

CHAPTER 9: SC'S STATE WILDLIFE GRANTS PROJECT SUMMARIES

South Carolina began implementing its Action Plan as soon as it was initially approved back in 2005. Since that time, 35 State Wildlife Grants have been completed and are summarized in this chapter. Table 8-1 lists them in numerical order. Due to personnel turnover, the author of the report may differ from the actual principal investigator (PI) of the project. This is noted in the title of each report. There are an additional 18 regular grants in progress as well as 3 competitive SWG grants, and those will be reviewed in the next revision of the SWAP. All final federal reports can be found online at the State Wildlife Grants website and go into more depth for each grant. The subjects of these projects range from research and survey to habitat enhancement.

TABLE 9-1: CLOSED SWG GRANTS FROM 2005-PRESENT

Federal Grant No.	Duration	Project / Grant Title
T-6	2004-2005	Census and Monitoring of Waterbird Nesting in the South Carolina Coastal Plain (<i>continued from R-3</i>)
T-7-R-2	2006-2008	Conservation of Water and Seabirds in South Carolina
T-8	2005-2007	South Carolina Stream Planning Project (<i>became T-25-R-1</i>)
T-9	2005-2013	Robust Redhorse Restoration and Conservation
T-10-P	2005-2009	Landscape Planning for Priority Species on Agricultural Lands (<i>also T-46</i>)
T-11	2005-2008	Restoration of Longleaf Pine Forest on State-owned Land
T-13-R	2006-2009	Conservation of Migratory Landbirds in South Carolina (<i>previously T-4</i>)
T-14-T	2005-2009	Development of BMPs for Sustaining Wildlife in the Maritime Zone of South Carolina
T-15-P	2005-2007	South Carolina Reptile and Amphibian Conservation Planning
T-16-R	2005-2009	Upland Habitat Improvements on Lewis Ocean Bay Heritage Preserve
T-17-R	2006-2010	Protection and Management of Seabird Colonies (Monitoring/Breeding Parameters)
T-19-R	2006-2010	Habitat Enhancement on North and South Williman Islands, Beaufort County, South Carolina
T-20	2006-2007	Status and Management Plan Development for Three Rare Burrowing Crayfish
T-23-R-1	2006-2011	Controlling Access to Known and Potential Bat Roosts
T-24	2006-2008	Fish Passage on the Broad River: An Assessment of Benefits of Freshwater Mussels
T-25-R-1	2006-2013	South Carolina Stream Assessment (<i>previously T-8</i>)
T-27-R-1	2009-2012	Habitat Improvement for Grassland Birds
T-30-R	2007-2008	Taxonomy, Life History, and Distribution of the Crayfish, <i>Procambarus echinatus</i> (Edisto Crayfish)
T-31-R-1	2007-2012	Assessing Introgressive Hybridization Within and Habitat Requirements of Native South Carolina Redeye Bass
T-32-T-1	2007-2008	Restoring Seabird Nesting on Bird Key Stono Seabird Sanctuary
T-33-R-1	2007-2012	Robust Redhorse Electrofishing and Radio Telemetry Tracking of the Great Pee Dee River, South Carolina
T-35	2009-2010	Identification of Diamondback Terrapin Habitats in South Carolina (<i>thesis</i>)
T-36-HM	2008-2010	A GIS Model to Guide Landscape Scale Restoration at the Woodbury Tract and Hamilton Ridge Properties
T-37-T	2008-2010	Carolina Herp Atlas
T-38-R-1	2010-2012	Mink Restoration and Monitoring Development Project (<i>see 2 theses</i>)
T-39-M-1	2008-2013	Prescribed Burning Crew for South Carolina DNR Lands
T-40-L	2008-2009	Conservation of Belfast Plantation, Phase I
T-42-R-1	2008-2009	Use of GIS to Assess the Demographic Isolation of RCW Groups in South Carolina
T-44-R	2008-2010	Least Tern Reproductive Success on Rooftops
T-47-R-1	2008-2011	Conservation of Breeding Painted Buntings and Other Songbird Indicators in Early-successional Shrub-scrub Habitat Modified by CP-33 Buffers in South Carolina
T-48-R	2008-2010	Effects of Predation on Seabird Nests in Cape Romain
T-50-L	2009-2010	Conservation of Belfast Phase II
T-51-R-1	2009-2011	Ecology and Impacts of Coyotes on Loggerhead Sea Turtles, Least Terns, and Other Wildlife: Implications for Management
T-54-R-1	2010-2013	Monitoring Impacts of Yellow Pine Restoration of Avifauna in the SC Mountains
T-55-R-1	2010-2012	Using Citizen Science in the Study and Conservation of Breeding Painted Buntings
T-61-R-1	2012-2013	Decision Support Tools for Stream Conservation
U2-1-HM-1	Incomplete	Multistate Sandhills Ecological Restoration Project: Alabama, Florida, Georgia, and South Carolina

Note: T-5, T-21, T-29, and T-52 were CWCS/SWAP revision grants. T-1, T-3, T-12, T-22, and T-28 are unassigned numbers. T-26 is being continued as T-57. T-34, T-41, T-43, T-45, T-49, and T-53 are still active.

Project Summaries

Census and Monitoring of Waterbird Nesting in the South Carolina Coastal Plain (Federal Grant #: T-6 (continued from grant R-3), Duration: 2004–2005) PI: Laurel Barnhill, SCDNR (formerly)

This grant is a continuation of South Carolina Grant R-3, which utilized WCRP funds. This grant picks up where Grant R-3 left off, with the exception that the Bald Eagle work initiated under R-3 continues under that grant and is excluded from this grant. To read a review of T-6, please see the online final report.

Conservation of Waterbirds and Seabirds in South Carolina (Federal Grant #: T-7-R-2, Duration: 2006–2008) PI: Thomas Murphy, SCDNR (retired); Author: Christine Hand, SCDNR

Grant T-7 funded the monitoring and management of waterbirds nesting on the South Carolina Coastal Plain from October 2006–September 2008. Bald Eagle surveys and ground visits were used to document chick production, estimate mortality rates, and assess population levels. Colonially nesting wading birds were surveyed. More extensive surveys were conducted at Wood Stork colonies to document nest numbers and to estimate productivity. A decline in numbers of colonially nesting wading birds that may be due to loss of habitat and drought conditions was documented. Movements from natural wetlands to constructed wetlands and an increase in human-bird interactions was observed. Censuses were conducted for 6 species of seabirds, and signs were posted to protect sensitive nesting areas. Least Terns nesting on rooftops were surveyed. American Oystercatchers were surveyed and banded to yield data that will improve regional estimates of survival. Research projects conducted by 3 graduate students at Clemson University were supported and coordinated. Research topics include seabird/human disturbance, techniques to enhance Oystercatcher productivity, and identifying preferred winter foraging habitat for Oystercatchers.

DNR staff participated in professional meetings including the annual Wood Stork Working Group, American Oystercatcher Working Group, and gave presentations to educate the public about coastal birds. Technical assistance was provided for a variety of projects including negotiating management zones around eagle nests and enhancing the use of managed impoundments by wading birds and shorebirds.

Robust Redhorse Restoration and Conservation (Federal Grant #: T-9, Duration: 2005-2013) PI: Ross Self, SCDNR; Author: Scott Lamprecht, SCDNR

The objective of this project was to establish self-sustaining populations of Robust Redhorse, (*Moxostoma robustum*), suckers in the Santee River Basin using Savannah River brood stock. The first step was to stock the Santee River Basin with cultured Savannah River strain Robust Redhorse (RRH). The Santee Basin was identified as a potential population establishment site because its size, location between two identified population, and evidence of historical RRH occurrence in the drainage. A primary consideration of this effort was to use progeny from 100 pairings to ensure that the new population would be genetically diverse. Brood stock collection was made from a numerically healthy and geographically nearby population of Savannah River

RRH. Fish were collected during their natural spawning activities over a mid-channel gravel bar using stationary electro-fishing grids and a mobile electro-fishing boat. Eggs and milt were immediately collected from the actively spawning adults, and fertilization occurred individually between eggs from one female and milt from one male. Depending on the quantity, a female's eggs were divided between 1 and 3 males. Fertilized eggs were transported to the Bayless Hatchery for incubation and hatching. Grow-out was made in production ponds at the Dennis Wildlife Center. Spawning efforts occurred in every spring from 2004-2013.

