

PROJECT COMPLETION REPORT
South Carolina Project T-2-2, Segment 2
South Carolina Endangered Species Program
South Carolina Department of Natural Resources
March 19, 2004 through September 30, 2006

Four of the five Objectives for T-2-2, Objectives 2-5, were completed during the original grant period of T-2-2. This grant was awarded a one-year, no-cost extension to continue work on Objective 1, Gopher Tortoise Research. Research on the gopher tortoise will continue under a new SWG grant T-26. In this report we will summarize the research and findings, to date, from the ongoing tortoise research. *NOTE: Research continued under T-57.*

Project 1: Herpetological Research and Survey in South Carolina.

Objective 1: Determine activity patterns, movement patterns, home range and habitat use for the protected population of gopher tortoises at Tillman Sandridge Heritage Preserve.

Accomplishments: Staff initiated a study of the gopher tortoise, a state endangered species, during FY 03. The study is being funded under the State Wildlife Grants program and is taking place at the Tillman Sand Ridge, near the town of Tillman

The goals of the tortoise project are to document the life history traits of the tortoise at the sites, including movement patterns, seasonal habitat use, home range size and reproductive ecology. In the spring of 2003 sixteen tortoises, four each of both sexes for a total of eight animals per site, were fitted with radio transmitters. These animals been tracked three times weekly with all burrow locations being identified using a global positioning system. At each tracking a data set including the location of the animal, its disposition (in the burrow, on the apron of the burrow, or out of the burrow) and weather conditions are recorded.

The Tillman Sand Ridge is a fluvial ridge located parallel to the Savannah River. Two specific tracts on this ridge comprise the study sites, the Tillman Sandridge Heritage Preserve (TSRHP) and the Public Service Authority (PSA) tract. TSRHP is a 900-acre preserve, of which approximately 300 acres consist of upland sandhill habitat, the preferred habitat of the tortoise. The PSA tract is approximately 1000 acres of which approximately 800 acres consist of upland sandhill habitat.

The TSRHP tract has been managed for the longleaf pine community, with management consisting of prescribed burning, particularly during the growing season, and removal of the scrub oak/hardwood under story. The PSA tract has been logged, with virtually all pine removed and is fire suppressed with a dense under story of scrub oak. Both sites support a sizeable tortoise population, based on anecdotal observation for the PSA tract and a population estimate developed for the TSRHP. We currently estimate that 125 adult tortoises comprise the TSRHP population. Tortoises at TSRHP are spread throughout the preserve.

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During FY04 the 16 telemetered tortoises were tracked an average of three times weekly. One female tortoise, PSA22, was found dead near a burrow with no apparent injuries or identifiable cause of death. The remaining 15 tortoises were tracked for the entire year. Minimum convex polygon (MCP) home ranges were calculated for all tortoises..

During Fiscal Year 05 fifteen gopher tortoises were tracked at the two sites an average of three times weekly. As in the past all locations were recorded using a Trimble ProXR GPS unit. Analysis of home range data was done using ArcView 3.2 with the USGS Animal Movement Extension.

During the summer two tortoises, one on each study site, lost their transmitter due to adhesive failure. Data for one tortoise is not included in analysis for this year. The other tortoise, a female, was captured in the same burrow it was using when the transmitter died, during the fall, and recaptured at this same burrow during the spring of 06. As such this data is being reported, at this time, but may be removed from future analysis. For reference we have modified our transmitter attachment method, now using a combination of epoxy adhesive and wire.



At the end of the FY05 field season all tracked tortoises were captured and their radios were removed for refurbishing.

During FY06 25 tortoises were trapped and outfitted with radios. Eleven of the tortoises were tracked for the previous three years and 14 were new tortoises, previously not tracked. During the summer of 06 one female tortoise on the PSA site died of unknown causes, making the total number of tortoises tracked during this period 24. Tortoises were tracked at three-day intervals, with all data being recorded as in the past, stored in an Access database and all new burrows GPS'd with the Trimble ProXR unit.

Table 1 summarizes the current data from the radio-telemetry portion of the study to date including minimum convex polygon home ranges and number of burrows used. The investigators used a different approach than in previous years to calculate the MCP home ranges reported in Table 1. In previous years home ranges were based on a dataset based on moves to and from individual burrows.

We are currently calculating MCP home ranges using each burrow occupied as a single point in a shapefile. We also used ArcGIS and the Hawth's Tools extension to calculate these current values, instead of ArcView 3.2 and the Animal Movement extension we have used in the past. In addition we have corrected the existing dataset to remove any errors. As such, some MCP home ranges in Table 1 differ from previously reported home ranges. MCP home ranges are calculated only for tortoises that used a minimum of three burrows within the year reported.

