FINAL PERFORMANCE REPORT
South Carolina Project T-13-R-1
South Carolina Department of Natural Resources
October 1, 2005 – September 30, 2006
Note: A second final report is attached below for revision 2.

Project: Conservation of Migratory Landbirds in South Carolina

Job 1: Bird Monitoring Plan

Objective: Develop and implement an integrated all-bird monitoring plan for SCDNR.

Accomplishments: A number of bird monitoring programs implemented by DNR were continued in order to monitor species of greatest conservation concern: Monitoring Avian Productivity and Survivorship (MAPS), Breeding Bird Survey (BBS), Christmas Bird Count, and Painted Bunting Feeder Watch. A modified BBS protocol was adopted and implemented as part of the overall bird-monitoring program for state lands.

Equipment to set up a MAPS station at Webb Wildlife Center was obtained and lanes were established, data was not collected this year due to a long delay receiving nets from overseas. Data was collected at McCrady Training Center from 18 May thru 8 August 2006 for a total of nine banding days. A total of 540 net hours were logged using 10 mist nests open for six hours each banding day (6:00am to 12:00pm). The total number of netted birds was 154 individuals representing 23 species for 0.3 birds netted per hour.

The state wide Breeding Bird Survey is coordinated by SCDNR staff and time is spent organizing volunteers for all routes to be run. Of the 22 routes distributed across the state, SCDNR personnel run eight. Modified BBS routes were established on Bonneau Ferry and Hamilton Ridge WMAs and run for the first time in May 2006. Webb Wildlife Center BBS route continued to be operated. Modified BBS routes on wildlife management areas represent the only bird monitoring taking place on these areas and is anticipated to be the first set in gathering trend information.

The Painted Bunting Observer Team project began in May with coordination of volunteers to collect observational data from their feeders. The goal was to test the effectiveness of citizen science methods and techniques in collecting useful datasets for Painted Bunting monitoring and habitat conservation. From 12 July to 11 October, a total of 29 banding days occurred in order to mark individuals to obtain better counts of number of buntings visiting feeders and for observers to collect duration data. Twenty-five different feeders were visited in 12 counties spanning the coast to the fall line. A total of 287 buntings were banded 88 or 31% were males – 78 or 27% were females – 49 or 17% were unknown; and 66 or 23% were ASY (after second year) males – 220 or 77% were green birds. The total capture hours were 496.75 that included net and trap hours. In addition to banding painted buntings, 20 other species (259 individuals) were opportunistically banded.

A bird identification workshop was conducted 24-26 May 2006 and 19 SCDNR employees participated. Dr. Fred Alsop, East Tennessee State University, was contracted to instruct participants. The workshop was conducted at the Webb Wildlife Center were food and lodging were covered for

all participants. This was the first bird identification workshop that had ever been conducted for DNR employees and was needed to train personnel to conduct monitoring activities on state lands.

Significant deviations: None.

Job Cost: $45,000

Job 2: Painted Bunting Nesting and Demographics

Objective: Find and monitor nesting success for a statistically significant number of nests in each of two habitat types: outer coastal plan maritime forest and inner coastal plan agriculture-old field habitat; quantify nesting habitat at the stand and landscape level; and correlate nesting success with habitat type.

Accomplishments: This is a Cooperative Research Project between the Clemson University Department of Forestry and Natural Resources and the South Carolina Department of Natural Resources. These accomplishments were submitted to Laurel Moore Barnhill, SCDNR by J. Drew Lanham, PhD- Principal Investigator and Kelly Blackburn, M.S. Graduate Research Assistant; September 29, 2006

The 2006 field season for the Painted Bunting (PABU) research project began mid-May. Two field sites were utilized throughout the summer. The first field site is Webb Wildlife Center, hereafter Site 1, located in Garnett, South Carolina. The second field site is Nemours Wildlife Foundation, hereafter Site 2. Data collection began by May 18 for Site 1 and by the second week of June for Site 2. While the original intent of the project was to asses the breeding productivity of painted buntings in agricultural and maritime locations, the late start within the breeding period and the apparent precocious nesting season precluded nest searching and obtaining any reliable estimates of nesting or productivity during 2006. However, because a stated goal of the project is to assess the usage of agricultural areas by PABU and other early successional species, efforts were shifted to obtain as much data as possible relative to PABU and other early-succession associated songbirds, especially indigo bunting and blue grosbeak two study sites managed intensively for wildlife using agricultural methods.

Data collection at Site 1 began by first identifying all known and unknown food plots. These plots ranged from ~ 10 acre dove fields to >1 acre strip plots. In approximately two weeks, over 100 food plots had been identified. Due to logistical constraints we decided to take a random sample of food plots. A three by three by three matrix was formed by sampling three large, 3 acres and larger, three medium, 1 to 3 acres, and three small food plots <1 acre, categorized by agricultural status. Each size class had old-field, fallow field and planted fields. Sample fields were randomly chosen from the total fields identified. Selected plots were marked via a handheld GPS unit and latitude, longitude and UTM coordinates were recorded for each field.

At Site 1, each plot was visited three times per week minimum. Census counts were taken within the first four hours following sunrise. An ATV was used to travel between sites. Site 2's plots were identified to follow the same matrix set up as Site 1. These plots were visited two times per week at minimum. Census counts began by 7 am.

Census counts consisted of visual and auditory identification of the target species. There was a five minute time period allotted to each count per plot. Target species and director competitors were identified by sex if possible and by behavior. Behaviors recorded included but are not limited too flying, singing, calling, allo-feeding, perching, chasing and on the ground.

The 2006 field season granted the opportunity to lay all ground work for future field seasons. All vital food plots are marked and their agriculture status known. Furthermore, while living at the Webb Wildlife Center and traveling to the Nemours Wildlife Foundation a healthy working relationship was established with the area managers.

For the 2007 field season, a significant amount of additional census data is needed. This will include continuing point count censuses, nest searches and vegetative and management characterization of use sites.

Significant Deviations: None

Job Cost: $18,000

Job 3: Swainson's Warbler (SWWA) movements, productivity, survival, and habitat use.

Objective: Determine breeding distribution; quantify breeding habitat at the stand and landscape level; and determine breeding densities.

Accomplishments: This report was submitted by John Gerwin, North Carolina State Museum of Natural Sciences.

Annual bird banding work was completed nearly as planned. We conducted 7 banding sessions at the Woodbury/IP site in Marion County, for a total of 168 hours. This is our 11th year of banding here, since 1996. This spring was fairly dry. We experienced one week of flooding after Hurricane Alberto, during which time access to the study site was limited. This season, we continued to capture some new, unbanded SWWA, but now most spring captures are of previously banded individuals. A number of birds recaptured, as in 2005, were 5-6 years old, along with the usual majority of birds that are 2-4 years. One bird was at least 7 years old. One recapture was of a bird banded as a juvenile, on-site, in 2005, about 50m away from where he was caught this year. We did not focus on nest searching this year, as that was a significant part of our efforts from 1998-2002. However, we continue to monitor some nests, from females who have transmitters, to investigate fecundity. We tracked four females this season, and highlights are included below. We followed numerous males, which provided good data on reproductive success also, as they care for fledged young.

Seventeen adults were radio tagged using (18) 0.6g transmitters (12 males, 5 females). Most of the transmitters were built to last ~45 days; some were built to last 30 days. All transmitters lasted a few days longer than their stated field life, affording us some extra time to get more points. Approximately 600 telemetry points were taken for these birds. We had fewer challenges this year. One female was never found again, after we attached a transmitter; she was most likely a migrant (it was very early in the season). Another female escaped from her harness, but was later recaptured and tagged successfully. The harness from which she escaped, and its transmitter, were taken deep into a crayfish tunnel. We attempted to dig it out, for a few hours, but had to give up. Antennas were

reinforced this year, and none were broken by birds. Last year a male got caught on a small cane stem, via the harness, and managed to extricate himself. This male has been in this same area since 2001, and returned again this year. He was recaptured and tagged, but we apparently induced a twist in his harness, and after only a few days our tech reported he had a leg problem. It took us another week to recapture him. His leg was indeed severely strained, and his weight was low (although he continued to sing and chase birds and was mated at the time). After harness removal, his nest failed in the egg stage, and that female divorced him. He continued to sing, and defend his territory, although he also continued to limp. Foraging was surely difficult, but a month later he had gained nearly 1g of weight. His tail feathers were ratty, as he could not walk quite correctly. The weight gain was encouraging. He was still being seen in late July, within his territory. This bird is at least 6 years old, and I do not expect him to return. One five year old male, who had moved a bit south from last year to occupy a territory now vacant (due to another 5 year old bird that did not return), was killed by a Barred Owl in the net. We generally suffer 1-2 raptor mortalities each year, but seeing it happen to a five year old bird was particularly disappointing. Three other males we tracked have been in the same territories for 4 and 5 years. One of these males mated with a female for the third year in a year. We also tagged this female for the second year. Her first two nests failed in the egg stage, but her third was successful. Young were at 8 days of age on August 4th, when we stopped field work. An age of 8 days is considered a success (they fledge on day 9 or 10). Her mate had a second female, a case of bigamy. This other female fledged two broods, based on following him to recently fledged young; both times while female #1 was incubating. His territory is in the northern section of the study site, and was ~10 hectares in size. A male tagged several hundred meters to the north also used an area ~10 hectares, and fledged at least one brood. In contrast, most of the birds in the southern section used areas of 4-6 hectares. As was the case last year, most males were easier to track (than females) and showed a strong affinity for singing, preening, and spending time, along the edges of light gaps that contained a high density of vines, and thick vegetation. We tracked another female that we had also tracked last year. She first mated the injured male mentioned above. After her first clutch failed, she moved to an adjacent territory with a male that we banded this season, thus likely a very young male. She attempted two more broods, both of which also failed in the egg stage. After the third one, her transmitter died. There was time for one more attempt, but we could not locate her again, and did not recapture her for the rest of the season. Thus, she layed 10 eggs, and none hatched. Another female, and male, both newly banded, were tracked. Their first nest failed in the egg stage, but the second brood fledged. It's clear that these birds keep attempting to raise young until August, both with re-nesting after failures AND successes. For the females tracked this season, although all were consistently found within the home range of their mates, we also found them on several occasions in adjacent territories. They appeared to be foraging when in an adjacent males' territory, but alternate behaviors are hard to detect.

Two males, each in territories adjacent to other birds, displayed interesting behavior. Each appeared to be un-mated, and when nests were successful in their neighbor's area, each was seen hanging around the young, and the now "receptive" female. One male indeed appeared to actually FEED one of the young, and the "father" tolerated this. Females begin re-nesting almost immediately after young fledge, and it appears that neighboring males are able to detect their breeding "state".

Again, males often kept or took young to the edges of disturbance gaps, thus I believe that the thick vine tangles are an important "hiding" and foraging habitat for recently fledged young.

Some other general highlights of banding include: 1) we recaptured a 6 year old Hooded Warbler, our oldest HOWA on record; 2) although we recaptured numerous Prothonotaries, including a 4 year old (a rare event for PROW0, we continue to mostly band new birds, and the recap's are mostly 2-3 years old. We again also captured numerous Louisiana waterthrushes, and it still appears that the Woodbury site is a "staging" area for migrating individuals. We detected our first LOWA on July 8.

Also note that we re-sighted several other individual SWWA in areas where we do not band, adding more points to our survivorship database. Several territories that had been occupied by "old" birds (e.g. 6 years) were occupied this year by 2-3 year old birds. SWWA continue to show high site fidelity to Woodbury in general, and to previous territories. We have detected a decline of territory occupancy along the north and west edges of our study area. However, what we learned this year is that males in those areas are defending territories much larger in size relative to birds in the south section.

In sum, we acquired over 500 telemetry points on a combined total of 12 males and 4 females. We recovered 12/18 transmitters, which can be recycled at a much reduced cost, in 2007.

In June the PI met with numerous SC DNR staff involved in the acquisition and management of the Woodbury tract, to discuss management options in light of the Swainson's Warbler and associated general bird research conducted thus far.

Through December we finished entering the banding and observational data into our spreadsheets.

In addition to field work, a part time person has been working on a database management system, along with our GIS/Database manager at the Museum. She spent 100's of hours collating data from the various sources that we have, including variously formatted electronic files, and field notebooks with raw data. When this project is completed, every Swainson's warbler on the Woodbury Tract study site, whose identity is known, or strongly "suspected" (based on say, 2 color bands instead of all four), will be in a spatially explicit database, with any associated notes and other records together.

Significant Deviations: None

Job Cost: $30,000

Total Project Cost: $93,000

FINAL PERFORMANCE REPORT
South Carolina State Wildlife Grant [T-13-2-R]
Grant Period October 1, 2006– September 30, 2008

TITLE: Conservation of Migratory Landbirds in South Carolina

GRANT OBJECTIVES

1. Conduct growing season prescribed burns on Bonneau Ferry WMA.

2. Expand research to develop a better understanding of Painted Bunting and Swainson's Warbler demographics and habitat needs in order to institute management practices that will increase their populations.
    a. Painted Bunting: Find and monitor nesting success for a statistically significant number of nests in inner coastal plain agriculture-old field habitat; quantify nesting habitat at the stand and landscape level; and correlate nesting success with habitat type.
    b. Swainson's warbler: Determine breeding distribution; quantify breeding habitat at the stand and landscape level; and determine breeding densities.
3. Develop and implement seamless monitoring protocols within the state that will provide a scientific basis for management and conservation planning for bird species with the greatest conservation need.

ACTIVITY OVERVIEW:

Activities associated with the grant are described below, according to the original tasks and subtasks in the Project Statement for this grant.

Tasks

I. Conduct growing season prescribed burns on Bonneau Ferry WMA.

Activity:
In May and June of 2008 a total of 406 acres were burned, adding to the 433 acres burned in 2007. DNR staff established necessary firebreaks each year.

Results: all desired burn blocks were burned. Good ground coverage was achieved with little to no crown scorch of mature trees. Burning was conducted around two red-cockaded woodpecker, one of which was in great need of understory control. Hardwood understory stunting appears to have been significant in all burned areas, however a few lower/wetter patches (most less than 1000 square feet) in some areas remained unburned, creating a mosaic of shrubby patches among herbaceous plant dominated understory with significant edge.

Significant deviations: none

II. Expand research to develop a better understanding of Painted Bunting and Swainson's Warbler demographics and habitat needs in order to institute management practices that will increase their populations.

Activity:
Conservation of Migratory Landbirds in South Carolina, Painted Bunting Studies -
Breeding Ecology of the Painted Bunting (Passerina ciris) and other early-successional passerines in agricultural landscapes on the coastal plain of South Carolina

The 2008 field season for the Painted Bunting (PABU) research project began early May. Two field sites were utilized throughout the summer. The first field site is Webb Wildlife Center, hereafter Site 1, located in Garnett, South Carolina. The second field site is Nemours Wildlife Foundation, hereafter Site 2. Data collection began by May 6 for Site 2 and by the second week of May for Site

1. Data collection focused on presence/absence data for the PABU, indigo bunting (INBU), blue grosbeak (BLGR) as well as the brown-headed cowbird (BHCB).

Data collection at Site 1 began by first returning to fields previously identified in the 2006 field season. An assessment was made to determine the condition of these fields and any changes from the previous season were noted. The original three by three by three field matrix was again for the 2008 field season. The matrix consisted of three large, 3 acre and larger plots, three medium, 1 to 3 acre plots, and three small food plots, <1 acre. Each field was categorized by agricultural status. Each size class had old-field, fallow field, planted fields or mixed fields. The mixed field category was added for the 2008 status due to the many managerial changes implemented during the research season.

At Site 2, each plot was visited three times per week minimum. Census counts were taken within the first four hours following sunrise. An ATV was used to travel between sites.
Site 2's plots were also the same as identified in the 2006 field season. Site 1 plots were visited two times per week at minimum. Census counts began by 7 am.

Census counts consisted of visual and auditory identification of the target species. There was a five minute time period allotted to each count per plot. Target species and director competitors were identified by sex if possible and by behavior. Behaviors recorded included but are not limited too flying, singing, calling, allo-feeding, perching, chasing and on the ground.

The 2008 field season granted the opportunity to achieve the main objective of collecting as much census data as possible, with a focus on Site 2 plots, as the previous two field seasons focused on Site 1. Additional food plot information was collected. Photographs and sketches were made of each plot and its vegetative composition.

Following the completion of the 2008 field season, preliminary analysis was completed on the three year data set. PROC GLIMMIX was run to compare the basic presence/absence data between the two field sites. For PABU, INBU, BLGR and BHCB there were no significant findings comparing the two sites. Similar analyses were completed to compare sex differentiation, plot size and status aspects and species interactions. There were no statistically significant findings to report.

At this time, the data from the three year research period is being worked in the research thesis for Kelly Blackburn. A final copy of this report should be available by mid March, 2009.