Of the 45 females spawned over 10 years, 3 females have been used more than once. However, 2 of these incidences occurred in 2010 where production failed. The number of eggs collected from each female varied, and their contribution to subsequent stocks was not monitored. Through the 2009 spring spawning season, we have produced offspring from 98 individual matings. However, production over the last 3 years has been minimal. As a result, we continued spawning efforts through the spring of 2013 in order to reach an introduction goal of 100 genetically distinct matings. Spawning efforts produced 15,000 eggs which resulted in the stocking of 11,000 fry into grow-out ponds. All fish stocked to date have been tagged with either coded wire (CW) tags or pit tags (P).

We also surveyed and monitored the growth, survival, maturation, and spawning success as well as habitat use of stocked RRH in the Santee River Basin and monitored existing populations in the Savannah and Pee Dee River systems. Monitoring efforts continued into 2013. Building on previous work, observations were collected incidental to anadromous fish monitoring below Wateree Dam, Columbia fish way monitoring on the Congaree River, directed collection effort in the Congaree and Wateree Rivers, and by telemetry studies described below. DNR collected 4 specimens in the lower Wateree River during December 2012 and subsequently equipped 2 with sonic transmitters. This collection was made by using transmittered fish to locate aggregations outside of the spawning season. Duke Power picked up 16 specimens during their 2013 spring anadromous fish survey of the Wateree Dam tailrace. The Columbia fishway monitoring was hampered by high flows and turbid water during the spring of 2013. However, when observations were made, RRH were observed moving upstream.

Because of the difficulty in collecting information on juvenile and RRH, a telemetry survey was initiated in 2009 in the Wateree River/Congaree portion of the system. A total of 14 fish have been actively monitored, and the following pattern has been observed during multiple years: all the study fish occupied the Wateree Tailrace during spawning season; all fish used the lower Congaree River after spawning season; 11 of the 14 fish traveled up the Congaree to at least the midway point; 9 of the 14 passed upstream of Rosewood landing; 2 were documented using the Broad River (below the Columbia Dam); 2 fish used the lower Saluda (one in successive years); and 3 fish were detected in the upper Santee River above Lake Marion. The repeated summertime use of the Congaree River is interesting because it is significantly cooler than the Wateree River and may indicate a temperature preference. It is interesting to note that while we observed fish exhibiting spawning behavior in the Wateree Dam tailrace, we observed significant numbers of fish ascending the Columbia Fishway. Long distance movement of these fish can occur relatively quickly; one fish moved downstream 124 km (77 mi.) in 2.6 days and there are numerous instances of fish moving more than 30 km/day (19 mi./day).

The project also gave us the opportunity to inform and educate the public about the relevance of our efforts to reestablish and conserve RRH in South Carolina. During the past year, staff members have included our RRH studies in all appropriate public outreach efforts. Staff often addressed the need for display specimens at the Charleston Aquarium. Staff attended the 2013 annual meeting of the Robust Redhorse Conservation Committee (RRCC) in Georgia, and a plan for brood stock collection, spawning, stocking and research efforts were reviewed. Conservation and recovery were coordinated among the agencies and organizations involved. Staff members were also actively involved in a larval fish toxicology study lead by an NC State researcher.

The development of baseline genetic data for the Savannah population was realized and a foundation for future evaluation of ongoing re-establishment within the Santee River System is being built. Subsequent to development of genetic markers, fin clips from all collected specimens were catalogued in order to determine stock contributions based on individual crossings and to detect evidence of natural recruitment.

Landscape Planning for Priority Wildlife Species on Agricultural Lands (Federal Grant #: T-10-P, Duration: 2005-2009) PI: Judy Barnes, SCDNR (retired); Author: Billy Dukes, SCDNR See also T-46.

The approach utilized in this grant was to employ 3 technical guidance biologists to work with USDA staff to engage in landscape-level planning for priority wildlife species on private agricultural lands. The technical guidance biologists worked to incorporate habitat restoration measures for priority wildlife species into plans written through the Conservation Reserve Program, Environmental Quality Incentives Program, Conservation Security Program, Wetland Reserve Program, Wildlife Habitat Incentives Program, Grassland Reserve Program, and Forest Land Enhancement Program.

Over the course of the grant period, 248 conservation plans potentially affecting 170,359 acres in 23 South Carolina counties were written. Technical guidance biologists also delivered 47 programs for a combined audience of 2,511 people. Nine news releases promoting habitat conservation for priority wildlife species were written and submitted, 6 technical brochures on various aspects of wildlife conservation were developed, and 22 fact sheets on threatened and endangered species were completed. In addition, one biologist provided technical guidance and assistance in the development of a statewide Gopher Tortoise Conservation Plan for South Carolina.

Restoration of Longleaf Pine Forests on State-Owned Lands (Federal Grant #: T-11-1-R, Duration: 2006-2008) PI and Author: Tim Ivey, SCDNR

The objective of T-11-1-R was to restore longleaf pine forests and associated herbaceous species on a minimum of 1,000 acres of state-owned lands. Accomplishments included herbicide treatment of 45 acres of established longleaf stands to reduce competing hardwood vegetation on three SCDNR-owned heritage preserves. Twenty-five acres of new longleaf plantings (8,000 seedlings) were established on Little Pee Dee River Heritage Preserve and 8500 containerized longleaf pine seedlings were interplanted within 42 acres of sparse existing stands of longleaf pine on Longleaf Pine Heritage Preserve. Re-establishment and/or improvement of 14 miles of

firebreaks and prescribe burning of 1,213 acres of longleaf stands occurred on Woods Bay and Longleaf Pine Heritage Preserves. Aerial herbicide site preparation and planting of 14,000 longleaf pine seedlings was conducted to convert 25 acres to longleaf pine on Congaree Bluff Heritage Preserve. Site preparation and planting of 25 acres of longleaf pine was accomplished at Janet Harrison High Pond Heritage Preserve. Herbicide release of competing vegetation with 40 acres of longleaf was conducted at Longleaf Pine and Lynchburg Savannah Heritage Preserves. Understory brush control was utilized in 140 acres of longleaf stands at Webb Wildlife WMA. The construction of 18 miles of new firelanes at Lewis Ocean Bay Heritage Preserve was also accomplished as well as 162 acres of site prep and longleaf pine establishment at Woodbury WMA. McBee WMA underwent 8 acres of longleaf planting while 25 acres of longleaf plantings were done at Hamilton Ridge WMA. Site prep and planting of 831 acres of longleaf pine at Manchester State Forest was also accomplished. Mechanical understory control of competing vegetation in 32 acres of longleaf pine stands at Lewis Ocean Bay Heritage Preserve and herbicide timber stand improvement of 40 acres at McBee WMA was completed. The total longleaf habitat improvements made equaled 1,510 acres with new longleaf pine stands established on 1,135 acres.

Conservation of Migratory Landbirds in South Carolina (Federal Grant #: T-13-R-2, Duration: 2006-2009) PI: Laurel Barnhill (formerly with SCDNR now USFWS); Author: Janet Thibault, SCDNR

Grant T-13-2-R funded prescribed burns at Bonneau Ferry Wildlife Management Area during the growing season of 2008. It also funded research on the habitat requirements and demographics of Swainson's Warblers (*Limnothlypis swainsonii*) and Painted Buntings (*Passerina ciris*) and the development of monitoring protocols for bird species with the greatest conservation need to better manage for these species in coastal South Carolina.

Productivity, survival, habitat use, diet, and movements of Swainson's Warblers were studied at the Woodbury Tract Wildlife Management Area during 2006-2009 and built upon previous research conducted since 1997. Swainson's Warblers were color banded and several were radio tagged and followed with telemetry equipment throughout the nesting season. The site fidelity to Woodbury Tract was high with most birds returning to the same territories year after year. Females appeared to breed after their initial hatch year, while first year males did not. Home ranges often overlapped with other Swainson's Warblers and territory sizes varied. Swainson's Warblers forage in the upper layer of decaying leaves, and hydrology and flooding of the site affects the timing of breeding and foraging opportunities for this species.

