notivagans	6
				Lasiurus borealis	20
				Lasiurus cinereus	2
				Myotis septentrionalis	12
					43
Alarka Laurel 1	Swain	USFS (Nantahala National Forest)	7/15/2010	*Eptesicus fuscus*	12
				Lasiurus borealis	13
				Lasiurus cinereus	3
				Myotis lucifugus	23
				Myotis septentrionalis	15
				Myotis sodalis	2
				Myotis species	1
				Perimyotis subflavus	1
					70
Buck Creek	Clay	USFS (Nantahala National Forest)	5/25/2010	None	**0**
Big Indian Creek	Macon	USFS (Nantahala National Forest)	6/8/2010	*Lasiurus borealis*	1
				Myotis septentrionalis	3
				Myotis lucifugus	1
					5

Ray's Branch	Macon	USFS (Nantahala National Forest)	6/7/2010	*Eptesicus fuscus*	8
				Lasiurus borealis	1
				Myotis leibii	1
				Myotis septentrionalis	4
					14
Nantahala River Bike Path	Macon	USFS (Nantahala National Forest)	6/15/2010	*Myotis septentrionalis*	**2**
Nantahala River Bike Path	Macon	USFS (Nantahala National Forest)	6/22/2010	*Eptesicus fuscus*	2
				Myotis leibii	1
				Myotis lucifugus	17
				Myotis septentrionalis	5
				Perimyotis subflavus	1
					26
Rattler Ford Campground	Graham	USFS (Nantahala National Forest)	6/17/2010	*Eptesicus fuscus*	2
				Myotis septentrionalis	2
				Lasiurus cinereus	1
					5
Little Snowbird Creek Park	Graham	Eastern Band of Cherokee Indians	6/23/2010	*Lasiurus borealis*	1
				Perimyotis subflavus	3
				Myotis lucifugus	1
					5
Davidson River/Pisgah Education Center	Transylvania	USFS (Pisgah National Forest)	7/6/2010	*Lasiurus borealis*	6
				Lasiurus cinereus	1
				Eptesicus fuscus	1
				Myotis lucifugus	39
				Myotis septentrionalis	2
				Myotis species	3
				Perimyotis subflavus	6
					58
Davidson River/Pisgah Education Center	Transylvania	USFS (Pisgah National Forest)	8/2/2010	*Lasiurus borealis*	12
				Lasiurus cinereus	1
				Myotis leibii	1
				Myotis lucifugus	22
				Myotis septentrionalis	8
				Myotis species	3
				Perimyotis subflavus	21
					68

Cherokee Tribal Hatchery	Swain	Eastern Band of Cherokee Indians	7/20/2010	*Eptesicus fuscus*	1
				Myotis lucifugus	10
				Myotis species	2
				Perimyotis subflavus	3
					16
Nantahala Dam Road	Macon	USFS (Nantahala National Forest)	7/28/2010	*Eptesicus fuscus*	4
				Lasiurus borealis	2
				Lasiurus cinereus	1
				Myotis leibii	4
				Myotis lucifugus	11
				Myotis septentrionalis	23
				Myotis species	3
				Perimyotis subflavus	8
				Unknown	1
					57
Laurel Branch Rd/FS 479G	Buncombe	USFS (Bent Creek Experimental Forest)	7/7/2010	*Eptesicus fuscus*	4
				Myotis septentrionalis	6
					10
Bunches Creek Gate	Swain	Eastern Band of Cherokee Indians	7/22/2010	*Eptesicus fuscus*	9
				Lasiurus borealis	4
				Myotis leibii	1
				Myotis lucifugus	9
				Myotis septentrionalis	11
				Myotis species	1
				Perimyotis subflavus	1
					36
Jenkins Creek	Swain	Eastern Band of Cherokee Indians	7/21/2010	*Eptesicus fuscus*	3
				Lasiurus borealis	6
				Myotis leibii	1
				Myotis lucifugus	5
				Myotis septentrionalis	8
				Perimyotis subflavus	4
				Unknown	1
					28
Cold Knob/FS 479H	Buncombe	USFS (Bent Creek Experimental Forest)	7/7/2010	*Eptesicus fuscus*	16
				Lasiurus borealis	5
				Myotis lucifugus	2
				Myotis septentrionalis	5

				Myotis species	1
				Perimyotis subflavus	1
					30
A-0009A - Carver Pond	Graham	Private (Peggy & Allen Carver)	7/27/2010	*Eptesicus fuscus*	3
				Lasiurus borealis	7
				Lasiurus cinereus	1
				Myotis lucifugus	1
				Myotis species	2
				Unknown	1
					15
A-0009N (FS 404)	Graham	USFS (Nantahala National Forest)	6/21/2010	*Eptesicus fuscus*	20
				Lasiurus borealis	8
				Myotis lucifugus	1
				Myotis septentrionalis	9
				Myotis species	1
				Perimyotis subflavus	6
					45
Hurricane Creek	Haywood	USFS (Pisgah National Forest)	6/30/2010	*Corynorhinus rafinesquii rafinesquii*	6
				Eptesicus fuscus	2
				Lasiurus borealis	5
				Myotis leibii	1
				Myotis lucifugus	2
				Myotis septentrionalis	5
					21
Pigeon River/Twelve Mile	Haywood	USFS (Pisgah National Forest)	7/1/2010	*Perimyotis subflavus*	1
				Myotis lucifugus	1
				Unknown	1
				Myotis grisescens	1
				Lasiurus borealis	1
					5
Pigeon River	Haywood	USFS (Pisgah National Forest)	7/1/2010	*Myotis lucifugus*	2
				Myotis septentrionalis	1
				Lasiurus borealis	2
					5
Little TN River/Hwy 28 Bridge	Macon	NCDOT	7/26/2010	*Myotis lucifugus*	**8**

Table7. North Carolina Wildlife Resources Commission summary of summer mist net surveys in the mountain region, July 1, 2009 to August 31, 2010.

Species	Number
Rafinesque's Big-eared Bat** (*Corynorhinus rafinesquii rafinesquii*)	6
Big Brown Bat (*Eptesicus fuscus*)	90
Silver-haired Bat *(Lasionycteris notivagans)*	6
Red Bat (*Lasiurus borealis*)	96
Hoary Bat *(Lasiurus cinereus)*	10
Gray Bat*** *(Myotis grisescens)*	1
Eastern Small-footed Bat* (*Myotis leibii*)	10
Little Brown Bat (*Myotis lucifugus*)	155
Northern Long-eared Bat (*Myotis septentrionalis*)	125
Indiana Bat*** (*Myotis sodalis*)	2
Tri-colored Bat *(Perimyotis subflavus)*	17
Myotis species	56
Unknown	4
TOTAL	**578**

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

B. Target Dates for Achievement and Accomplishment

On schedule.

C. Significant Deviations

No surveys were conducted for non-volant mammals during this period. WNS surveillance and monitoring became the Western Region's priority due to the emerging WNS threat and state budget constraints on staffing.

D. Remarks

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, in collaboration with key partners, including the US Fish and Wildlife Service, we drafted a White Nose Syndrome Surveillance and Response Plan for North Carolina. This plan has helped guide us as we make decisions about how to prepare for the likely arrival of WNS to North Carolina's bats. Along with this, we increased our survey and monitoring efforts with bats in light of this emerging disease. We made visits to hibernacula specifically to do surveillance for WNS, including

surveys done in late winter/early spring when signs of WNS should be more obvious (if present). Likewise, we worked with partners all over the state to create a list of sites suitable for long-term monitoring of bats in the summer months. This list is made up of mist-netting sites, bridge roosts, and Anabat (bat detector) locations/routes that we already have good datasets for, so that we'll be able to look at changes in our summer bat populations due to WNS and other stressors over time.

Mist netting surveys resulted in some exciting finds. One gray bat, two Indiana bats, and six Rafinesque's big-eared bats were captured, as well as 10 small footed bats. We also had an interesting capture in Rutherford County during winter hibernacula surveys. An Indiana bat was observed at Sliding Rock Cave in the Rumbling Bald area.

We continue to have issues with vandalism of both the inner and outer gates at Cranberry Mine in Avery County. The recent gate vandalism has potentially increased disturbance to bats. Plans are underway to better secure the gates to provide a more suitable roost.

E. Recommendations

We should continue to gather data that will help solidify our understanding of bat populations in North Carolina. Thus, we must continue regular surveys and surveillance for White Nose Syndrome at known bat hibernacula in order to assess population trends over time. Likewise, we should, in cooperation with key partners, work on strengthening our long-term summer monitoring program. We must also continue cooperating with other agencies and individuals to compile data into our comprehensive bat database.

F. Estimated Cost

$97,051 (including in-kind and other non-federal match)

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Final Performance Report

State: North Carolina **Project Number:** T-11 - P

Period Covered: July 1, 2009 – August 31, 2010

Project Title: State Wildlife Grant 07- Wildlife Management:

Study Title: Western Region Reptile Conservation

Objectives:

1. To survey for state listed and high priority reptiles throughout western North Carolina (Table 1), including new sites and "re-discovery" of historic sites
2. To assess (when possible) the relative abundance as well as the requirements and availability of habitat for rare or poorly known reptiles throughout western North Carolina
3. To implement long-term population monitoring studies to monitor trends and to examine the effects of habitat management on certain species (as time allows and when enough information is available for a particular species) so that we can make more informed conservation and management decisions
4. Provide information regarding the status and distribution of reptiles (technical guidance) to state and federal agencies and other organizations/individuals that will further the goals of the North Carolina Wildlife Action Plan

A. Activity

This year's activities included continued efforts on the bog turtle project, coordination of the statewide mark-recapture box turtle study (i.e., the Box Turtle Connection), continued efforts to learn more about the aquatic turtle assemblages in western North Carolina, and recording of incidental observations of priority reptile species. More information about each of these projects is outlined below. Technical guidance was also provided periodically to conservation partners and the public.

Staff participated in several important meetings with volunteers, non-governmental organizations, and other state and federal agencies and gave several presentations about priority reptiles. Data compilation and management are integral to successfully meeting the objectives of this project. Communication efforts directed towards researchers, wildlife enthusiasts, and other stakeholders continue to be an invaluable source of data. Results of these activities led to collaborative projects, volunteer contributions, and increased efficiency in achieving project objectives.

Bog Turtles

From July 1, 2009 – August 31, 2010 we continued to compile existing data in cooperation with a very active group of volunteers, Project Bog Turtle. We entered data into and managed the Microsoft Access database that serves as the permanent storage medium for all bog turtle data

generated in North Carolina. We also continued to communicate and foster working relationships with project collaborators including private groups, non-governmental organizations, federal agencies, and citizen volunteers. Other activities this year included meeting with landowners to discuss options for protecting their land, providing technical guidance to partners and citizens, and presenting an update on survey activities, results, and habitat management projects at Project Bog Turtle's Annual Meeting.

During this time period, surveys were conducted in fall 2009 and summer 2010 for bog turtles, with extensive efforts from volunteers and inter-agency collaborators. One hundred and seventy-eight (178) bog turtles (including 68 new individuals) were captured during 38 site visits (Table 1). Compared to sampling efforts in 2008-2009, we made slightly fewer site visits this year but captured more turtles (Figure 1). The number of sites visited is lower due to efforts to improve and standardize our data collection methods and due to reduced staff in our program.

Table 1. Summary by NC County of reported survey visits from July 31, 2009 – August 31, 2010 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
Ashe	6	4	0	10	3	7	10
Avery	2	1	0	3	0	2	2
Buncombe	6	0	0	6	2	0	2
Henderson	3	0	0	3	1	6	7
Macon	1	1	0	2	0	0	0
Wilkes	12	1	1	13	62	94	156
Yancey	1	0	0	1	0	1	1
TOTALS	**31**	**7**	**1**	**38**	**68**	**110**	**178**

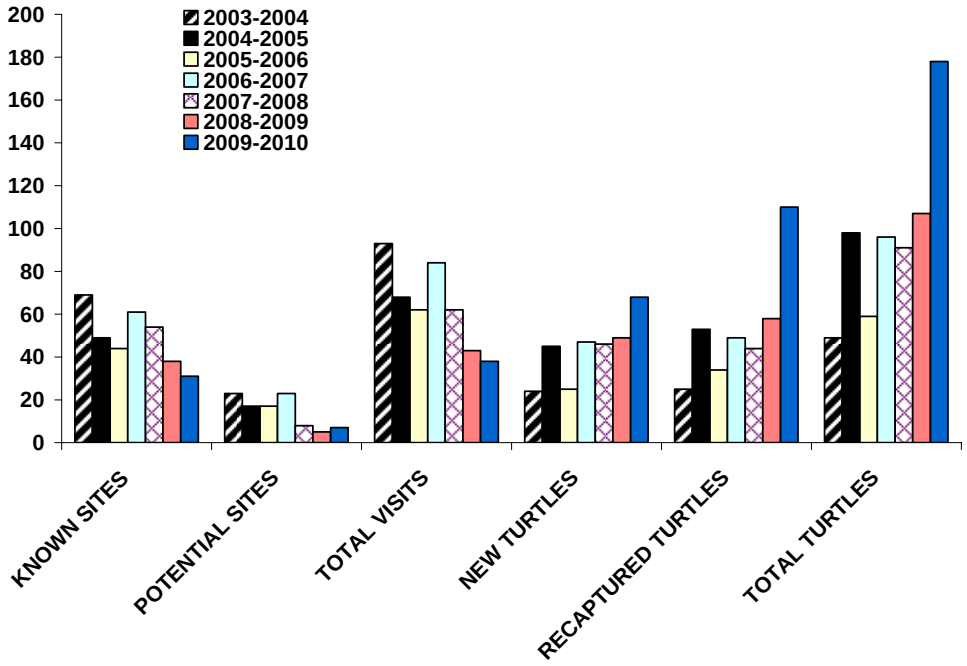


Figure 1. NC Wildlife Resources Commission bog turtle site visits and survey results shown for every year beginning with the 2003-2004 fiscal year and up to the 2009-2010 fiscal year.

Box Turtles

We continue to encourage the public to submit basic 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 will 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 ameliorate the problem if possible. The box turtle is the most highly reported species on the Carolina Herp Atlas; a total of 1321 box turtles have been reported thus far (as of December 14, 2010). Note that this total includes both North and South Carolina records, though the vast majority were from North Carolina. These data will be compiled and summarized in the future.

In an effort to better understand the box turtle's status and presumed declines, a collaborative box turtle research group, called "Box Turtle Connection," (BTC) was formed in 2007 to begin planning a state-wide mark-recapture study on box turtles. Representatives of this group include staff from NC Wildlife Resources Commission, NC State Parks, UNC-Greensboro, Duke University, NC Museum of Natural Sciences, NC Zoo, and Davidson College. The main research objectives of this group are to gather baseline data, as well as information about activity levels, health status, landscape level influences, and to compare among ecosystem types across the state. There are currently 34 study sites across North Carolina, with each project leader running their own mark-recapture study (see Table 2). Project sites are located in 27 counties, although some sites go across county boundaries, and therefore are shown as being in multiple counties (Table 2).

Table 2. Box Turtle Connection study sites by North Carolina County. Note that sites are fairly well spread across the state.

County	Number of Sites	County	Number of Sites	County	Number of Sites
Ashe	1	Gates	1	Rockingham	1
Burke	1	Guilford	4	Stanly	1
Camden	1	Guilford, Rockingham	1	Stokes	1
Chatham	1	McDowell & Burke	1	Surry	1
Columbus	1	Mecklenburg	2	Transylvania	1
Cumberland, Hoke, Moore, & Harnett	1	Orange	1	Wake	5
Durham	1	Orange & Durham	1	Wayne	1
Durham, Wake	1	Randolph	1	Yancey	1
Gaston	1	Robeson	1		

Regular management of the online data entry website and communication with the project leaders has been necessary throughout the year. The online data entry system has vastly streamlined the data entry process and provides a more secure method for storing data (data are regularly backed up on the server). As of December 2010, there had been a total of 1247 captures in the BTC project (see Table 3). The first year that data were collected on this project was 2008. However, some sites were recording box turtle captures before the project officially started; this explains why there are captures shown in Table 3 in the years preceding 2008. A thorough analysis requires additional years of mark-recapture data on this project.

Table 3. Number of captures by year in the Box Turtle Connection Mark-Recapture Project.

Year	# Turtles Captured
2002	5
2003	13
2004	25
2005	31
2006	9
2007	18
2008	265
2009	565
2010	316*
TOTAL	**1247**

*Not all 2010 data have been entered.

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. In addition, we have been gathering data on several other species (or subspecies) that were not previously known to North Carolina, such as the Cumberland slider (*Trachemys scripta troosti*) and the common map turtle (*Graptemys geographica*), and species that are found outside their known range, such as the river cooter (*Pseudemys concinna*). 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 conducted four trapping events, two of which were at the same location on consecutive years (Table 4). Turtle hoop traps of various sizes were set for three trap nights during each trapping event. All turtles captured were measured and marked before released. A total of eight target species were captured in these efforts, including two stripeneck musk turtles, three eastern spiny softshell turtles, and three Cumberland sliders (see Table 4). Other species captured include the snapping turtle (*Chelydra serpentina serpentina*) and the common musk turtle (*Sternotherus odoratus*).