Swainson's Warbler (SWWA) movements, productivity, survival, and habitat use.
Annual bird banding work was completed nearly as planned. We conducted 6 banding sessions at the Woodbury/IP site in Marion County, for a total of 144 hours. This is our 13th year of banding here, since 1996. In addition, Amelia Savage continued her work on crop-flushing individual warblers, for a diet analysis. She target netted many additional birds outside our main study area, but within Woodbury/Potato Bed tracts. This spring was fairly wet – we experienced two flood events in early and mid-April. Summer was fairly dry. There were no hurricanes that impacted the study site. Funds were used to pay for salaries for Savage, a half time field tech, and a month each for two other technicians. Two of us visited the site from April 6-9 and documented at least 6 singing males on April 7, including 3 identified by color bands. This season, we continued to capture new, unbanded SWWA – more so than in the previous few years. A number of birds recaptured, as in recent years,

were 5-6 years old, along with the usual majority of birds that are 2-4 years. We recaptured 3 birds that were at least 8 years old, and a 10 year old bird (the 9 year old male from last year). This is now the oldest age SWWA ever recorded. We recaptured another young male that had been banded as a fledgling on site in 2007. In total, we captured 89 SWWA. This includes 58 unbanded and 31 recaptures. Of the unbanded birds, 33 were "AHY/ASY" (adults - 10 females, 23 males); 22 were scored as "SY" (1 year old), and 2 were "hatch year" birds (young fledged on-site); and one was "sex unknown". Of the 31 recaptures, there were 22 males, and 9 females. For comparison, in 2006, we captured 91 SWWA. This includes 44 unbanded, and 47 recaptures. Of those unbanded birds, 67 were "AHY" (adults), 5 were scored as "SY" (2 years old), and 19 were "hatch year" birds (young fledged on-site). In 2005 we captured 69 SWWA individuals. Of these, 41 were recaptures and 28 were new. Of the 28 new ones, 13 were "hatch year" birds. We saw more HY birds in 2008, but we did not capture many. Also, we did not band during the last week of July, when we often catch this age class. Note also that we began sampling birds "off the grid" in 2007 and continued in 2008, and most of these were unbanded. Amelia reports that even with the 2007 effort, birds she caught this year off the grid we again mostly unbanded. But it appears that a number of young (SY) birds, especially males, were recruited into the area.

We did not focus on nest searching this year, as that was a significant part of our efforts from 1998-2002. However, we continue to monitor some nests, from females who have transmitters, to investigate fecundity. Following males can provide good data on reproductive success also, as they care for fledged young - highlights are included below, at the end of this narrative.

Twenty two adults were radio tagged using 0.7g transmitters (16 males, 6 females). Most of the transmitters were built to last ~45 days; some were built to last 21 days. Half were attached with a medium weight surgical thread. This thread held up better than last year, but a number of birds were still able to break the thread by around Day 30. By that time, we had accumulated enough data points to be a success, but extra points are always welcome. For the other birds we used a slightly stronger sewing thread and these lasted the entire time. Over 700 telemetry points were taken for these birds. We generally suffer 1-2 raptor-caused mortalities each year, but no SWWA were killed by raptors in nets this year.

Two graduate students worked on parts of the project: Amy Plahuta, on telemetry; and Amelia Savage, on food resources and diet. Amelia crop-flushed 69 individual birds, for 100 samples. Again at each capture site she collected 4 leaf litter samples and took microsite vegetation data. By the end of August she had sorted and ID'd all the invertebrate samples. No birds were harmed, and none appeared negatively affected. Indeed, most were recaptured several weeks later for a second sample. Some were detected into late July. Based on preliminary analyses, SWWA appear to be selecting Araneae (spiders), Coleoptera (beetles), Lepidoptera (butterfly/moth) and Hemiptera (true bugs – "hatch year" young birds only).

Some other general highlights include: 1) Swallow-tailed kites were again irregularly seen along Horseshoe Road, adjacent to our study site entrance.

2) We re-sighted several other individual SWWA in areas where we do not band, adding more points to our survivorship database. Several territories that had been occupied by "old" birds (e.g. 6 years) were occupied this year by 2-3 year old birds. SWWA continue to show high site fidelity to Woodbury in general, and to previous territories.

3) We tracked birds across 17 territories. We documented fledged young in 10 of those. There were signs that a few others did produce young. Woodbury continues to be place of high SWWA productivity, compared to data from at least two other sites.

In sum, we acquired over 700 telemetry points on a combined total of 16 males and 6 females. We attempted 6 other birds: 2 females were caught near the Great Pee Dee river and ended up on the other side; the transmitter from one male was found in an owl pellet, before we had collected enough data; we had the wrong frequency for one male, and this was not discovered until it was too late to get data; the transmitters on two birds were removed by the birds before enough data were acquired (male and female).

Throughout the year the PI met and communicated with SC DNR staff involved in the management of the Woodbury tract, to discuss management options in light of the Swainson's Warbler project and IP's desire to accelerate the harvesting contract.

Telemetry data were being entered into their respective electronic files at the time of this writing.

Significant deviations: none. Extension requested to allow for a complete analysis and write up of findings for the entire study period.

III. Develop and implement seamless monitoring protocols within the state that will provide a scientific basis for management and conservation planning for bird species with the greatest conservation need.

Activity:
A number of bird monitoring programs implemented by DNR were continued in order to monitor species of greatest conservation concern: Monitoring Avian Productivity and Survivorship (MAPS), Breeding Bird Survey (BBS), Christmas Bird Count, and Painted Bunting Feeder Watch. A modified BBS protocol was adopted and implemented as part of the overall bird-monitoring program for state lands.

The state wide Breeding Bird Survey is coordinated by SCDNR staff and time was spent organizing volunteers for all routes to be run. Of the 22 routes distributed across the state, SCDNR personnel run eight. State WMA BBS routes continue to be run on Bonneau Ferry, Hamilton Ridge and Webb Wildlife Center. Modified BBS routes on wildlife management areas represent the only bird monitoring taking place on these areas highlighting the importance of repeating each year.

Bird identification workshops were conducted 7-11 May 2007 and 5-9 May 2008. In 2007, the first three days were at Donnelly WMA and the last two days at Table Rock State Park. Twenty SCDNR employees participated at Donnelly WMA and 11 at Table Rock. In 2008, the workshop started in the Pee Dee region of the state and moved for the final 2 days to capture higher elevation birds found in and around Table Rock State Park. Participation was similar to 2007, with 20 people attending in the beginning of the week and 14 the end. Dr. Fred Alsop, East Tennessee State University, was contracted to instruct participants.

The Painted Bunting Observer Team project began in May 2006 with coordination of volunteers to collect observational data from their feeders. The goal is to test the effectiveness of citizen science methods and techniques in collecting useful datasets for Painted Bunting monitoring and habitat conservation. In 2007, banding occurred in South Carolina between 17 April and 26 September at 45 sites in 10 counties on 49 days for a total of 624.5 banding hours (1.33 buntings captured per hour, 0.90 bunting banded per hour, and 0.20 buntings recaptured per hour). A total of 575 buntings were banded and 125 buntings were recaptured. Of the total captured, 245 (43%) were males (66% [162] adult plumaged and 34% [83] green birds), 192 (33%) were females, and 138 (24%) were of unknown sex. Of the 125 total recaptures, 65 (52%) were males, 48 (38%) were females, and 12 (10%) were unknown sex. Fifty-seven additional species were captured: Blue Jay, Carolina Chickadee, Tufted Titmouse, Brown-headed Nuthatch, Carolina Wren, Yellow-throated Warbler, Chipping Sparrow, Northern Cardinal, Blue Grosbeak, Indigo Bunting, Red-wined Blackbird, House Finch, and American Goldfinch.

In 2008, banding occurred from May 3 to August 21 and 175 buntings were captured of which 120 (69%) were banded and 55 (31%) were recaptures. Of the 120 banded, 48 were males (40%), 48 females (40%) and 24 were unknown (20%). Twenty-six (22%) were adult ASY males and 92 (77%) were green birds. A total of 55 buntings were recaptured representing 53 individuals: 27 males – 49%, 27 females – 49% and 1 unknown – 1%; 26 were adult males (ASYs) – 47% and 30 were green birds – 55%. In terms of effort, 123.75 trap hours were expended where 1.41 buntings were captured per trap hour, 0.96 buntings banded per trap hour, and 0.44 buntings recaptured per trap hour. A total of 14 different sites were visited with some having repeat visits (21 total visits) for an average of 5.89 trap hours.

In 2007, the Eastern Painted Bunting Working Group designed and initiated a systematic annual survey for the eastern population of the Painted Bunting. The survey was designed to provide reliable information on bunting distribution and abundance using data a collected by biologists and volunteers using simple standardized protocols. Specific objectives are to determine a range wide population size, stratified where possible by states, habitats, and/or applicable delineations (e.g., coastal versus inland areas), and to determine the densities of breeding birds by major habitat types. Implementation and data collection occurs at the state level. Selection and ground truthing of transect points in South Carolina occurred in April 2007 (40 transects of 12 points each and 20 cluster sites of 6 points each). A cadre of volunteers and biologists were solicited to run 5 minute point counts for 3 repetitions for each transect and cluster. All data was collected in May and June. Individuals were responsible for entering their data on into an on-line data base and staff acted in a coordinator role to verify data entries. In 2008, cluster sites were re-established due to some sampling errors. Coordination continued to organize volunteers and biologists to collect and submit data, as well as verifying entered data and reporting results to the Working Group.

Data from Monitoring Avian Productive and Survivorship mist net stations continue to provide valuable information. Overall, the number of species captured at the McCrady site remains consistent but the overall number of individuals declined. It is anticipated that habitat changes within the 10 acre site have resulted in it being less desirable for fledgling feeding. In contrast, the highest numbers of birds captured per day were at Webb, an area maintained in early succession hedge rows surrounded by small grain fields and mature mixed pine stands with an herbaceous understory.

2008 MAPS (Monitoring Avian Production and Survivorship) Report

McCrady Training Center, Fort Jackson established in 2002
51 species netted & observed

- 29 species (57%) were permanent residents
- 22 species (43%) were neotropical migrants

20 species & 79 birds were netted

- 19 species (95%) & 46 (58%) individuals were banded
  - 6 species (32%) & 20 individuals (43%) were permanent residents
  - 13 species (68%) & 26 individuals (52%) were neotropical migrants
- 6 species (30%) & 23 (29%) birds were recaptured
  - 3 species (50%) & 17 birds (74%) were permanent residents
  - 3 species (50%) & 4 birds (17%) were neotropical migrants
- 4 species (20%) & 10 (13%) birds were unbanded
  - 2 species (50%) & 3 birds (30%) were permanent residents
  - 2 species (50%) & 7 birds (70%) were neotropical migrants

31 species observed

- 23 species (74%) were permanent residents
- 8 species (26 %) were neotropical migrants

7 banding days

- average of 5 species & 10 individuals banded per banding date
- average of 2 species & 3 birds recaptured per banding date
- average of .1 species & 1 bird unbanded per banding date

10 nets used & 416.50 total net hours

- .19 birds netted per net hour
- .11 birds banded per net hour
- .05 birds recaptured per net hour
- .02 birds unbanded per net hour

Top 9 species banded; 4 species are permanent residents and 5 species are neotropical migrants: 8 Carolina Wren, 4 White-eyed Vireo, 3 Tufted Titmouse, 5 Northern Cardinal, 4 Blue Grosbeak, 3 Yellow-breasted Chat, 5 Indigo Bunting, 3 Carolina Chickadee and 2 Prairie Warbler.

Top 3 species recaptured; 2 species are permanent residents and 1 species was a neotropical migrant: 8 Northern Cardinal, 8 Carolina Wren, and 2 Indigo Bunting

Webb Wildlife Center, established in 2007
37 species netted & observed

- 19 species (51%) were permanent residents
- 18 species (49%) were neotropical migrants

22 species & 309 birds were netted

- 21 species (95%) & 239 (77%) individuals were banded
  - 7 species (33%) & 64 individuals (27%) were permanent residents

14 species (67%) & 175 individuals (73%) were neotropical migrants

- 6 species (27%) & 40 (13%) birds were recaptured
  - 1 species (17%) & 16 birds (40%) were permanent residents
  - 5 species (83%) & 24 birds (60%) were neotropical migrants
- 11 species (50%) & 30 (10%) birds were unbanded
  - 2 species (18%) & 4 birds (13%) were permanent residents
  - 9 species (82%) & 20 birds (87%) were neotropical migrants

33 species observed

- 19 species (58%) were permanent residents
- 14 species (42%) were neotropical migrants

4 banding days

- average of 12 species & 60 individuals banded per banding date
- average of 5 species & 10 birds recaptured per banding date
- average of 4 species & 8 bird unbanded per banding date

10 nets used & 225 total net hours

- 1.37 birds netted per net hour
- 1.06 birds banded per net hour
- 0.18 birds recaptured per net hour
- 0.13 birds unbanded per net hour

Top 10 species banded; 2 species are permanent residents and 8 species are neotropical migrants: 51 Indigo Bunting, 15 Common Yellowthroat, 9 Carolina Wren, 43 Northern Cardinal, 11 White-eyed Vireo, 7 Red-eyed Vireo, 43 Painted Bunting, 11 Blue Grosbeak, 7 Blue-gray Gnatcatcher, and 19 Yellow-breasted Chat.

Top 3 species recaptured; 1 species is a permanent resident and 2 species are neotropical migrants: 16 Northern Cardinal, 8 White-eyed Vireo, and 8 Yellow-breasted Chat.

Significant deviations: none

Estimated Federal Cost (grant level): 117,228.54

Recommendations: Grant has been extended to allow for complete analysis of research projects.

Conservation of Migratory Landbirds in South Carolina, Swainson's Warbler Studies

South Carolina Department of Natural Resources

John A. Gerwin, Curator of Birds
North Carolina Museum of Natural Sciences
Raleigh, NC 27601

Introduction

We have studied a population of Swainson's Warbler, (*Limnothlypis swainsonii*), since 1997, at the Woodbury Tract (now Wildlife Management Area). We began our work at this site in 1996 with a large array of habitat-specific point count surveys and mist-netting/banding operations. The point counts provided an estimate of relative abundance of bird species across the landscape, and indicated the presence of a handful of Swainson's in an area of Woodbury north of Horseshoe Lake. Banding efforts there confirmed these and the presence of many more Swainson's than the surveys indicated. We decided to pursue a more focused study, which again, began in 1997.

Songbird density alone is not a reliable indicator of habitat quality since it does not provide sufficient data to expose the source-sink dynamics of a population within a study area (Van Horne 1983, Pulliam 1988). Understanding proximate causes of population fluctuations allows investigators and land managers to identify habitats and landscapes that promote high survival and reproduction [Partners in Flight Working Group (PIFWG) 2002]. The quantification of demographic parameters such as adult survivorship, site fidelity, and nest success within migratory bird populations is critical to specific conservation efforts. Demographic studies are needed to measure population trends of high conservation priority species, such as Swainson's Warbler, that are not well surveyed by conventional methodologies (Brown and Dickson 1994, PIFWG 2002).

We used mist-netting, color-banding, nest searching/monitoring, "stomach" content analysis, and radio telemetry to learn about the breeding biology and demographics of this population. By necessity, this report will include results from outside the scope of the main grant to which this pertains (#T-13-1-R). I will focus on the years for the T-13 award (2006-2008 inclusive) but also include results from T-4 (2004-2005); and to put it all into context, I reference results from earlier work that was funded by other sources.

Study area

The 8,000 hectare Woodbury Tract (Wildlife Management Area), lies 8 miles south of Britton's Neck, Marion Co., South Carolina (33° 52′ N; 79° 22′ W), in the Southeastern Coastal Plain on a peninsula formed by the confluence of the Great Pee Dee and Little Pee Dee rivers (Figure 1). This area has been owned by Georgia Pacific Corporation and International Paper and was managed primarily for wood fiber production. In 2006 International Paper divested of most of its timber holdings, and the State of South Carolina acquired this tract and placed it in their game management system. It is now the Woodbury Game Management Area. The tract consists of a mosaic of pine and hardwood forests ranging from 0 to 25 m in elevation. Included in this landscape are Carolina bays, sandhills, uplands of planted loblolly (*Pinus taeda*) and longleaf pine (*Pinus palustris*), and large expanses of bottomland hardwood forest (BHF) interspersed with gum (*Nyssa* spp.) and cypress swamps (*Taxodium* spp.) along with drainage sloughs and oxbow lakes.

The study site was located in the northern portion of the broad floodplain of the Great Pee Dee River that defines the western edge of the peninsula (see Figures 1,2). This study area of approximately 280 hectares was subjected to a slightly different management regime than the remainder of the riparian corridor. Here, a site-preparation method known as shearing was used subsequent to timber harvests from 1970 to 1985. Shearing involves the use of a specialized bulldozer to cut hardwood stumps at ground level while removing saplings and debris. As a result, an even-aged stand of desirable crop trees regenerates from stump sprouts and root suckers in the absence of competition. We suspect that harvest patches and sheared spots were more convoluted than typical geometrically harvested upland stands due to the wetness of the site and the maintenance of riparian slough and pond buffers. This could have diminished the even-age effect of this

regeneration and created a high edge-to-area ratio. It also could have contributed to the high incidence of canopy gap ("light gap") formation, which host high densities of blackberry (*Rubus* sp.) and vine thickets, documented by Peters (1999) and Thompson (2005).