The ecology of painted buntings and other early-successional passerines was studied at the Webb Center Wildlife Management Area and The Nemours Wildlife Foundation during the breeding seasons of 2006-2008. The study assessed the suitability of wildlife food plots in these two differently managed landscapes and how the management regimes affected the occurrence of Painted Buntings and other bunting species. Results indicated that buntings were not likely to be present at either of the managed sites due to the frequency of management at these areas. Buntings likely prefer larger areas of old/fallow fields that are interspersed among mid- to late-successional forests.

Development of Best Management Practices for Sustaining Wildlife in the Maritime Zone of South Carolina (Federal Grant #: T-14-T, Duration: 2005-2009) PI and Author: David Whitaker, SCDNR

The goal of this project was to develop Best Management Practices (BMPs) for anyone building a home or development within an existing maritime forest. These BMPs would have the goal of minimizing ecological impacts to native fauna and flora. Staff conducted an intensive literature review, contacted numerous managers of “low impact” coastal developments to review their development guidelines and regulations, and interviewed various experts. Staff asked for advice from upland mammal biologists, botanists, ornithologists, herpetologists, foresters, and others. A 76-page booklet entitled, “Best Management Practices for Wildlife in Maritime Forest Developments” was published in November 2009. This document reviewed the animal species of the Maritime Forest with emphasis on habitat requirements for each, and special emphasis was given to SWAP priority species. This was followed by detailed descriptions of BMPs at the community, neighborhood, and individual home levels. Immediately after printing, 225 copies were distributed to planners and other officials of coastal communities, Office of Coastal Resources, Coastal Conservation Association, SC Forestry Commission, various SCDNR staff, SC Sea Grant office, SC Wildlife Federation, Coastal Conservation Association, and a number of private citizens. Additionally, the complete document was made available on the SCDNR website with 1,429 requests for the document being made in the first month after publication.

SC Reptile and Amphibian Conservation Planning (Federal Grant #: T-15-P, Duration: 2005-2007) PI: Steve Bennett, SCDNR (retired); Author: Will Dillman, SCDNR

This multi-task project included 4 separate jobs for 4 separate priority species: gopher tortoise, diamondback rattlesnake, timber rattlesnake, and seepage slope salamanders. Each job will be addressed in its own section.

Gopher Tortoise Management – The objective of this job was to develop a plan to recover and enhance the gopher tortoise population at Aiken Gopher Tortoise Heritage Preserve (AGTHP) in Aiken County to include the re-stocking of tortoises from the surrounding habitat and from other sites in South Carolina. Three 1 ha (2.5 ac.) pens were established on site at the Aiken Gopher Tortoise Heritage Preserve to provide an area to house relocated tortoises. These pens housed groups of tortoises for approximately one year, and then were removed to allow the tortoises to become “established” in their new environment. Waif gopher tortoises were received from a variety of different places within the Southeastern US, and several federal and state agencies and placed into the pens. Pen 1 housed waif tortoises from the Southeast and a group of hatchling tortoises from Hilda, SC that were contained within the pen under a separate hatchling enclosure. Pen 2 contained tortoises that were trapped on the AGTHP and considered to be the “resident” group. Efforts were made to trap and relocate all known Gopher Tortoises occurring on the site. In addition, aprons of AGTHP tortoises were excavated during the summer of 2007 by Tracey Tuberville and Kurt Buhlmann. One gopher tortoise nest containing two eggs was found. One of the eggs hatched, the other was infertile. That hatchling is small and is currently being maintained at SREL with the intention of adding it to the Pen 2 population in the spring of 2008. Pen 3 was used to house a group of gopher tortoises from a private property owner near the town of Grays, SC. In addition, two separate introductions of hatchling tortoises were made to Pen 3

during the Project period. Six hatchlings from laboratory-hatched eggs from the Tillman Sand Ridge Heritage Preserve were released into Pen 3 with starter burrows during summer 2007. An additional 6 hatchlings (also from Tillman Sand Ridge HP) were released into Pen 3 but covered under an 8 ft. x 8 ft. wire mesh cage in the autumn of 2007. The intention of the cage was to prevent predation by coyotes, crows, or raccoons. To date, the hatchlings seem to be surviving under the cages.

All tortoises have been measured, marked, and had blood samples taken (by Tracey Tuberville) for further genetic analyses. At the conclusion of this project, 56 tortoises were contained in the pens at the AGTHP.

Diamondback Rattlesnake Management – The first objective of this job was to determine the feasibility of managing rattlesnake populations by translocating Eastern diamondback rattlesnakes to sites with appropriate habitat within the historic range of the species, and to develop a model for eastern diamondback rattlesnake demography to include population size, survivorship, mortality, growth patterns, age classes, and sex ratio. The second objective was to conduct research and monitoring at the Webb Wildlife Center (continuation of ongoing monitoring) and at least 3 other public properties in the SC Coastal Plain that support longleaf pine habitat. Another task was to determine the potential distribution of longleaf pine habitat on public properties in the SC Coastal Plain using a qualitative vector GIS model.

The study was initiated in 2006, encompassing 4 study areas in the South Carolina Coastal Plain: Hoover Plantation (Jasper County), Nemours Wildlife Foundation (Beaufort County), Cheehaw Combahee Plantation (Colleton County), and Donnelly Wildlife Management Area (DWMA; Colleton County). In 2007, we added another study site, Okeetee Plantation (Jasper County), and discontinued efforts to monitor the EDB at DWMA. The study areas comprised varying degrees of upland pine savanna, and thus harbored Eastern diamondback rattlesnakes. In March 2007, we translocated all of the study animals that were telemetered in 2006 to the Webb Wildlife Center. We captured 4 new rattlesnakes (Nemours, N=1; Cheehaw Combahee Plantation, N = 3), and they were translocated in March 2008. All telemetered rattlesnakes were located weekly. We will continue to quantify movement patterns using data collected in 2007 following November ingress. We have begun our analysis comparing pre- and post-translocation movements using the individuals that were captured in 2006.

The long-term monitoring and research on the diamondback rattlesnake population at Webb Wildlife Center continued, and additional surveys were performed at Donnelly Wildlife Management Area, Cheehaw Combahee Plantation, Hoover Plantation, and Nemours Wildlife Foundation. No Diamondbacks were found at Donnelly Wildlife Management Area; however, diamondbacks were found at the other properties surveyed.

Timber Rattlesnake Surveys – The objectives of this job were to (1) determine the distribution of the montane phase and the Coastal Plain phase of this species in the region and to (2) develop a management strategy for the timber rattlesnake on public lands in South Carolina. (3) The population size and demography at selected sites had to be determined and included gathering information on population structure, sex ratios, mortality, reproductive success, survivorship, and

mortality. (4) The home range size had to be determined as well as habitat use and seasonal activity patterns for both "forms" of this species in this region using radio telemetry.

Between September 2006 and fall 2007, 15 timber rattlesnakes were implanted with radio transmitters and tracked. During the course of the study, hibernation, courtship, mating, and birthing were observed. Movements of male snakes appeared to be greater than those of the females, and both sexes showed an affinity for wooded areas. Both the montane and Coastal Plain phase of the timber rattlesnake were captured, implanted, and tracked. Currently, there appears to be no elevation, habitat, or sex differences in either phase of the Upstate timber rattlesnake. Data collected during this study has contributed to the understanding of the biology and habitat requirements of this species in South Carolina.

Seepage Slope Salamander Investigations – The objective of this project was to develop a predictive model for Coastal Plain seepage slope habitat as a means of identifying potential habitat for the Southern dusky salamander and Chamberlain's dwarf salamander, and to survey potential habitat for presence/absence of the target species. During the study, we collected specimens of the southern dusky salamander, when present, for genetic analysis to determine if there are “cryptic” species of this complex found in South Carolina.

Eight seep sites were monitored with water sampling wells and cover-board transects. Water quality and hydrology sampling was conducted at all seeps quarterly during the reporting period, and cover-boards were sampled three times. We initiated a molecular phylogeny study involving the two focal species of this project *Desmognathus auriculatus* and *Eurycea chamberlainii*. The goal of this study was to resolve the phylogenetic—and eventually the taxonomic status—of these 2 species and their “closest” relatives in South Carolina. Additionally, staff surveyed 26 sites for Plethodontid salamanders. Some of these sites were historic locations for *Desmognathus* and others were new sites selected due to their hydrologic and topographic characteristics. Salamander species in the family Plethodontidae were collected at 18 of these sites—*Eurycea chamberlainii* at 2 sites and *Desmognathus auriculatus* at 9 sites. One additional site in the Piedmont was sampled and a *Desmognathus* was collected there.