Table 4. Trapping events, number of trap nights, and captures for priority aquatic turtle species between July 1, 2009 and August 31, 2010.

Trapping Site	County	Month/Year	Total # of Trap Nights	Target species (# captured)
French Broad River at Huff Island	Madison	August 2009	82	*Trachemys s. troosti* (3)
Shuler Creek	Cherokee	Aug/Sept 2009	38	*Sternotherus m. peltifer* (1)
Valley River	Cherokee	September 2009	42	none
French Broad River at Huff Island	Madison	August 2010	84	*Apalone spinifera spinifera* (3), *Sternotherus m. peltifer* (1), *Pseudemys concinna* (1)

Priority Reptiles

Visual encounter surveys and road cruising surveys, as well as reported records from other biologists yielded locality information for several other priority reptile species (Table 5). Because of limited staffing, we were unable to survey the 10 artificial cover study sites that were set up in 2007-2008 (Table 6). Likewise, most reptile observations have been incidental in nature, such as snakes found alive or dead on the road, reptiles captured while conducting other surveys, or observations reported by other biologists.

Table 5. Target reptile species documented in western North Carolina from July 1, 2009 to August 31, 2010.

Scientific Name	Common Name	County	# Observed	Observation/Method
Lampropeltis g. getula	Eastern Kingsnake	Wilkes	1	visual encounter survey
Pseudemys c. concinna	Eastern River Cooter	Rutherford	2	electroshocking, boat electrofishing
Apalone s. spinifera	Eastern Spiny Softshell	Madison (1), Buncombe (2)	3	visual encounter survey
Crotalus horridus	Timber Rattlesnake	Henderson (2), Haywood (3)	5	visual encounter survey, road cruising

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

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

B. Target Dates for Achievement and Accomplishment

On schedule

C. Significant Deviations

None

D. Remarks

In summary, one hundred and seventy-eight (178) bog turtles (including 68 new individuals) were captured during 38 site visits. Another highlight of the bog turtle project was the discovery of a new site in Wilkes County, Sawyer bog; thus far, two adult bog turtles have been found. Of significant note, a bog (Mulberry Mill) recently acquired by the NC Wildlife Resources

Commission in Wilkes County had three years of low captures (2007: 1; 2008: 0; 2009: 2). Speculation was that the turtles at that site were more difficult to capture and/or had moved into another area during the extreme drought affecting the region. The capture of eight bog turtles at this wetland in May 2010 provided confirmed that the population remains extant.

The state-wide mark-recapture box turtle study, the Box Turtle Connection, was continued in 2009-2010, at a current total of 34 study sites across North Carolina. Collaboration with many partners throughout the state and the hard work of each site's project leader are essential components to the longevity of this project. The total number of box turtle captures (1247 total) in this project is impressive, and indicative of the high level of enthusiasm and dedication that the project leaders have shown. Thus far, this project is showing itself to be quite successful, with great potential to answer some of the most important questions about the status of box turtles in North Carolina.

In the aquatic turtle project, we continue to capture priority species, such as the two stripeneck musk turtles and three eastern spiny softshell turtles caught this year, as well as the capture of several somewhat unexpected species, including the three Cumberland sliders and one river cooter captured. Through these trapping efforts, we have learned of additional subspecies and species that were not known within North Carolina or within particular areas of NC, thereby gaining a better understanding of the species assemblages and distribution of aquatic turtles in western North Carolina.

Records submitted by the public and partner agencies and organizations have proven invaluable for gaining new locality records for priority reptiles in the mountain region. This is particularly true with the records this past year. Many of the records of priority reptile species were sent in by NC Wildlife Resources Commission staff from other divisions and staff from other governmental entities (e.g., UNC-Asheville, NC DWQ) that we frequently partner with on conservation efforts.

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. 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 multiple survey iterations, 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).

As time and resources allow in the upcoming years, we should continue to monitor bog turtle populations, learn more about the effects of different types of habitat management of bogs, take action to better manage and protect priority habitats, gather data on priority reptile species, learn more about the distribution, status, and habitat use of aquatic turtles, and continue to improve upon the Box Turtle Connection project. In addition, of immediate importance is to invest time in updating, organizing, and managing the reptile databases, especially the bog turtle database, in order to better answer key questions pertaining to the long term persistence of these reptile species in North Carolina. Data sharing, collaboration, and coordination of survey and

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

F. Estimated Cost

$157,021 (including in-kind and other non-federal match)

G. References

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

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

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

Final Performance Report

State: North Carolina **Project Number:** T – 11 -P

Period Covered: July 1, 2009 - August 31, 2010

Grant Title: State Wildlife Grants 07-Wildlife Management

Project Title: NC Partners in Amphibian and Reptile Conservation

Objectives:

The North Carolina Partners in Amphibian and Reptile Conservation (NCPARC) program will:

- Continue to develop and coordinate a North Carolina chapter of PARC to cooperatively promote conservation and assist with conservation planning.
- Continue to develop and reinforce partnerships that will benefit reptile and amphibian 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 reptile and amphibian conservation.
- Coordinate the North Carolina Calling Amphibian Survey Program (CASP) and assist with other monitoring and research programs.
- Coordinate and facilitate the exchange of information about the status and needs of reptiles and amphibians for citizens and natural resource professionals through the NCPARC education and outreach technical working group, the policy, regulation and trade technical working group, and the research, inventory, monitoring and management technical working group.
- Train natural resource professionals and volunteers to help survey reptile and amphibian populations, and assist agencies, non-governmental organizations and private entities to implement herpetofaunal monitoring, research, and habitat management programs.

A. Activity

The principle objective of this project is to coordinate a North Carolina chapter of Partners in Amphibian and Reptile Conservation (NCPARC) to promote herpetological conservation and assist with planning herpetological research initiatives. The NCPARC program has involved: 1) continued NCPARC coordination; 2) cooperative planning, development and initiation of citizen participation projects as recommended by the NCPARC education and outreach technical working group; 3) facilitation of and cooperative participation in planning statewide projects to continue to address herpetological needs as determined by the NCPARC research, inventory, monitoring and management technical working group; and 4) coordination of the NC Calling Amphibian Survey Program (CASP).

Coordination and Communication

Maintaining close coordination and communication among NCPARC members involved providing technical guidance and facilitation of meetings of the three technical working groups, the steering committee, and an annual meeting of the entire NCPARC membership. Website pages were updated routinely and a newsletter was published to keep the NCPARC body informed of ongoing initiatives and activities. The NCPARC Coordinator also provided technical guidance on matters related to planning, research, monitoring, conservation and management of reptiles and amphibians to agencies, private conservation organizations and citizens.

NCPARC Research/Monitoring Programs and Partnerships

1. *The North Carolina Calling Amphibian Survey Program (CASP)*
In the fall of 2009, all data from the 2009 field season was entered into the online North American Amphibian Monitoring Program (NAAMP) database. All NAAMP data is available online: http://www.pwrc.usgs.gov/naamp/. In 2009, forty-two volunteers collected data on forty-nine CASP routes. Twenty-five of NC's thirty native anuran species were detected on these routes. Of these twenty-five, six are priority species listed in the North Carolina Wildlife Action Plan (*Bufo quercicus*, *Hyla andersonii*, *Hyla gratiosa*, *Pseudacris brimleyi*, *Pseudacris nigrita*, *Pseudacris ornata*). Data collection continued for the 2010 field season. Although data from the 2010 season has not yet been entered or reviewed, seventy-one observers were assigned to sixty-three routes. Data entry by observers began in July and August along with review by the coordinator. All data will be entered and reviewed by November 1, 2010.

2. *The Carolina Herp Atlas (CHA)*
The CHA was officially launched in March 2007. Prior to the launch, the Davidson College Herpetology Lab imported approximately 3900 records, primarily from Mecklenburg, Iredell, and Cabarrus counties in the western Piedmont of North Carolina. From March 2007 through August 31, 2010, the CHA totaled 809 registered users. The CHA received 11,589 reptile and amphibian records from North Carolina. Of those, 5040 were accompanied by voucher photograph and/or given a status of 10 (the highest confidence rating). A total of 141 North Carolina reptile and amphibian species have at least 1 record in the CHA.

Thus far, the CHA has collected species-level, distribution data on 141 species of amphibians and reptiles, including the occurrence of 29 anurans, 47 salamanders, 36 snakes, 11 lizards, 17 turtles, and the American alligator. The most commonly reported species include eastern box turtle (*Terrapene Carolina;* 1192 records), painted turtle (*Chrysemys picta*; 790 records), rat snake (*Elaphe obsoleta*; 585 records), black racer (*Coluber constrictor*; 547 records) and copperhead (*Agkistrodon contortrix*; 137 records).

Amphibians considered special concern, threatened, or endangered by the state of North Carolina for which records have been submitted include green salamander (*Aneides aeneus*; 12 records), Tiger salamander (*Ambystoma tigrinum*; 17 records), mole salamander (*Ambystoma talpoideum*; 6 records), eastern hellbender (*Cryptobranchus alleganiensis*; 6 records), dwarf salamander (*Eurycea quadridigitata*; 7 records), four-toed salamander (*Hemidactylium scutatum*; 5 records), Pine Barrens Treefrog (*Hyla andersonii*; 2 records), Eastern zigzag salamander (*Plethodon*

ventralis; 1 record), Wehrle's salamander (*Plethodon wehrlei*; 2 records), mountain chorus frog (*Pseudacris brachyphona*; 12 records) and Carolina gopher frog (*Rana capito*; 3 records).

Reptiles considered special concern, threatened or endangered by the state of North Carolina that have been submitted to the CHA include American alligator (*Alligator mississippiensis*; 18 records), eastern diamondback rattlesnake (*Crotalus adamanteus*; 5 records), loggerhead sea turtle (*Caretta caretta*; 6 records), timber rattlesnake (*Crotalus horridus*; 163 records), coal skink (*Eumeces anthracinus*; 2 records) bog turtle (*Glyptemys muhlenbergii*; 8 records), diamondback terrapin (*Malaclemys terrapin*; 5 record), southern hognose snake (*Heterodon simus*; 18 records), northern pine snake (*Pituophis melanoleucus*; 17 records) and pigmy rattlesnake (*Sistrurus miliarius*; 49 records).

3. *Ribbit Radio*

The recent surge in the development and application of species occurrence models has been associated with an acknowledgment among ecologists that species are detected imperfectly due to observation error. Standard models now allow unbiased estimation of occupancy probability when false negative detections occur, but this is conditional on no false positive detections and sufficient incorporation of explanatory variables for the false negative detection process. These assumptions are likely reasonable in many circumstances, but there is mounting evidence that false positive errors and detection probability heterogeneity may be much more prevalent in studies relying on auditory cues for species detection (e.g., songbird or calling amphibian surveys).

We modified a system originally developed to simulate avian point counts (Bird Radio) to experimentally assess factors influencing detection probabilities on auditory counts of calling anurans. We estimated the effective and maximum detection radii of both human listeners and automatic detection devices for several anuran species. We assessed the effects of factors, such as the type and volume of background noise, on detection radii and detection probabilities. Finally, we explored the possibility of estimating anuran chorus size (abundance or relative abundance indices/states) via broadcasting a known number of calling 'individuals' and subsequent analysis of data collected via automatic recording devices and human listeners. The goals of this research were to address previously unexplored sources of variation in the anuran detection process to target application or development of model-based methods to address, estimate and accommodate these sources of variation. Additionally, the modified Bird/Anuran radio may also serve as a powerful training device for NC CASP volunteers and serve as a prototype for other state agencies' training programs.

We used field survey data from a simulated calling anuran system of known occupancy state to investigate the biases induced by these errors in dynamic models of species occurrence. Despite the participation of expert observers in simplified field conditions, both false positive errors and site detection probability heterogeneity were extensive for most species in the survey. We found that even low levels of false positive errors, constituting as little as 1% of all detections, can cause severe overestimation of site occupancy, colonization, and local extinction probabilities. Further, un-modeled detection probability heterogeneity induced substantial underestimation of occupancy and overestimation of colonization and local extinction probabilities. Completely spurious relationships between species occurrence and explanatory variables were also found.

Such misleading inferences would likely have deleterious implications for conservation and management programs. We contend that all forms of observation error, including false positive errors and heterogeneous detection probabilities, must be incorporated into the estimation framework to facilitate reliable inferences about occupancy and its associated vital rate parameters.

4. *Population status, distribution, and phylogeography of the seepage salamander (*Desmognathus aeneus*) in North Carolina*

We have attempted to compile all historical localities in NC for *Desmognathus aeneus*. To this end we visited the North Carolina Museum of Natural Sciences in March and examined all of their holdings of *D. aeneus*. We also contacted Richard Bruce and James Petranka and received all of their personal records of *D. aeneus*. All records available on Herpnet were downloaded and all literature records were compiled (ex Harrison 1967). For all historic localities that did not provide coordinates the site descriptions were used to locate the site on a topographic map (Acmemapper) and then coordinates were assigned. All of these sites were used to create a point shapefile in ArcGIS. This resulted in 48 records of seepage salamanders in NC. It is important to note that 14 of these sites lie very close to another (often 1 km or so apart) in the vicinity of Standing Indian and the Coweeta Long Term Ecological Research site. All historic localities are from five counties: Swain, Graham, Cherokee, Clay and Macon.

Eight days between April 23-June 21 were spent in the field visiting sites. An attempt was made to visit historic collection localities (or very nearby areas when access was not available) as well as visiting newly located areas containing suitable habitat within the range extent of seepage salamanders as delimited by our records. Additionally half of a day was devoted, unsuccessfully to searching suitable habitat in areas near Lake Toxaway as seepage salamanders are known from the Savannah River drainage but have not been recorded from that far east.

We visited 23 sites that we deemed to have habitat suitable for seepage salamanders. We found populations at 16 sites. Of the 7 sites we did not find seepage salamanders at, only one is a historic site and that one is farther east than the species has been commonly found and is represented by a photograph shown to Richard Bruce who confirmed the identification but was unable to find any specimens in several searches that he made in that area. Of the 16 sites we did locate specimens at, 8 of them were historic sites while the remaining 8 sites were newly located populations.

Tissue samples have been collected from all localities and will be sequenced this fall after the last collecting trips have been conducted. The first round of DNA extractions occurred in August. We anticipate spending another 6-8 days in the field during September and October, 2010.

B. Target Dates for Achievement and Accomplishment

On schedule

C. Significant Deviations

None

D. Remarks

The CHA has thus far been a highly successful, citizen-science based project to document the distribution of reptiles and amphibians in North Carolina. The collection of 11,589 reptile and amphibians observational records from North Carolina (16,568 total from North and South Carolina) during the first 3 years suggests that the CHA has the potential to surpass many other citizen-science based herpetological atlas projects. Thus far, the CHA represents a significant step towards development of a better understanding the distributions of reptiles and amphibians in the Carolinas. The interactive nature of the CHA appears to appeal to a wide variety of people, including school teachers, professional herpetologists, and those generally interested in wildlife.

E. Recommendations

None

F. Estimated Cost

$ 130,050 (including in-kind and non-federal partner match)

Prepared By: Jeff Hall
Partners in Amphibian and Reptile Conservation Biologist
Division of Wildlife Management

Final Performance Report

State: North Carolina **Project Number:** T – 11 -P

Period Covered: July 1, 2009 - August 31, 2010

Grant Title: State Wildlife Grants 07-Wildlife Management

Project Title: Wildlife Diversity Coordination

Objectives:
To establish and maintain management control systems adequate to meet requirements for administration of Federal-Assistance Programs and integrate them with non-federally funded projects into a comprehensive Wildlife Diversity Program to achieve NC Wildlife Action Plan goals.

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 and documentation 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 Action Plan 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, and compiled and reviewed in-kind match documentation to assure consistency with program standards.

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. These included a Wildlife Diversity Program Manager's meeting, 3 Joint Venture and Atlantic Flyway meetings, and numerous WRC coordination meetings. 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

On schedule

C. Significant Deviations

None

D. Estimated Cost

$137,624

Prepared By: Chris McGrath
Wildlife Diversity Program Coordinator
Division of Wildlife Management

Annual Performance Report

State: North Carolina **Project Number:** E-16-3

Period Covered: July 1, 2009 - June 30, 2010

Grant Title: North Carolina Terrestrial Endangered Species

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, and together they 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 beach 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 & Wildlife Service to ensure that these activities do not result in the take of viable nests or hatchlings. The Sea Turtle Project Biologist spends a considerable amount of time addressing environmental concerns as they relate to sea turtles, including reviewing Endangered Species Permit applications and a growing number of environmental impact documents.

Nest Surveys and Protection

In 2009, 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 2009, 83 permits were issued to volunteer coordinators, 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. Also, more than 600 additional individuals who operated under umbrella beach project permits contributed significantly to sea turtle management efforts.