Home ranges for male tortoises are typically larger than those for female tortoises, and they typically use more burrows than female tortoises. We are currently developing a model to better define factors potentially affecting home range size and burrow use so we can test for statistical differences. We are also developing Kernel Home Range estimates for all tortoises. Maps 1-4 are provided as examples of burrow use shapefiles and MCP shapefiles for all tortoises tracked during FY06.



Thirty-eight tortoises (other than ones captured for the telemetry study) were captured during FY 03 through FY05, seventeen on the Public Service Authority Property and twenty-one on Tillman Sandridge Heritage Preserve. Blood samples were taken from approximately 50% of these animals and are currently being analyzed to determine paternity relationships in this population. In addition eggs were collected and incubated from ten females. The hatchling tortoises are being raised until such time that blood samples can be collected from them, and sex determined, then they will be released near the mothers primary burrow site. All tortoises captured were individually marked, measured, weighed, and their sex was determined. Further analysis of this data set will be presented in the final report.

During 2006, active gopher tortoise burrows were trapped using wire mesh live traps. Tortoises were trapped for the purpose of obtaining individuals for the radio-telemetry study, assessing reproductive condition & clutch size in females, and to obtain better understanding of population size of tortoises on the Tillman Sand Ridge.

During 2006, there were 42 captures of 39 individuals—14 adult males (270-324 mm CL), 23 adult females (257-340 mm CL), and 2 immature animals (72 and 197 mm CL). The individuals captured included 23 captures from the 2005 trapping effort and 1 recapture from earlier studies (prior to 2000). Fifteen new animals were captured. Average size of PSA females (314 mm CL) was slightly larger than average size of TSR females (296 mm CL), potentially reflecting a skewed population demography in PSA towards older, mature individuals with fewer recruits. Based on x-rays, average clutch size is 5.75 eggs.

Blood samples were collected from new individuals for use in future parentage analysis studies (see also nest surveys) and for general population genetics analyses.

Summarize nest surveys: A total of 25 aprons at TSR and 17 aprons at PSA were searched for nests by excavating the aprons. Burrows selected for nest surveys included burrows known to have been used by telemetered females during the 2006 nesting season, burrows known to have been used for nest sites in previous years (based on previous nest searches or the presence of egg fragments), and also active burrows in sunny open areas and dense burrow concentrations.

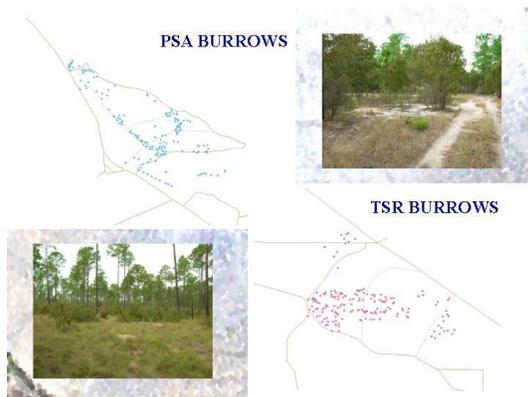
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Nest searches were conducted during September when eggs were hatching or close to hatching, so as not to disturb eggs during early incubation. Intact nests were collected to determine clutch size, hatching success, and hatchling size and to obtain a non-destructive DNA sample (blood) for future parentage analysis.

At TSR, evidence of successful hatching & emergence was evident from nest cavities with recent eggshell fragments in at least 3 burrows. One depredated nest was found behind another burrow entrance. In addition, one clutch of 2 un-hatched eggs was collected later produced two hatchlings, which hatched starting 5 October. This clutch was the last to hatch and the hatchlings were small and underweight; one subsequently died in early November in the lab. At burrow 19, 5 live recently hatched tortoises were found buried in the apron on 21 September. The front limb of another hatchling was also found. There were no signs of fire ants or subterranean tunnels or external digging to indicate mammalian predator, but one of the live hatchlings had swollen inflamed eyelid. An additional clutch of 5 eggs was found at burrow 176; the eggs never hatched and may be from a previous year.

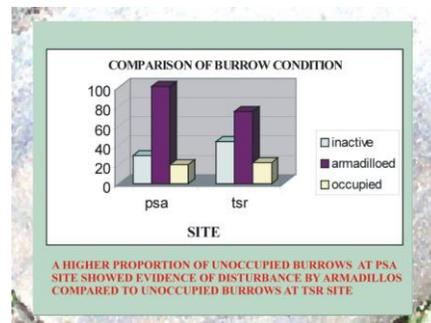
At PSA, evidence of successful hatching and emergence was found at least one burrow. In addition, a clutch of 4 eggs was found in the process of hatching.