Preliminary results from the molecular phylogeny study indicate that the “focal” species *Desmognathus auriculatus*, Southern dusky salamander does not occur in South Carolina. To date, this analysis has identified 4 separate lineages of *Desmognathus* in the Coastal Plain and Piedmont of South Carolina, none of which are closely aligned with *D. auriculatus*.

Upland Habitat Improvements on Lewis Ocean Bay Heritage Preserve (Federal Grant #: T-16-1-R, Duration: 2007-2008) PI and Author: Tim Ivey, SCDNR

The objective of the habitat improvement project at Lewis Ocean Bay Heritage Preserve was to restore grassland, pine savannah, and pine woodland habitat sites within the 3-year funding period. Habitat restoration and management included clearing competing vegetation along 13 miles of roads, ditches, and rights-of-ways; 210 acres of competing understory removed from longleaf stands using herbicides and mechanical removal; 20 acres of longleaf pine stands underplanted with longleaf seedlings; 533 acres converted from slash pine to longleaf pine; and 18 miles of new firebreaks established. In addition, 76 miles of firebreaks were maintained and 2,338 acres prescribe burned.

Protection and Management of Seabird Colonies (Monitoring/Breeding Parameters)

(Federal Grant #: T-17-R, Duration: 2006-2010) PI: Laurel Barnhill (formerly with SCDNR and now USFWS); Author: Janet Thibault, SCDNR

Seabirds such as Brown Pelicans, Sandwich Terns, Royal Terns, and Black Skimmers nest in large colonies on isolated islands and are susceptible to human disturbance. Over time, effects of disturbance may manifest as reduced reproductive success and increased energy expenditure on the part of adults and young. In 2006, the South Carolina Department of Natural Resources (DNR) established 3 barrier island seabird sanctuaries in Charleston County: Crab Bank, Bird Key, and Deveaux Bank. New regulations were designed to limit human disturbance and prohibited public access at Crab Bank and Bird Key during the nesting season and limited access to below the high tide line at Deveaux Bank. All 3 of these islands provide nesting habitat and stopover locations for seabirds and shorebirds which require islands that have suitable habitat for nesting and rearing young. The goal of this project was to monitor seabird colonies on these DNR protected islands and collect baseline measures of breeding parameters, determine habitat use of seabirds and shorebirds on the islands, and to better evaluate the health and condition of seabird populations in South Carolina in relation to the new regulations and for future comparisons. Research was conducted from 2006 to 2008.

Overall, the effects of the new seabird conservation regulations resulted in an increase in size of the Black Skimmer colony on Crab Bank, increased productivity of Black Skimmers at Deveaux Bank, and a re-establishment of nesting of Black Skimmers on Bird Key. Colony size and reproductive success of Brown Pelican and tern species at other islands was variable among locations and years. The results of the intertidal surveys indicated that the intertidal area is an essential component of seabird breeding habitat and is used for loafing, feeding, courtship, and chick-rearing by seabirds and shorebirds. The majority of birds were located along the water and on the lower portion of the beach during surveys. Brown Pelicans, Laughing Gulls, Black Skimmers, and Royal, Sandwich, and Gull-billed Terns were most frequently engaged in loafing and maintenance behavior in the intertidal zone of the islands, while shorebirds were most often observed foraging there. The health parameter analyses revealed that age was a significant factor affecting many health parameters of Brown Pelican nestlings. Packed cell volume increased with age when compared to wild adults. Levels of proteins and cholesterol were higher in the older age category, which may be necessary to support physiological development. Collection of baseline data such as that collected in this study provides a means to monitor the health of nesting populations and provides baseline data for comparative and long-term studies. These data are particularly valuable after catastrophic disease outbreaks or environmental contamination events.

Habitat Enhancement on North and South Williman Islands, Beaufort County, SC (Federal Grant #: T-19-R, Duration: 2006-2010) PI and Author: John McCord, SCDNR (retired)

This was a large, non-native invasive species eradication project that occurred on North Williman Island and South Williman Island which are located in north Beaufort County, South Carolina. Both islands exceed 1,000 acres in total size, and both are composed of a mosaic of

tidal estuarine marshland and interspersed hammocks (small upland islands also called hummocks). These islands are State-owned and are under the management authority of SCDNR.

North Williman Island includes 9 hammocks, ranging from 1.5 to 436.4 acres, while South Williman Island contains 12 hammocks, 0.4 to 688.4 acres in size. Biological inventories of plants and animals were performed by SCDNR on all of the hammocks of North Williman Island and South Williman Island during fall 2003 through winter 2005-2006. These initial SCDNR surveys revealed significant habitat degradation that was presumed to be caused primarily by the impacts of the invasive Chinese tallowtree (*Triadica sebifera*) and, specifically on several hammocks of North Williman Island, by feral goats (*Capra hircus*).

Habitat enhancement activities for this project were performed primarily on the largest hammocks within both North Williman Island and South Williman Island, hereafter referred to as "Goat Island" (436.4 acres) and "Big South Williman Island" (668.4 acres), respectively. Chinese tallowtree was particularly abundant and problematic in association with isolated freshwater depression wetlands. Such freshwater wetlands are most abundant on the largest hammocks within both North Williman Island and South Williman Island, and particularly on "Goat Island" and "Big South Williman Island". Chinese tallowtree out-competes many native plants and, as observed in isolated wetlands on both North Williman Island and South Williman Island, may ultimately produce nearly mono-species stands. Fallen leaves of Chinese tallowtree can alter water chemistry and water quality and may negatively impact populations of some amphibians. Additionally, dense populations of Chinese tallowtree may limit surface water availability and alter hydrology in isolated wetlands due to high water demand and heightened evapotranspiration during late spring through early fall.

Feral goats were only present on several nearly interconnected hammocks within North Williman Island, and these grazing mammals were typically only observed on "Goat Island". Evidence of over-browsing by feral goats was obvious and widespread, particularly on "Goat Island". Native plant diversity and populations of individual plant species were obviously suppressed relative to the observed status of such made during SCDNR surveys of nearby hammocks of comparable size and habitat diversity and where feral goats were not present.

Habitat restoration and enhancement efforts on North Williman Island were primarily based upon attempts to remedy and/or reduce perceived negative ecological impacts from both feral goats and Chinese tallowtree. The successful removal of the population of approximately 100 feral goats from "Goat Island" and all of North Williman Island was completed in early 2008. After goats were successfully removed, 423 seedlings of sweetgrass (*Muhlenbergia sericea*) were planted within 12 colonies on "Goat Island" at scattered sites in the upland transition zone just inland of tidewater influence. Though considered uncommon, this native grass was found to be rather widespread on hammocks within North Williman Island and South Williman Island that were not impacted by feral goats. Sweetgrass and other native grasses provide valuable cover and seeds for wildlife. Only a few damaged specimens of this species were observed on "Goat Island" prior to the successful removal of feral goats. The overall survival rate for planted sweetgrass was nearly 75%, and thriving colonies remained at most planting sites at the completion of this project.

Fourteen trips were made to North Williman Island for herbicide injection of Chinese tallowtrees from 5 November 2007 through 20 December 2007. Approximately 4,750 such plants were injected with herbicides (50% Habitat® or 50% Clearcast™) over 5 North Williman Island hammocks. The remaining 4 North Williman Island hammocks do not have suitable habitat for Chinese tallowtree. The total acreage canvassed for Chinese tallowtree herbicide treatment was ~526.5 acres, requiring 272.5 man/woman-hours. A general evaluation of herbicide injection results was made from spring 2008 through summer 2010 and indicated the successful kill of ~95% of the total Chinese tallowtree (tree-stage plants) population for the entire North Williman Island hammock group. Isolated, low-salinity wetlands were of highest priority in the attempted eradication of Chinese tallowtree. The kill rate for tree-stage Chinese tallowtrees associated with 17 such wetlands likely approached 98%, with nearly 2,500 mature trees killed. Observations through the summer of 2010 revealed a gradual positive response of native plant communities throughout North Williman Island hammocks on which Chinese tallowtree was eradicated and particularly on hammocks on which feral goats were removed in addition to Chinese tallowtree eradication.