Nest Surveys and Protection

During the 2009 nesting season, there were 1190 sea turtle crawls observed on ocean-facing beaches in North Carolina. Of these, 622 were sea turtle nests (614 laid by loggerheads, 4 laid by green turtles, 3 laid by leatherbacks, and one laid by an unidentified species – see Table 1), and the remainder were non-nesting emergences (also referred to as "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 614 loggerhead nests is lower than the state average (734 nests/yr), based on the previous 17 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 (or <3% of the entire ocean coastline of NC). Similarly, Lea-Hutaff Island (~4 miles) is not monitored daily, although there is regular observer effort several times a week during the nesting season.

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. In 2009, 220 loggerhead nests (35.8%), 1 green turtle nest (25.0%), and 1 leatherback nest (33.3%) 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 (72.6% ±3.2 SE, n=221) and *in situ* nests (57.2% ±2.8 SE, n=382) were significantly different ($p<0.0001$, 2-tailed Mann Whitney non-parametric test, data transformed using the arcsin function). The lower emergence success of many nests was likely related to the passage of Hurricane Bill near Bermuda in late August 2009, which created heavy surf that inundated or eroded incubating clutches of egg. Emergence success for green turtle nests was 30.0% (n=4) and for leatherback nests was 52.3% (n=3). Mean clutch size for loggerhead nests was = 117.8 eggs (range: 40-182), based on relocated nests only, with no prior predation observed. For green turtles, mean clutch size was = 126.3 eggs (range: 114-137); for leatherbacks, mean clutch size was = 90.3 (range: 85-99).

Although no satellite tags were deployed on nesting females in 2009 in North Carolina, the four loggerheads from the 2008 nesting season continued to transmit data in 2009, while they

remained on their seasonal or annual foraging grounds. Full maps of the migratory routes and foraging areas of the turtles are available at: http://www.seaturtle.org/tracking/?project_id=230 .

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 2009, 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 ocean-front areas are 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

$155,820 (including in-kind contributions)

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

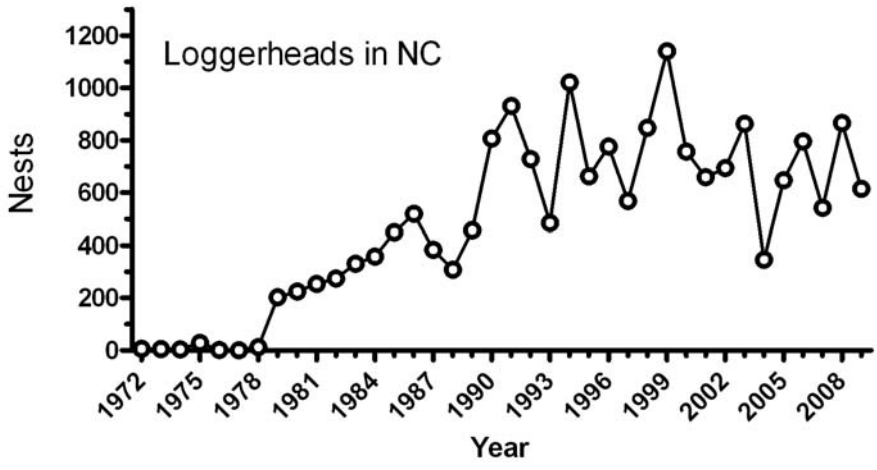


Figure 1: Annual numbers of loggerhead nests laid on ocean-facing beaches in North Carolina, 1972-2009. Statewide standardized monitoring for sea turtle nesting was established in the mid-1990s.

Table 1. Observed loggerhead turtle nests laid on beaches in North Carolina, May-September 2009. Nests laid by other species are noted at the bottom of the table.

PROJECT	LOGGERHEAD TURTLE NESTS
VA STATELINE TO SOUTH NAGS HEAD	6[a]
PEA ISLAND NWR	10
CAPE HATTERAS NATIONAL SEASHORE	101[a,b]
CAPE LOOKOUT NATIONAL SEASHORE	140[c]
FORT MACON STATE PARK	6
BOGUE BANKS	29
HAMMOCKS BEACH STATE PARK	8
CAMP LEJEUNE MARINE CORPS BASE	35
TOPSAIL ISLAND	58[d]
LEA-HUTAFF ISLANDS	2
FIGURE 8 ISLAND	10
WRIGHTSVILLE BEACH	1
MASONBORO ISLAND	6
CAROLINA BEACH	12[a]
KURE BEACH	1
FORT FISHER STATE PARK	14
BALD HEAD ISLAND	36[c]
CASWELL BEACH	27
OAK ISLAND	56
HOLDEN BEACH	23
OCEAN ISLE BEACH	25
SUNSET BEACH and BIRD ISLAND	8
TOTAL	**614**

[a]One leatherback nest was also observed on this beach.

[b]Two green turtle nests were also observed on this beach

[c]One green turtle nest were also observed on this beach

[d]One nest laid by an unidentified species also occurred on this beach

Annual Performance Report

State: North Carolina **Project Number:** E-16 -3

Period Covered: July 1, 2009 – June 30, 2010

Grant Title: North Carolina Terrestrial Endangered Species

Project Title: Northern Flying Squirrel Habitat Management

Objectives:

The two main goals of this project are to ensure that conifers remain extant in the area inhabited by Carolina northern flying squirrels and to mitigate for the road barrier issue. Objectives to accomplish these goals include:

- Working with the U.S. Forest Service to engage appropriate management to stave-off complete loss of hemlocks from this recovery area.
- Providing technical guidance to U.S. Forest Service for establishing suitable conifers to replace the declining hemlocks.
- Evaluating use of six road-crossing structures.

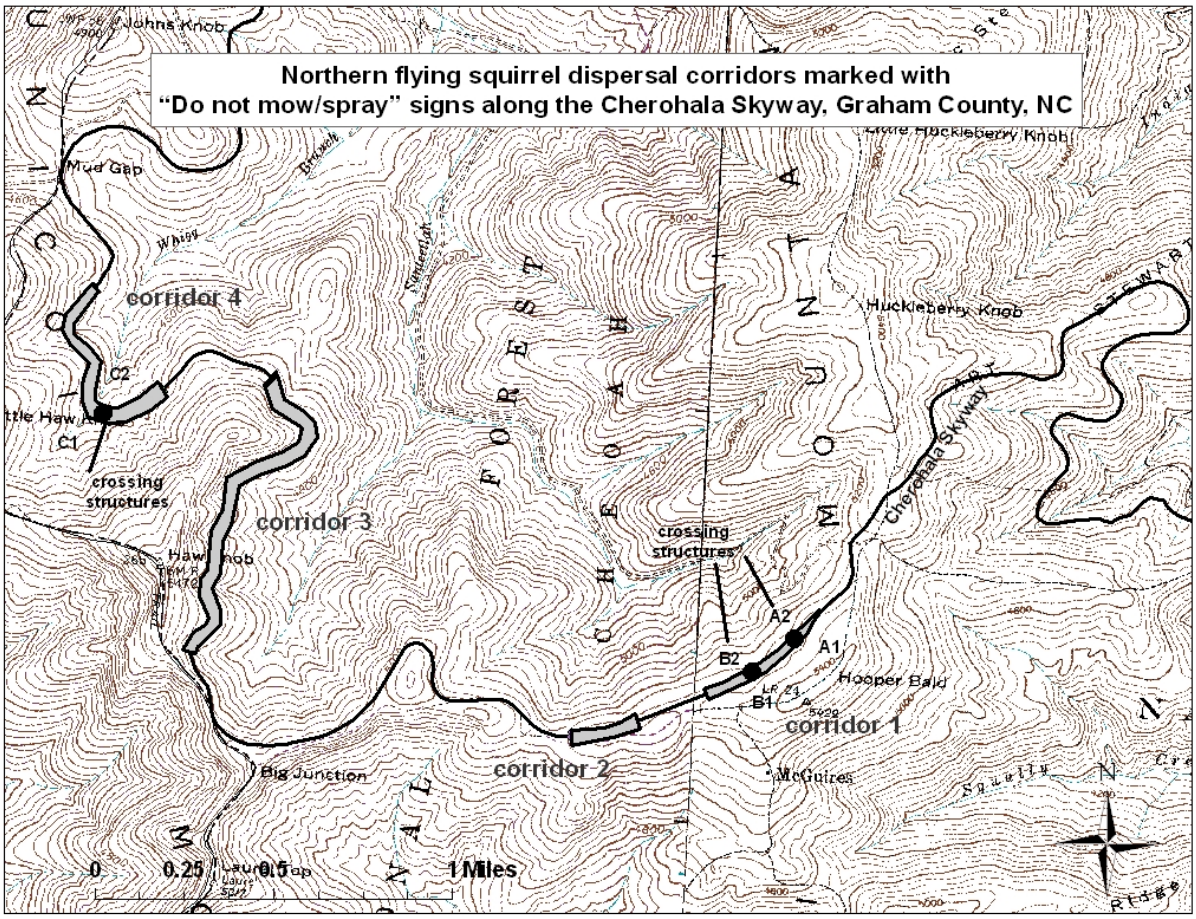
A. Activity

This year's activities consisted of technical guidance on future conifer plantings and hemlock treatment, signage to protect the designated dispersal corridors, and evaluation of flying squirrels' use of the crossing structures.

Conifer habitat- NCWRC identified locations for future conifer plantings. Given a shortage of red spruce seedlings in the Great Balsams available for direct transplant, a decision was made to propagate spruce from seed. Southern Highlands Reserve, a non-profit group involved in native plant restoration, assisted NCWRC with red spruce cone collection from the Great Balsams and has started seed germination at their facility in Lake Toxaway, NC. Seedlings will be available for transplant in three years.

Dispersal corridors- While the crossing structures provide a short-term solution to the road barrier, the long term solution is to narrow the gap by allowing trees to regenerate along the road shoulder. To protect tree seedlings along the road shoulder from roadside vegetation management sixteen "do not mow/ do not spray" signs were posted after consultation with NC Department of Transportation. These signs delineate four dispersal corridors, all having suitable habitat on both sides of the road and two having crossing structures (Figure 1).

Figure 1. Northern flying squirrel dispersal corridors marked with “Do not mow/spray” signs along the Cherohala Skyway, Graham County, NC.



Crossing structure evaluation- Use of the structures was determined via continuous video monitoring with Bushnell Trophy video cameras through June 2010. Cameras were checked on September 13, 2009, January 16, 2010, and June 17, 2010 and taken down during the last check. Twenty-three videos recorded northern flying squirrels exploring the poles. In 13 of these videos, flying squirrels leaped across the Skyway from the horizontal launch beam. All three corridors and all six poles are now being used by northern flying squirrels. Captures from nest boxes and discovery of birch bark nests in escape shelters on two poles (one occupied by a flying squirrel during the June 2010 camera check) provided further evidence of squirrel movement across the road and use of the poles. In August 2009, in an isolated patch of habitat on the south side of the Skyway, below Hooper Bald, a birch bark nest was found in a nest box for the first time. Subsequently, in May 2010, a previously untagged northern flying squirrel was captured from this box and ear-tagged. Camera monitoring answered the remaining evaluation questions, such that additional radio-telemetry tracking was unnecessary. The poles do not appear to increase risk of predation. In 15 months of camera monitoring only one barred owl was video-taped in Whigg Cove.

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. These results show that flying squirrels will readily use the crossing structures to cross the Cherohala Skyway. Thus, populations have been reconnected in these areas after being divided for 20 years by the Skyway. We expect this will increase the potential for gene flow in this recovery area.

E. Recommendations

NCWRC should remain actively involved in the conifer planting project. Seedlings will be ready for transplant in approximately three years, though there may be opportunities to transplant Fraser fir in the interim.

Nest box surveys should continue both to monitor the population and obtain further evidence of marked individuals using home ranges that span both sides of the Skyway. If sightings of barred owls perched on the poles increase, further camera monitoring may be necessary.

F. Estimated Cost

$9,219 (Including In-Kind contributions)

G. References

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Prepared By: Chris Kelly
Mountain Wildlife Diversity Biologist
North Carolina Wildlife Resources Commission

Annual Performance Report

State: North Carolina **Project Number:** E-16-3

Period Covered: July 1, 2009 – June 30, 2010

Grant Title: North Carolina Terrestrial Endangered Species

Project Title: Landscape and Conservation Genetics of the Northern Flying Squirrel

Objectives:

The objective of this project is to provide the state agencies with a detailed report on levels of genetic variability for the northern flying squirrel (*Glaucomys sabrinus*). Furthermore, we will assess how the genetic variability is distributed across the landscape. We will analyze between 5 and 8 nuclear loci using microsatellites.

A. Activity

The staff of the North Carolina Wildlife Resources Commission collaborated with Brian Arbogast and Katelyn Shumaker of the University of North Carolina-Wilmington. NCWRC collected blood samples from northern flying squirrels in western North Carolina which were analyzed at UNC-W. 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 and Recommendations

This study indicated that there are three distinct populations of *G. sabrinus* in the Appalachians. Virginia samples form their own population segment, separate from *G. s. coloratus* and *G. s. fuscus*. This finding warrants further study with increased sample sizes and testing of higher number of microsatellite loci.

E. Estimated Cost

$3,777 (including in-kind contributions).

Prepared By: Chris Kelly
Mountain Wildlife Diversity Biologist, NCWRC

APPENDIX A.

Conservation Genetics of the Northern Flying Squirrel (*Glaucomys sabrinus coloratus*) in North Carolina and Virginia

A Report on the Results of Research Conducted Under Cooperative Agreement Between North Carolina Wildlife Resources Commission And University of North Carolina at Wilmington, Wilmington, North Carolina 28407

Prepared by

Brian S. Arbogast and Katelyn I. Schumacher
Department of Biology and Marine Biology
University of North Carolina, Wilmington
Wilmington, NC 28403

18 June, 2010

Original Proposal Abstract:

The northern flying squirrel, *Glaucomys sabrinus*, occurs in spruce-fir forests on high-elevation peaks in the central and southern Appalachians. There are two subspecies, *G. S. fuscus* (primarily in West Virginia) and *G. s. coloratus* (primarily in North Carolina and Tennessee), both of which have been listed as endangered at the federal level. There are also two very small populations in southwestern Virginia in the Grayson Highlands/ Mt. Rogers area. The subspecific status of these Virginia populations is uncertain; they have been treated as both *G. s. fuscus* and *G. s. coloratus* in the past, depending on the author. Currently, they are considered to be *G. s. coloratus*. Recently, *G. s. fuscus* in West Virginia was taken off the federal endangered species list (although this decision is being appealed). However, *G. s. coloratus* remains on the list, and it appears that it will be for the foreseeable future. In this study, modern molecular genetic approaches will be used to analyze the DNA from flying squirrel populations in North Carolina, West Virginia and Virginia. By comparing the DNA of these populations, it should be possible to determine which subspecies the Virginia populations belong to, or, if they are a distinct population, unique from both. In addition, levels of genetic diversity in flying squirrels sampled from large geographic recovery areas in North Carolina will be compared to those sampled from small recovery areas in NC and neighboring states. This will provide insights into the relative loss of genetic diversity (if any) in the small populations due to inbreeding. All of this information will be useful for conservation planning for this species.

Main Objectives Outlined in the Proposal and Cooperative Agreement:

1 Oversee the completion of a microsatellite analysis of approximately 40 individuals (30-50 depending on quality and availability of samples) using a minimum of five microsatellite loci.
2 Produce a detailed report to the North Carolina Wildlife Resources Commission

on the results of this work, with particular attention given to how the genetic analysis can inform current and future management decisions.

3 Complete both items 1 and 2 above for the sum of $3,000, paid as outlined in the Terms and Conditions of the Cooperative Agreement.

4 Provide the completed report on or before June 30, 2010.

BUDGET SUMMARY

ORIGINAL BUDGET:
Total Requested From Agency $3,000.00 Cost Sharing—UNCW: campus overhead not charged to NCWRC = $750.00 TOTAL BUDGET = $3,750.00

EXPENSE SUMMARY

UNCW Funds
Overhead not charged by UNCW = $750.00

NCWRC Funds

		Supplies:
QIAGEN INC	$483.53	(DNA extraction kit)
QIAGEN INC	$329.17	(DNA extraction kit)
QIAGEN INC	$96.21	(PCR Taq Polymerase)
SARSTEDT INC.	$294.00	(Filter tips, Tubes etc.)
	$1,202.91	

Tuition $1,778.83 (In-state tuition for Katelyn S. Schumacher)
TOTAL $2,981.74 (excluding $750.00 F&A not charged by UNCW)

Introduction

Definitive taxonomy is critical to conservation because it provides the source for recognition and protection of endangered species (O'Brien 1994). Precise measures of distinctness and taxonomic hierarchy among constituent taxa are important for ranking and allocating resources to species recovery plans (May 1990). Likewise, determining how landscape characteristics and gene flow create substructure at fine taxonomic levels is important for delineating management, conservation, and evolutionary significant units (Manel et al. 2003).