The habitat structure of this site is a closed-canopy hardwood forest with an overstory dominated by sweetgum (*Liquidambar styraciflua*), sugarberry (*Celtis laevigata*), red maple (*Acer rubrum*), sycamore (*Platanus occidentalis*), green ash (*Fraxinus pensylvanica*), swamp laurel oak (*Quercus laurifolia*), and cottonwood (*Populus* spp.). Leaf litter is nearly continuous and reaches depths of up to 12.5 cm (Thompson 2005). Within the closed-canopy matrix are gaps of various sizes estimated to be up to an acre in area. These are believed to be caused by both tree falls and logging deck operations that caused soil compaction followed by poor tree regeneration. Dominant gap species are giant cane (*Arundinaria gigantea*), blackberry (*Rubus* sp.), and vines such as wild grape (*Vitis* spp.), greenbrier (*Smilax* spp.), Virginia creeper (*Parthenocissus quinquefolia*), trumpet creeper (*Campsis radicans*) and poison ivy (*Toxicodendron radicans*), along with various shrubs and saplings. Subcanopy development is variable across the site. It is thickest in proximity to roads, drainage sloughs and gaps, and tends to be thinner beneath maturing forest. The subcanopy and understory are comprised of sapling-stage overstory species, gap species, and also include American hornbeam (*Carpinus caroliniana*), several hollies (*Ilex* spp.), red mulberry (*Morus rubra*), boxelder (*Acer negundo*), river birch (*Betula nigra*), elm (*Ulmus* spp.), hawthorn (*Crataegus* sp.), and dwarf palmetto (*Sabal minor*) (Thompson 2005). There is a logging road that divides the study site into two areas, north and south. It appears that the area to the north was logged first, as the trees here appear older, the understory less dense and the vine thickets less abundant (Thompson 2005).

Winter and spring flooding of the Great Pee Dee River occurs frequently at the site (see Figure 3). The bottomlands remain inundated until the river level falls and evapotranspiration rates increase during the spring. Recharged ponds and oxbow lakes drain slowly through narrow sloughs, which are often dammed by beaver (*Castor canadensis*).

Rainfall varies annually. During the breeding season, a "typical" year might include regular afternoon, or overnight "summer" showers, with warm sunny days. But we experienced drought years (e.g. 1999, 2000, 2002), whereas 2003 was a year with the third-highest flood levels in recorded history. We were not able to do much work in 2003 due to access issues, because of the high water levels.

Diverse soil types within the study area have been identified as Rogers, Chastain, Pee Dee, and Roanoke types (Peters 1999).

We expanded the study area in 2007-08 for the diet study.

Study species

The Swainson's Warbler (SWWA) is one of the least understood passerines in North America (Brown and Dickson 1994). Its cryptic coloration, secretive habits, and its strong association with inaccessible floodplain forests make it a difficult species to study. The Swainson's Warbler is a Neotropical migrant that breeds in bottomland forests of the South Atlantic and Gulf Coastal Plains, and in riparian rhododendron (*Rhododendron* spp.) thickets and cove hardwood forests in the southern Appalachian Mountains (Brown and Dickson 1994). It will also use some pine-dominated areas (Carrie 1996, Henry 2004). It forages almost exclusively by overturning leaf litter with its bill and probing for invertebrates beneath (Meanley 1971, Barrow 1990, Brown and Dickson 1994, Graves 1998). Prime foraging habitat is relatively free from herbaceous ground cover (Graves

2002). In our study area, males begin to arrive by early April and defend territories; females arrive soon after (earliest known female arrival at Woodbury is April 16th). The open-cup nest is relatively large and loosely built of leafy matter and resembles the ubiquitous clumps of debris deposited by floodwater into the forest undergrowth (Figures 7,8). Nests are usually located in the margin between dense gaps and closed-canopy forest and are placed in a shrub/vine tangle at a height of 0.5 – 3.5 m (Meanley 1971, Brown and Dickson 1994, Peters 1999, Thompson 2005; Figure 7). In the Coastal Plain, the Swainson's Warbler has long been thought to require cane brakes (*Arundinaria gigantea*) embedded within a large (≥ 350 ha), mature bottomland hardwood forest (Meanley 1971, Eddleman et al. 1980, Thomas et al.1996). Recent investigations indicate that breeding habitat selection is more significantly influenced by physiognomic structure and hydrology than by floristic components (Peters 1999, Graves 2001 and 2002, Thompson 2005). Graves (2002) found that significantly less cane was contained in core territories than in non-use BHF habitat. A closed deciduous canopy (attained ≥ 15 years after harvest) and periodic flooding creates optimal foraging area by depositing leaf litter and retarding the growth of heavy herbaceous ground cover, while canopy gaps provide sufficiently dense cover as well as nesting substrate via the vine thickets that develop around them. These findings indicate that Swainson's Warbler might be more compatible with certain timber management practices than previously thought.

Methods

Mist-netting/banding – In 1996 eight net arrays of 10-14 nets each were established across the peninsula, including the adjacent property called Giles Bay. By 1999 a total of four nearly contiguous mist-net arrays were in operation within the SWWA study site (2 in the northern section, 2 in the southern; see Figure 2 for main study site location). In 2006 one of the northern arrays was discontinued and replaced by an array in the southern part. Nets were laid out in a more or less linear pattern up to 100 m apart in close proximity to logging roads. Because roads and trails tended to occupy the highest ground within the site, nets placed nearby facilitated access during flood periods. Constant-effort mist-netting and banding (Ralph et al. 1993, Pyle et al. 1997) were conducted during the breeding season from 1998-2008. Banding operations took place approximately every 10 days from May 1 until end of July. Beginning in 1999, with fewer arrays closer together, we could do the arrays more times each season. In most years we could complete at least 6 banding sessions, sometimes seven or eight. Nets were opened between 0600-0700 hours and operated for 6 hours, or until ambient temperatures were judged to be too high to safely capture and handle birds without causing heat stress (90° F). Operations were also discontinued in cases of rain or high winds. Nets were checked every 45 minutes.

Sex was determined by the presence of a brood patch or cloacal protuberance. Breeding condition was noted by the various stages of a brood patch (partially vascularized, fully vascularized, or feathers regrowing) or a cloacal protuberance (small, medium, or large). Age was classified as follows: Hatching Year (HY – birds that hatched/were raised on site), based on plumage characteristics and by incomplete skull ossification; Second Year (SY – birds that are one year old, thus beginning their second year of life); and After Hatching Year (AHY), based on breeding condition, plumage, and complete skull ossification. Each bird received an aluminum federal band, and each adult Swainson's Warbler was fitted with a unique combination of three plastic color bands. This allowed us to re-sight and track individuals without having to recapture them. Beginning in 2004, hatch-year birds were fitted with an aluminum band on one leg, and an orange band on the other. This allowed us to quickly ascertain, by re-sighting, if a bird was a hatch-year bird that had survived its first migration and returned to our study site.

Each season we made a considerable effort to target-net Swainson's Warblers. Once located, a singing male was lured with tape-recorded songs into a net placed within its territory. This method was employed throughout the season but was especially effective in the early spring (April-May) during the territory establishment and courtship period. Target nets were also used to capture and mark Swainson's Warblers at nests (especially females), and for capturing birds away from the main study site for the diet analysis.

Vegetation sampling – Vegetation data were collected during various parts of the overall study. For the diet analysis, see below under that section for the setup process. Within the 5 m radius plot, we visually estimated ground cover as % switchcane cover, % other grass cover, % other herbaceous cover, % vine cover, % woody debris, % bare ground, % standing water, and % herb-free litter. We used a convex densiometer to estimate canopy cover at the center of the plot. Within the 11.3-m radius plot, we counted and measured the diameter at breast height (dbh) of all trees. Trees were separated into five categories based on dbh: # saplings (<2.5-cm dbh and >30-cm tall); # poles (2.5-8-cm dbh); # small trees (8–23-cm dbh); # medium trees (23–38-cm-dbh); and # large trees (>38-cm dbh). Additionally, understory vegetation density was assessed by standing in the center of the plot and reading a density board positioned at 11.3m in four cardinal directions. Immediately adjacent to leaf litter samples (described below) we recorded % soil moisture, soil pH (Kelway soil pH and Moisture Meter), and leaf litter depth in mm.

Radio telemetry – We began using this technique in 2004. We used a figure-8 leg-loop harness to attach radio units to birds. We started with 0.4g units in 2004, which were increased to 0.6 in 2005, and 0.7g from 2006-2008. We used digital receivers from Communication Specialists in 2004. In 2005 we switched to analog receivers from Wildlife Materials when we discovered our Comm. Spec. units were broken and not holding up to rigorous field work. This caused a delay in the attachment of units on birds until later May. Units in 2004 were engineered to last 70 days. In 2005, I switched to a mix of units of 30 and 45 days, which we used for the remainder of the study. We used 3-element Yagi antennas with the receivers. Birds were tracked during the life of the radio unit until at least 20 points were obtained. In each subsequent year, we attempted to get more points/bird. In 2008, our target was 30 points/bird. Once located, we noted the birds' behavior and recorded the location with a hand-held GPS unit. Most of the time the GPS units we used were recreational grade "quality" with an accuracy of 10 meters.

Geolocation data were plotted in ArcView 9.1, and are currently being analyzed using Spatial Analyst to estimate home ranges and territories of radioed birds. For this report, I have visually estimated a sub-sample of representative home ranges.

Diet analysis – From 15 April to 31 July in 2007 and 2008, we captured SWWA individuals in the mist net arrays and target nets. Each newly captured and recaptured SWWA was crop-flushed, and processed like other captures (weight, age, etc.). Crop-flushing occurred as soon as we removed each bird from the net because of the high digestibility rates of prey items. To avoid excessive stress, we did not crop-flush any bird recaptured within one week of a previous crop-flush (Major 1990). We flushed crops by inserting a 2-mm diameter plastic catheter down the throat into the crop through which we gently squirted warm water, while slowly removing the catheter (Moorman et al. 2007). We collected crop contents into a clean plastic bowl. We preserved crop contents in 75% ethanol in plastic vials for later identification (Major 1990). A dissecting microscope was used to count and identify to the order, arthropod fragments found in the crop contents because the small fragments made it difficult to be any more specific. The fragmentary nature of the crop contents made it difficult to count the exact number of individual arthropods found in each crop sample. Therefore, we estimated conservatively, and multiple individuals of the same order were counted only if we observed fragments of the same kind (e.g. legs, antennae, and eyes) in excess to what is normally found on an individual arthropod (Moorman et al. 2007).

To quantify the arthropods available to SWWA, we hand collected leaf litter and associated litter-dwelling arthropods within a 0.25-m^2 frame placed in a random location within each of the four quadrants of the 5-m plot. Arthropods from the 4 sub-sampling plots were combined for each plot. We collected all leaf litter from the top surface of leaf litter to bare earth and stored each sample in a plastic bag until placing it in a Berlese funnel for 24 hours to extract the arthropods (Barberena-Arias and Aide 2003). If the leaf litter was not completely dry after 24 hours it was left in the funnel until it was dry. Arthropods were preserved in 75% ethanol, and later identified to order and counted.

Vegetation and leaf litter were removed from the immediate vicinity during set-up of mist nets. Therefore, approximately 20m from each SWWA capture location, we established two concentric circular microhabitat sampling plots (5-m radius plot located in the center of an 11.3-m radius plot). When SWWA were captured using call broadcasts (target netting), the plots were located in the direction the SWWA was initially heard before capture. For SWWA captured during passive netting, we used a random direction. If the plot center fell in areas where SWWA do not forage, e.g. in a body of water or light gap, we relocated the plot to the nearest edge of the body of water or light gap.

We checked for seasonal changes in the litter dwelling arthropod community by collecting leaf litter samples after 15 June 2007 from locations immediately adjacent to leaf litter samples collected before 15 June 2007. Also, to assess the portion of the arthropod community actually available to SWWA, we separated 28 leaf litter samples collected in 2008 into the upper, dry portion of leaf litter and the lower, decaying leaf litter near the soil. The lower, decaying portion of the leaf litter was distinguished from the upper, dry portion by the presence of decaying leaves, which did not occur in the upper layer.

Results

Banding efforts:

2006 - We conducted 7 banding sessions at the main site, for a total of 168 hours. This was our 11th year of banding here, since 1996. The spring season was fairly dry. We experienced one week of flooding after Hurricane Alberto, during which time access to the study site was limited. A number of birds recaptured, as in 2005, were 5-6 years old, along with the usual majority of birds that are 2-4 years. One bird was at least 7 years old. One recapture was of a bird first banded as a juvenile (see JUVENILE RECAP below), on-site, in 2005, about 50m away from where he was caught this year. In total, we captured 91 SWWA. This includes 44 unbanded and 47 recaptures. Of the unbanded birds, 20 were “AHY” (adults), 5 were scored as “SY” (beginning their second year of life), and 19 were “hatch year” birds (young fledged on-site). Of the recaptures, there were 34 males, and 13 females. For comparison, in 2005 we captured 69 SWWA individuals. Of these, 41 were recaptures and 28 were new. Of the 28 new ones, 13 were “hatch year” birds. One five year old male, who had moved a bit south from his 2005 area, to occupy a territory now vacant (due to another 5 year old bird that did not return), was killed by a Barred Owl in the net. We generally suffer 1-2 raptor mortalities each year.

2007 – We conducted 7 banding sessions at the Woodbury/IP site in Marion County, for a total of 168 hours. In addition, a new graduate did some target banding for SWWA in areas of the Wildlife Management Area that were “off” from the main study site. This is our 12th year of banding here, since 1996. This spring and summer were fairly dry. There were no hurricanes that impacted the study site. We recaptured 3 birds that were at least 8 years old, and one 9 year old male (this is our 2nd such bird, and the oldest age recorded to date for a SWWA). We also recaptured two 6 year old females (6 years is the oldest record for any female thus far). We recaptured 2 more young males, and one young female, that had been banded as fledglings on site in 2006. In total, we

captured 73 SWWA. This includes 27 unbanded and 46 recaptures. Of the unbanded birds, 10 were “AHY” (adults), 8 were scored as “SY” (1 year old), and 9 were “hatch year” birds (young fledged on-site). Of the 46 recaptures, there were 36 males, and 10 females. We generally suffer 1-2 raptor-caused mortalities each year, but no SWWA were killed in nets this year.

2008 – We conducted 6 banding sessions at the Woodbury site, for a total of 144 hours. This is our 13th year of banding here, since 1996. Graduate student Amelia Savage continued her work on crop-flushing individual warblers, for a diet analysis. She target netted many additional birds outside our main study area, but within Woodbury/Potato Bed tracts. This spring was fairly wet – we experienced two flood events in early and mid-April. Summer was fairly dry. There were no hurricanes that impacted the study site. I visited the site from April 6-9 and documented at least 6 singing males on April 7, including 3 identified by color bands. We recaptured 3 birds that were at least 8 years old, and a 10 year old bird (the 9 year old male from last year). This is now the oldest age SWWA ever recorded. We recaptured another young male that had been banded as a fledgling on site in 2007. In total, we captured 89 SWWA. This includes 58 unbanded and 31 recaptures. Of the unbanded birds, 33 were “AHY/ASY” (adults - 10 females, 23 males); 22 were scored as “SY” (1 year old), and 2 were “hatch year” birds (young fledged on-site); and one was “sex unknown”. Of the 31 recaptures, there were 22 males, and 9 females. We saw more hatch-year birds in 2008, but we did not capture many. But, we did not band during the last week of July, when we often catch this age class. We generally suffer 1-2 raptor-caused mortalities each year, but no SWWA were killed by raptors in nets this year.

Telemetry:

2006 - We acquired approximately 600 telemetry points on a combined total of 12 males and 4 females. Seventeen adults were radio tagged using 0.6g transmitters (12 males, 5 females). One female was never found again, after we attached a transmitter; she was most likely a migrant (it was very early in the season). Most of the transmitters were built to last ~45 days; some were built to last 30 days. All transmitters lasted a few days longer than their stated field life, affording us some extra time to get more points. We had fewer challenges this year. A female escaped from her harness, but was later recaptured and tagged successfully. The harness from which she escaped and its transmitter were taken deep into a crayfish tunnel. We attempted to dig it out, for a few hours, but had to give up. Antennas were reinforced this year, and none were broken by birds, as they were in 2005.

Last year a male got caught on a small cane stem, via the harness, and managed to extricate himself; this was only a week or so after radio-tagging him. This male has been in this same area since 2001, and returned again this year. He was recaptured and tagged, but we apparently induced a twist in his harness, and after only a few days the field tech reported he had a leg problem. It took us another week to recapture him. His leg was indeed severely strained, and his weight was low (although he continued to sing and chase birds and was mated at the time). After harness removal, his nest failed in the egg stage, and that female divorced him. He continued to sing, and defend his territory, although he also continued to limp. Foraging was surely difficult, but a month later he had gained nearly 1g of weight. His tail feathers were ratty, as he could not walk quite correctly. He was seen in late July, within his territory. This bird was at least 6 years old, and I did not expect him to return in 2007 (and he did not). We got few points on him in 2005 and 2006, but he used an area of ~5 ha (11 ac).

Two other males we tracked have been in the same territories for 4 and 5 years. One of these males mated with the same female for the third year in a year. We also tagged this female for the second year in a row. Her first two nests failed in the egg stage, but her third was successful. Young were at 8 days of age on August 4th, when we stopped field work. An age of 8 days is considered a success (they fledge on day 9 or 10). The male’s territory was in the northern section of the study site, and was ~9 hectares (20 acres) in size. He had a second female, a case of bigamy. This second female fledged two broods, based on our following him to recently fledged

young; both times while female #1 was incubating. Female #1 foraged in an area mostly within the male's home range, using an area ~4 ha (9 ac) in size.