Primarily due to funding limitations, habitat enhancement on South Williman Island was limited to the placement of Wood Duck (*Aix sponsa*) nesting boxes (one box each) in 7 isolated wetlands within "Big South Williman Island". Two Wood Duck nesting boxes were placed in an isolated freshwater wetland on "Goat Island". Wood Duck had been recorded in winter on both islands during initial SCDNR surveys, but no evidence of nesting was observed prior to these habitat enhancement efforts. All nesting boxes were erected in late winter 2008, and all boxes were inspected for signs of Wood Duck nesting activity during each spring, 2008-2010. One, 2 and 6 boxes were used by nesting wood duck in 2008, 2009, and 2010, respectively. The observed increase in nest box utilization over the 3 years of observations suggests a likely increase in the local Wood Duck population in the vicinity of the Williman Islands, potentially in response to the provision of nesting cavities.

In addition to the aforementioned habitat enhancement activities, complimentary habitat enhancement and restoration activities were achieved on "Goat Island" through a Cooperative Agreement between the United States Department of the Interior, Fish and Wildlife Service and SCDNR from 1 August 2008 through 30 June 2010. The Cooperative Agreement included: (1) the follow-up eradication of Chinese tallowtree (mostly seedlings); (2) the removal of dead tree-stage Chinese tallowtree snags (trees killed by herbicide injection in late 2007 and early 2008) from 3 isolated wetlands which previously had particularly dense stands of this invasive plant; and (3) the damming of old historic drainage ditches associated with 5 isolated wetlands. Positive responses of native plants, plant communities and wildlife observed on "Goat Island" through the completion of this project should be attributed to habitat enhancement activities achieved through both this project and the Cooperative Agreement.

"Goat Island" was more severely negatively impacted by the combined impacts of feral goats and Chinese tallowtree than was any other hammock within either North Williman Island or South Williman Island. Both habitat restoration, as observed through positive responses of native plants and plant communities, and positive responses of wildlife were most obvious on this North Williman Island hammock. Habitat enhancement and restoration activities yielded a nearly immediate positive response in recovery of native plant communities, particularly in and near

isolated wetlands and on the periphery or outer upland fringe of hammocks that had been drastically impacted by browsing goats. Wetland plant diversity increased dramatically, as demonstrated by a threefold increase in recorded plant species diversity in one isolated wetland as compared to the recorded diversity prior to habitat enhancement activities. Buttonbush (*Cephalanthus occidentalis*), which is a valuable wetland wildlife plant, responded dramatically to the removal of over-shading Chinese tallowtrees and to the removal of feral goats. Prior to habitat enhancement activities, buttonbush was fairly widespread and abundant in wetlands on “Goat Island”, but practically all specimens were in poor condition and few, if any, specimens produced blooms or seeds. Following habitat enhancement activities, buttonbush specimens throughout wetlands on “Goat Island” displayed dramatic growth of new stems and foliage and produced abundant flowers and seeds by 2009 and 2010. Plants typical of the upland-tidal marsh ecotone recovered from severe browsing with sprouting of new growth and by recolonization from seedlings. Sweetgrass plantings in peripheral upland areas of “Goat Island” were very successful and supplemented natural colonies of native grasses, including several naturally occurring sweetgrass colonies which slowly recovered and became established after goat removal. The recovery of this forest edge habitat should provide additional breeding and foraging habitat for Painted Bunting (*Passerina ciris*), a species of highest conservation priority in South Carolina and throughout the region. The recovery of forested plant communities and habitats was more subtle since much of “Goat Island” and other North Williman Island hammocks are covered in closed canopy forest. Subcanopy shrubs, saplings, and herbs slowly responded with resprouting from previously heavily browsed trunks and stems and from rootstock. Also, substantial and diverse germination from the seed-bank was observed. Prior to removal of feral goats, seedlings—including those of Chinese tallowtree—were quickly consumed and were rarely observed. Several decades will likely be required for subcanopy plant communities to recover to a stage similar to such communities on nearby hammocks that have not been impacted by feral goats. With further recovery of shrub thickets and habitat complexity anticipated for “Goat Island” over the next several decades, additional recruitment of breeding birds will likely occur as gradually recovering habitats become suitable as nesting and brood-rearing habitat.

Amphibians and dragonflies were quickly recruited to depression wetlands that displayed enhanced surface water duration following removal of Chinese tallowtree and damming of drainage ditches. Increased surface water retention in such isolated wetlands on “Goat Island” will likely sponsor an increased distribution of “Lunz’s crayfish”—or hammock crayfish—(*Procambarus lunzi*), a species of conservation priority in South Carolina, as well as other aquatic animals as well. Increased surface water retention may also attract American alligator (*Alligator mississippiensis*) to additional wetlands on “Goat Island”, which could result in the creation of dens and pools that may further enhance wetlands for potential colonization by additional aquatic species.

A rookery used by 4 species of wadingbirds was found in the largest wetland on “Goat Island” during SCDNR surveys in spring 2006. The removal of hundreds of large Chinese tallowtrees from the perimeter of this wetland may have improved the quality of this wetland for wadingbird nesting and foraging habitat. Both White Ibis (*Eudocimus albus*) and the endangered Wood Stork (*Myctera americana*) were observed in higher numbers in association with this wetland after the removal of Chinese tallowtrees, indicating that access to shallow water foraging sites was

improved. Wading bird nests were not observed in Chinese tallowtrees in spring 2006 or in spring 2007, and all wading bird nests were in either buttonbush or Coastal Plain willow (*Salix caroliniana*). Both of these native wetland plants responded very positively with enhanced growth following the eradication of competing Chinese tallowtrees. By the spring of 2010, 5 species of wadingbirds, all of which are considered priority conservation species in South Carolina, were recorded within the rookery in this wetland. Also, 2 Great Blue Heron (*Ardea herodias*) nests were constructed in large pines bordering a small, open, isolated wetland on "Goat Island" in spring 2010. No wading bird nesting activity had been observed in association with this wetland prior to the eradication of many large Chinese tallowtrees that had dominated the perimeter of this and other wetlands.

Habitat restoration and enhancement efforts on North Williman Island—particularly on "Goat Island"—and on "Big South Williman Island" yielded varied positive ecological impacts. The gradual recovery of habitats and plant communities should continue well into the future throughout North Williman Island hammocks on which habitat restoration and enhancement activities were conducted under this and the complementary Cooperative Agreement. Particularly for "Goat Island", where the most intensive habitat enhancement efforts were made and where feral goats had drastically impacted nearly all habitats by over-browsing, native plant communities and associated wildlife should continue to show positive responses well into the future. However, since seeds of Chinese tallowtree are very resilient within the seed-bank and can also be transported by birds and by water, future herbicide control of this aggressively invasive plant on hammocks of North Williman Island may be necessary to prevent recolonization by Chinese tallowtree. Because of the positive results of efforts on hammocks of North Williman Island, serious consideration should be given to the expansion of Chinese tallowtree eradication throughout the hammocks of South Williman Island, where many isolated freshwater wetlands remained heavily colonized by Chinese tallowtree at the end of this project in 2010.

Status and Management Plan Development for Three Rare Burrowing Crayfish, *Distocambarus youngineri*, *D. hunteri*, and *Cambarus reflexus* (Federal Grant #: T-20, Duration: 2006-2007) PI: Jennifer Price (formerly SCDNR); Author: Jim Bulak, SCDNR

The purpose of this study was to create habitat models for 3 species of crayfish of conservation concern in South Carolina - *Distocambarus youngineri*, *D. hunteri*, and *Cambarus reflexus*. For the two species of *Distocambarus*, soils data were used to predict occurrence sites. The developed habitat model was a significant predictor of *D. youngineri* occurrence. This species was found in Piedmont prairie habitat. Future management efforts should focus on acquiring property with prairie or savanna-like vegetation structure in the Piedmont. Perhaps due to a severe drought during the collection period, *D. hunteri* was not collected during the study. Future efforts should use genetic techniques to verify collections of *D. hunteri*; its status of "critically imperiled" is appropriate.