In the Appalachian Mountains of southeastern North America, remnant patches of spruce-fir (*Picea rubens-Abies* sp.) forest occur as a series of disjunct, high-elevation (>1,300m) "sky-islands." These forests are considered to be Pleistocene relicts, many of which have been isolated from northern forest for 8,000-10,000 years (Delcourt and

Delcourt 1984). Over the last 100 years, these spruce-fir forests have experienced severe levels of habitat degradation and fragmentation due to timber operations, high-intensity fires, overgrazing, and invasive species (reviewed in Browne et al. 1999). Today, spruce-fir forest and associated boreal-adapted species cover a total area of less than 270 km^2 in the Appalachians (White et al. 1993, Browne et al. 1999). As a result, this ecosystem is considered to be one of the most critically endangered (>98% decline) in the United States (Noss et al. 1995).

This study focuses on the landscape and conservation genetics of the northern flying squirrel, *Glaucomys sabrinus,* in the central and southern Appalachians. Although *G. sabrinus* is distributed broadly throughout northern North America, two subspecies are endemic to the spruce-fir sky islands of the Appalachians. Prior to being listed as federally endangered in 1985, fewer than 30 specimens of *G. s. coloratus* and *G. s. fuscus* were known from the entire Appalachians (US Fish and Wildlife Service 1990). Today, *G. s. fuscus* is considered to occur primarily in the central Appalachian mountains of West Virginia (WV), whereas *G. s. coloratus* occurs primarily in the southern Appalachians of North Carolina (NC) and Tennessee. Two small and highly isolated populations of *G. sabrinus* also occur on the two tallest summits in Virginia (VA), Mount Rogers and Whitetop Mountain. The taxonomic status of these particular populations remains uncertain (USFWS 2006). The original endangered species recovery plan treated the southwestern VA flying squirrels as *G. s. coloratus* based solely on geographic proximity (USFWS 1990), however the USFWS now recognizes that the taxonomic placement of southwestern VA specimens remains an open question (USFWS 2006).

Recent events have made clarifying the taxonomic status of southwestern Virginia populations of *G. sabrinus* a critical conservation issue; *G. s. fuscus* was delisted in 2008 due to “recovery” (Federal Register 2008), while *G. s. coloratus* retained its status as Federally Endangered. The delisting of *G. s. fuscus* was based primarily on nest box survey estimates of population persistence (USFWS 2006) and a lack of evidence supporting the existence of distinct population segments within *G. s. fuscus* (Federal Register 2008). Although Arbogast et al. 2005 and Sparks 2005 collected some molecular genetic data on populations of *G. sabrinus* in the Appalachians, these studies were limited in number of geographic localities and molecular markers examined. As such, no investigation to date has used molecular markers to definitively evaluate the population structure of *G. sabrinus* within or across Appalachian subspecies. In particular, the taxonomic placement of southwestern VA specimens remains unresolved. The VA Department of Game and Inland Fisheries currently categorizes *G. sabrinus* from Mount Rogers and Whitetop Mountain as *G. s. coloratus* (http://www.dgif.virginia.gov), thus these populations remain protected under the Endangered Species Act. However, as mentioned above, the USFWS recognizes that the taxonomic placement of southwestern VA specimens is uncertain (USFWS 2006). These observations highlight the need to clarify the status of the southwestern VA populations of *G. sabrinus* and to conduct a thorough analysis of population structure for this species across the central and southern Appalachians.

The long-term goal of this research project is to collect a sufficient amount of genetic data from appropriate molecular markers and geographic localities to definitively address the most critical aspects of conservation of the northern flying squirrels in the

Appalachians. For this initial study supported by NCWRC, we have targeted a subset of samples and molecular markers in order to provide the foundation for reaching these goals. We attempted to address to primary questions, as outlined in the Agreement.

1. *To use microsatellite data to evaluate the validity of current subspecies designations of G. sabrinus in the Appalachians, with an emphasis on clarifying the status of the VA populations. We evaluated the following hypotheses:*

    A. The VA populations can be definitively assigned to *G. s. fuscus*
    B. The VA populations can be definitively assigned to *G. s. coloratus*
    C. The VA populations have mixed ancestry from *G. s. fuscus* **and** *G. s. coloratus*.
    D. The VA populations are genetically **distinct from both** *G. s. fuscus* and *G. s. coloratus*.

2. *To use microsatellite data to assess population structure and differentiation of G. sabrinus at both broad and fine geographical scales in order to compare genetic diversity between populations and/or recovery areas (if recovery areas are resolved as unique genetic populations). This objective is contingent upon availability of sufficient samples/genotypes from genetically distinct large and small recovery areas. We began by evaluating the following hypotheses:*

Subspecies differentiation

A. high genetic differentiation is observed between some **or** all subspecies.
B. high levels of genetic differentiation **are not** observed between **any** subspecies.

Population Structure

A. strong population structure is observed within some **or** all subspecies.
B. strong population structure is **not** observed within **any** subspecies.

Addressing each of these objectives will have direct implications for conservation of northern flying squirrels in the Appalachians. First, this study will examine the long-standing ambiguity over the taxonomic affinity of the southwestern VA populations. Second, by detailing geographic patterns of genetic population structure of *G. sabrinus,* this study may aid in identification of areas that should be targeted for adaptive management. If some or all subspecies exhibit strong population structuring based on preliminary analyses, this will permit a targeted comparison of levels of genetic variation in large vs. small populations/ geographic recovery areas.

Methods

Sample Collection & Preparation

Collaborators provided genetic samples of *Glaucomys sabrinus* individuals from localities in North Carolina (NC), Virginia (VA), and West Virginia (WV). NC Wildlife

Resources Commission (NCWRC) provided funding for analyzing samples from NC and VA. The WV Department of Natural Resources (WWDNR) provided funding for a more extensive landscape genetics study of *G. sabrinus fuscus* in WV; for comparative purposes, we included some of these in this analysis (a full report on the landscape genetics of *G. s. fuscus* will be provided to the WVDNR in a separate report in 2011). Samples from the NCWRC (N=25) and WVDNR (N=114) consisted of whole blood dried and immobilized on FTA Cards (Whatman Inc., Piscataway, NJ, USA). Total DNA was extracted from the FTA Cards using QIAGEN DNeasy Blood and Tissue Kits (Qiagen, Valencia, CA, USA) and following standardized protocol for isolation of total DNA from FTA cards (Qiagen 2010). All remaining NC samples (N=46) and all VA samples (N=52) were provided as DNA extracts from Arlena Wartell (University of Georgia) and Bonnie Brown (VA Commonwealth University), respectively. We analyzed a representative subset of these samples for this study (101 individuals total: NC=25; VA=33; WV=43). DNA extracts were assessed for DNA concentration and purity using a NanoDrop 2000 spectrophotometer (Thermo Fisher Scientific, Waltham, MA, USA). Samples from VA were cleaned of excess salts using a supplementary protocol provided by Qiagen technical support services.

Microsatellite Genotyping

Extracted DNA was used as a template in the Polymerase Chain Reaction (PCR), a technique that allows the amplification of a specific region of DNA that lies between two regions of known DNA sequences (primers). We genotyped individuals at 5 polymorphic microsatellite loci using previously described northern flying squirrel (*Glaucomys sabrinus*) primers (GS-4, GS-8, GS-10, GS-13, GS-16; Zittlau et al. 2000). We preformed PCR in a 20 µL cocktail containing approximately 25 ng genomic DNA, 200 µM mixture of the four deoxyribonucleotides (dATP, dCTP, dGTP, dTTP), 0.16 µM forward primer, 0.16 µM fluorescently-tagged reverse primer, 1X TopTaq PCR Buffer (Qiagen, Valencia, CA, USA), and 1.25 units of TopTaq DNA polymerase (Qiagen, Valencia, CA, USA). Amplification was conducted on a BIO-RAD C1000 thermal cycler (Bio-Rad Laboratories Inc., Hercules, CA, USA) and PCR running conditions were optimized for each primer pair in the lab. PCR products were visualized via capillary electrophoresis on an ABI 3130*xl* Genetic Analyzer (Applied Biosystems, Foster City, CA, USA) and analyzed using GeneMapper v4.1 software (Applied Biosystems, Foster City, USA). We visually confirmed all PCR product autoscores by GeneMapper and compiled allele scores for individuals into 5-locus genotypes for subsequent analyses.

For analyses in this report, 101 individuals were genotyped for at least 4 loci, and for 88 of these individuals, all 5 loci were genotyped. Preliminary attempts of utilizing samples from Arlena Wartell were largely unsuccessful (53.3% PCR failure to amplify in the 2 loci, GS-10 and GS-16, tested). We are currently troubleshooting these samples so as to incorporate them in the future analyses, however the results in this report only include NC samples from NCWRC. Likewise, we are currently working to (1) finish the remaining samples, for which we have incomplete (less than 4 loci) genotypes, and (2) expand our genotypes to include three additional microsatellite loci.

Number of Populations

We used STRUCTURE v.2.3.3 (Pritchard et al. 2000, Falush et al. 2003, Falush

et al. 2007) – a free, downloadable software program (available at http://pritch.bsd.uchicago.edu/structure.html) – to infer population structure and assign sampled individuals to genetically defined populations using no *a priori* information. STRUCTURE first assumes that there are *K* populations (where *K* may be unknown) and proceeds by using a Bayesian clustering approach to randomly assign individuals, on the basis of their genotype, to *K* populations that minimize Hardy-Weinberg and linkage disequilibrium (non-random allele association between loci) while simultaneously estimating allele frequencies within clusters (Pritchard et al. 2000). For each *K*, STRUCTURE subsequently calculates the likelihood of an individual belonging to each population (*Q*) and probabilistically assigns that individual to one or more populations (Pritchard et al. 2000); these probabilities are graphically represented as *Q*-plots in the STRUCTURE output.

We used both the admixture and no admixture ancestry models (Pritchard et al. 2000), which either allow or prohibit that individuals may draw some fraction of their genome from one or more discrete populations (Pritchard et al. 2000). We used both correlated (Falush et al. 2003) and independent (Pritchard et al. 2000) allele frequency models, meaning that we (respectively) expect relatively similar or reasonably different allele frequencies between populations. The allele frequency models were incorporated with the ancestry models as follows: admixture-correlated (AD-COR) and no admixture-independent (NO-IND). We chose these models because they generally allow for detection of subtle (AD-COR; connected, closely related) and defined (NO-IND; isolated, highly differentiated) population structure. For both the AD-COR and NO-IND models, we used an initial burn-in of 100,000 iterations of the Markov chain followed by 100,000 iterations for all runs (N=5) of each *K* (1 to 10) to obtain an accurate measure of the most likely number of populations (*K*).

We applied the Evanno et al. (2005) method to our STRUCTURE results using the web-based version of STRUCTURE HARVESTER v0.56.4 (Earl 2009; available at http://taylor0.biology.ucla.edu/struct_harvest/) in order to determine the number of *K*, or genetic populations in our *G. sabrinus* sampling. Evanno et al. (2005) showed that *delta K*, the *ad hoc* quantity related to the second order rate of change of the log probability of data with respect to the number of clusters, is a good predictor of the real number of sampled populations within a given data set. Based on the *delta K* results, we then chose the appropriate *Q*-plot to examine the assignment of individuals to these genetically determined populations.

Population Differentiation & Genetic Diversity

We used the web-based version of GENEPOP 4.0.10 (Raymond and Rousset 1995, Rousset 2008; available at http://genepop.curtin.edu.au/) to test for deviations from Hardy-Weinberg equilibrium and linkage disequilibrium (Bonferroni correction applied for multiple tests) within each of the populations defined by STRUCTURE. We also used GENEPOP to generate summaries of allele frequencies and heterozygosity within each population. We used GENEPOP to test for genic differentiation, with the null hypothesis that alleles are drawn from the same distribution in all populations. Rejection of the genic differentiation null would indicate that the populations defined by STRUCTURE have significantly different allele frequency distributions, as one would expect from distinct genetic populations.

We further used GENEPOP and the methods of to assess population differentiation as measured by pairwise F_{ST} (Wright 1969, Weir and Cockerham 1984) and Rho_{ST} (Michalakis and Excoffier 1996, Rousset 1996) comparisons for all population pairs. F_{ST} and Rho_{ST} provide an estimate of how much unique genetic variation is contained in each population relative to the total system (Wright 1969, Rousset 1996); thus, a low value indicates a high level of connectivity over evolutionary time. F_{ST} uses the infinite alleles model and Rho_{ST} uses the stepwise mutation model which take into account differences between allele identity and allele sizes, respectively, when inferring shared ancestry. Both models have been used to describe microsatellite mutational processes, and both statistics are commonly reported in population genetic analyses, so we report both here. Although both statistics have a theoretical range of 0 to 1.0, the observed maximum is usually much less than 1.0. We followed the commonly used qualitative guidelines suggested by Wright (1978) for the interpretation of F_{ST} (see Figure 3, Results).

Results & Discussion

Number of Populations

STRUCTURE HARVESTER showed that both the AD-COR and NO-IND models in STRUCTURE yielded 3 populations. The NO-IND model had a *delta K* value at *K*=3 that was nearly an order of magnitude higher than that of *K*=3 for the AD-COR model (Figure 1). This suggests that the NO-IND model is a better model for the populations. Likewise, though *Q*-plots for both models at *K*=3 revealed the same pattern of population structure – with each sampled state (NC, VA, WV) existing as a unique population – individual plots in the NO-IND model generally had slightly higher resolution of individual assignments (Figure 2). For the NO-IND model, 95 of the 101 individuals sampled were at least strongly (>80% probability) assigned to the same population as their state of origin (Figure 2), with 79 of these individuals being assigned with very high certainty (>99% probability). An additional 3 individuals – 1 from VA and 2 from WV – appeared to be admixed, having been assigned to their state of origin with low (53.4-58.1% probability) levels of certainty (Figure 2). The remaining 3 individuals were very strongly (>99% probability) assigned to a different population than their origin (*i.e.,* “misassigned”): one individual each from NC and VA assigned to WV, and one individual from WV assigned to NC (Figure 2).

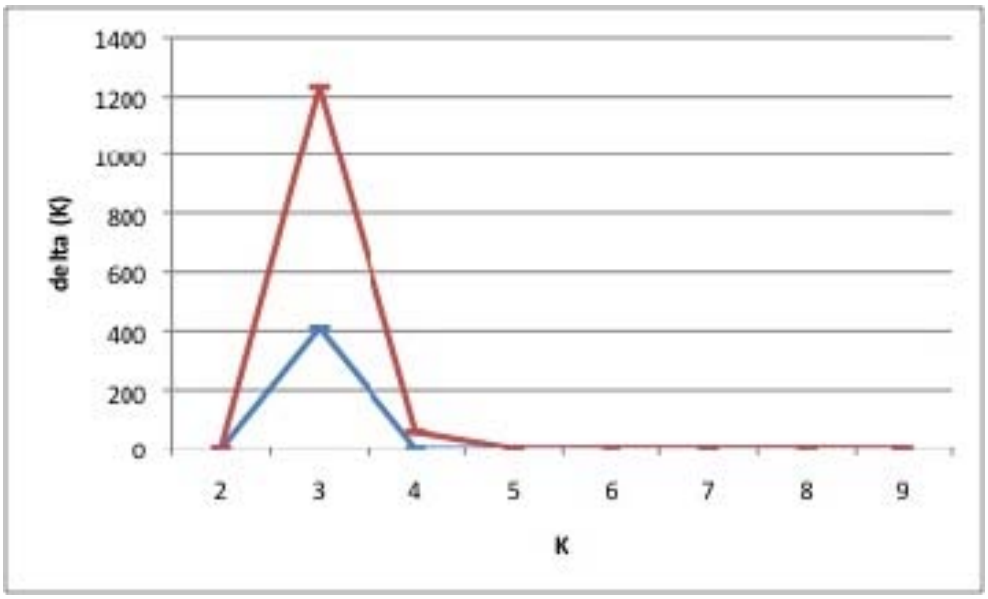

Figure 1. Plot of *delta K* for the AD-COR (Blue) and NO-IND (Red) models as determined by STRUCTURE HARVESTER. Note that the peak in both models at *K*=3, and no other peaks in competing models of *K*, indicate that the sampled data can be attributed to 3 distinct populations. Also note that delta *K* at *K*=3 for the NO-IND model is nearly an order of magnitude higher than delta *K* for the AD-COR model, suggesting that the NO-IND model better indicator of population ancestry and assignment for the sampled data set.