During the winter of 2004 staff examined 152 tortoise burrows at the PSA site and 136 burrows at the TSRHP site. Each burrow was examined with a burrow camera to determine occupancy. In addition the width of each burrow opening was measured, the direction of the burrow opening and the condition of the burrow were recorded and the location of each burrow was determined using a Trimble Global Positioning System.

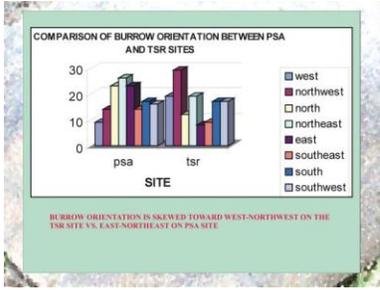


The burrow samples on each site were not random, they were obtained by walking transects through the sites and visually locating burrows. Burrow distribution throughout each site differed greatly and appears to be based on the habitat structure of each site. Burrows on the PSA site were located primarily along roads, power line cuts and other man-made openings. Burrows on the TSRHP were dispersed throughout the habitat and appear to be independent of man-made openings.

Occupancy rates did not differ significantly between the study sites, but the levels and types of burrow disturbance did. Tortoise burrows at the PSA site were disturbed or altered by armadillos to a greater degree than burrows at the TSRHP. This difference may be due to the difference in habitat conditions as degraded habitat may favor armadillos.

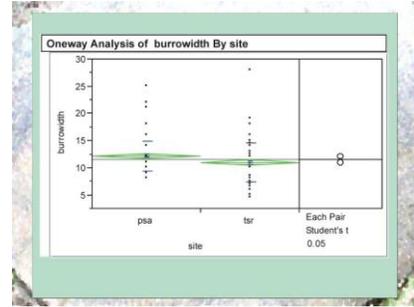


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Orientation of the burrows (direction that the opening faces) differed between sites. Burrow openings on the PSA site faced predominantly north, northeast and east, meaning that they would face the morning sun. Burrows at TSRHP faced predominantly west and northwest, facing the evening or setting sun. These differences may also be attributable to habitat condition, primarily amount of canopy closure at PSA.

The major difference between burrows at PSA and TSRHP was in the width of the burrow opening. Average burrow size at PSA was significantly larger than TSRHP. This likely indicates a lack of recruitment at PSA, as burrow width is an accurate predictor of the size of the tortoise that constructed the burrow. Reduced recruitment may be directly linked to the quality of the habitat at PSA.



Tortoise home range and habitat quality data, collected during FY03 and FY04, was used to provide a baseline in examining the effect of different management strategies on the species. The U.S. Army Corps of Engineers (USACOE) provided funding for data collection at sites, other than TSR and PSA. A final report provided to USACOE Construction Engineering Laboratory is provided in Appendix 1.

Significant Deviations: None

Objective 2: Determine the presence or absence and abundance of the pine snake, southern hognose snake, and mimic glass lizard at selected Heritage Preserves that provide appropriate habitat for these species and are within the historical range of these species.

Accomplishments: Cover object sampling arrays were established at the Tillman Sandridge Heritage Preserve, Congaree Bluffs Heritage Preserve and Aiken Gopher Tortoise Heritage Preserve. Sampling arrays consist of 20 or more cover objects, either wood or metal, in linear or cross-shaped alignments located at different community types, ecotones or areas of these preserves. Locations of all arrays have been recorded using a Global Positioning System. Systematic sampling at these arrays will begin during late winter of 2004.

A small grant was made to a student at North Carolina State University to assist him in a reptile survey of the Carolina Sandhills National Wildlife Refuge. This survey produced two new records for the northern pine snake at this site. These records have been stored in the Heritage database. Additional records for the northern pine snake and southern hognose snakes were obtained through surveys at the Francis Marion National Forest.

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During FY03 cover object sampling arrays were established at the Tillman Sandridge Heritage Preserve, Congaree Bluffs Heritage Preserve and Aiken Gopher Tortoise Heritage Preserve. Sampling arrays consist of 20 or more cover objects, either wood or metal, in linear or cross-shaped alignments located at different community types, ecotones or areas of these preserves. Locations of all arrays have been recorded using a Global Positioning System. Systematic sampling at these arrays will begin during late winter of 2004.

All arrays were checked at least once a month during late winter through early summer and again during the fall in FY04. No pine snakes, southern hognose snakes or mimic glass lizards were observed under cover objects at any sample site during the sampling period. Pine snakes were observed, either dead on the road or alive on the road, at the Tillman Sand Ridge site during the sampling period.

It is possible that these species are not susceptible to sampling by cover objects and we may be able to determine that at the end of this study. Cover objects at the Webb Wildlife Center, near the Tillman Sand Ridge have proven useful in sampling large, upland snakes that are primarily fossorial as are the target species.

This Objective was completed in FY04.