Cambarus reflexus habitat was modeled at the Webb Wildlife Center, Palachucola Wildlife Management Area (WMA), and Hamilton Ridge WMA. Model selection indicated that the presence of wiregrass (*Aristida* sp.) was the most important habitat component, indicating *C. reflexus* was associated with high quality, fire-maintained, pine savanna habitats in the Coastal

Plain. The species appears to be limited to the Coastal Plain and sensitive to soil surface disturbances. Management should focus on maintaining remnant pine savanna stands with prescribed burns to help maintain this species.

Controlling Access to Known and Potential Bat Roosts (Federal Grant #: T-23-R-1 F06AF00025, Duration: 2006-2011) PI and Author: Mary Bunch, SCDNR

Human disturbance is a very significant threat to bat colonies. Disturbance can be in the form of recreational caving, mining, or exclusions or disruptions to natural or man-made roosts. This project sought to protect some important bat roosts from human disturbance and to find new bat colonies. When awarded funding in 2006, White-nose Syndrome (WNS), a disease of hibernating bats, had not yet been discovered.

We assessed known roosts for suitability to bat-friendly gating or other measures to reduce disturbance. Sites with priority species from South Carolina's Comprehensive Wildlife Conservation Strategy (CWCS), the Rafinesque's big-eared bat (*Corynorhinus rafinesquii*), Southeastern myotis (*Myotis austroriparius*), and small-footed myotis (*Myotis leibii*) were given highest priority, but other bat species would also benefit from the work. We partnered with the US Forest Service and The Nature Conservancy to erect 6 bat-friendly gates at 5 locations, and modified an existing barricade to allow bat passage at another site. We also sought to place a bat-friendly cupola on an open shaft to a tunnel, but lacked sufficient funds for such a large project. We planned to erect a fence (site was not suited to gating) around the state's largest southeastern bat colony, but state parks declined the fence because they didn't want to maintain a fence. We mapped 338 potential mine sites and 17 old wells. All of the wells and 54 of the mine sites were evaluated. None of the wells were good bat habitat. Many of the old mine sites had no underground structure but we did locate 8 mine adits with tri-colored bats (*Perimyotis subflavus*). Of those, 5 would be suitable for gating.

Concrete bat roosts were built at 4 locations to serve as alternate roosts for Rafinesque's big-eared bats where known roosts were imperiled or limited. Other bats will also use the structures. Currently, all of those new roosts are in use by bats. After dramatic WNS related mortality was noted in other colonial hibernating bats typical to our mountains, we provided bat boxes to 3 state parks with known vulnerable colonies (threatened by exclusion), with great success at one of the parks.

Fish Passage on the Broad River: An Assessment of the Benefits to Freshwater Mussels (Federal Grant #: T-24, Duration: 2006-2008) PI: Jennifer Price (formerly SCDNR); Author: Jim Bulak, SCDNR

The objective of this work was to determine the effects of a newly constructed fish passage facility on the Broad River in Columbia, SC to freshwater mussel populations. Surveys were conducted on the Broad River, upstream of the dam, and on the Broad and Congaree Rivers, downstream of the dam. Nine species of mussels were downstream of the dam and 4 species were observed in upstream areas to Parr Reservoir. The Broad River upstream of Parr Reservoir contained sparse populations of mussels, possibly due to habitat degradation associated with sedimentation. Efforts were made to collect gravid females and determine the seasonality of

reproduction of the various mussel species. Peak reproduction and release of glochidia generally occurred in April through June, though this general trend exhibited variability among the various species. Fish host evaluation was conducted for 6 species of mussels - *Ligumia nasuta*, *Elliptio roanokensis*, *Lampsilis cariosa*, *Lampsilis radiata*, and *Elliptio congarea*. Results suggest that the fish lift will benefit mussel populations upstream of the dam (to Parr Reservoir) as increased passage of glochidia-carrying fishes from the more species rich areas downstream of the dam should increase colonization potential. Continued monitoring is recommended.

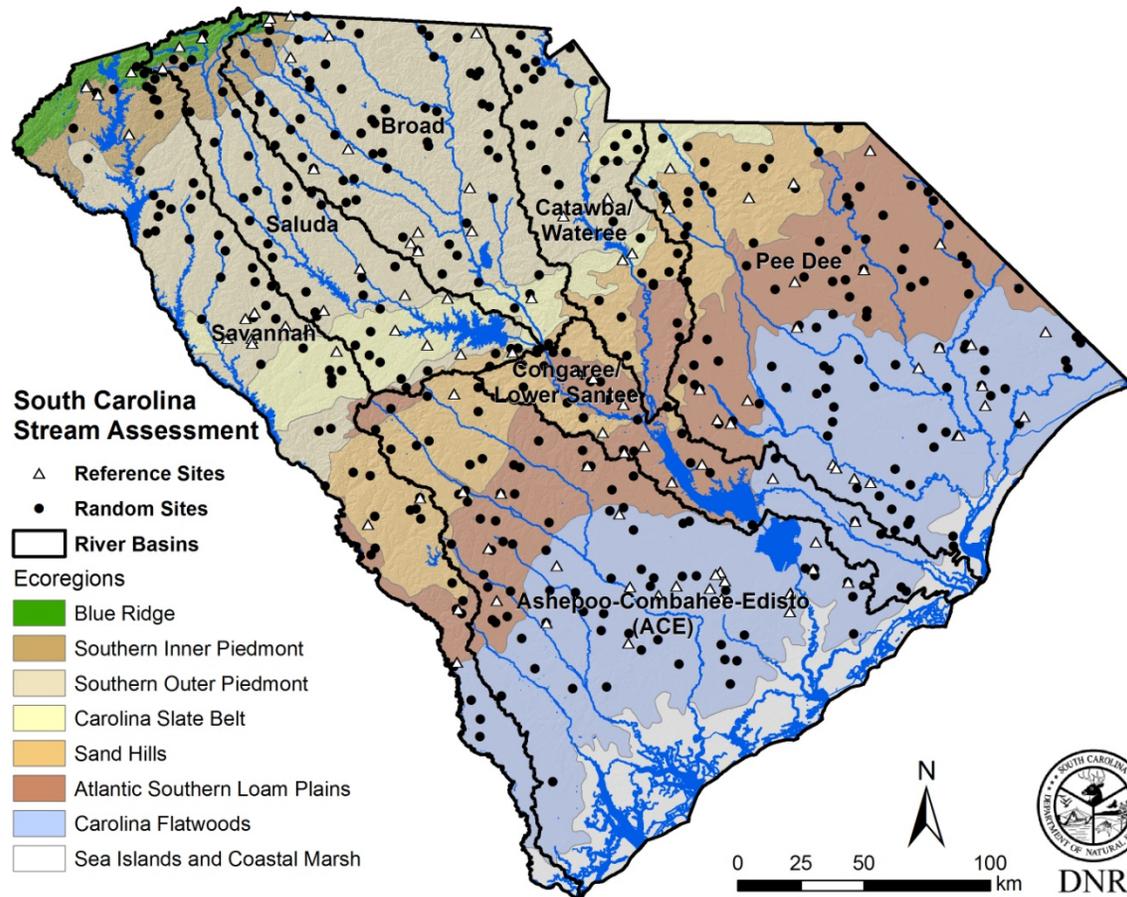
South Carolina Stream Conservation Planning Project [SC Stream Assessment] (Federal Grant #: T-25-R-1 F06AF00027 [formerly T-8], Duration: 2006-2013) PI and Author: Mark Scott, SCDNR; Map created by Kevin Kubach, SCDNR

The objective of this project was to conduct an assessment of wadeable streams to gather appropriate data that will allow SCDNR to design effective and efficient management strategies to protect, conserve, and restore the aquatic resources of the State. Freshwater species worldwide face accelerated extinction rates relative to most other wildlife taxa. The Southeastern US, in particular, has been suffering long-term declines in native species of fish and aquatic invertebrates. SC SWAP species of concern number well over 100 fish, reptiles, amphibians, mussels, crayfish, and snails that are directly dependent on aquatic systems for most or all of their life-stages. Common threats appear in their species accounts, generally associated with pollution from point- and non-point sources. Reversing the decline of native aquatic species requires an understanding of factors that are critical for maintenance of suitable habitat capable of supporting sensitive taxa. It follows that we must also understand the threats that degrade the quality of aquatic habitats to the point where they no longer support vulnerable species. The South Carolina Stream Assessment was designed to provide information to fill these gaps.