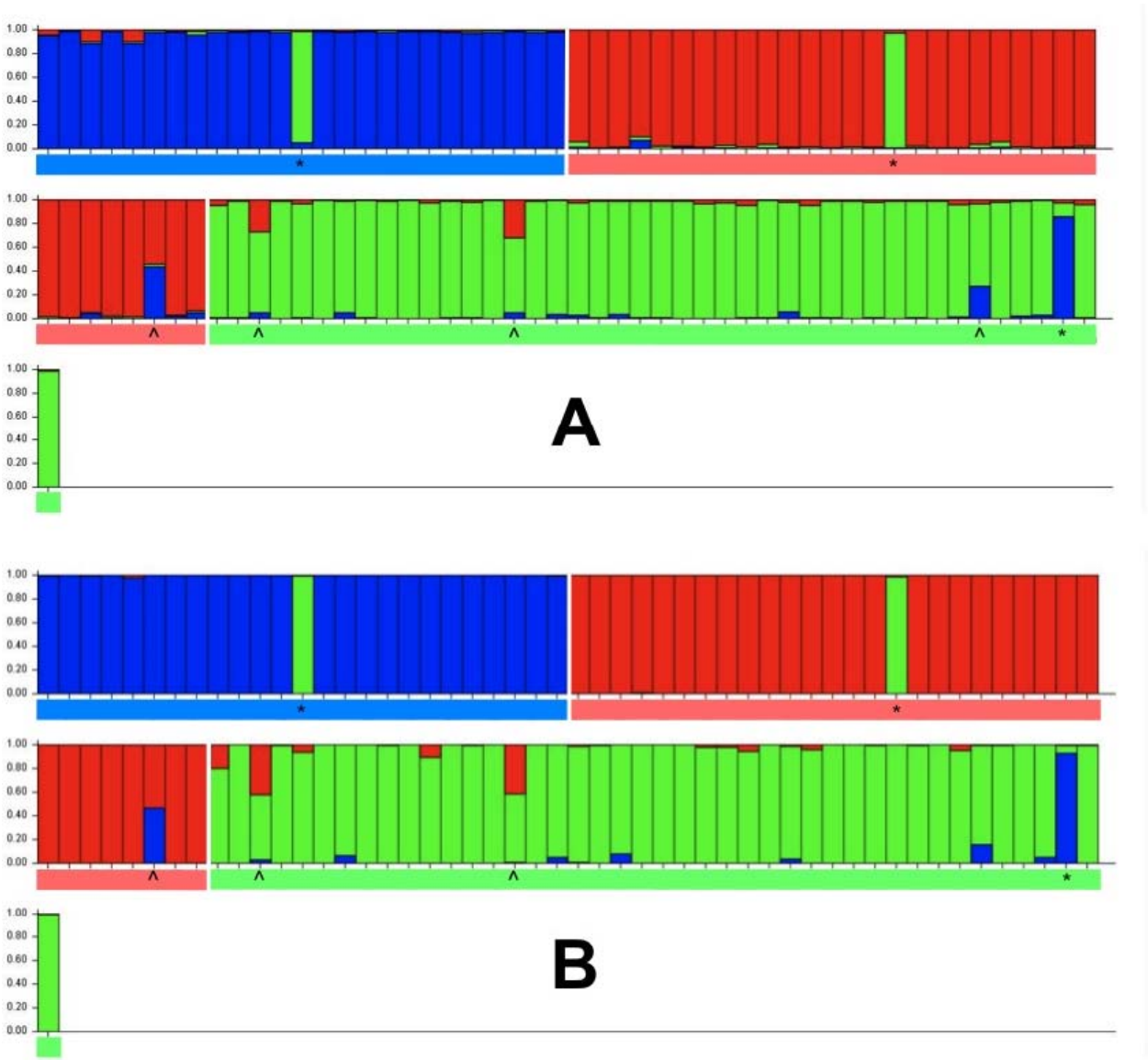

Figure 2. *Q*-plot output of STRUCTURE v.2.3.3 and assignment of individuals for the (A) AD-COR and (B) NO-IND models. Each vertical column (*Q*-plot) signifies a single individual's probability (0-100%) that it originated from the North Carolina (1,Blue), Virginia (2,Red), or West Virginia (3,Green) population. Individuals in both plots are arranged left-to-right in the same order as samples appear in Appendix 1, with the colored horizontal bars indicating the population of sample origin (NC-Blue, Red-VA, WB-Green) for each individual. *Q*-plots marked with a caret (^) indicate individuals assigned to their population of origin with low certainty ("admixed"). *Q*-plots marked with an asterisk (*) indicate individuals assigned to a population different from that of their origin ("misassigned").

Generally, individuals that appear to be misassigned or admixed would be interpreted as dispersers and first-generation offspring of mating between individuals from two different populations. However, accuracy of assignments can depend on a number of factors, including the amount of admixture among populations (Pritchard et al. 2000). The no admixture (NO-IND) model appeared to be the best indicator of assignment for the sampled populations, with 78.2% of individuals very strongly assigned to their population of origin and very low levels of admixture (2.97%) and misassignment (2.97%). Likewise, it is highly unlikely that *G. sabrinus* from different

states are in contact with one another, nonetheless dispersing such great distances (such as from NC to WV) within their lifetime. It is most likely an artifact from the number of loci used in this analysis, a factor known to affect the accuracy of the estimates for *Q* (Pritchard et al. 2000) because increasing the number of loci used will generally decrease errors in assignment (Rosenberg et al. 2001). Therefore, we are currently working to increase our genotypes to 8 microsatellite loci in order to minimize inaccurate assignments due to missing genotype data or random chance.

STRUCTURE generally only elucidates the highest level of population structure in a given sample set (Pritchard et al. 2000). The high assignment level of individuals and extreme low probability of any other *K* led us to find no indications of substructure within our collective sample set. To test these observations, we subsequently ran each population on its own in STRUCTURE, and again failed to find any indications of subtle substructure (all populations ran individually came out as K=1). Though STRUCTURE was able to pick up on drastic differences between the 3 populations, our sample size was likely not sufficient to detect any subtle substructure within these larger populations. For example, of the 25 samples from NC, 8 were from Grandfather Mountain and the remaining 17 were from Black Mountain. If these two massifs were considered subpopulations of the greater NC population, we would likely not only need to sample more individuals from these mountains, but also from other mountains within NC. Likewise, genotyping at more loci would likely give us better resolution of any existing substructure. However, it is highly unlikely that additional samples and loci would collapse the relationships among populations found in this study; rather, if fragmentation within each population is significant enough to be detected with this greater sample set, we would see subpopulations within one or more of our already defined populations.

We are currently working to expand our data set to include additional samples (such as incomplete genotypes from all 3 populations, and samples provided by Arlena Wartell) as well as including 3 additional microsatellite loci. Therefore, since at this time our data do not suggest any substructure (Objective #2B), all subsequent analyses in this report only make comparisons between the 3 identified populations (Objective #2A) and test the results of STRUCTURE (Objective #1).

Population Differentiation & Genetic Diversity

For all remaining analyses, individuals were separated into three populations (NC, VA, and WV) based on their capture origin. All results of tests reported here are from analyses for which we excluded the 6 individuals that could possibly have been considered admixed/misassigned. However, inclusion or exclusion of these individuals did not appear to affect the outcomes of the tests.

No significant deviations from Hardy-Weinberg were found following Bonferroni correction (all $p>0.0033$). One deviation from linkage equilibrium was detected after Bonferroni correction (all remaining $p>0.0017$): GS-08/GS-13 in the NC population. Since this pair of loci was in equilibrium in all other populations – and if these loci were actually linked, we would expect deviations in all 3 populations – all loci were used in subsequent analyses.

Mean number of alleles per locus was highest in WV, then in NC and VA respectively (Table 1). Private alleles (alleles only observed in one population) were observed in WV (37.8% of WV alleles) and NC (12.5% of NC alleles), but

absent in VA (Table 1). Mean observed heterozygosity was slightly higher than expected in NC and VA, but slightly lower than expected in WV (Table 1).

Table 1: Sample sizes (N), mean number of alleles (A), number of private alleles and their proportion of the total number of alleles in a population, mean expected heterozygosity (H_E), and mean observed heterozygosity (H_E) for *G. sabrinus* populations as identified by STRUCTURE. Heterozygosity estimates were calculated in GENEPOP and all other measures (including standard error (SE) of all means) were calculated in Excel.

		A				H_E	H_O
Population	**N**	**Mean**	**SE**	**Private**	**% of Total**	**Mean SE**	**Mean SE**
NC VA WV	24 31 40	4.800 3.800 7.400	0.860 0.374 0.510	3 0 14	0.125 0 0.378	0.558 0.118 0.518 0.046 0.784 0.015	0.590 0.131 0.576 0.084 0.729 0.044

All population pairs exhibited highly significant genic differentiation (all p<<0.0000), initially suggesting that the 3 populations are indeed very distinct genetic populations. Further, populations exhibited differentiation as measured by F_{ST}, with all pairwise F_{ST} comparisons exhibiting great (>0.15) to very great (>0.25) genetic differentiation (F_{ST} range: 0.1883-0.3500; Figure 3). The NC and VA populations exhibited higher differentiation (at least qualitatively) between each other (F_{ST}=0.3500) than either population did with WV. Likewise, WV showed increasing differentiation with distance from the remaining populations, such that WV was more differentiated from the NC population (F_{ST}=0.2110) than the VA population (F_{ST}=0.1883). Rho_{ST} comparisons showed the same patterns as described above, though all estimates were much higher (Rho_{ST}=0.3955-0.5489), with some values being nearly twice that of the F_{ST} estimates (Figure 3). Regardless of statistic used, all population pairs were considered to exhibit at least "great differentiation", further supporting findings by STRUCTURE.

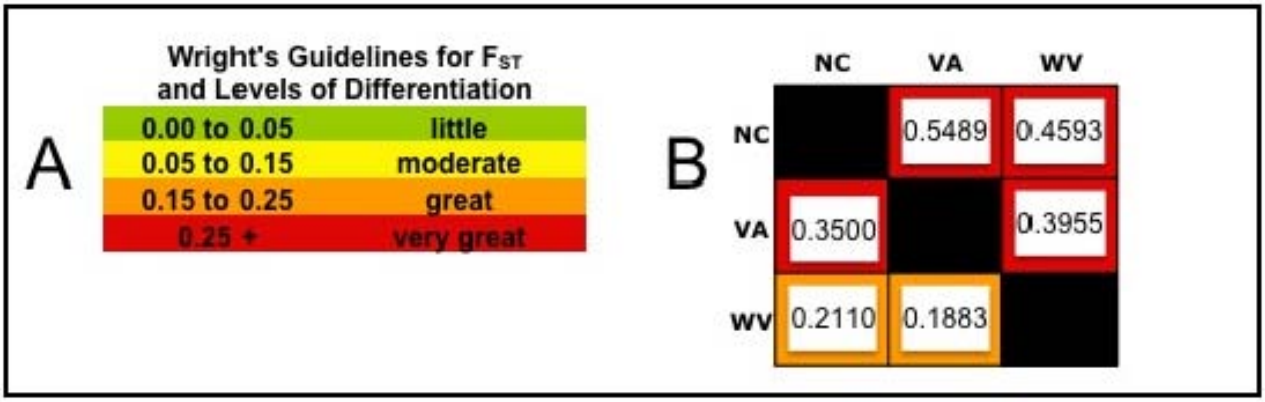

Figure 3. (A) Wright's guidelines for deciphering levels of population differentiation using the statistic F_{ST}. (B) Pairwise estimates of F_{ST} (below diagonal) and Rho_{ST} (above diagonal) for each population pair. Color codes in B correspond to the appropriate level of differentiation as shown in A.

Summary

We evaluated the current subspecific designation and population structure of *G. sabrinus* in the central and southern Appalachians, with an emphasis on clarifying the status of the VA populations. Although the cooperative agreement stated we would analyze approximately 40 individuals, we were able to analyze 101 total samples (NC, N=25; VA, N=33; and WV, N=43) to address these objectives. For 88 of these we had data from all five loci. **The most important finding in our study is that the microsatellites we examined indicate that there are 3 very distinct populations of *G. sabrinus* in the central and southern Appalachians. Most significantly, our finding that VA samples form their own population segment – just as do *G. s. coloratus* from NC and *G. s. fuscus* from WV – suggests that *G. sabrinus* in VA may represent a distinct subspecies currently unrecognized by state and federal agencies (Figs 1 & 2). This clearly warrants additional study.**

Although our analyses allow us to say with great certainty that *G. sabrinus* from each state exist as unique *populations* (NC, VA, WV), applying a mitochondrial framework to our study will give us additional data to aid in determining if each population should possibly be considered its own *subspecies* (*i.e., G. sabrinus coloratus*, *G. sabrinus* subspecies?, *G. sabrinus fuscus*). To investigate this hypothesis, we intend to amplify and sequence a portion of the mitochondrial DNA hypervariable control region, a rapidly evolving mitochondrial marker that is frequently used, often along with microsatellites, to assess specific and subspecific status. We would combine our samples with existing homologous sequences for 205 individuals of *G. sabrinus* from across North America (B. Arbogast, unpublished data). Similar geographic patterns of genetic differentiation in mitochondrial DNA and microsatellites would be very strong evidence that three distinct subspecies of *G. sabrinus* occur in the central and southern Appalachians.

The no admixture-independent model was the best determinant of individual assignment in STRUCTURE, indicating that the populations do not experience sufficient levels of contemporary gene flow that would homogenize allele frequencies across populations. This observation is supported by the strong assignment probabilities (78.2% assigned to their population of origin with >80% certainty; 94.1% assigned to their population of origin with >90% certainty). Likewise, tests of genic differentiation were highly significant ($p<<0.0000$), showing that the allele frequencies for each population are not drawn from the same distribution, as is also suggested from the independent alleles model in STRUCTURE. Such highly differentiated distributions suggest that minimal interpopulation dispersal (i.e., at least one migrant per generation) has likely been absent for quite some time, and that random genetic drift has caused these populations to diverge. However, in populations of small size, drift can also act over relatively few generations (in terms of evolutionary time) to promote population divergence.

Mean number of alleles per locus was highest in WV, then in NC and VA respectively (Table 1). Private alleles (alleles only observed in one population) were observed in WV (37.8% of WV alleles) and NC (12.5% of NC alleles), but absent in VA (Table 1). Both these observations suggest that the WV population has greater genetic diversity than NC and VA, as would be expected because WV holds a larger population

(both in number of individuals and geographic area of occurance) of *G. sabrinus* than in NC and VA. The VA population having the least amount of unique genetic diversity (such as private alleles) not unexpected, as *G. sabrinus* from VA (Mount Rogers and Whitetop Mountain) inhabit only approximately 550 hectares of spruce-fir forest (Rheinhardt 1984).

Mean observed heterozygosity was slightly higher than expected in NC and VA, but slightly lower than expected in WV (Table 1), though these differences within and across populations are likely not significant. With further testing of microsatellite loci, more detailed analyses – such as estimations of effective population size, levels of inbreeding, and isolation by distance – will be appropriate to test as well.

F_{ST}/Rho_{ST} estimates for population differentiation further showed that all population pairs were at least greatly differentiated (F_{ST}=0.1883-0.3500; Rho_{ST}=0.39550.5489), suggesting that population divergence occurred some time in the past on an evolutionary time scale as opposed to recent fragmentation. Interestingly, NC and VA were more differentiated from each other (F_{ST}=0.3500, Rho_{ST}=0.5489) than either was from WV (F_{ST}=0.2110, Rho_{ST}=0.4593; and F_{ST}=0.1883, Rho_{ST}=0.3955 respectively). However, WV population showed increasing differentiation with increasing distance from the remaining populations, such that WV was more differentiated from the NC population (F_{ST}=0.2110) than the VA population (F_{ST}=0.1883).

Finally, although STRUCTURE was able to clearly detect the genetic differences between the 3 highly differentiated populations (NC, WV, VA), it did not indicate any significant substructure within any of these populations. This was true even when the populations were each independently analyzed in STRUCTURE. This indicates that we need to increase our sample size and the number of microsatellite loci analyzed in order to obtain the resolution required to detect any existing substructure at this spatial scale. We are currently working to expand our current data set (101 individuals, 5 microsatellite loci) to include all obtained samples (N=237) and 3 additional microsatellite loci. This will also allow us to better address levels of genetic variation between large and small populations/ recovery areas.

Management Recommendations

As outlined above, more work must be done to follow up on both aspects of this study. However, the evidence presented here strongly suggests that there are 3 very distinct populations of *G. sabrinus* in the central and southern Appalachians. Most significantly, our finding that VA samples form their own population segment – just as do *G. s. coloratus* from NC and *G. s. fuscus* from WV – suggests that *G. sabrinus* in VA may represent a distinct subspecies currently unrecognized by state and federal agencies. From a management perspective, this is obviously of great importance, and warrants more research, as this may lead to a future change in taxonomic and conservation status of the VA populations (*i.e.,* from State Endangered to Federally Endangered). This study also highlights the importance of examining unsurveyed populations, such as Longhope, that are geographically positioned in between NC and VA populations of *G. sabrinus*.

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Semi-Annual Progress Report
North Carolina Sea Turtle Stranding and Salvage Network
1 July 2009 – 31 December 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 2009 – 30 June 2010

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 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, Hammocks Beach State Park, Beaufort, and Cape Hatteras.