A male tagged several hundred meters to the north used an area ~7 ha (16 ac), and fledged at least one brood. A male (COLORS: light green/dark pink, # 15, Figure 9) tagged in the central part of the study site occupied an area of ~6.3 ha (15.6 ac). He was at least 6 years old, and has been in this territory each of those years. He was tagged again in 2007 and 2008 (see LIGHT GREEN/DARK PINK below in each year). In contrast, most of the birds in the southern section used areas of 4-6 hectares (9-13.5 ac). A male (COLORS: light green-light blue, # 17, Figure 9) in the southern part of the study site occupied an area of ~4 ha (9.9 ac), not including some outlier points.

JUVENILE RECAP (#9, Figure 9): this one-year old male was tagged and followed for ~45 days. He was difficult to track, as he wandered widely, occupying an area ~6.3 hectares (15.6 acres) in size. This area overlapped the home ranges of several older males in the southern section. This bird was tagged again in 2007 and 2008 (see below).

An adult male we targeted in the southern section and banded, was radio-tagged (#12, Figure 9). This individual ranged over an area ~2 ha (4.5 ac), and he and his mate fledged at least one brood.

Another male (#8, Figure 9) and female, in the southern section, both newly banded, were tracked. I estimate his home range to be ~6 ha (13.5 ac), with the female residing within this area, for the most part (we found her in an adjacent territory twice). Their first nest failed in the egg stage, but the second brood fledged. His was one of the largest home ranges for this southern section.

We tracked another female that we had also tracked in 2005 (#5, Figure 9). In 2006, she first mated with the injured male mentioned above. After her first clutch failed, she moved to an adjacent territory with a male that we banded this season, thus likely a very young male. She attempted two more broods, both of which also failed in the egg stage. After the third attempt, her transmitter died. There was time for one more attempt, but we could not locate her again, and did not recapture her for the rest of the season. Thus, she laid 10 eggs, and none hatched. She foraged in an area of ~6 ha (13.5 ac), which included forays into at least two other males' territories.

It's clear that these birds keep attempting to breed until August, both with re-nesting after failures AND successes. For the females tracked this season, although all were consistently found within the home range of their mates, we also found them on several occasions in adjacent territories. They appeared to be foraging when in an adjacent males' territory, but alternate behaviors are hard to detect.

As was the case last year, most males were easier to track (than females) and showed a strong affinity for singing, preening, and spending time along the edges of light gaps that contained a high density of vines, and thick vegetation.

Two males (#'s 2 and 13, Figure 9), each in territories adjacent to other birds, displayed interesting behavior. Each appeared to be un-mated, and when nests were successful in their neighbor's area, each was seen hanging around the young, and the now "receptive" female. One male indeed appeared to actually FEED one of the young, and the "father" tolerated this. Females begin re-nesting almost immediately after young fledge, and it appears that neighboring males are able to detect their breeding "state".

Again, males often kept or took young to the edges of disturbance gaps, thus I believe that the thick vine tangles are an important "hiding" and foraging habitat for recently fledged young.

2007 - Twenty three adults were radio tagged using 0.6 – 0.7g transmitters (18 males, 5 females). Most of the transmitters were built to last ~45 days; some were built to last 30 days. Most were attached with a new, lighter, surgical thread. This proved to be problematic, as knots did not hold as well, and males were able to break the harness. Approximately 630 telemetry points were taken for these birds. We tracked at least 4 SY (birds in their second year, or, one year old, males). One disappeared within 2 weeks, likely wandering. He tried to establish a territory between 4 other older males. One stayed within a very small area. One mostly stayed in a small area, but wandered

at other times, when we could not find him. The harness knot failed on the 4th after about 3 weeks. One female escaped from her harness, early on.

We tracked three males in 2007 that had also been tracked in 2006. Bird 4 (Figure 10) was the same as bird 9 in 2006. In 2007 he was back in the same general idea, but he assumed the territory now vacant when the bird injured in 2006 did not return. It's interesting that he occupied an estimated home range similar to 2006 – 6.3 ha (15.6 ac). Bird #17 (LIGHT GREEN/DARK PINK; Figure 11) was the same as #15 in 2006. He was back in the same territory for his 7th year, and I estimate his home range in 2007 at 6.3 ha (15.6 ac), which is the same as 2006. Bird #7 (Figure 12) was the same as #10 in 2006. In 2007, a one year old male held a small territory just south of this birds' area. I estimate #7's home range to be ~4.6 ha (11.5 ac), compared to 9 ha (20 ac) the previous year. I attribute this to the presence of his new neighbor.

A one-year old male set up a "territory" between two older males in the northern section of the study site (#8, Figure 12). He consistently sang from a very small area, around a small light gap, and I estimate his home range at 0.91 ha (2.3 ac). He never attracted a mate. Another one-year old male primarily occupied a similarly small area, but was found several times at points 500m away. Thus, he roamed over an area 25 ha in size (56 ac). This bird was un-mated and this is not an area he defended. Rather, this seems to be the typical behavior of many young males who are trying to establish a territory and attract a mate.

In the central part of the study site, a bird at least 8 years old (#15, Figure 11) was recaptured and tagged while he was feeding recently fledged young. Young just off the nest generally cause adults to forage close by, thus resulting in a smaller estimate. The area this bird primarily occupied was ~4 ha (9 ac) in size. But we did find him wandering over an area 15 ha (34 ac) in size. His neighbor to the east (#16, Figure 11), who also fledged a brood, used an area ~6 ha (14 ac) in size, but who also wandered west 100m into #15's territory. A male just south, #3 (Figure 11) ranged over an area ~12 ha (27 ac).

Things are a bit messier in the southern part of the study site. Birds sing a lot and appear to defend territories, but there is also broad overlap in the home ranges, involving not just nearest neighbors, but other birds that are >1 territory away. We also found females roaming among adjacent territories. Bird #1 (Figure 10), a six-year old male, occupied an area of ~9 ha (20 ac). We found two nests that we judged to be within his home range. But the data show the females (#'s 18 and 19, Figure 10) to be in mostly separate areas. Bird #18 is mostly within the territory of #1, and it's very possible that #19 was mated to a different male, and happened to build her nest at the overlap of the two home ranges. We did catch a 2 year old male in "her" area and that may have been her mate. #18 occupied an area of ~6 ha (14 ac), whereas #19 was found over an area ~12 ha (27 ac) in size.

Home range estimates for some of the other birds found in the southern area are (Figure 11): Bird #21, male – 9 ha (20 ac); Bird #14, female – 6 ha (14 ac); Bird #23, male, mated to #14 – 6 ha (14 ac); Bird #12, male – 12 ha (27 ac); Bird #6, male – 9 ha (20 ac);

Nesting success and telemetry: Our use of telemetry to assess nest success is a hybrid of gathering data on movements of males, coupled with the fact that males continue to feed fledglings for 3 weeks post-fledging. We also tag some females to gather home range data and are able to find/track some nesting attempts this way. Thus, we know of at least 8 successful attempts, from within 19 "tracked" territories (42%), and one anecdotal observation. We can state that 5 failed for sure. But we're left with 4 "uncertain" fates, due to transmitter's falling off early; and at least 2 "likely" failures based on timing of nest events documented mid-season. 2 young males had not attracted a mate by at least mid June, and one simply left the area shortly after being tagged. There was in fact yet another SY male (not radio tagged), another bird banded as a "local" in 2006, who was recaptured and monitored a bit b/c he was easy to detect all season. He also spent the season un-mated. All four un-mated males were SY's – two banded on site as fledglings, and two scored by tail pattern/wear. Conversely, at least one known SY female mated and fledged young in early June, surely her first attempt.

2008 - Twenty two adults were radio tagged using 0.7g transmitters (16 males, 6 females). Most of the transmitters were built to last ~45 days; some were built to last 21 days. Half were attached with a medium weight surgical thread. This thread held up better than last year, but a number of birds were still able to break the thread by around Day 30. By that time, we had usually accumulated enough data points to be a success. For the other birds we used a slightly stronger sewing thread and these lasted the entire time. Over 700 telemetry points were taken for these birds.

We attempted 6 other birds: 2 females were caught near the Great Pee Dee river and ended up on the other side; the transmitter from one male was found in an owl pellet, before we had collected enough data; we had the wrong frequency for one male, and this was not discovered until it was too late to get data; the transmitters on two birds were removed by the birds before enough data were acquired (male and female).

Again, we put radios on birds that we had tagged in previous years, to look at any potential changes in area usage. See Figure's 13 and 14 for 2008 birds. Bird #7 (LIGHT GREEN/DARK PINK) was tagged for the 3rd year in a row. Each year he broke or escaped from the harness, but a minimum number of points (20) had been obtained to estimate his home range. In 2008 this estimate was about 50% of what it was the previous two years, at 3.3 ha (8.2 ac). I have no explanation, except perhaps the birds' health. When we caught him, he was full of "pox" looking marks on his ventral side, and a loose piece of skin and feathers was sloughing off. Indeed, that piece fell off while we were processing him. I decided to tag him and we followed him until he broke the harness. I also went into his territory in July and played a SWWA song, to which he responded quite vigorously. Thus, he sang and behaved normally, but he may have been in poorer health, and at 8 years, I consider him a very old bird.

Bird #2 was #17 in 2006. In 2008 he was in nearly the same area, but the area used I estimate at 4 ha (10 ac), the same as in 2006. And yet, in 2008, he was confirmed as having two females nesting within his territory. The two active nests were 75m apart. The earlier of the two was midway into the incubation period, at which time I found the second nest in which the female has just laid her first egg. Both nests failed: that of the first female when the babies were 6 days old, that of the second during incubation. The first female, Bird #3, occupied an area ~3 ha, mostly within the territory of #2.

Bird #4 was tagged for the 3rd year in a row (#4 in 2007, #9 in 2006). I estimate his home range in 2008 at 4 ha (10 ac), a bit smaller than the previous years. Bird #5 was in the same area he has occupied since 2003. He was tagged for the 4th year in a row and occupied the same basic home range as before, ~5 ha (11 ac). Two males to the north and northeast were in home ranges I estimate to be 5.6 ha (#9) and 8.4 ha (19 ac., #10). We followed #9's mate, #11, whose home range I estimate at 4 ha (10 ac), that was within her mate's area.

Bird #12, in the southern area where SWWA seem to be in higher density, occupied an area ~3 ha (7 ac). His mate, #14, occupied a similarly-sized area although she often roamed outside his territory, to the east. Other birds in the section occupied home ranges of a similar size, generally 3-5 ha (7-11 ac).

Nesting success and telemetry: We tracked birds across 18 territories. We documented fledged young in 10 of those (55%). There were signs that a few others also produced young. I believe that 3 did not produce young. I classified 5 as "uncertain", due to transmitter's falling off early, or males being tagged late in the season; and thus I cannot assess/state for sure. I believe, however, that young were produced in at least two of these five territories; thus nest success for those territories tracked may have been 66%. Woodbury continues to be place of high SWWA productivity, compared to data from at least two other sites (White River NWR, AK, and Roanoke River NWR, NC, nest success reported to be ~30% at each site).

Conclusions

Survivorship/Age – Figure 4 shows graphs of the ages of males and females, across the years of 2004-2008. The pattern shown is fairly typical, with many more young birds than older birds. I was however a bit surprised at how many birds survived into their 6th year and beyond ("A5Y" = after fifth year, etc). Not surprisingly, we have fewer data points for females, as they are simply more difficult to capture and follow. Thus, although they seem to survive fewer years, that may be a reflection of low sample size. It may also be a biological reality, due to the stresses of nest building, egg laying, and doing this multiple times per breeding season. In general, these graphs indicate that the majority of birds may live 4-5 years.

Philopatry – The fidelity to the Woodbury site shown by SWWA was quite high. Most of the birds we followed returned to the same territories year after year. Some birds that did not return to the exact same area were later found in nearby territories. We tracked two birds that we banded as fledglings on-site. They returned to the same area the following year, as one year old males, and were unsuccessful at attracting a mate, or carving out a good territory. But they returned to the same area in their 3rd year and then acquired mates and held "normal" territories. We documented several other one year old males who did not mate, nor hold full territories, and I conclude that this is a general pattern for this species. We had one conclusive one year old female who did mate (with a nine year old male) and fledged young from what was surely her first attempt ever. This nine year old male returned one more season in 2008. For several years he occupied a territory that was subsequently harvested during the winter of 2002/2003. Upon his return, he moved west across the logging road into the mature forest, and set up a new territory, which he held for the next 5 years. But he was basically in the same area for 9 years. We followed several other males who returned to the same territories for 5, 6, 7 and 8 years. This is a common pattern in male birds, but up to now undocumented in SWWA. We also had several females return to the same territories 2-3 years, and one female returned and mated with the same male for 3 seasons in a row.

Productivity – While not a focus of this grant cycle, it was an ongoing component from earlier work. Several things that we did elucidate from continued monitoring of this SWWA population, including the use of telemetry, are as follows: 1) age of first breeding.- as indicated above, I believe most one year old males do not breed, whereas all females likely do. In addition to the above anecdotes, there appeared to be more males than females, again a "typical" passerine pattern, and thus with females in "high demand", they are courted and bred in their second year (= one year old). 2) Several males were found to have two females, thus, in bigamous relationships. This had been suspected for a long time, and there is one published instance of this from Louisiana. But the telemetry and color-banding helped us confirm it in several instances on Woodbury. 3) Females will re-nest throughout the breeding season. We documented several cases of "double brooding", defined as two successful clutches in one season. But we also documented numerous cases of continued re-nesting attempts after failures occurred. Two females made 3 attempts; one female was successful on the first, but the next two failed. For the other female, all three attempts failed in the egg stage, likely snake predation. This bird, thus, laid 10 eggs in one season, and none of them hatched. Also, birds continued to breed into August, with our latest nest having four day old chicks on August 6th of one year. Most bird species at Woodbury are through breeding by early July. 4) We showed that following males via telemetry is a reasonable way to assess productivity. Since it is difficult to locate all nests, it is very helpful to use an alternative method like telemetry. Males care for the young after they fledge, at which time females begin to re-nest. Males continue this parental care for 3+ weeks post-fledging. Earlier nest searching efforts indicated a nest success rate of ~40%. Our results, by the year, show that nest success (measured by us as "fledged young events/territory") can be as high as 55%, and that this higher rate may be closer to biological reality, than the 40% estimate. Either estimate is higher than those from two other SWWA studies, and may reflect a difference in predation pressure, or an issue again with not finding all the nests. At any

rate, the productivity of young SWWA on the Woodbury site is respectable and I would classify this population as a “source”, versus a sink.

Cowbirds – We noted the incidence of cowbirds eggs whenever nests were found. From 1998-2001 the cowbird parasitism rate on SWWA was 9%, which is similar to the overall parasitism rate for passerines in the southeast. During the winter of 2002/2003 a lot of timber was harvested on the east side of the study area. Over the next 5 years we found another 30+ nests but only one had a cowbird egg. Thus, in spite of the increase in edge/early succession habitat, the cowbird parasitism rate on SWWA appeared to decrease significantly.

Habitat preferences – This topic was addressed by an earlier student in the late 1990’s. What I looked at with the telemetry was how parents, especially males, reacted to our presence when tending to fledglings. Earlier observations indicated a reliance by SWWA on vine tangles to protect young. Our telemetry work further indicated this to be the case. When we approached adults with young, the young were immediately led into the nearest vine tangle/thicket. Nests are consistently placed along the edges of these tangles, and thus vine tangles are an important component in the breeding lifecycle of SWWA.

Range of territories/home ranges – I use territory to refer to those areas that appeared to be defended by birds, whereas home range refers to the entire space a bird is willing/able to use. The home range of any given bird often overlaps with the home range of a neighbor, at least in Swainson’s warblers. Birds were found to use home ranges spanning from just a couple acres to nearly 30 acres (0.9 – 12 hectares). I noted a few patterns. Some young males (one year old) occupied very small territories (they sang consistently from the same locations, and did not wander), which I would expect. Some of them wandered more; they sang some, but did not seem to attempt much defense of an area, but rather ranged widely among several other birds territories. These wandering males were found across areas as much as 56 acres. But, this was not a “territory”, and we were fortunate to be able to track the two individuals that did wander so much.

We were unable to find birds about 5% of the time. We know from some of the data that these birds will wander among neighboring territories, and at times some were simply out of our range. Anich et al. (2009) found similar results in Arkansas.

Birds in the northern part of the study site appeared to occupy larger territories. Also, in general there was less overlap of home ranges among these birds. Conversely, birds in the southern section seemed to occupy smaller territories; or, there were many birds there which fledged young from much smaller territories. Also, in this area, there was much overlapping of space use among these birds….a lot of “trespassing”. The northern area was shown in the late 1990’s to have fewer vine thickets, which are a critical component of the nest cycle for SWWA. There are many more such thickets in the southern area, and I propose that this is a main factor for why the territories are smaller.

Females generally occupied the areas within their mates’ home range, although many of them were also found to wander into neighboring territories. Some of the females used areas that were less acreage than their mates; others used as much.