Watersheds of appropriate size (4 km² to 150 km²) were sampling units stratified by unique combinations of ecoregion and major river basin in the state, called "ecobasins". Two methods of watershed selection were employed. The first method established long-term annual monitoring of least-impacted, or reference, watersheds, identified by biologists familiar with the region. This method is intended to provide expected resource condition as well as range due to temporal variability. The second method employed random selection of watersheds within ecobasin strata to allow statistically defensible estimates of statewide resource parameters from the sample data. Data collection was identical in both sampling designs, occurring at two spatial scales:

- *Watershed* – Point-sources as measured by NPDES permits; non-point sources as measured by appropriate land use/land cover classes in entire basin and within riparian buffer, hydrological disruption as measured by impounded area or occurrence of dams.
- *Stream Reach* – Selected measures of channel geomorphology and flow characteristics, water quality, and vertebrate and invertebrate community structure.

The Stream Assessment project ran from 2006 to 2013, with the data collection phase completed in 5 years and resulting in nearly 700 samples, each of which has over 200 associated variables that reside in an Oracle database titled StreamWeb. Estimates of stream resource condition have been calculated and mapped, and a number of publications and presentations have been produced to communicate various aspects of these data and results.



Habitat Improvement for Grassland Birds (Federal Grant #: T-27-R-1, Duration: 2006-2012)
 PI: Tim Ivey; Author: Brett M. Moule, SCDNR

The goal of this project was to improve grassland bird habitat on Oak Lea Wildlife Management Areas (WMA), Bland Tract WMA, and Toumey Tract WMA by developing and implementing various management strategies (e.g. burning, mowing, disking; creating fallow buffers and fallow fields; establishing longleaf pine and native grasses) and monitoring bird population responses. Over the course of the grant period, 496 acres were winter disked to improve brood rearing and songbird habitat. In order to improve native grass habitat, 1,247 acres were burned while 2,095 acres were disked, fertilized, and planted to enhance forage for dove, quail, and migratory songbirds. Fallow buffer areas totaling 410 acres were maintained. Soft mast seedlings (6,200) and hardwood mast trees (400) were planted.

Fall quail covey counts were conducted on Oak Lea WMA, Bland Tract WMA, and Toumey Tract WMA in either October or November each year. Survey points were established on all 3 tracts, and summer quail and songbird surveys were conducted in July. These call counts were continued annually to monitor the impacts of management activities on quail and grassland birds. Dove banding was conducted each year as part of the Eastern Management Unit project. Quail

banding occurred the first year with walk-in trap sites to monitor impacts of hunting on the population.

Taxonomy, Life History, and Distribution of the Crayfish, *Procambarus echinatus* (Federal Grant #: T-30-R, Duration: 2007-2008) PI: William Poly (formerly SCDNR); Author: Jim Bulak, SCDNR

The goals of this project were to examine the distribution, abundance, life history, and taxonomic status of the Edisto crayfish (*Procambarus echinatus*), a crayfish species of conservation concern. Surveys were made in the Salkehatchie, Edisto, Ashepoo, and Coosawhatchie River drainages. Detailed, quantitative sampling was conducted at 3 specific sites within these drainages. Collections indicated that *P.echinatus* was common in the study area, suggesting the perceived rarity of the species was associated with limited sampling for crayfish in these systems. The habitat for this species was undercut banks with root masses and accumulations of leafy debris in areas of good flow. Collections indicated that a new, distinct species, similar to *P.echinatus*, may be found in the South Edisto River and its tributaries as there was a substantial difference in the size of the structure of reproducing adults. This species was found in similar habitat to *P.echinatus*. Some concern exists that continued population expansion in Aiken County could impact the South Fork Edisto River crayfish. Additional monitoring of this perceived new species is recommended.

Assessing Introgressive Hybridization Within and Habitat Requirements of Native South Carolina Redeye Bass (Federal Grant #: T-31-R, Duration: 2007-2012) PI and Author: Jean Leitner, SCDNR

A survey was conducted to assess genetic impacts of Alabama Bass (*Micropterus henshalli*) introductions to Redeye Bass (*M. coosae*) in the Savannah Basin. Analysis was completed for N=669 Black Bass collected in 2004, and N=632 black bass collected in 2010 from reservoir sites on Lakes Russell, Hartwell, Keowee and Jocassee. Species composition was compared, and showed a precipitous decline in Redeye Bass collected from 2004 to 2010. Our 2004 survey indicated redeye bass had been virtually eliminated from Lakes Keowee and Russell, where they comprised 0% and 2% of black bass collected, respectively. Collections in 2010 show little change in Redeye Bass proportions from these two lakes, but a decline is evident in Lakes Hartwell (from 26% to 8%) and Jocassee (from 39% to 14%). Hybrids between the two species were prevalent in collections and ranged across years/reservoirs from 26% to 54% of black bass collected. Proportions of hybrids increased from 2004–2010 on all but Lake Russell.

Genetic analysis of black bass collected from Savannah basin tributaries in 2009 and 2010 confirmed non-natives and/or hybrids from 5 of 9 collection sites, and from at least one tributary associated with each of 3 reservoirs. Three of these collections represent new documentation of Alabama Spotted Bass hybrids, as we collected only native black bass from those sites in 2004. The potential for the spread of Alabama Spotted Bass and their hybrids from the reservoirs to additional tributary populations is indicated. A new incidence of the non-native Smallmouth Bass (*M. dolomieu*) and their hybrids was documented in the Savannah River, as was the presence of an extant Redeye Bass population throughout the Enoree River in the Santee drainage.

A GIS database was developed that includes all Savannah and Santee basin black bass collections associated with this study (2004–present), all Savannah and Santee Basin South Carolina DNR stream team collections made within the range of Redeye Bass (2008–present), and all historic South Carolina stream database collections that include record of Redeye Bass (1962–2002). The spatial distribution of tributary collections that included hybrids between Alabama Bass and Redeye Bass provides important information with respect to the spread of non-native black bass alleles in the Savannah Basin. Tributary populations where hybrids have been collected were those in closest geographic proximity to the reservoirs, within which non-native alleles are already widespread. Our results indicate that the spread of Alabama Bass alleles into the sampled tributary populations is the result of upstream movement from the reservoirs.

New genetic assays for the mtDNA locus ND2 were successfully developed. ND2 is one of 4 loci used to differentiate the species of black bass found, or having genetic influence in South Carolina populations. Previously, sequencing of all loci was necessary to classify individual fish as a particular species or hybrid. Primers were designed for haplotypes specific for Largemouth Bass (*M. salmoides*), Florida Bass (*M. floridanus*), Alabama Bass, Redeye Bass, and Smallmouth Bass. These new assays provide a new tool, less expensive and time consuming than sequencing, for the evaluation of hybridization among black bass in South Carolina.

In an effort to assess the status of Redeye Bass in the Santee drainage as native or introduced, species of minnow were collected from sites within the Santee, Tennessee (French Broad), and Savannah River drainages. Genetic divergence among drainages, and diversity within drainages, was compared to that for Redeye bass in the Savannah and Santee drainages. The Santee population of Redeye Bass is not genetically differentiated from populations collected throughout the upper Savannah River drainage. In contrast, Saffron and Warpaint Shiner populations collected in the Savannah and Santee drainages are significantly differentiated from each other. Pair-wise comparisons between individuals sampled from these 2 drainages, for 2 loci, were significantly differentiated. Results indicate that the Santee Basin Redeye Bass populations evaluated here are the result of a more recent, and likely human-mediated, introduction of fish originating from the Savannah Basin.

Restoring Seabird Nesting on Bird Key Stono Seabird Sanctuary (Federal Grant #: T-32-T-1, Duration: 2007-2008) PI and Author: Felicia Sanders, SCDNR

Bird Key Stono Seabird Sanctuary is an estuarine sandbar that provides nesting, roosting, and foraging habitat for a variety of seabirds and shorebirds. From the late 1980s–1994, it was the largest Brown Pelican rookery in North America. Isolated sand islands, such as Bird Key, make ideal nesting habitat due to the lack of mammalian predators such as raccoons. Bird Key was designated as a Seabird Sanctuary in March 2006 because of its importance as a seabird nesting island and because seabirds were declining probably due to human disturbance. The “sanctuary” status limited human disturbance on the island. This project used social attraction to decoy seabirds to Bird Key in efforts to increase the number of birds nesting on the island. Social attraction is a combination of decoys and a sound system. The sound system is a solar-powered audio system which continuously plays the calls of nesting seabirds.