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. Discussions continued among stranding coordinators in the SE region and the NMFS on the best ways to streamline state and national stranding databases. A new regional necropsy form was also drafted, proofed, and finalized.

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 55 live cold-stunned turtles that were found stranded from 7-31 December. They were comprised of 44 green turtles, 5 loggerheads, and 6 Kemp's ridleys. Thirty-five turtles were found within 1 week beginning 21 December along the inshore (sound-side) beaches in Carteret and Dare counties. An additional 13 green turtles, 5 Kemp's ridleys, and 3 loggerheads stranded dead and were classified as part of this cold stunning event given the proximity in time and location to the live stranded turtles 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 Aquaria, NC State University, the Virginia Aquarium, the South Carolina Aquarium, the Georgia Sea Turtle Center, Sea World Orlando, NMFS, and numerous individuals.

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

1. There were 405 stranded turtles reported by the STSSN during this period: 95 loggerheads, 232 green turtles, 71 Kemp's ridleys, 2 leatherbacks, 1 hawksbill and 4 unidentified species. Of these, 40 loggerheads, 105 green turtles, 32 Kemp's ridleys, and 1 leatherback were necropsied by NCWRC staff and permitted volunteers. These examinations revealed 73 females, 44 males, and 61 turtles with unclassifiable gonads. Of those necropsied, two loggerheads showed signs of illness and infection, including low muscle and fat loads, high parasite counts, and paleness. Two other loggerheads revealed hyperinflated lungs and foam in the trachea. Three green turtles revealed numerous plastic pieces in the gut, one of

which may have been the cause of death. Five green turtles had hyperinflated lungs and foam in the trachea. One Kemp's ridley was characterized by its body cavity filled with air and severely compressed organs, which may be indicative of forced submergence. Another Kemp's ridley had a severe liver and lung infection. One Leatherback had a large amount of plastic in its lower GI tract. All other specimens appeared healthy or were otherwise inconclusive. Many of the green turtles 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), whelks, 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. These specimens are in storage at NOAA-Beaufort Laboratory for later use. Longline hooks were extracted from two loggerheads and sent to NMFS-Pascagoula for gear analysis.

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

1. The STSSN recovered 71 live-stranded sea turtles during the reporting period: 15 loggerheads, 47 green turtles, 8 Kemp's ridleys, and 1 hawksbill. One loggerhead was disentangled from discarded fishing line and released immediately. Forty-eight turtles were brought to the NEST facility at NC Aquarium on Roanoke Island. One loggerhead and 1 Kemp's ridley died shortly after being admitted. One lethargic loggerhead was released and one green turtle that had cuts to its flippers has been successfully released. The hawksbill was found lethargic and was transferred to Florida for release following treatment. Three loggerheads, 36 green turtles, and 4 Kemp's ridleys were admitted for cold stunning. Three green turtles and 1 Kemp's ridley died during rehabilitation, and 1 green turtle had to be euthanized because of severe predator damage. Two of the loggerheads and 2 green turtles were transferred to the VA Aquarium, 2 green turtles were transferred to the South Carolina Sea Turtle Hospital, and 4 greens were transferred to the NC Aquarium at Fort Fisher. All 3 loggerheads and 22 green turtles have been released.
   Ten turtles were sent to the Karen Beasley Sea Turtle Rescue and Rehabilitation Center on Topsail Island. Four loggerheads were emaciated and lethargic. Two

died shortly after rescue; the remaining two are currently in rehabilitation. Three loggerheads suffered boat prop wounds. One died but the other two are recovering. One Kemp's ridley died after a few days in rehabilitation. The two green turtles were lethargic, one with severe emaciation. Both are currently in rehabilitation.

An additional twelve cold stuns were admitted for rehabilitation at the NC Aquarium-Pine Knoll Shores (1 loggerhead, 3 green turtles, 1 Kemp's ridley), SC Aquarium Sea Turtle Hospital (1 green turtle), and the GA Sea Turtle Center (4 green turtles, 1 loggerhead, and 1 Kemp's ridley). One green turtle has been released.

Five cold-stunned Kemp's ridleys and the hawksbill were transferred to Sea World Orlando for rehabilitation and release.

2. Several releases of rehabilitated turtles occurred during the reporting period. Seven green turtles, 2 loggerheads, and one Kemp's ridley from the Topsail Turtle Hospital were released off of Topsail Beach. With the help of the NC Aquariums and a local charter boat captain, five offshore trips to the Gulf Stream aided in the release of 17 yearling loggerheads that had been held at UNC-Chapel Hill and various aquariums.

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 2010 – 30 June 2010

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 2010

F. Summary of Progress:

Job 1 Title: STSSN Recruitment, Training, and Improved Data Collection and Coverage

1. To enhance and strengthen the overall sea turtle 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, universities, local town employees, and members of the public.

2. During this reporting period, identification/stranding workshops for volunteers were held in Holden Beach, Bald Head Island, Wrightsville Beach, Swansboro, Pine Knoll Shores, Cape Hatteras. One-on-one training of volunteers was conducted when the opportunity arose.

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 season that began in late 2009 continued into early 2010. Two hundred turtles observed stranded (122 loggerheads, 55 greens, and 23 Kemp's ridleys) were determined to be associated with cold stunning. These stranded turtles from early 2010 can be further separated into two separate cold stunning events. The first event, with about half of the observed stranded turtles (n = 91), occurred throughout the month of January, mostly along soundside beaches from Salvo to Ocracoke Island. Of these turtles, 19 turtles were alive when encountered. Three turtles died subsequently and the remaining 16 were released back to the ocean. The second event (n = 109), made up mostly of loggerheads (93%), occurred along the offshore beaches of Ocracoke and North Core Banks from 6-8 February. Twenty-five of these turtles were alive and 19 were eventually released; the other 6 did not survive. This event is being attributed to warm Gulf Stream waters that meandered within 5 miles of the coastline and strong N-NW winds that pushed overwintering turtles into the cold nearshore waters and eventually on land. Necropsies revealed characteristics indicative of cold stunning.

5. The Coordinator and Assistant Coordinator participated in conducting necropsies of >450 sea turtle carcasses that were shipped to North Carolina after the major cold-stunning event in Florida in early January. The resulting data are being shared with NOAA, Florida FWC, NCSU College of Veterinary Medicine, and NCWRC.

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

1. During the reporting period, there were 374 stranded turtles observed by the STSSN: 198 loggerheads, 108 green turtles, 67 Kemp's ridleys, and 1 unidentified species. Of these, 37 loggerheads, 52 green turtles, and 35 Kemp's ridleys were necropsied by NCWRC staff and permitted volunteers. These examinations revealed 69 females, 27 males, and 28 turtles with unclassifiable gonads. The majority of the turtles necropsied had no remarkable findings. One Kemp's ridley

was found with both front flippers bound by twine; bruising and scrapes examined during necropsy determined that the turtle may have been deliberately bound and dragged ante mortem. The case was reported to state and federal law enforcement agents. One loggerhead and 1 Kemp's ridley were found to be in poor body condition. These turtles were emaciated and covered in epibiota. Two greens and 1 loggerhead had small bits of plastic in their gut, although these objects were most likely not the cause of death.

2. Several necropsy workshops were held during this reporting period including workshops at UNC-Wilmington, Coastal Carolina Community College, and Sea Turtle Camp, a non-profit marine biology camp for teenagers.

3. Necropsy supplies were issued to the STSSN on an as-needed basis throughout this reporting period.

4. During the reporting period a variety of samples were collected for research purposes. Humeri and/or eyes were collected from 39 loggerheads and 47 green turtles for ageing. Muscle tissue was collected on an opportunistic basis from green turtles for DNA analysis. Front flippers were collected from 35 Kemp's ridleys that stranded dead for coded wire tag scanning and ageing. These specimens are in storage at NOAA-Beaufort Laboratory for later analyses. Six loggerhead carapaces were salvaged for a barnacle study being conducted by South Carolina DNR and one skull from a loggerhead was collected and prepared as a teaching aid. Twenty green turtle carcasses, 2 loggerhead carcasses and 9 Kemp's ridley carcasses 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 58 live-stranded sea turtles during the reporting period. These included 32 loggerheads, 16 green turtles, and 10 Kemp's ridleys. Nine loggerheads, 4 green turtles, and 4 Kemp's ridleys died shortly after rescue. These turtles had succumbed to boat strike injuries, cold stunning, or severe emaciation. Twenty-three loggerheads, 9 green turtles, and 4 Kemp's ridleys were treated for cold stunning and have been released. These turtles were cared for by the NC Aquariums, Karen Beasley Sea Turtle Rescue and Rehabilitation Center, South Carolina Aquarium, Georgia Aquarium, Georgia Sea Turtle Center and Sea World Orlando. One loggerhead and 3 green turtles, all suffering from emaciation, are currently being held at the Karen Beasley Sea Turtle Rescue and Rehabilitation Center. Another Kemp's ridley that was found entangled in debris and severely dehydrated, is also being treated at the Center.

2. Eight releases of rehabilitated turtles occurred during the reporting period. Fourteen loggerheads, 43 greens, and 4 Kemp's ridleys were released into the

Gulf Stream with the help of the US Coast Guard and local charter boat captains in 6 separate releases. Two beach releases were held, sending 11 loggerheads, 5 greens, and 1 Kemp's ridley 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.

FINAL PERFORMANCE REPORT

State: North Carolina **Project Number: I-1 Segment 3**

Period Covered: July 1, 2006 - June 30, 2010

Program: Landowner Incentive Program Tier II

Project Title: Red-cockaded Woodpecker Habitat Management (Tier II)

Objectives:

1. To enhance and/or maintain habitat for RCWs on 2,000 acres of properly managed sites through long-term management commitments by private landowners enrolled in Safe Harbor.
2. To provide financial assistance to private landowners enrolled in Safe Harbor for implementation of habitat management techniques that will benefit RCWs and other species associated with longleaf pine savannahs.
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

2003-2010 Activity

A total of five landowners performed habitat management on 5,905 forested acres in five Coastal Plain counties (Table 1) during the overall Grant Period. Management practices included prescribed fire, chemical and manual hardwood and understory control, woodland thinning, and planting of longleaf pines. RCWs are currently present on Camp Pretty Pond and were last seen on Shaken Creek in 2005. Not included in Table 1 is the cost associated with the publication of informative Safe Harbor pamphlets, which were printed in 2006 for $1,342.00.

Table 1. Habitat management conducted on private lands, 2003-2010.

Landowner/Property	County	Management[1]	Acres	SHA[2]
Dr. Riddick Ricks/Whispering Pines	Northampton	PF, HC, WT	1,419	Yes
The Nature Conservancy/Shaken Creek	Pender	PF	3,640	No
Girl Scouts-NC Coastal Pines/Camp Pretty Pond	Brunswick	WT	51	Yes
K.C. Sledge, K.S. Fort, & S. Longwood LTD - Hilton Properties LTD Partnership	Brunswick & New Hanover	PF	495	Yes
EI DuPont de Nemours & Co	Bladen & Cumberland	PF, WT, HC, LL	300	Yes

[1] PF = prescribed fire, HC = hardwood control, WT = woodland thinning, LL = longleaf plantings

[2] Safe Harbor Agreement

2009-2010 Activity

The North Carolina Wildlife Resources Commission (NCWRC) provided financial assistance for non-commercial thinning or prescribed burns on two Safe Harbor sites - Camp Pretty Pond (51 acres) in Brunswick County and the Ricks' property (1300 acres) in Northampton County. Several cavities benefited directly from the habitat management on Camp Pretty Pond and all three RCW clusters contained active nests. RCWs remain absent from the Ricks' property; however, it is anticipated that this management will create potential RCW habitat, and several other plant and animal species will respond positively to the lower basal area, increased light penetration to the understory, and reduced density of hardwoods.

The NCWRC also provided funding to The Nature Conservancy to conduct prescribed burning on 1740 acres of longleaf pine savannah at Shaken Creek in Pender County. This tract is situated within the Onslow Bight region of the coastal plain and is adjacent to Holly Shelter Game Land; a part of the Coastal North Carolina Primary Core recovery population of RCWs. This property is being managed for long-term restoration of natural communities including red-cockaded woodpeckers.

B. Target Dates for Achievement and Accomplishment

Project activities were accomplished within specified timeframes.

C. Significant Deviation

No significant deviations.

D. Remarks

Longleaf pine savannahs support a diverse assemblage of endemic plant communities as well as the most resident vertebrate species of any other habitat type in the Coastal Plain of the southeastern United States. Prescribed fire is considered the most efficient and cost effective tool for managing longleaf pine ecosystems by creating a mosaic of habitat suitable for its native species. Woodland thinning and hardwood understory control regulate competition and enable longleaf pines to reach mature and healthy sizes. These practices have been implemented by our LIP participants and will help restore or maintain the groundcover diversity and structural integrity required by many imperiled species, including red-cockaded woodpecker (*Picoides borealis*), pine barrens treefrog (*Hyla andersonii*), and sweet pitcher plant (*Sarracenia rubra*).

E. Recommendations

Administration of the North Carolina Safe Harbor Program has been funded by the Landowner Incentive Program which has been terminated. We recommend utilization of the NC Wildlife Conservation Lands Program (WCLP) to help landowners afford RCW habitat management

activities. Other opportunities for private landowner assistance for RCW habitat management include the Wildlife Habitat Incentives Program (WHIP) available through county Natural Resources Conservation Services (NRCS) offices.

F. Estimated Cost

Segment 3 - $106,667.00 (including landowner cost)
All Segments - $217,831.84 (including landowner cost)

Prepared By: John Carpenter
Wildlife Diversity Biologist
Wildlife Diversity Program

FINAL PERFORMANCE REPORT

State: North Carolina **Project Number: I-5**

Period Covered: April 1, 2006 – June 30, 2010

Program: Landowner Incentive Program Tier 1

Project Title: Statewide Red-cockaded Woodpecker (RCW) Safe Harbor Program for North Carolina

Objectives:

Program Objectives
1. To coordinate with Service personnel to complete the Statewide Safe Harbor application process and receive an Enhancement of Survival permit.
2. To prepare Safe Harbor Management Agreements for landowners who meet the program criteria. Landowners will be issued a Certificate of Inclusion for their participation in the program.
3. To attend meetings of appropriate professional and community groups to promote Safe Harbor, RCW conservation, and beneficial habitat management either through presentations, dissemination of program literature, or networking.
4. To prepare and/or update Safe Harbor program literature and to create a website for dissemination of information about the program, RCWs, and coastal pine ecosystems.
5. To conduct surveys for presence of RCW cavity trees, RCW reproductive activity, habitat condition, and completion of habitat management. Other species-at-risk observed on a property will also be recorded.

A. Activity

A final Statewide RCW Safe Harbor Agreement was completed for North Carolina and an Enhancement of Survival Permit was received from the regional FWS office in December, 2006. As of July 2010, a total of six properties (Table 1) are enrolled in Safe Harbor agreements with the North Carolina Wildlife Resources Commission (NCWRC). All six of these landowners hold Certificates of Inclusion. 10,931 acres are now enrolled in Safe Harbor which includes 4,923 acres of potential RCW habitat. Three groups of RCWs are now protected under this Safe Harbor program. Each landowner has been contacted at least annually to verify ongoing management activities and discuss additional needed or desired management. All RCW groups on Safe Harbor landowner's properties have been monitored annually for activity and reproductive success.

Table 1. Current Safe Harbor agreements in North Carolina.

Landowner	Enrolled (acres)	Potential Habitat (acres)	County	RCWs?	Cavity Trees?
Johnston Community College	176	56	Johnston	N	Y
EI DuPont de Nemours & Co	2112	936	Bladen/Cumberland	N	N
Dr. Riddick Ricks	1300	800	Northampton	N	N
Girl Scouts-NC Coastal Pines	135	61	Brunswick	Y	Y
K.C. Sledge, K.S. Fort, & S. Longwood LTD	3100	1880	Brunswick	N	N
Hilton Properties LTD Partnership	4108	1190	New Hanover	N	N

2009-2010 Activity

A baseline RCW survey was performed on approximately 70 acres at the Lanier property in Brunswick County, which is currently being considered for a Safe Harbor Agreement. No RCWs were encountered. An additional Survey was conducted on the 1,248 acre John Thomas property in Pender Co., and a Safe Harbor draft was written for his evaluation.

RCW nest checks were conducted with US Fish and Wildlife personnel at Boiling Spring Lakes in Brunswick County. A total of nine active nests were found while two additional cavities inspected were usurped by the European Starling (*Sturnus vulgaris*).

In support of the NC Statewide Safe Harbor Program, the NCWRC wildlife biologist met with the Boiling Spring Lakes (BSL) Preserve Advisory Committee to discuss RCW habitat and population management, regulatory compliance, and the current status of RCW populations in BSL.