Hydrology – This is an important factor in the life cycle of SWWA. Figure 3 shows flow data for four years, of the Great Pee Dee River. This river greatly affects the condition of the primary SWWA study site at Woodbury. High spring floods in late April/early May did cause a delay in nesting at Woodbury in some years, and this may be a driving force in the evolution of the late-season nesting shown by SWWA. Severe floods scour the ground, which both brings in nutrient-rich sediment and removes the decaying leaf litter. It can take a few years for the leaf litter to re-accumulate, which we saw after the severe flooding on 2003. Presumably, the removal of the leaf litter temporarily reduces the foraging quality of the area for SWWA.

Diet – Figure 5 shows the results of our diet study. SWWA clearly selected for spiders and beetles on the breeding grounds (Araneae and Coleoptera). Other slightly preferred orders are Lepidoptera (moths and butterflies) and Hymenoptera (ants, bees, wasps). We also show that SWWA forage in the upper layer of decaying leaves, not the lower layer at the soil surface. Thus, leaf litter depth is likely an important factor in their foraging preferences, and there is likely an optimum depth range.

Management – The study site consists of two broad areas, north and south, that differ by harvest year, and thus, age of regenerating forest. The northern section was harvested about 5 years before the southern one. There may have been some other differences during or after the harvest. The northern area had many fewer vine thickets or tangles, than the southern area. These thickets occur where light is able to penetrate the forest, in "light" gaps created by weather or human-caused events. Soil compaction appeared to play a positive role in that trees did not regenerate in these spots, which allowed vine thickets to persist. SWWA use light gaps with vine tangles of all sizes, from very small to very large. Such gaps could be created with group selection cuts, or even single tree selection cuts. Small cuts of 0.5 ha should prove viable for maintaining breeding SWWA. If the forest is allowed to mature, continuously, I expect SWWA numbers to decrease, as areas are shaded out and the vine thickets decrease in size and overall abundance. Weather events of course can create gaps via tree blowdowns. But, in our nest study, 90% of ~150 nests were located within 5 m of a vine thicket, and most of those were placed within the vine thickets, as vines plus giant cane were the most common nest substrates. Thus, some management may be needed if one wishes to maintain the high density of SWWA found at this study site.

Giant cane was certainly used by SWWA for nesting, but it did not appear to be a critical component on the Woodbury Tract. Thus, I encourage management practices that would enhance cane growth and regeneration, as those practices fit within a larger program. I do not see the need to make exclusive, expensive efforts to generate more cane. At our study area along the Roanoke River, cane was more predominant, and vines less so, and there SWWA used cane for nesting much more than at Woodbury. In Arkansas and Georgia, cane is also prevalent at sites studies in these states, with SWWA using the cane there. But at Woodbury, where cane is much less abundant, yet vine thickets are in high density, SWWA used vines for nesting. Thus I conclude that either substrate is viable for SWWA nesting.

We worked in an area approximately 2.5 x 0.6 km, or roughly 1.5 square kilometers. Within this area we delineated about 30 territories (I'm still analyzing data). The "thumb" area just WSW of our main study area also had SWWA in it, but we did not do telemetry in that area. Some birds out there were targeted for survivorship and diet studies. The density of SWWA in this area is fairly high, which I attribute to the combination of good leaf litter levels, reasonable hydrological events at sustainable intervals, high density of vine thickets, some giant cane on site, and a high stem density in the understory.

There is a high density of feral hogs on the Woodbury Management Unit. I did not see any evidence of adverse affects from these hogs – we never found a nest knocked over for example. In fact, it's possible the hogs have a positive affect by their foraging behavior. SWWA avoid heavy sedge/grass areas on the forest floor, and via the foraging action of hogs, these areas were cleared of this vegetation. Although turned over dirt remained, within a few seasons enough falling leaves should accumulate in those spots to create good SWWA foraging sites. I have no data to back this up, and it is pure conjecture, but a possibility. Of course, the hogs have other affects, some surely negative, on other flora and fauna of the area.

Figure 1. Woodbury Wildlife Management Area, with Swainson's Warbler main study site highlighted with red box near upper left.

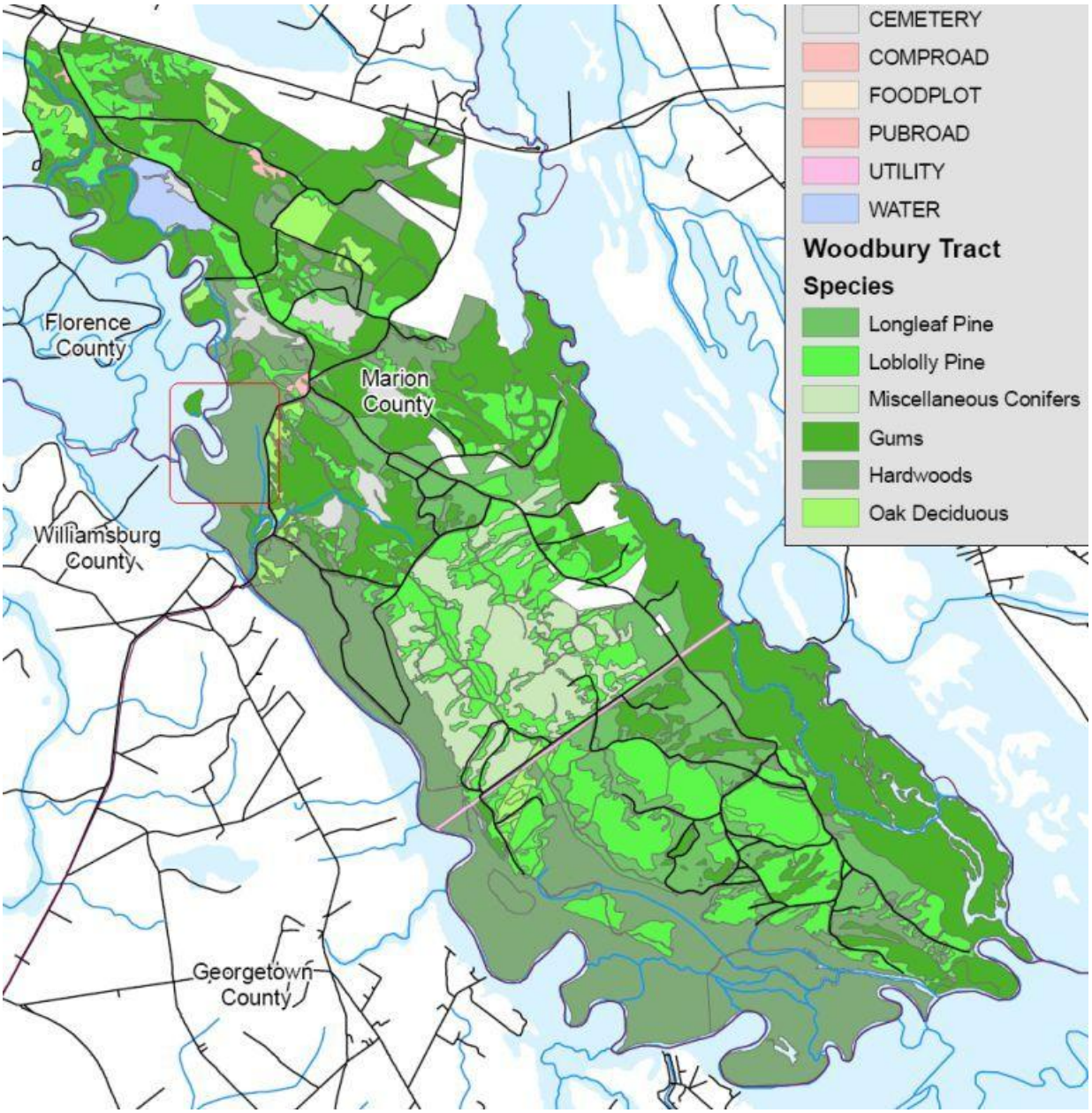


Figure 2. An aerial image from Google Earth, ~2005, of the main SWWA study area and some surroundings. Trees in the northern area seemed to be a bit older than in the southern area.

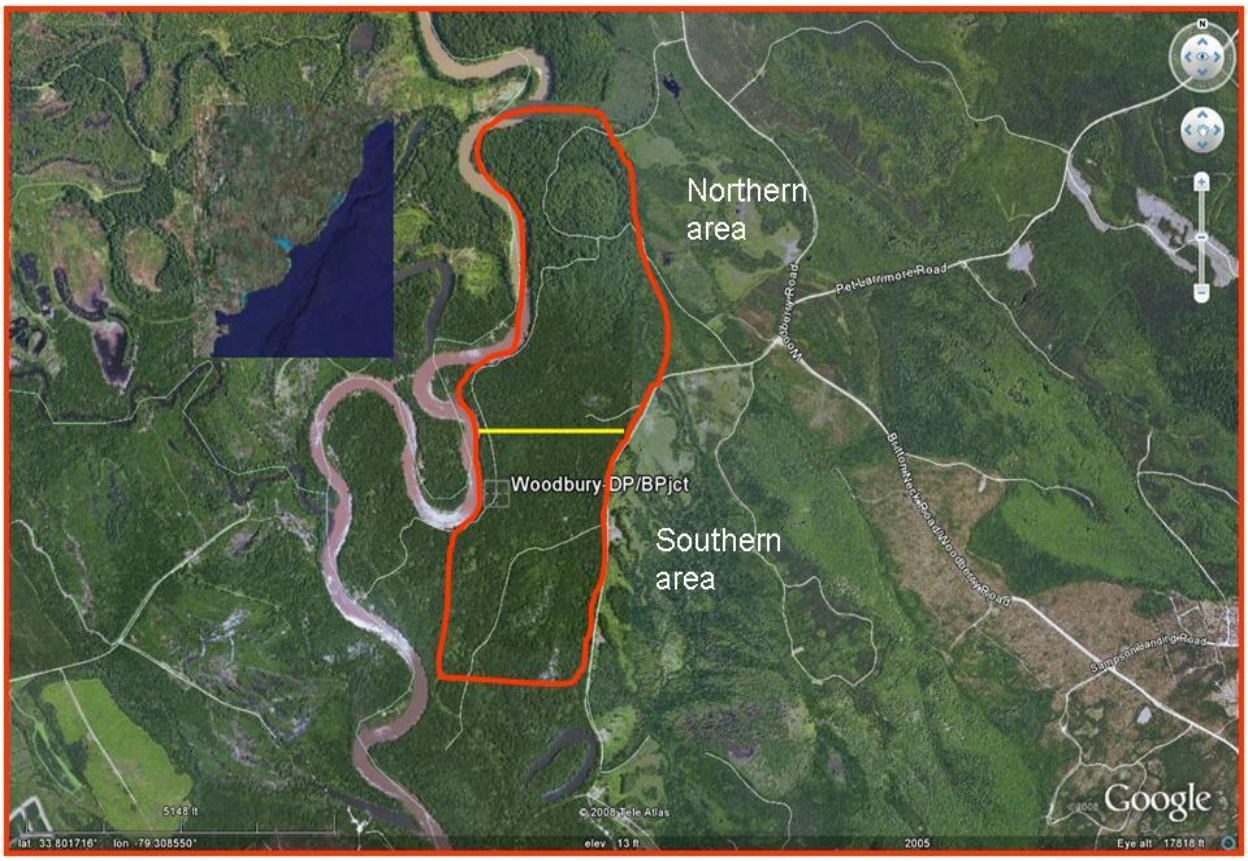


Figure 3. This shows 4 years of flow rates for the Great Pee Dee River. Note the higher rate for 1998. In years like this, Swainson's will delay nest initiation. The severe flooding of 2003 caused the leaf litter to be scoured away and it was two years before a decent leaf litter layer was back on the ground.

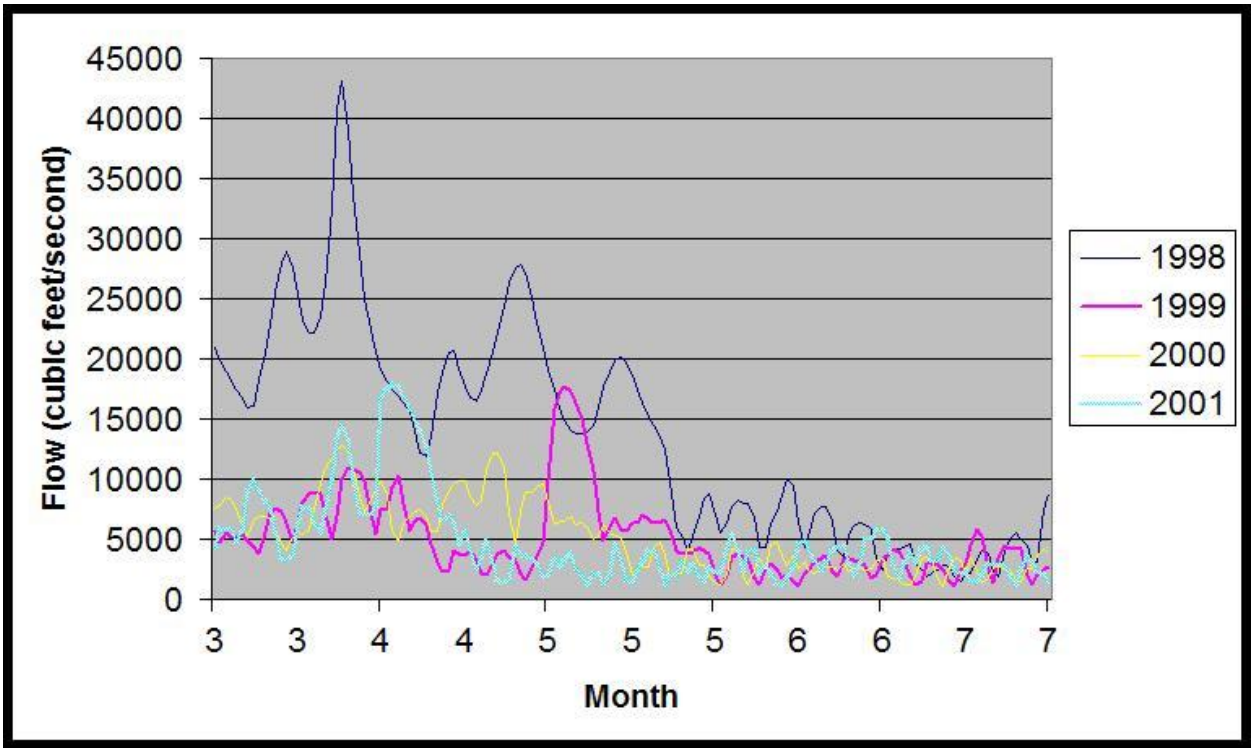
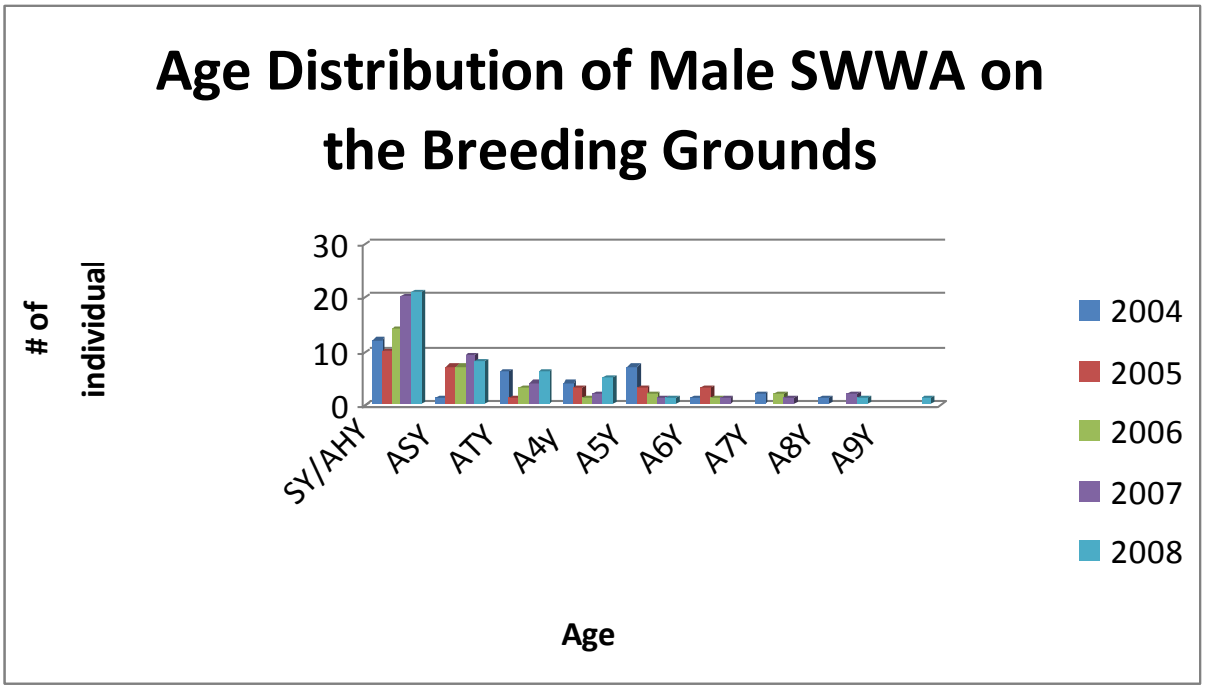


Figure 4. Age distributions of male and female SWWA at Woodbury WMA.