Significant Deviations: None

Objective 3: Survey selected state owned and managed natural areas, including Heritage Preserves within the Blue Ridge Escarpment area of South Carolina to determine the presence or absence and abundance of the following species: milk snake, coal skink, wood frog, pine snake and green salamander.

Accomplishments: Four study areas within the Blue Ridge Escarpment/Upper Piedmont region of South Carolina were established during FY 04. Clemson South Forest and Fant's Grove WMA and Clemson North Forest, owned and managed by Clemson University, Keowee-Toxaway State Park, owned and managed by S.C. Department of Parks Recreation and Tourism and Bad Creek Pump Storage site, owned and managed by Duke Power.

Cover object arrays were established at all sites and checked at least once a month, during FY04, by volunteers. The following species were documented during this study:

Clemson South Forest and Fant's Grove
WMA

Bufo americanus
Hyla chrysoscelis
Rana catesbeiana
Agkistrodon contortrix

Carphophis amoenus
Cemophora coccinea
Coluber constrictor
Diadophis punctatus
Nerodia sipedon
Pantherophis allegheniensis
Pantherophis guttatus

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Clemson North Forest at Isaqueena

Plethodon teyahalee
Pseudotriton ruber
Bufo americanus
Hyla chrysoscelis
Hyla crucifer
Pseudacris triseriata
Carphophis amoenus
Coluber constrictor
Diadophis punctatus
Nerodia sipedon
Pantherophis allegheniensis
Regina septemvittata
Storeria occipitomaculata
Terrapene carolina
Anolis carolinensis
Sceloporus undulatus
Notopthalmus viridescens

Keowee Toxaway State Park

Aneides aeneus
Storeria dekayi
Storeria occipitomaculata
Anolis carolinensis
Eumeces fasciatus

Pseudotriton ruber
Bufo americanus
Pseudacris triseriata
Agkistrodon contortrix
Carphophis amoenus
Crotalus horridus
Storeria occipitomaculata
Anolis carolinensis
Eumeces fasciatus
Sceloporus undulatus
Terrapene carolina

Bad Creek Pump Station

Desmognathus ocoee
Rana clamitans
Agkistrodon contortrix
Coluber constrictor
Diadophis punctatus
Lampropeltis getulus
Anolis carolinensis
Sceloporus undulatus
Terrapene carolina

This Objective was completed during FY04.

Significant Deviation: None

Objective 4: Obtain an inventory and status analysis for the Catawba River Corridor's amphibian and reptile populations; provide information to determine the list of species of concern and their distribution, and compile data on the habitats and environmental components for the Catawba River Corridor's amphibian and reptile fauna.

Accomplishments: Coverboard sample sites were established at four sites in the Catawba River Corridor including, Anne Springs Close Greenway, Historic Brattonsville, Landsford Canal State Park, and the McColl Tract of the Museum of York County and the Rock Hill Blackjacks Heritage Preserve. Education coordinators for SCDNR, the Anne Springs Close Greenway, South Carolina Wildlife Federation and Landsford Canal State park met to organize local school participation in this project. To date four area schools are serving as partners in this project including Gold Hill Elementary School, Springfield Elementary School, Fort mill Elementary School and Rock Hill High School.

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A coverboard demonstration was presented at a South Carolina Wildlife habitat workshop held at Rock Hill Blackjacks Heritage Preserve. Participants in the coverboard project began checking coverboards in April of 2003. A list of amphibian and reptile species documented for all sites, to date, is presented below.

Pseudemys concinna	river cooter
Terrapene carolina	eastern box turtle
Storeria dekayi	brown snake
Diadophis punctatus	ringneck snake
Carphophis amoenus	eastern worm snake
Lampropeltis getula	eastern kingsnake
Agkistrodon contortrix	copperhead
Pseudotriton montanus	mud salamander
Plethodon glutinosus	slimy salamander
Bufo woodhousei	Fowler's toad
Hyla chrysoscelis	gray treefrog
Acris crepitans	Northern cricket frog

The SCDNR staff member who initiated this portion of the study retired during Fiscal Year 04. Volunteers are currently coordinating this portion of the study. SCDNR expended no funds during FY 04 or FY 05 on this portion of the study.

Significant Deviations: None

Objective 5: Develop a statewide comprehensive conservation plan for reptile and amphibian species in South Carolina with a focus on species of high conservation concern and habitats that support rare, endemic or particularly diverse reptile and amphibian assemblages.

Accomplishments: Staff has prepared the amphibian and reptile portion of the Comprehensive Wildlife Conservation Plan (CWCP) addressing the conservation needs of 49 species deemed to be in greatest need of conservation. The CWCP has been submitted and approved by USFWS and staff is currently working on amphibian and reptile conservation objectives identified in the plan.

This Objective was completed during FY05.

Significant Deviations: None

Total Project Cost: \$110,070

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