B. Target Dates for Achievement and Accomplishment

The lead biologist on the Safe Harbor Program was lost during this last year of the project and because of statewide budget concerns we were unable to hire a replacement for an eight month period. Even during the absence of that biologist, we were able to continue to meet the project goals and objectives.

C. Significant Deviation

Red-cockaded Woodpecker monitoring was limited in 2010 due to a change in personnel. A full-time wildlife biologist began work on April 15 after an eight month vacancy. Project Activity was therefore limited during the final year of the project while overall project objectives were met.

D. Remarks

Throughout this project we were fortunate to work with several large landowners that are providing many acres of habitat for RCWs. Although we did not state an exact number of expected Safe Harbor Agreements or number of acres protected in our planning documents, we would have liked the numbers in both cases to have been higher. This is in part due to the delayed timeframe in which we received our Enhancement of Survival Permit (Dec., 2006). Still, over 10,900 acres have been enrolled during the grant, and technical guidance has been provided to the landowners to facilitate management that will benefit RCWs and other priority wildlife species such as Bachman's Sparrow, loggerhead shrike, pygmy rattlesnake and many others. We continue to receive some interest in the program from landowners who are concerned about potential negative economic effects of RCWs on their property, and we have provided guidance where appropriate. We hope to pursue a more proactive approach to increase landowner involvement in the Safe Harbor Program by identifying suitable RCW nesting, foraging, and/or corridor habitat using a geographic information system. Those landowners would be more appropriate to contact and educate about RCW habitat use and movements and encouraged to enroll, but we suggest that the Safe Harbor Program not be promoted on lands where RCWs could not inhabit because of habitat limitations or population isolation issues.

E. Recommendations

Administration of the North Carolina Safe Harbor Program has been funded by the Landowner Incentive Program which has been terminated. NCWRC should continue to administer the North Carolina Safe Harbor Program on suitable lands, through the State Wildlife Grants Program or other grants to ensure that NCWRC can continue to provide this service to North Carolina property owners and manage the program.

F. Estimated Cost

$22,406.79 Total cost for 2009-2010 period.
$167,244.29 Overall cost for the grant

Prepared By: John Carpenter
Wildlife Diversity Biologist
Wildlife Diversity Program

WCS Wildlife Action Opportunities Fund
Grantee Progress Reporting Form
North Carolina Wildlife Resources Commission

The Wildlife Conservation Society is pleased to have made a grant to your organization. As part of our grant agreement, semi-annual and final reports are required on the progress of your project. This reporting structure is established as a means to better follow the success of your project, track the impact of individual grants that we make, as well as our overall effectiveness as a philanthropic program. Key to this assessment is our commitment to being a learning partner alongside our grantees. We are providing a list of general questions to ignite concise feedback on various aspects of the projects.

Succinct answers will best serve our purposes in analysis and implementation. We would also appreciate any photos or maps you might include to better illustrate your important work. Also, please attach copies of any publications created for this project or any media coverage of the work.

With the exception of the budget summary, which should be given to-date, please report on changes and progress only since your previous progress report. Your final report should be a comprehensive assessment of the entire project.

Please respond to the following questions:

Section I - Outcomes

1. What is the overall status of your project? Please list the goals and outcomes that were outlined in your proposal and briefly describe your progress on each.

Outcome 1: Three partner organizations will be trained on how to implement the Green Growth Toolbox (GGT).

- NC Wildlife Resources Commission (WRC) participated in a "dry run" GGT workshop for Coastal Land Trust and Sustainable Sandhills, providing them with guidance and support.
- Staff from Sustainable Sandhills & US Fish and Wildlife Service participated in Green Growth Toolbox training workshops put on by WRC, advancing their training and expertise.
- An additional "train-the-trainer" workshop for external partners not explicitly connected to this grant was attended by 15 individuals on July 8, 2010, including staff from the NC Division of Community Assistance (the state agency responsible for local planning assistance), regional Councils of Government, a land trust, and other organizations. These partners will seek opportunities to integrate Green Growth Toolbox principles into their work. They will be responsible for funding their own implementation activities but WRC will provide them with technical support, potentially expanding the scope of impact this project will have.

Outcome 2: Regional appendices and datasets are available in all eco-regions of the state.

- Regional appendices and datasets were completed for the Sandhills and Coastal regions of North Carolina. The Mountain region dataset has been developed and the appendix will be completed soon. Appendices and datasets are available on the project website: http://www.ncwildlife.org/greengrowth/Conservation_Data.htm

Outcome 3: Staff from 20 communities across the state's 4 eco-regions will receive Green Growth Toolbox training by September 2011.

- Since the last report, staff from 19 communities in the Piedmont, Sandhills and Coast have received Green Growth Toolbox training, including Orange County and 3 of its municipalities, Anson County and 2 of its municipalities, Moore County and 5 of its municipalities, Fort Bragg, and 5 municipalities from Brunswick, New Hanover, and Pender counties.

Outcome 4: Staff from 20 jurisdictions across the state's 4 eco-regions receive follow up technical guidance using the Green Growth Toolbox.

- In this reporting period, technical guidance was provided to 9 communities in 2 eco-regions.
- Technical guidance for Green Growth recommendations included:
    - Contributions to development of the Chatham County conservation plan
    - An open space property site management plan in Wake Co
    - Greenway establishment on a 20 acre parcel in Orange Co
    - Review of a new storm water ordinance for Town of Navassa
    - Input at 6 meetings of the Montgomery Co Land Use Plan Advisory Committee
    - Input on the Anson County county-wide zoning ordinance (5 different contacts)
    - Comments on Stanly County Land Use Plan

In addition to these outcomes, numerous communication activities have occurred to introduce regional partners, our target audience, and the general public to the Green Growth Toolbox project. Communication activities thus far include:

- Delivered presentations on the Green Growth Toolbox to over 400 stakeholders (planners, elected officials, developers, resource professionals) around the state in the following venues:
    - Community Conservation Standing Committee meeting of the Division of Soil & Water Conservation
    - North Carolina Association of Soil & Water Districts annual meeting
    - 2nd annual North Carolina Urban Forestry Conference
    - Cape Fear Arch Conservation Collaborative
    - Eagles Island Coalition meeting
    - Blue Ridge Sustainability Institute
    - Warren Wilson College class
    - Hendersonville City Council
    - National American Planning Association conference
    - Moore County planning staff
    - Several other locations
- Publication and distribution of an executive summary brochure (see attached).
- Distribution of a press release highlighting our receipt of the WCS WAOF grant, and our goal to expand implementation of the Green Growth Toolbox statewide (see attached).

2. We understand that variance from original plans occurs often. Has your project varied from the initial goals and objectives that were outlined in your grant proposal? If so, please briefly describe any changes in your plans.

Variance from original plans during this reporting period included:

- Due to the delay in receiving funding, we delayed the "due date" for regional appendices and GIS datasets. At this point, the Coastal and Sandhills datasets and regional appendices are complete. The Mountain conservation data and related maps have been completed and the mountain appendix is in process.
- The "train the trainer" workshop for additional partners mentioned above was not part of the original proposal, but should enhance the impact of this project.

3. What have been the key factors to your success thus far?

This project has benefited from several years of groundwork being laid for the Green Growth Toolbox by WRC. Our success with grant-related activities can be attributed to motivated and capable staff in our partner organizations and the existence of working relationships with local governments. In addition, growing interest in and awareness of the Green Growth Toolbox is contributing to our success.

4. Please describe any unanticipated benefits you have encountered during your work on this project.

The level of interest from other entities in implementing the Green Growth Toolbox, even without direct funding available, was somewhat unexpected and led to the second "train the trainer" workshop.

5. What conservation impact do you believe that the project has made thus far and/or how has this work furthered implementation of your State Wildlife Action Plan(s) or any other strategic conservation plans? What good conservation stories does your project have to tell?

At least 5 communities have downloaded Green Growth Toolbox conservation data and have begun using it in planning decisions. We anticipate that at least some additional communities who have participated in GGT training workshops will begin using conservation data in planning. The Montgomery County Land Use Plan, Anson County-wide zoning ordinance, Stanly County Land Use Plan, Town of Navassa Storm Water Ordinance, and several development projects have been influenced by GGT recommendations. We anticipate this will lead to fewer negative impacts to priority wildlife habitats than would have occurred without GGT intervention. Workshop participants have verbally expressed their intention to use the Green Growth Toolbox in the coming months and years.

Second, we anticipate that individuals who participated in our second "train the trainer" workshop will begin to use Green Growth Toolbox data and recommendations in guidance they provide to communities in their region. We also anticipate a few individuals from this second "train the trainer" will help organize a Green Growth Toolbox workshop in counties where NCWRC staff and partner training capacity does not yet exist.

5. Other than fundraising, what have been the largest impediments to your project's success? What were your stumbling blocks and how did you overcome them?

Through our outreach and training efforts, we have generally seen strong support by planning staff for implementing the GGT. In some instances, the lack of political will by elected officials to change or create favorable policies is an impediment. We are attempting to overcome this impediment by communicating the benefits of green growth to elected officials and building grass roots support from community groups who in turn can encourage their representatives to enact green growth policies.

Salaries and wages 1. Program staff salaries, wages, and benefits Title of position	Number of People	% time on project	Total	Wildlife Conservation Society (WCS) Share	All non-WCS Funds
Urban Wildlife Biologist, NCWRC	1	75%	$14,435.00	$7,217.50	$7,217.50
Piedmont Land Conservation Biologist, NCWRC	1	38%	$9,231.57	$4,615.79	$4,615.79
Piedmont Wildlife Diversity Supervisor, NCWRC	1	10%	$5,921.67		$5,921.67
Cape Fear Arch Coordinator, NC Coastal Land Trust	1	50%	$44,024.00	$14,839.00	$29,185.00
Executive Director, Sustainable Sandhills	1	5%	$9,688.50	$6,459.00	$3,229.50
Green Growth Planner, Sustainable Sandhills	1	50%	$25,836.00	$12,918.00	$12,918.00
Regional Planner, Land of Sky Regional Council	1	50%	$50,599.00	$11,317.00	$39,282.00
GIS Planner, Land of Sky Regional Council	1	3%	$6,040.00		$6,040.00
Total salaries, wages, and benefits	8		$165,775.74	$57,366.29	$108,409.46
2. Contract services Type of consultant or contractor	Number of days on project	Daily rate fee basis			
Graphic Designer	~10		$2,089.52	$1,044.76	$1,044.76
Total contract services			$2,089.52	$1,044.76	$1,044.76
Other Expenses					
3. Travel			$11,815.57	$2,490.79	$9,324.79
4. Communications			$622.66	$13.83	$608.83
5. Capital expenses			$8,206.95	$3,672.98	$4,533.98

(supplies/materials/ equipment)			
6. Other (Specify line items)			
7. Overhead/Indirect Costs (WCS share is max 10% of request amount)	$13,187.00	$7,762.00	$5,425.00
Total project expenses	$188,510.44	$72,350.64	$129,346.81

6. How is fundraising for your project progressing and how have existing funds been used?

a. Provide a list of additional funding sources for the project. Indicate the status of these sources – received, committed or pending.

- State Wildlife Grants ($76,000)— received
- Z. Smith Reynolds Foundation grant to NC Coastal Land Trust ($25,000)— received
- Wal-Mart Foundation grant to NC Coastal Land Trust ($11,600) – received
- Sustainable Sandhills funds ($37,300)—These revolving funds include membership fees, private donations, and earned income, and are continually raised.
- Federal Highway Administration Eco-Logical grant ($13,500)—received.
- Community Foundation of Western North Carolina grant to Land of Sky Regional Council ($25,000)--received
- Z. Smith Reynolds Foundation grant to Land of Sky Regional Council ($20,000) – received
- NC Coastal Land Trust in-kind match ($4,900)—These operating funds will be raised through member and major donor contributions.
- Land-of-Sky Regional Council and Linking Lands and Communities funds—Additional support will be contributed to this project through a combination of foundation grants, public funds, and in-kind donations.

b. Did this grant assist your organization in obtaining funds from other sources? If so, how?

This grant is being used by WRC to leverage State Wildlife Grant funds (at a 1:1 ratio) to support Green Growth Toolbox efforts. The Land-of-Sky Regional Council has used this grant as match for their other grants.

c. Provide a list of project expenditures to date on this grant. Please match line items to the budget in your grant agreement. Many grantees find a budget table useful here.

Project Expenditures (September 2009 – August 2010)

Section III – Partnerships for implementation

8. Tell us about any interaction you have had with both your public agency and private NGO partners on this project, either positive or negative.

During this past reporting period, we have communicated regularly with our NGO partners. We have provided support to them as they develop regional datasets and appendices, and plan regional training workshops. All partners involved in this grant have assisted each other in developing regional datasets and appendices and have attended and assisted with each others' training workshops.

9. Are any of these partnerships new as a result of this grant or this project?

As explained in the last interim report, the NCWRC has indirectly worked with all of our NGO partners in the past. However, the strength and content of the partnerships formed through this grant are new.

10. How have those new partners contributed to or supported your work?

See response in the March 2010 interim report.

Interim Report[1]

submitted to NC Audubon

Year-round Study of American Oystercatchers at Selected Sites in North Carolina

N.C. Wildlife Resources Commission

Sara H. Schweitzer, Wildlife Diversity Biologist, Coastal Waterbirds

[1]Not all data are compiled or analyzed for this interim report.

Breeding season (late April–July 2010).— Data provided by NCSU researchers and their collaborators.

Numbers of American Oystercatchers at selected sites during fall migration (August–October 2010). – We counted numbers of American Oystercatchers in 2 areas – Oregon Inlet and Back Sound. Sites within each area were visited at least every 2 days through August, then once per week in September and October. When possible (birds were not tucking their bill and closing their eyes; wind was calm (≤5 mph) and boat was steady), we counted numbers of adults and young (hatch-year or subadult with dark bill and nondefinitive eye coloration), and recorded band identification using a spotting scope.

The Oregon Inlet area included sandbar, barrier island, and dredged-material island habitats (n = 13 sites). The mean number recorded in this area was 3.6 oystercatchers per visit (±2.8 birds/day s.d., n = 23 days). The greatest number on any one day was 10 oystercatchers on 18 August.

The Back Sound area included barrier island shoreline, a dredged-material island, natural shoals, and shell rakes. The mean number of oystercatchers in this area was 113.6 bird/day (±48.5 birds/day, s.d., n = 5 days). The greatest number of oystercatchers during this time span was 169 on 3 September.

Numbers of American Oystercatchers at selected sites during winter (November – December 2010). – We conducted 1-2 surveys per month during winter. On 29 November, there were an estimated 150 oystercatchers in the Back Sound area.

Coastwide estimate of numbers of nesting pairs of American Oystercatchers.– During the 2010 nesting season (late April–June), WRC biologists collaborated with cooperators to obtain numbers of nesting pairs of American Oystercatchers for the state. Data were summarized by county and type of habitat on which American Oystercatchers nested (Table 1). The total estimated number of pairs for 2010 was 369 (Table 1), an increase in number of pairs compared to estimates in 2004 (327 nesting pairs) and 2007 (339 nesting pairs). However, we do not know if the increase in number of nesting pairs is accurate or if increased survey effort and knowledge

of nesting areas are affecting the increased estimate. The percentage of nesting pairs on dredged-material islands may be increasing while the percentage on natural barrier island habitats appears to be decreasing. Further analyses would be necessary to determine if these changes in percentages of nests on different habitat types were significant; thus, with our cooperators, we will continue to monitor nesting pairs of American Oystercatchers along the North Carolina coast. If the increase in percentage of nests on dredged-material islands is significant, it would indicate the increased importance of these types of habitat, and the possible decline in quality of other sites. Management and conservation actions should address these changes so this species of special concern will continue to contribute to the Atlantic population of American Oystercatchers.

Financial statements for grant.— Expenditures for the periods, January through August 2010 (Table 2); and September – December 2010 (Table 3), reflect work done on this project by NCWRC personnel.

Table 1. Numbers of American Oystercatcher pairs reported during the 2010 breeding season in North Carolina.

		All natural island habitats					
County	**Barrier island**	**Natural island**	**Marsh**	**Shellrake**	**Dredge spoil island**	**Other (rooftop)**	**Total**
Brunswick	5	3		4	40		52
New Hanover	46				13		59
Pender	17				3		20
Onslow	4	10	6	21	3		44
Carteret	62	16	18	11	20	5	132
Hyde	4	1		1	17		23
Dare	17	5	3		14		39
Totals	155	35	27	37	110	5	**369**

Table 2. Financial statement, 1 January through 31 August 2010, reflecting expenditures by NCWRC personnel on this project.

ITEM	DESCRIPTION	EXPENDITURE
Personnel and Benefits	Hours on project by NCWRC biologists	7036.97
Travel	Mileage on vehicles, ferry, lodging, subsistence	1526.99
Boat Use	Boat hours @ 30 $/hr	1080.00
	TOTAL	**$9643.96**

Table 3. Financial statement, 1 September through 31 December 2010, reflecting expenditures by NCWRC personnel on this project.