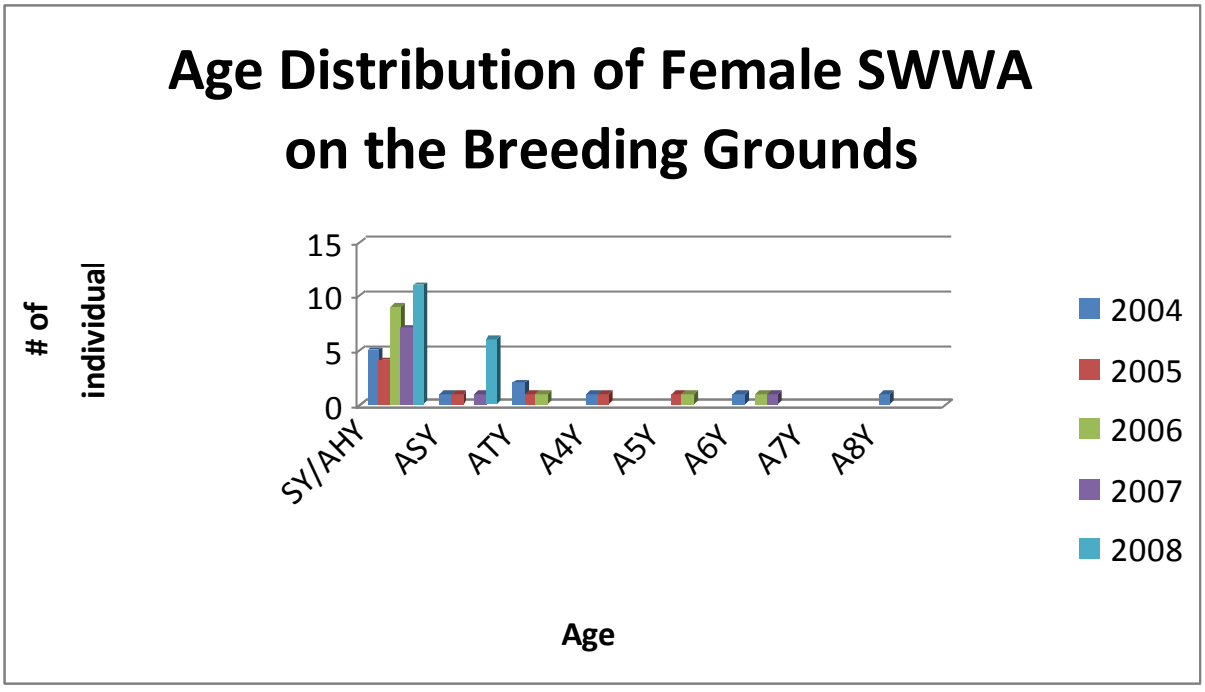


Figure 5. Diet preferences of SWWA at Woodbury WMA. Winter data from Guatemala.

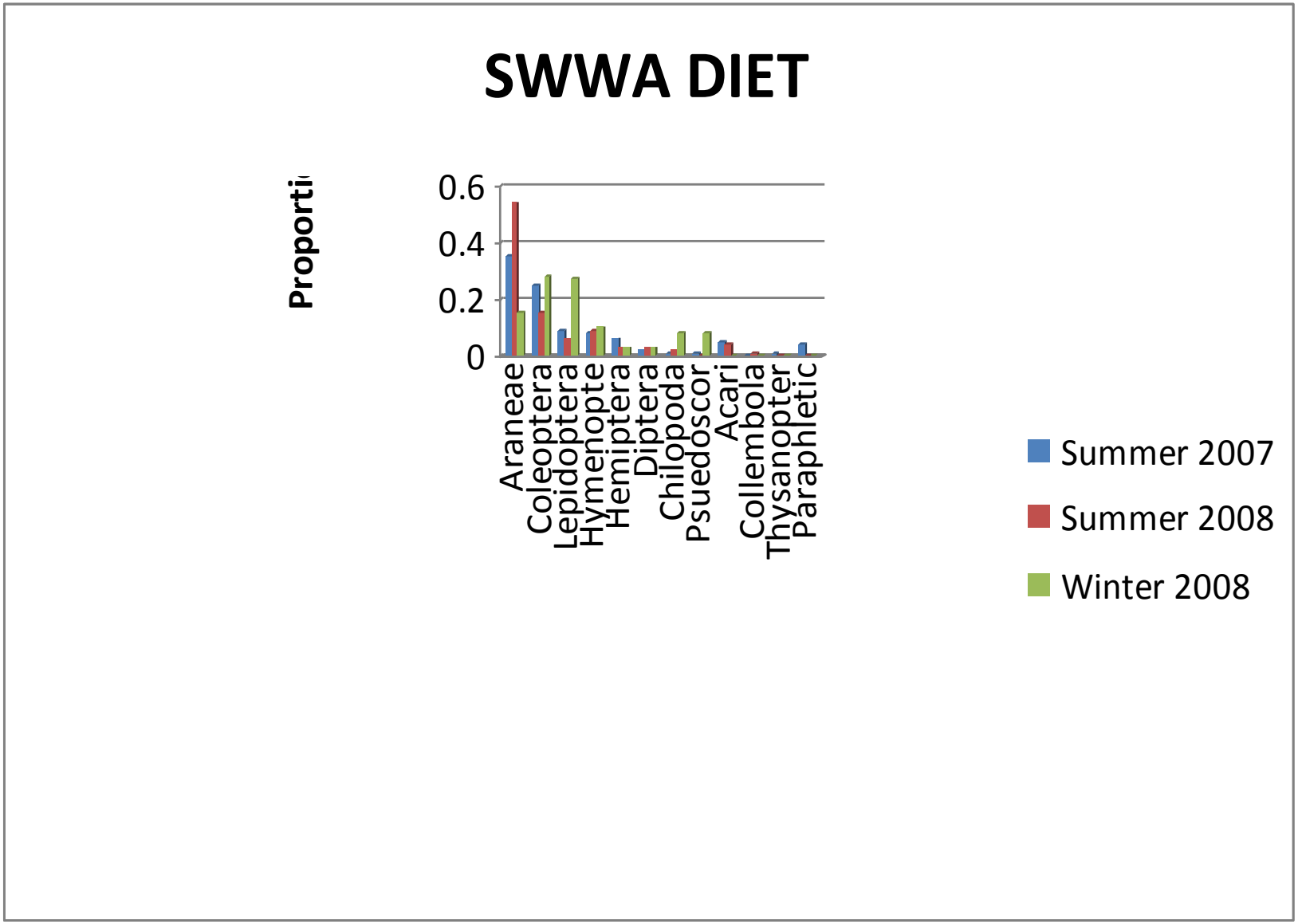


Figure 6. Transmitters showing the figure-8 harness tied on; and one of the SWWA with the unit attached.

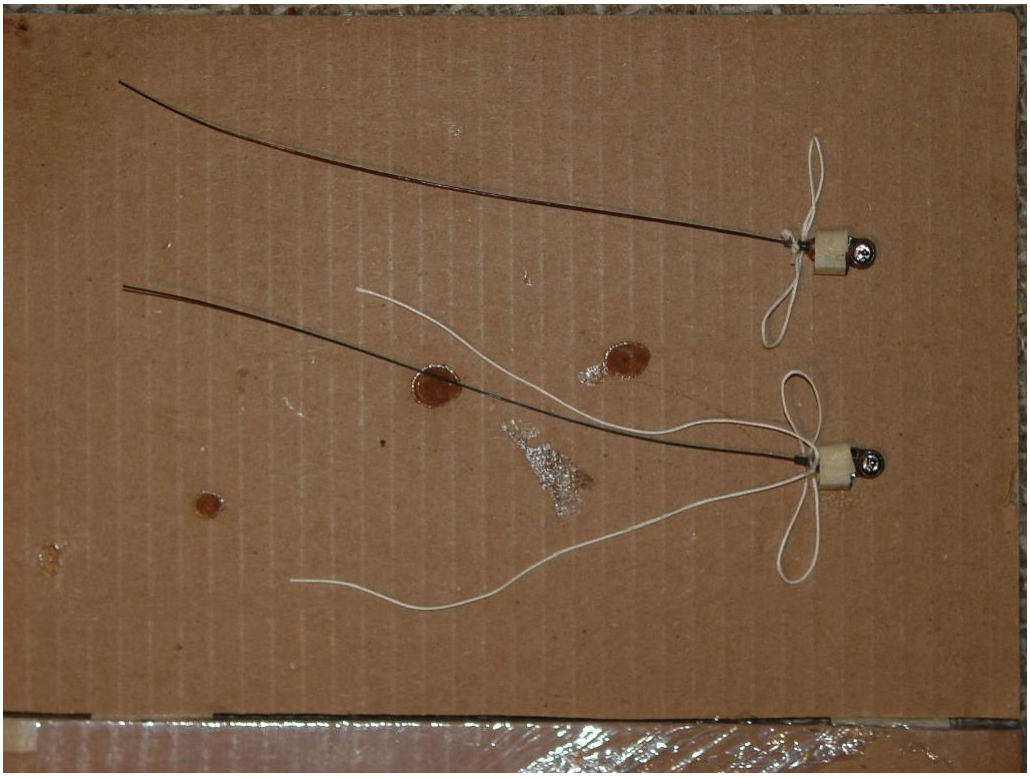


Figure 7. Two SWWA nests, showing typical placement within edge of vine thicket/light gap.

Figure 8. Close up of SWWA nest, with incubating female. Note Trumpet Creeper and Greenbrier vines as live substrates. Dead vines are usually Trumpet Creeper and grape ssp. Lower nest mostly in cane, showing typical 3-egg clutch.

Figure 9. Telemetry point map of birds in the central and southern parts of the study site, 2006.

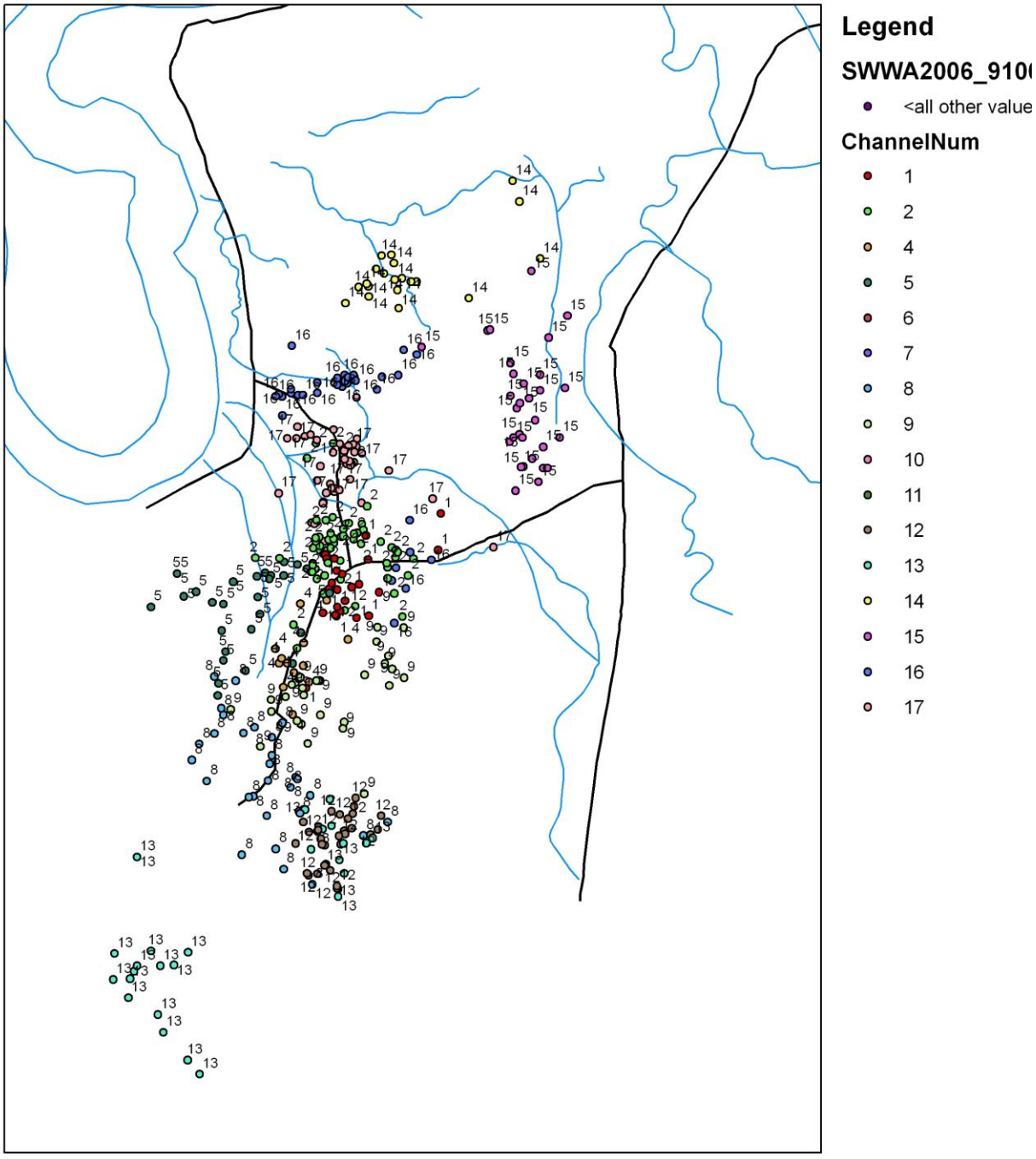


Figure 10. Telemetry point map of birds in the southern part of the study site, 2007.

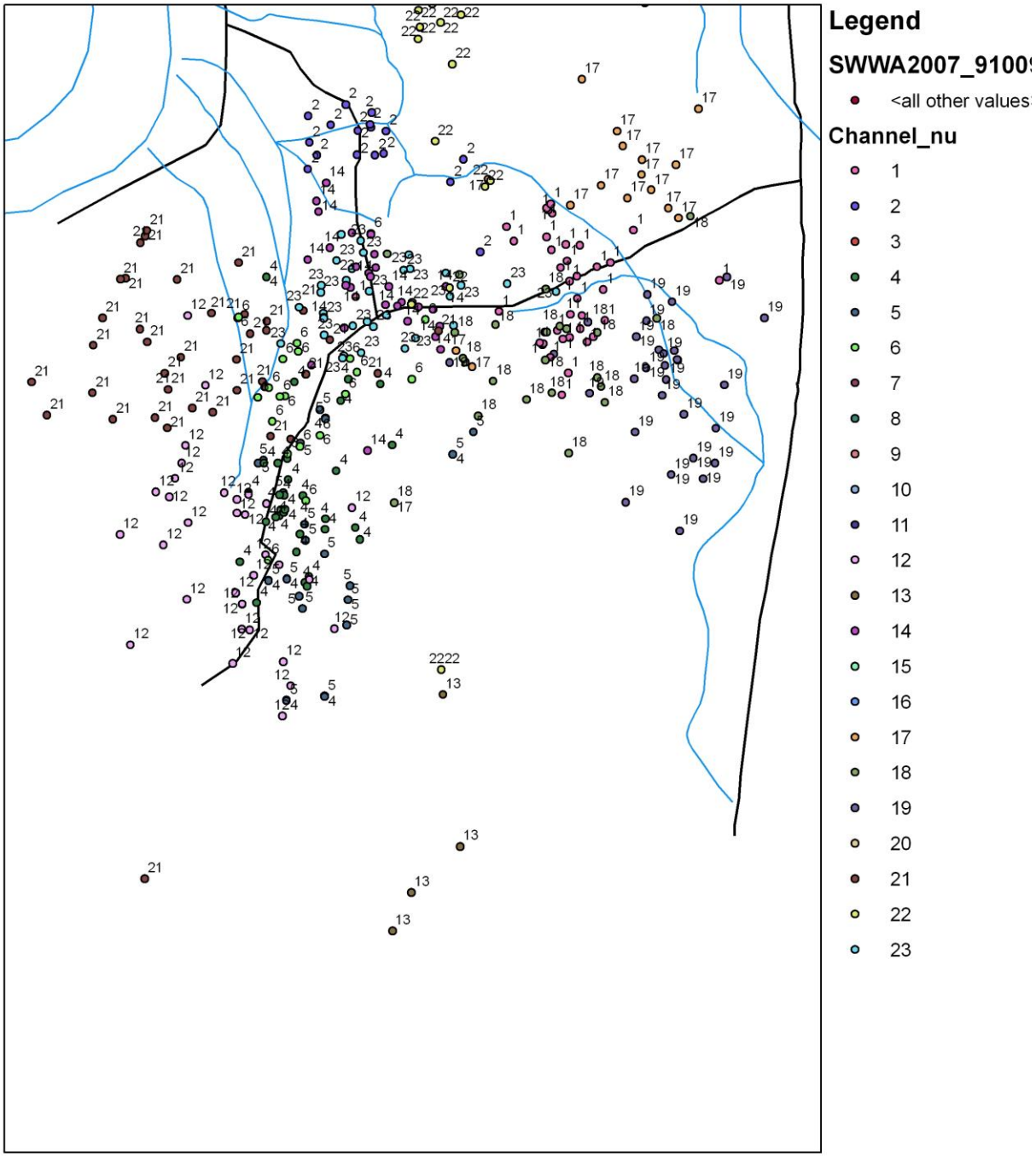


Figure 11. Telemetry point map of birds in the central and southern parts of the study site, 2007.

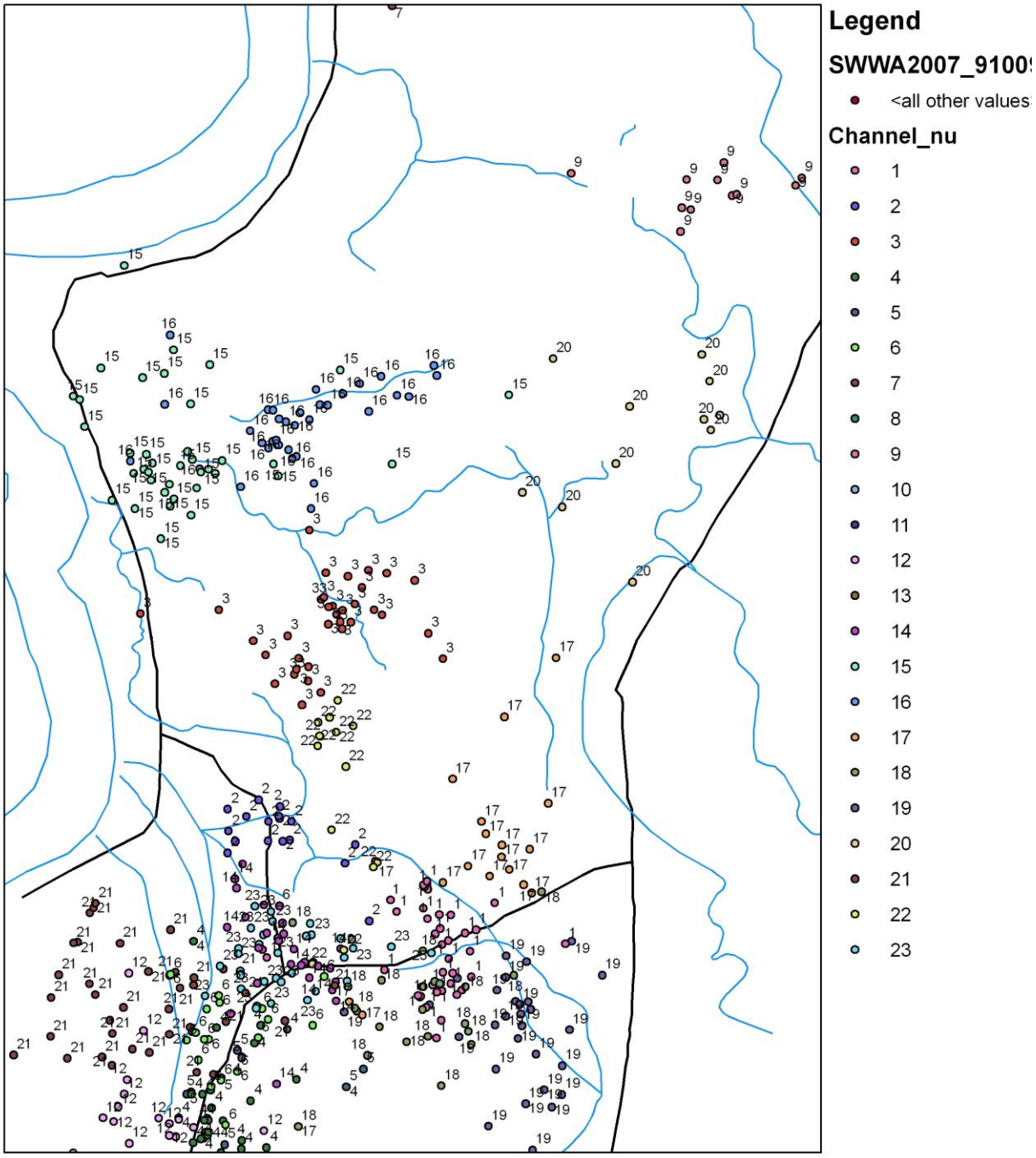


Figure 12. Telemetry point map of birds in the northern part of the study site, 2007.

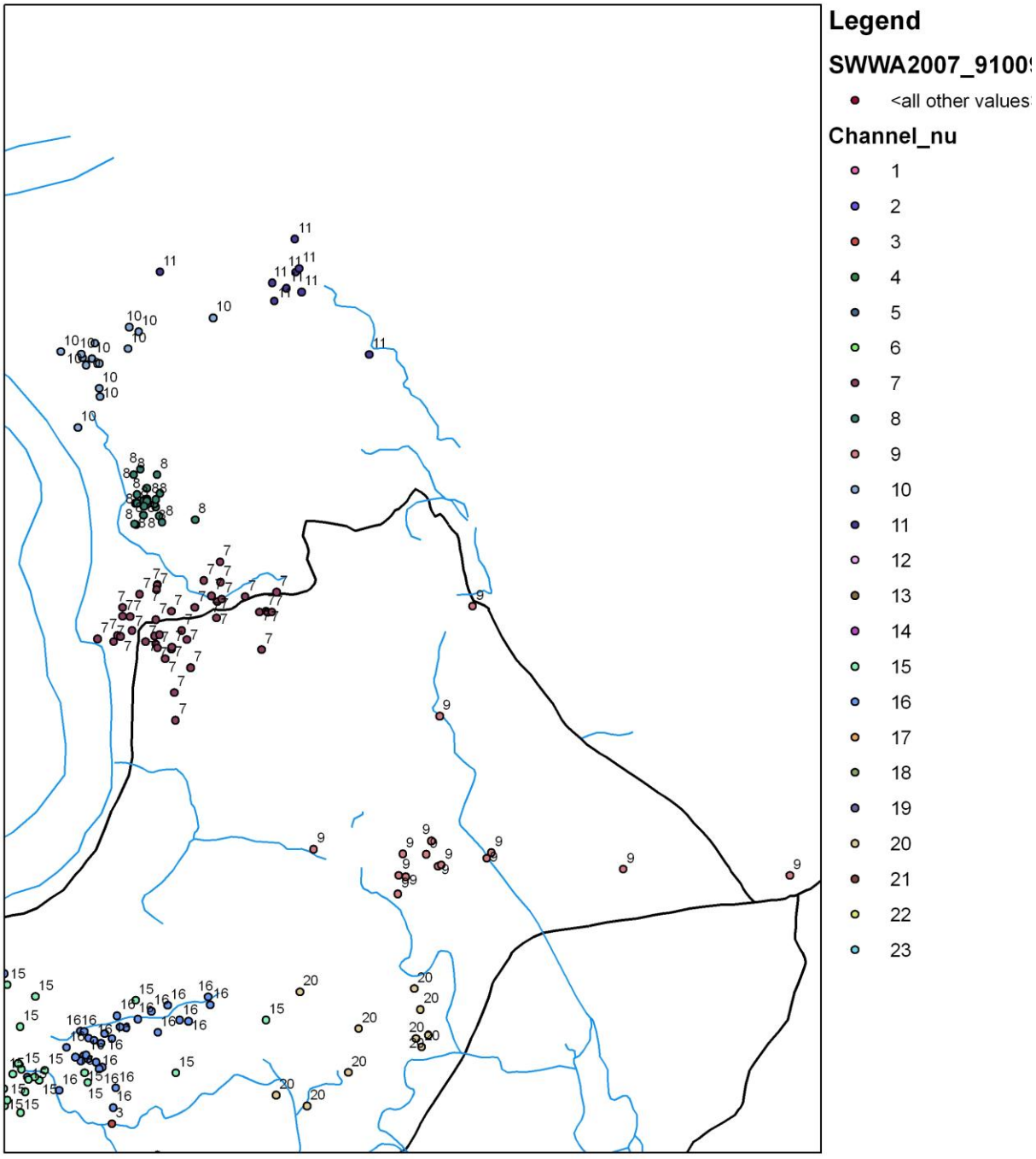


Figure 13. Telemetry point map of birds in the southern parts of the study site, 2008.

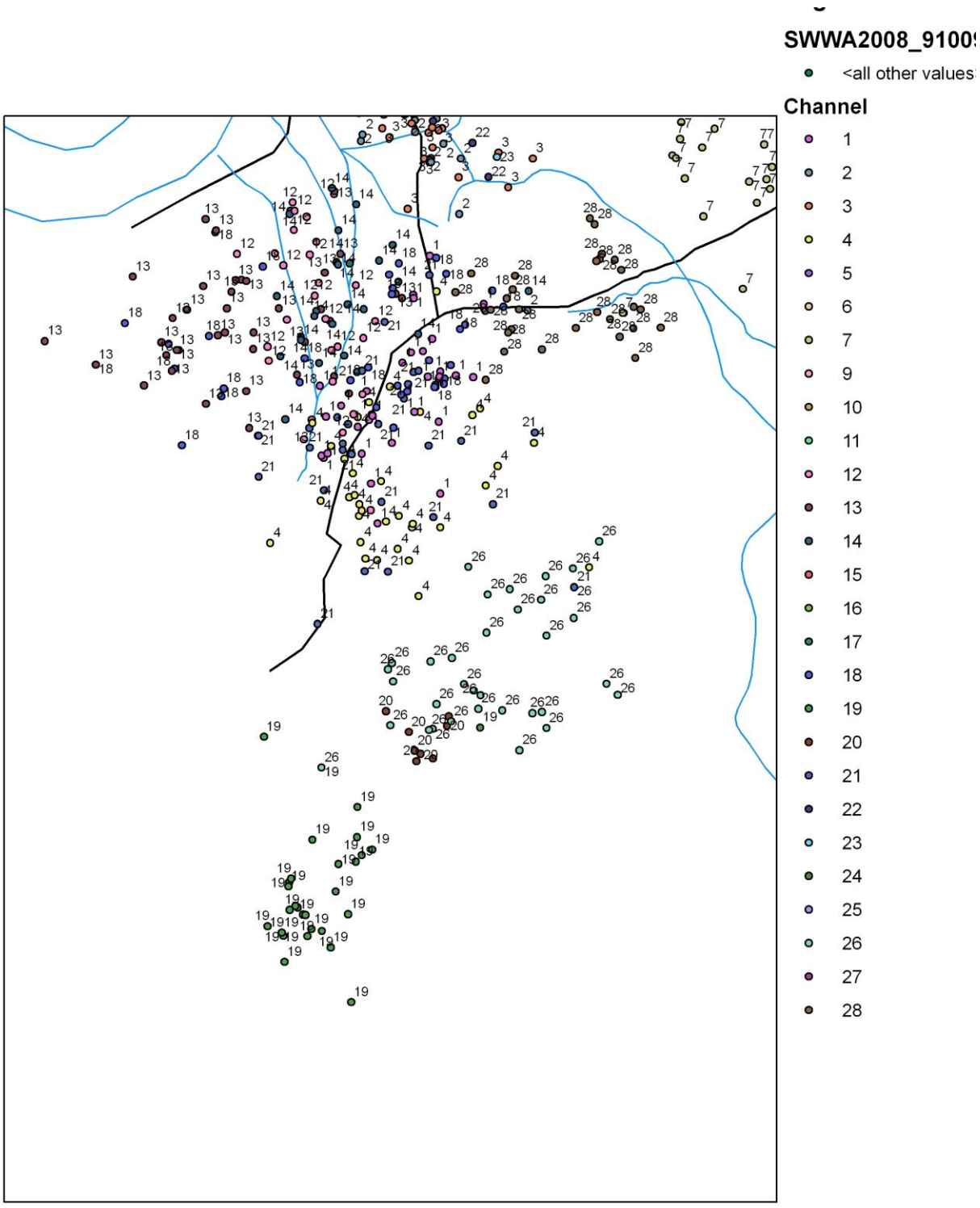
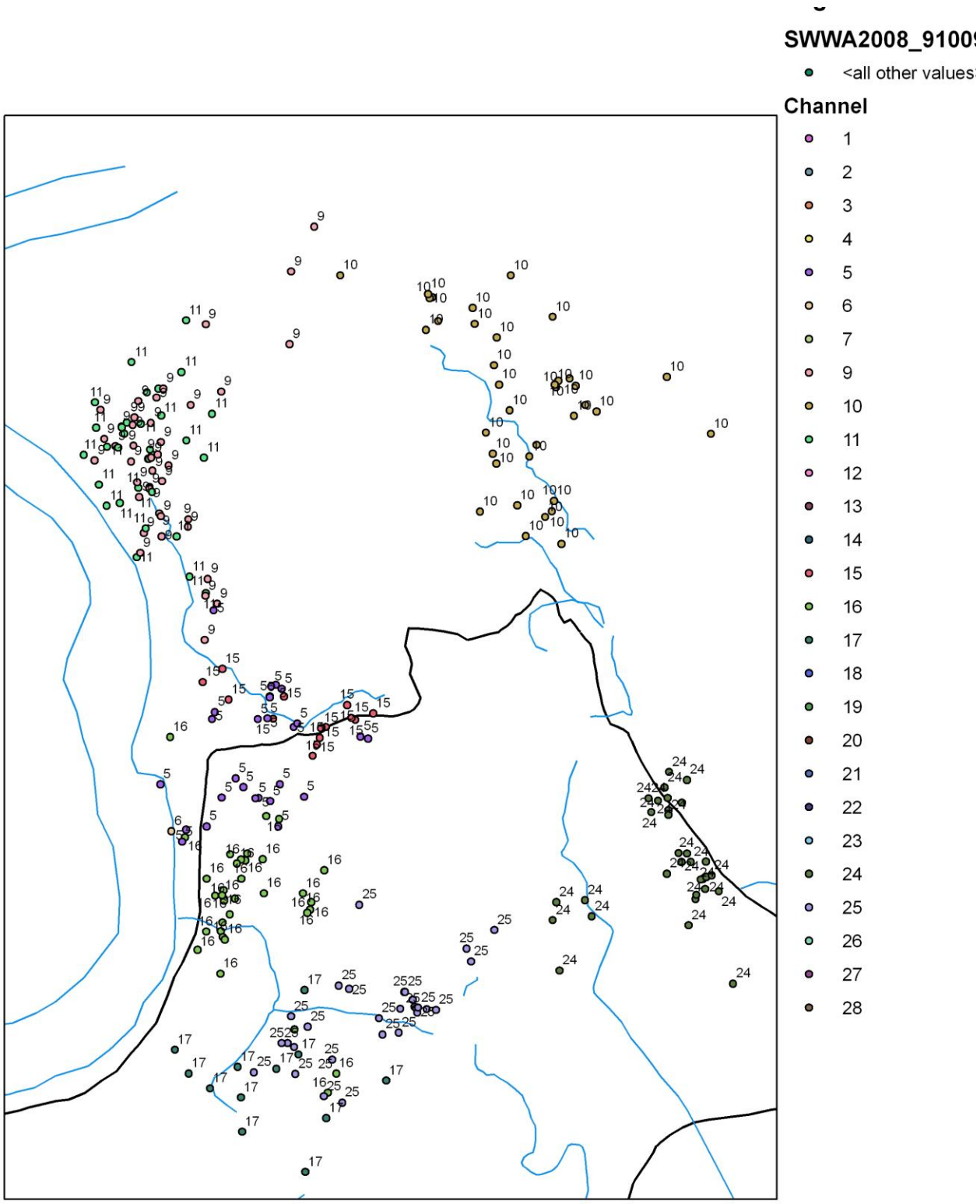


Figure 14. Telemetry point map of birds in the northern part of the study site, 2008.



Literature cited

ANICH, N.M., T. J. BENSON, AND J. C. BEDNARZ. 2009. Estimating territory and home range sizes: do singing locations alone provide an accurate estimate of space use? Auk: 126(3): 626-634.

BARBERNNA-ARIAS, M.F. and T.M. AIDE. 2003. Species diversity and trophic composition of litter insects during plant secondary succession. Caribbean Journal of Science 39: 161–169.

BARROW, W. C. 1990. Ecology of small insectivorous birds in a bottomland hardwood forest. Ph.D. dissertation. Louisiana State University, Baton Rouge, LA.

BROWN, R. E., AND J. G. DICKSON. 1994. Swainson's Warbler (*Limnothlypis swainsonsii*). *In* The Birds of North America, No. 126 (A. Poole and F. Gill, Eds.). Philadelphia: The Academy of Natural Sciences; Washington, D.C.: American Ornithologists' Union.

CARRIE, N. R. 1996. Swainson's Warblers nesting in early seral pine forest in east Texas. Wilson's Bulletin. 108(4):802-804.

EDDLEMAN, W. R., K. E. EVANS, AND W. H. ELDER. 1980. Habitat characteristics and management of Swainson's Warbler in southern Illinois. Wildlife Society Bulletin. 8:228-233.

GRAVES, G. R. 1998. Stereotyped foraging behavior of the Swainson's Warbler. Journal of Field Ornithology. 69:121-127.

GRAVES, G. R. 2001. Factors governing the distribution of Swainson's Warbler along a hydrological gradient in Great Dismal Swamp. The Auk. 118(3): 650-664.

GRAVES, G. R. 2002. Habitat characteristics in the core breeding range of the Swainson's Warbler. Wilson Bulletin. 114(2):210-220.