ITEM	DESCRIPTION	EXPENDITURE
Personnel and Benefits	Hours on project by NCWRC biologists	1743.53
Travel	Mileage on vehicles, ferry, lodging, subsistence	243.12
Boat Use	Boat hours @ 30 $/hr	840.00
	TOTAL	**$2826.65**

Final Report

USFWS Grant Agreement # 401814J011

State: North Carolina

Period Covered: May 15, 2004 - September 30, 2010

Project Title: Bog Turtle Habitat Restoration and Enhancement in Western North Carolina

Objectives:

Identify sites and restore, enhance, and protect wetland/bog habitats in western North Carolina

A. Summary

This grant agreement (#401814J011) had two sub-periods with separate landowner projects. A previously submitted report described activities accomplished during the first sub-period, from May 15, 2004 – June 30, 2008 (Graeter, 2008) at McClures, Bowlin, and Peak Creek sites. The second portion of this grant (beginning July 1, 2008) funded habitat management efforts at three privately owned bog sites in western North Carolina: 1) Kanuga bog (Henderson County), 2) Wildcat bog (Wilkes County), and 3) Danny Smith bog (Surry County), and accomplishments at the latter 3 will be described in this report.

All three sites support bog turtle populations, albeit to varying degrees, presumably because of degrading habitat from succession of the trees and woody shrubs into these previously herbaceous dominated wetlands. These three sites are somewhat different in terms of structure and specific management needs, but the overarching goal at all three sites was to thin the woody vegetation (e.g., everything from large maple trees to alder thickets) in order to improve the habitat for bog turtles and priority wetland plant species. Thus, although the plan varied from one site to the next, the focus at all three sites was to allow more sunlight to reach the ground, while making sure to maintain a variety of vegetative structure and diversity within the wetland. To reach this objective, different management zones were identified within each site, with specific tasks outlined for each area. A simple management plan was developed with the NC Wildlife Resources Commission, the landowners, and the USFWS Project Officer. A landowner agreement was also developed and signed by each landowner.

B. Project Implementation

North Carolina Wildlife Resources Commission (NCWRC) staff, contractors, and/or volunteers were utilized in the work days. NCWRC staff guided and oversaw the work done by contractors and volunteers in order to ensure efforts were completed as desired. Work included manual removal and thinning of shrubs and trees in each wetland, including but not limited to alders and maples. At each bog site, hand tools, including hand-held clippers and loppers, and chainsaws

were used. All cut woody material was removed from the site after work was completed and either burned or chipped. A wetland approved herbicide, Rodeo (a surfactant-free 53.8% Glyphosate product), by Dow AgroSciences, was applied directly to cut stems immediately after cutting in order to suppress re-growth. The Specimen Label for this product directs the user to mix it with water to create between 50-100% solution (we used 80% solution) for applying to cut-stems. A hand-held spray bottle with a sponge wrapped around the end was used for application. This controlled application method should help suppress trees and shrubs from re-sprouting while also eliminating effects on non-target species.

Photos were taken before the management work began and immediately after work was completed at each site to document the work accomplished. Note that we will monitor the condition of the habitat at these sites over time to help inform future management at these bogs and other wetland sites. Likewise, we will continue to conduct surveys for bog turtles and rare plants at these sites on a regular basis.

Kanuga Bog (Henderson Co.)

The NC Wildlife Resources Commission's Wildlife Diversity program conducted habitat management at Kanuga Bog with the help of many volunteers for two days in September 2010. The main problems to address included 1) an almost completely homogeneous area of tall, densely growing alders in one portion of the bog, 2) the one small open area (with sphagnum and pitcher plants) was being encroached from all sides by woody vegetation, 3) presence of invasive plant species, and 4) the Clemson Pond Leveler that was installed several years ago was not functioning properly, so that the beavers were being allowed to dam up the wetland with too much standing water. Thus, we focused on the following management zones: A) a small area that includes the main pitcher plant area, B) buffer to NE/E of main pitcher plant area, C) area between Zone A & B and dirt pathway, and G) area to west of section of boardwalk that leads to open-top gazebo. In Zone A, the plan was to carefully remove most of the woody plants. The main objective in Zone B was to selectively thin woody plants, targeting sourwood, grape, tulip tree, holly, alder, maple, and other shrubs. In Zone C, we planned to thin out the alders and swamp roses, but allow some survival of the roses. The plan in Zone G was to thin the alders extensively to create a much more open area, while leaving some alders along the boardwalk for aesthetics. If time allowed, we hoped to work on eradicating some of the invasive plant species present in and along the perimeter of the wetland.

We accomplished all goals we set out to accomplish in Zones A, B, C, and G (approximately half an acre in size combined), leaving a matrix of open areas and areas with shrubs in the bog (see Figure 1). However, the Clemson Pond Leveler still needs additional maintenance work and shovels proved to be an inadequate tool for removing some non-native hosta plants growing in the wetland. The Kanuga staff were advised of other methods of removal that may work to eradicate the hostas.

<u>Figure 1</u>: Photos of Kanuga Bog before (August 27, 2010) and after (September 21, 2010) habitat management work occurred. Before and after photos show the following areas: A) looking south from boardwalk [Zones G & C], B) looking north from dirt walkway [Zone C], and C) main pitcher plant area [Zones A & B]. Note that the "before" photo shown of the main pitcher plan area was taken from farther away than the "after" photo.

These two workdays were seen as a necessary short-term management effort, but long-term management recommendations were discussed at length with LeeAnne Martin, the Director of the Mountain Trail Outdoor School and subsequently, a summary of these recommendations was sent to her to share with the Kanuga board (see Table 1).

Table 1: Long term management recommendations suggested for Kanuga bog

Management Zone	Description of Zone	Long Term Management Recommendations
A	Main pitcher plant area	Monitor regularly to determine when careful removal of woody vegetation should be conducted
B	NE/E area around Zone A	Monitor regularly to determine when selective thinning is needed in this zone, targeting mainly sourwood, grape, tulip tree, holly, alder, maple and other shrubs.
C	Area between Zone A & B and dirt pathway	Re-set Clemson Pond Leveler, then monitor regularly to ensure proper functioning; monitor this zone for management needed - thin alders and swamp rose to create structural variety in this zone
E	Southern portion of bog between dirt walkway and lake	1) Monitor the size of this area and the vegetation, 2) Thin the alders, 3) Remove larger maple trees, 4) Leave open delta as is (looks great for bog turtles).
F	Area along lakeside with pitcher plants	Continue to protect and regularly monitor this zone for any future management needs.
G	Area to west of section of boardwalk that leads to open-top gazebo	Keep alders thinned out to allow some plant diversity and more sun; leave some alders along edge of boardwalk for aesthetics.
H	Wetland area north of boardwalk	Needs further evaluation to determine plan for management of this area
all zones	Entire bog	Removal and monitoring of non-native invasive plants, including but not necessarily limited to hostas, microstegium, flag irises, murdania, multiflora rose
all zones	Entire bog	Consider removing some of the larger maples
all zones	Entire bog	Monitor water level in the bog
all zones	Entire bog	Inventory the bog (for plants and wildlife)

Planning and key decisions about habitat management at this site were done in cooperation with several key partners, including US Fish & Wildlife Service biologists from the Asheville Field Office, a botanist from the NC Natural Heritage Program, members of Project Bog Turtle, and staff at Kanuga Conferences Inc. Volunteers played an especially critical role in the accomplishments made in two workdays. Kanuga allowed their Mountain Trail Outdoor School staff to contribute a significant amount of time to the workdays in addition to several other volunteers.

Wildcat Bog (Wilkes Co.)

Some habitat management work had been conducted at this bog in 2005 and it needed some more work to maintain it as suitable habitat for bog turtles. Since the last management effort, it had grown up considerably in woody shrubs, tree saplings, and trees and had a massive tangled growth of smilax vines in one area. The main issues that needed to be addressed were 1) a portion of the more open area still looked fairly good but it was being heavily encroached by a

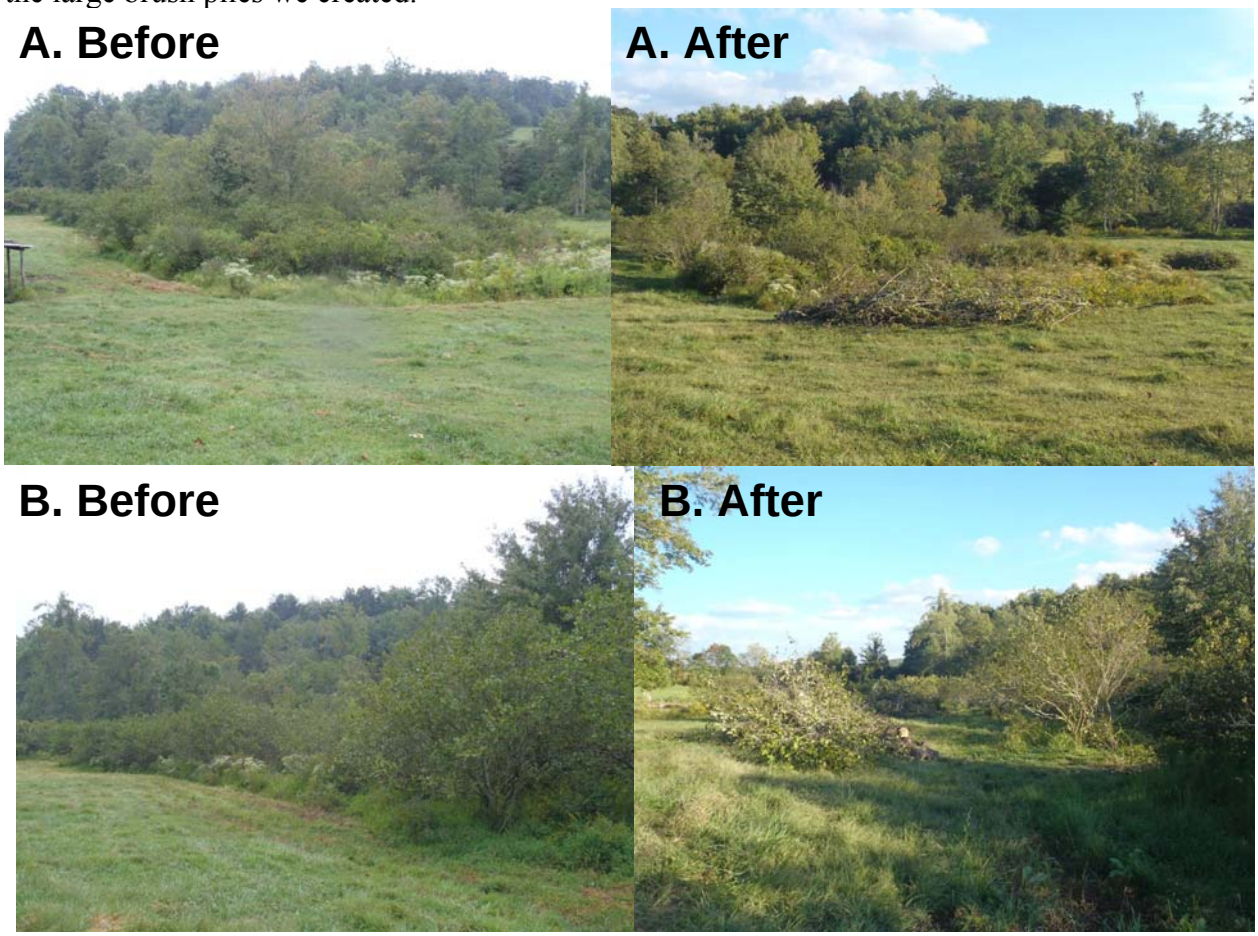
dense thicket of alders blanketed by smilax vines, 2) some large maple trees were creating a significant amount of shade, and 3) the alders growing in the longitudinal section of the bog were getting very dense. From this information, we designated different management zones at Wildcat bog (Table 2) and then prioritized them as there was too much work to accomplish in the time available.

Table 2. Management zones and associated goals for habitat management workday at Wildcat Bog (Wilkes Co.) in September 2010

Management Zone	Description of Zone	September 2010 Management Goals
A	Far NW area of bog, most open part of bog	Thin alders and knock back smilax
B	Area to south of Zone A, containing several large maples	Cut 2 of large maple trees to reduce shading of bog
C	20ft wide wet boggy area running North-South along East edge	Thin out alders, leaving some along field edge to define edge of wetland
D	Large area in middle of bog	Thin alders and sapling maples
E	Open area with only minimally moist soils, near maple at southern end of wetland	No plans for management because of dry conditions

In one workday we were able to complete our ambitious goals for management zone A, B, and C (see Table 2), covering about ½ an acre area. The goals set for zones A and C were the most critical areas to address and we were very satisfied with the outcome at the end of the day (see Figure 2). In addition, by expanding westward from the middle of Zone C, we were able to do some thinning of Zone D (about a 20ft wide area opening that went through to the west side of the bog. The landowner, Don Fletcher, offered to burn the piles of woody debris that we placed in the field surrounding the wetland, so this saved us a lot of time that we would have otherwise spent tending the wood chipper. The informal plan devised for this workday can serve as a guide for future habitat management workdays that we or our partners are able to arrange at this bog.

Figure 2: Photos of Wildcat Bog before (September 8, 2010) and after (September 28, 2010) habitat management work occurred. Before and after photos show the following areas: A) northwestern portion of bog [Zone A], B) 20ft wide wet boggy area running North-South along East edge [Zone C]. Note that it was difficult to capture the changes in Zone C in photos due to the large brush piles we created.



Danny Smith Bog (Surry Co.)

Years of unchecked succession had rendered this site potentially unsuitable for bog turtles. When we began work, it was basically a forested wetland with minimal direct light reaching the ground. It was an ambitious undertaking as this site had been allowed to succeed far from the more open wetland it once was. Bog turtles have not been seen at this bog in several years, so the hope is that by restoring it to more suitable primary habitat, they may be able to return and begin using it again.

Contractors were hired to carry out objectives at this site and they worked for two full days. With their equipment, they were able to accomplish more in a shorter amount of time than volunteers with hand tools could. The biggest time saving device was that they had the ability to set up a tractor in the field and pull cut limbs and branches out with a chain and winch. They used a large industrial chipper, which drastically sped up this step of the process. In addition, their professional tree trimmer staff member was able to carefully drop the large trees in sections, thereby minimizing disturbance to the site from the tree felling.

The main issues that needed to be addressed were 1) 4-5 large trees shading the best bog habitat at this site, and 2) woody shrubs were crowded along the edges of wet areas, providing even more shade. Two management zones were designated and flagged for the contractors: A) the area shaded by the large trees, with multiple ditches and springs fingering out from the hillside, and B) a wide, wet mucky area downstream of the large trees. Both of these zones were in the central portion of the larger bog on the west side (about 3/4 acre total), and were accessed where the dirt road meets the small field on the southwest side of the bog. In two days work, the contractors were able to do all the work that we had outlined to accomplish in Zones A and B (Table 3). See Figure 3 for before and after photos of the site.

Table 3. Management zones and associated goals for habitat management workdays at Danny Smith Bog (Surry Co.) in September 2010

Management Zone	Description of Zone	September 2010 Management Goals
A	Main bog area shaded by large trees	Cut 4-5 large trees (maples, tulip poplar); thin saplings and shrubs
B	Along 15ft wide wet swath running NW-SE immediately downstream of main bog area and upstream from the main stream	Cut larger saplings (mostly maples) and thin shrubs

Figure 3. Photos of Danny Smith Bog before (September 9, 2010) and after (September 17, 2010) habitat management occurred. Before and after photos show the following areas: A) main bog area shaded by large trees [Zone A], B) 15ft wide wet swath running NW-SE immediately downstream of main bog area and upstream from the main stream (Zone B]. Note that the change in the habitat was much more obvious when present at the site than apparent in the photos.

C. Estimated Project Expenses (July 1, 2008-September 30, 2010)

WRC Staff and subcontractor Expenses	$8,306
Volunteer Services (In-kind)	$4,274
Total Cost	$12,580

D. Conclusions

The habitat management objectives set for each site were successfully met, as outlined above. In fact, our accomplishments surpassed what we had hoped to complete in the time we had, in part because of the hard work of our volunteers. The work done at all three sites as part of this

project resulted in much more open and structurally variable bog habitats. The evidence at other bogs indicates that opening up the habitat through habitat management efforts improves the habitat conditions for bog turtles as well as many of the rare plants.

Most habitat management projects need to be continually monitored over time. Future surveys will be conducted to monitor the response of the vegetation and bog turtle population at each site in order to determine future habitat management needs. Although we did accomplish a lot, there always remains more to do. For example, some of the management zones were not addressed during these work days. Furthermore, there is a real need to establish long-term management plans for many of the bog turtle sites in North Carolina.

E. Literature Cited

Graeter, Gabrielle J. *Final Report for USFWS Grant Agreement #401814J011, May 15, 2004-June 30, 2008.* A report prepared by the North Carolina Wildlife Resources Commission, 2008. Print.

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