HENRY, D. R. 2004. Reproductive Success and Habitat Selection of Swainson's Warbler in Managed Pine versus Bottomland Hardwood Forests. Ph.D. dissertation. Tulane University.

MAJOR, R.E. 1990. Stomach flushing of an insectivorous bird: an assessment of differential digestibility of prey and the risk to birds. Australian Wildlife Research 17: 647-657.

MEANLEY, B. 1971. Natural history of the Swainson's Warbler. North American Fauna. 69:1-90.

MOORMAN, C. E., L. T. BOWEN, J. C. KILGO, C. E. SORENSON, J. L. HANULA, S. HORN, and M. D. ULYSHEN. 2007. Seasonal diets of insectivorous birds using canopy gaps in a bottomland forest. Journal of Field Ornithology 78:1-10.

PARTNERS IN FLIGHT WORKING GROUP. 2002. Priority research needs for the conservation of Neotropical migrant landbirds. Journal of Field Ornithology. 73(4):329-339.

PETERS, K.A. 1999. Swainson's Warbler (*Limnothlypis swainsonii*) habitat selection in a managed bottomland hardwood forest in South Carolina. Master's Thesis. North Carolina State Univ., Raleigh, N.C. 95pp.

PULLIAM, H. R. 1988. Sources, sinks, and population regulation. The American Naturalist. 132(5):652-661.

PYLE, P., S. N. G. HOWELL, D. F. DESANTE, R. P. YUNICK, AND MARY GUSTUFSON. 1997. Identification Guide to North American birds, part I: Columbidae to Ploceide. Slate Creek Press, Bolinas, California.

RALPH, C. J., G. R. GEUPEL, P. PYLE, T. E. MARTIN, D. F. DESANTE. 1993. Handbook of field methods for monitoring landbirds. Gen. Tech. Rep. PSW-GTR-144. Albany, CA: Pacific Southwest Research Station, Forest Service, USDA.; 41p.

THOMAS, B. G., E. P. WIGGERS, AND R. L. CLAWSON. 1996. Habitat selection and breeding status of Swainson's Warblers in southern Missouri. Journal of Wildlife Management. 60:611-616.

THOMPSON, J. L. 2005. Breeding biology of Swainson's Warblers in a Managed South Carolina Bottomland Forest. Ph.D dissertation. North Carolina State University.

VAN HORNE, B. 1983. Density as a misleading indicator of habitat quality. Journal of Wildlife Management. 47(4):893-901.

Final Report
DRAFT

Conservation of Migratory Landbirds in South Carolina, Painted Bunting Studies
Breeding Ecology of the Painted Bunting (Passerina ciris) and other early-successional passerines in agricultural landscapes on the coastal plain of South Carolina

A Cooperative Research Project between the Clemson University Department of Forestry and Natural Resources and the South Carolina Department of Natural Resources

Submitted to
Laurel Moore Barnhill, SCDNR
by
J. Drew Lanham, PhD- Principal Investigator
and Kelly Blackburn, M.S. Graduate Research Assistant

September 30, 2009

Introduction

The painted bunting (*Passerina ciris*) is a declining songbird that exists primarily in southeastern coastal scrub and early-successional agrarian habitats. In South Carolina, painted buntings and other species associated with shrub-scrub habitats may benefit from federal set-aside programs for conservation of birds and other wildlife, frequently classified as Conservation Reserve Programs (CRP). These programs have been widely implemented across the southeastern U.S. landscape for the purposes of soil conservation, protection of food and fiber resources, reduction of sedimentation in water bodies, improvement of water quality, enhancement of forest and wetland resources and the establishment of wildlife habitat. The creation of wildlife habitat is critical where species such as the northern bobwhite (*Colinus virginianus*) and associated avifauna are at risk due to loss of existing "native" habitats. Wildlife food plots are intensively managed areas that are frequently implemented within the context of CRP programs to attract game species such as northern bobwhite, whitetail deer (*Odecoileus virginianus*), wild turkey, (*Meleagris gallopavo*), and mourning doves (*Zenaida macroura*). While these intensively managed are frequently posited as being beneficial to both game and nongame species, there has been little work to document how wildlife food plots might impact the conservation of "non-target" wildlife such as songbirds .

Although properties at the Webb Wildlife Area and Nemours are not enrolled in any of the federal subsidy programs, they are nonetheless managed in ways that closely approximate the management prescriptions for CRP. There is currently little data for the southeastern United States and none for the coastal plain of South Carolina that addresses the effectiveness of CRP-type management in attracting nongame birds of conservation concern. Moreover, there is a lack of information available to managers which might help them understand how food plots might best be managed to provide habitat for a multitude of species, including nongame species such as songbirds. In this study we assessed the suitability of variably –sized wildlife food plots on two differently managed landscapes on the lower coastal plain of South Carolina in Hampton County (Web Wildlife Management Area) and The Nemours Wildlife Foundation in Beaufort County to provide basic information on the suitability of these habitats . In particular, we hope to understand how the intensity of food plot management over time and space might alter agrarian and early-successional habitats that make them more or less suitable to painted buntings and associated nongame avifauna including blue grosbeaks (*Guiraca caerulea*) and indigo buntings (*Passerina cyanea*) .

Study Sites and Methods

Two field sites with historically known populations of painted buntings were utilized for this study; the Webb Wildlife Management Area in Garnett, South Carolina and the Nemours Wildlife Foundation in Seabrook, South Carolina. A random sample of plots of varying size and habitat status was chosen for each field site, totaling 46 sample plots. Three sizes and conditions of plots were chosen: small (<1 acre); medium (1-3 acres); and large (>3 acres). Point counts were conducted from sunrise until 11 am at each site. Due to the number and distances between field sites and among the food plots, plots were not surveyed every day. Most food plots were surveyed within one week of the previous survey on a three day rotation. Point count samples were conducted from May through the end of July in 2006, 2007 and 2008. The presence of painted buntings, indigo buntings, blue grosbeaks and brown-headed cowbirds were all recorded in an attempt to determine presence in food plot patches and potential relationships to patch size, patch type, and management intensity.

There were very few records of painted bunting or any of the other species occurring in food plots during the three field seasons (< 50 records/species/season) As a result of this low sample size, statistical comparisons using bird occurrences as a metric were limited. Sample sizes could have been bolstered by combining records across seasons but we did not because of highly variable food plot manipulations within and between seasons. After revisiting the analyses and initial questions of “Do painted buntings and /or the other focal species occur/co-

occur differently in habitat patches that differ by size, management history or landscape context?" We modified our question to ascertain how the wildlife management practices implemented at the two field sites might affect the occurrence of the focal species. We thought it might be particularly useful to do so in light of federal set-aside programs implemented for the conservation of avifauna. One of the programs, CP 33 (Conservation Practice 33) - Habitat Buffers for Upland Birds, was created to provide sufficient brooding, feeding and cover habitat for the bobwhite quail. Currently, there is speculation regarding the benefit of the CP -33 regime for species other than the bobwhite quail that may use similar habitats (Brady, S.J., 2007). For this portion of the study we defined "optimal" habitat for PABU, BLGR, INBU as old fields (areas not planted or cultivated for >2 years). Suitable habitats were fallow (fields not cultivated or planted for 1-2 years) and marginal areas were defined as planted fields (cultivated and planted at least once per year). We believe our modified assessment might add information to a limited data base and thus help managers and policy makers render better decisions regarding the planning and implementation of such programs.

To determine whether or not there were any relationship between species presence and study sites, and study plots, I used a generalized linear mixed model. Each year was examined separately due to important temporal changes that occur between and across years, such as plot changes, bird life span and others. Data was examined to see if there was any statistical significance between the relationships of species and habitat. The three years of data was analyzed using PROC GLIMMIX that was run in the SAS statistical package, version 9.2. PROC GLIMMIX is a "procedure [that] fits statistical models to data with correlations or non-constant variability and where the response is not necessarily normally distributed." (SAS 1990, 9.2) Statistical inference was performed for the following fixed effects: bird presence against site and week across a binomial distribution; total bird presence was also compared against plot size, again across a binomial distribution.

Results

Bunting occurrence by field site and food plot size

In 2006, there was a 6% (SEM=0.06183) chance of any bird being present at Webb. At Nemours, there was a 12% (SEM=0.1227) chance of any bird present. There was no difference in the probability of occurrence between the three field sizes and there was a very low probability that there would be any bird present. There was a slightly higher chance of seeing any bird early in the season at either site, but this was not statistically significant ($p \leq .05$).

For 2007, there was a 5% (SEM=0.05695) chance of any bird being present at Webb. At Nemours, there was a 7% (SEM=0.07107) chance of any bird present. There were no difference in probability of occurrence between the three field sizes and there was very low probability that there would be any bird present. There was not much variation in bird presence over the course of the field season, but this was not statistically significant ($p \leq .05$).

For 2008, the analysis of bird presence across sites and weeks did not converge. The data did converge for the analysis across plot sizes. There was a 9% (SEM= 0.09887) chance of any bird being present in small plots. For medium plots, there was a 12% (SEM= 0.1270) chance and a 14% (SEM=0.1406) chance in large plots of any bird being present.

Management intensity and bird occurrence

After identifying over 150 wildlife food plots at the Webb Center Wildlife Management Area, we reduced the number of plots for study to better fit the logistical constraints of travel, time and personnel. At the beginning of the 2006 field season, most food plots seemed to remain consistent in terms of plantings and size and so these two characteristics were chosen as identifying factors. The Webb Center is a dynamic landscape and fields were consistently undergoing change via sundry management scenarios (disking, burning, mowing, planting etc…). The study plots at Nemours Plantation also changed, but not at the frequency of change that occurred at the Webb Center. Once the plots were selected, daily point counts began. Point counts consisted of visiting each plot as frequently as possible over the course of a week. Throughout the three seasons of field work, there were extensive, repetitive habitat changes occurring within the plots of interest. These changes included planting of fallow fields, mowing, tilling, burning, and herbicide application. At the Webb Wildlife Center, over the three seasons of field work, we recorded 45 total changes to the plots of interest (Table 1). At Nemours, we recorded 13 changes over those three field seasons. The changes at Nemours were limited to mowing and tilling, however; logging and timber clearing occurred in the areas surrounding several plots (Table 2). Summing field types across both Webb and Nemours and all field seasons, a total of 30 old fields had 15 recorded changes. Therefore, across both landscapes, there was a 50% chance of ideal bunting habitat being altered in a way that leads to a less than ideal habitat. We hypothesize that this may be a partial explanation as to why there were so few buntings of any species recorded in food plots over the nine months of field work. In a total of 61 fallow fields, again summed across sites and seasons, we recorded 31 changes. Again, there was just over a 50% probability of a change occurring in habitats that seem to be second in preference for buntings. Multiple changes were also recorded in planted fields. Of the summed 28 planted fields, only 7 changes were recorded. This meant that there was a 25% chance that a planted field would be altered. Notably, the number of planted fields decreased

each year. In 2006 Nemours began with 10 planted fields and had no planted fields by 2008. However, by then we had to enter a new category "mixed" food plots due to the large number of areas where multiple treatments had been implemented. Plots, of any stage, would be partially mowed and allowed to re-grow naturally, or a section would be tilled and planted. There were a total of 19 mixed plots across sites and seasons and these mixed plots had 5 changes. There was a 26% of a change occurring in a mixed plot. While the heterogeneity of a mixed plot with a variety of habitats and habitat structures would be appear to present highly suitable habitats for buntings, we surmise that the low numbers of birds actually recorded in these sites could be due to the high frequency of changes and consistent disturbance to the field "canopy" (e.g. high growing vegetation such as weeds and wax myrtle (*Myrica cerifera*), that might have made these plots more attractive as breeding and or foraging habitat for the bunting functional group. Changes to food plots by season are shown in Tables 3 and 4.

At Webb in 2006, a total of 21 changes were recorded. 52% of these changes occurred in fallow fields. Six (29%) of changes occurred in old fields, the most preferred habitat type. The remainder of the changes occurred in planted fields. Some of these changes resulted in additional 'mixed' fields for 2007. In 2007, a total of 8 changes were recorded. There was no known reason for the reduction in changes from 2006 to 2007. The 8 changes recorded in 2007 were almost evenly distributed across field types. 16 changes were recorded for the 2008 season at Webb. 50% of these changes occurred in fallow fields and the other 50% occurred in old fields, the two best habitats for buntings. This was a 50% increase in the number of changes from 2007 to 2008.

The probability of a change occurring was calculated by determining the total number of changes divided by the total number of observations for each season and each site. In 2006, a total of 22 changes occurred at Webb. Based on the total number of observations, this leads to a 15% chance of a change occurring at this site in 2006. Of the 22 changes, half of them occurred to fallow field plots. The majority of these changes (91%) were tilling of the fallow plots. The second most frequent change occurred in old plots and 100% of old field changes were tilling. Planted plots were changed 5 times in 2006 and were tilled four times and mowed once.

At Nemours in 2006, only three changes were recorded. Two occurred in fallow fields and one in a planted field. No changes were recorded in old fields. All three changes were mowing. Over the 26 point counts in 2006, there was a 12% chance of a change occurring.

In 2007, there were a total of nine changes that occurred mid-season (May-June) at Webb. This was a 4% chance of change occurring over the total number of observations. Five of these changes occurred in planted fields and the other four changes occurred in mixed plots.

Three of these changes were tilling and five of them were mowing. The only other change that occurred was burning.

Nemours incurred 9 changes within the 2007 field season. Five of the changes occurred in fallow fields, three in planted fields and one in old fields. Seven of the changes (77%) were mowing and two were tilling. Thus there was a 6% chance of a change occurring at Nemours in 2007.

In 2008, 17 changes occurred within the field season at Webb, leading to a 14% chance of a change occurring within the 119 point counts. The changes that occurred in 2008 were much more varied than previous years. Mowing, burning, tilling, herbicide application and planting were all recorded. No changes occurred within planted fields and 94% of the changes occurred within fallow and old fields. The only other change that occurred was in a mixed plot. Of these changes recorded in 2008, there was a 47% chance that they would occur in a fallow or old field.

In 2008, only one change was recorded at Nemours. This change was mowing in a fallow field. No changes were recorded in planted or old fields. There was a 0.4% chance of a change occurring at Nemours in 2008.

Discussion

At this point, it is difficult to make landscape wide recommendations for the two study sites as the landscapes were constantly changing. The management regimes of Webb and portions of Nemours seemed to comply with some of the standards required for private lands enrolled in conservation reserve programs. While neither site was enrolled in any such program, the practices implemented could provide a model for landowners and natural resources managers to understand how such programs might impact songbird conservation. While we believe that the CRP-type practices implemented at both sites may be good in theory, we hypothesize that the frequency and intensity of management disturbance to old fields and fallow fields, preferred habitats for the bunting complex in this landscape (Garcia 2004), might discourage their occurrences, especially breeding, as weedy, shrubby vegetation is consistently controlled. "Rough" (shrubby, weedy) edges, filed buffers and hedgerows were present in both areas, but perhaps not as extensively as they might for the bunting complex to thrive. Our analysis and frequent observations of painted buntings in wooded areas between food plots suggests that the species may be more likely to occur in medium to large sized (> 1 acre) old and fallow fields (food plots) that are interspersed among mid to late -successional forests.

Table 1 – The number of changes that occurred in each plot type that were recorded at Site 1 over 3 field seasons

Year	Planted	Fallow	Old	Mixed	Total
2006	10	12	6	1	29
2007	2	12	5	10	29
2008	0	11	11	7	29

Table 2 – The number of changes that occurred in each plot type that were recorded at Site 2 over 3 field seasons.

Year	Planted	Fallow	Old	Mixed	Total
2006	6	8	3	0	17
2007	6	9	2	0	17
2008	4	9	3	1	17

Table 3 – The number of times each type of change was recorded in each plot type for three field seasons at Site 1.

Year	Plot type	Mow	Till	Burn	Herbicide	Plant
2006	Planted		4			
	Fallow		10			1
	Old		6			
	mixed					
2007	Planted					
	Fallow	2	2			
	Old					
	Mixed		3	1		
2008	Planted					
	Fallow	4	1		2	1
	Old	1	3	2	2	
	Mixed			1		

Table 4 – The number of times each type of change was recorded in each plot type for three field seasons at Site 2.

Year	Plot type	Mow	Till	Burn	Herbicide	Plant
2006	Planted	1				
	Fallow	2				
	Old					
	mixed					
2007	Planted	2	1			
	Fallow	5				
	Old		1			
	Mixed					
2008	Planted					
	Fallow					
	Old					
	Mixed					

Literature Cited

Brady, Stephen, J. 2007. Effects of Cropland Conservation Practices on Fish and Wildlife Habitat. The Wildlife Society Technical Review 07-1.

Garcia, J.O. 2004. Nest ecology of the painted bunting (Passerina ciris) in two habitat types in South Carolina. Thesis (M.S.) Clemson University.

Legrand, H.G., M.J. Chamberlain, E.B. Moser. 2007. Diversity and Abundance of Breeding Birds in a Managed Loblolly Pine Forest in Louisiana. American Midlands Naturalist 157:329-344.

Lowther, P.E., S.M. Lanyon, C.W. Thompson. 1999. Painted Bunting in The Birds of North America. Birds of North America, Inc. Philadelphia, Pennsylvania, USA.