Unpainted 122 Royal Tern, 52 Black Skimmer, and 32 Least Tern decoys were purchased and shipped to Huntington State Park. Horry County school children painted the decoys as part of an educational program about seabirds. At the beginning of the nesting season, Least Tern decoys were spaced approximately 1 m apart on Bird Key. Black Skimmer decoys were placed approximately 2 m apart in 2 separate flocks of 26 decoys each. Royal Terns were placed approximately ½ m apart in one colony. The sound system was placed near the Royal Tern decoys. The sound system constantly played Black Skimmer, Least Tern, and Royal Tern calls. Five days after placing decoys on the island, approximately 40 Black Skimmers were roosting with and courting the decoys. Royal Terns and Least Terns were observed roosting with their decoys. The seabirds were mostly unsuccessful due to depredation by a Great Horned Owl although they nested on Bird Key in low numbers. These decoys were used in other projects to attract nesting seabirds and continued to be part of an educational program for school groups.

Robust Redhorse Electrofishing and Radio Telemetry Tracking of the Great Pee Dee River, SC (Federal Grant #: T-33-R-1 F07AF00062, Duration: 2007-2012) PIs: Ross Self, SCDNR and Elizabeth Osier (formerly with SCDNR); Author: Robert Stroud, SCDNR

In late April and early May of 2008, SCDNR Freshwater Fisheries Region 2 personnel met with NCWRC, Progress Energy, Duke Energy, South Carolina Aquarium, and North Carolina Natural History Museum personnel to sample the Great Pee Dee River in NC by electrofishing for spawning Robust Redhorse. Twenty-three Robust Redhorse were collected between 22 April and 8 May 2008, of which 7 were recaptures from previous years, 2 were within year recaptures, and 14 were newly collected fish. All fish were PIT tagged and 10 had new radio tags surgically implanted. The fish ranged from 576 to 766 mm with a weight range of 2,630 to 8,450 grams. All fish were adult and many were ready to spawn.

In October 2008, boat electrofishing was conducted for two days on the Pee Dee River focusing below the South Carolina state line. One Robust Redhorse was collected. In late April and early May of 2009, the survey was conducted above the South Carolina state line using boat electrofishing. The areas targeted were known Robust Redhorse spawning grounds and locations where radio telemetered fish were detected. Twenty Robust Redhorse were collected between 20 April and 7 May 2009, of which 8 individuals were newly collected fish. All fish were PIT tagged and 10 had new radio tags surgically implanted. The fish ranged from 594 to 740 mm with a weight range of 2,986 to 6,660 grams. All fish were adult and many were ready to spawn.

Spring electrofishing for Robust Redhorse was not conducted in the Pee Dee River during or after October 1, 2009. At the September 2009 annual meeting of the Yadkin-Pee Dee Technical Working Group of the Robust Redhorse Conservation Committee, it was decided that spring electrofishing would be suspended for 4 to 5 years until minimum flows are established at the Blewitt Falls Hydroelectric Facility.

SCDNR Freshwater Fisheries personnel participated in radio telemetry tracking of previously tagged Robust Redhorse in the Great Pee Dee River in October, November, and December 2007; February 2008; March, April, July and August 2010; and March 2011. In 18 days of tracking during the grant period, 6 different fish were located a total of 22 times in the SC portion of the Great Pee Dee River. Habitat ranged from open channel to along the riverbank, and always in

association with submerged woody debris. Region 2's participation in tracking was not required from March 2008 through July 2009 due to a NC State graduate student having been funded by Progress Energy for the work. Radio telemetry tracking was not performed during 2012 due to the expected expiration of transmitter battery life.

Identification of Diamondback Terrapin Habitats in South Carolina (Federal Grant #: T-35, Duration: 2009-2010) PIs: Erin Levesque (SCDNR), David Whitaker (SCDNR), and Elizabeth Broyles (CofC graduate student); Author: Elizabeth Broyles, College of Charleston

Very little is known about the current population number, sex ratio, and distribution of diamondback terrapin populations in Charleston, South Carolina estuaries. Terrapins were caught in the Ashley River, and population estimates were calculated using mark and recapture techniques and analyzed using the MARK program. Population size was estimated to be 3060 with a 95 % confidence interval of 1,964-4,156. This gives around 179-378 terrapins per km² of marsh habitat. The sex ratio was 1.7:1 male biased ($p < 0.001$). Investigations into changes in land usage were used to reveal reasons for change in terrapin abundance in the watersheds of the Ashley River, the Wando River, and the Charleston Harbor from 1995-2009. The number of terrapins caught at all Wando River sites combined significantly decreased during the study period ($r = 0.83$, $p < 0.001$). There has been approximately 12.9 km² (10% of 127.72 km²) of land use change in the Wando River watershed from 1996-2006. Diamondback terrapin abundance, estimated via catch per unit effort, has remained constant for most of the Ashley River and Charleston Harbor areas. Land use change has been minimal ($\leq 2\%$) in both of these watersheds during the same time frame. The Wando River, on the other hand, had a significant decline in terrapin catch per unit of effort (CPUE) and also had a much greater amount (10%) of land use change. Land use can encroach on terrapin habitats and nesting sites as well as impact food and foraging areas. If the declining trend of the terrapin population in the Wando River continues, regulatory intervention may need to be considered. This information on population size, sex ratios, and distribution can be used as a baseline to track long-term changes in terrapin populations. This project produced a Master's thesis entitled, "Diamondback Terrapins (*Malaclemys terrapin*) of Charleston, South Carolina: Population Estimate, Sex Ratios, and Distribution."

A GIS Model to Guide Landscape-scale Restoration at the Woodbury Tract and Hamilton Ridge Properties (Federal Grant #: T-36-HM, Duration: 2008-2010) PI: Steve Bennett, SCDNR (retired); Author: Will Dillman, SCDNR

The purpose of this investigation was to create a GIS-based model of pre-fire excluded landscape patch dynamics and hydrologic change for the Woodberry Tract and Hamilton Ridge properties. At the time of this project, these two properties were recent acquisitions by the SCDNR. Land use histories varied for both properties but included a variety of industrial forestry practices. In developing a Conservation Plan for these properties, the hopes were to (1) restore important ecological processes to the landscape (e.g. fire), and (2) provide habitat structures needed to maximize conservation benefits while using the species composition of the current industrial forest.

The use of GIS and a selection of historical aerial photography of the sites allowed identification of reference forest conditions, and the ability to identify likely locations where remnant fire-maintained landscapes most recently occurred. We were also able to create a GIS coverage identifying former isolated wetlands and a GIS coverage identifying changes in hydrology related to road construction and ditching at the Woodberry Tract and Hamilton Ridge properties. Indices were created to quantify mechanical degradation to the wetland area, provide measures of ecological integrity, and to measure the restoration potential of each wetland, based on time since degradation and current habitat structure, relative to other isolated wetlands in the study area.

Carolina Herp Atlas (Federal Grant #: T-37-T, Duration: 2008-2010) PI: Steve Bennett, SCDNR (retired); Author: Will Dillman, SCDNR

The objective of this project was to develop the Carolina Herp Atlas (CHA) (www.carolinaherpatlas.org) and to provide detailed locality data on the reptiles and amphibians of the Carolinas, in particular those species whose distribution and status are poorly known. The CHA was officially launched in March 2007. Prior to the launch, the Davidson College Herpetology Lab imported approximately 3,900 records, primarily from Mecklenburg, Iredell, and Cabarrus counties in the western Piedmont of North Carolina. From March 2007 through 16 November 2010, the CHA totaled 839 registered users, 91 of which identified South Carolina as their home residence. The CHA received 4,930 reptile and amphibian records from South Carolina. Of the 5,008 records, 912 were accompanied by a voucher photograph and/or given a status of 10. A total of 122 South Carolina reptile and amphibian species have at least 1 record in the CHA. Thus far, the CHA has collected species-level distribution data on 151 species of amphibians and reptiles, including the occurrence of 32 anurans, 29 salamanders, 37 snakes, 11 lizards, 14 turtles, and the American alligator.

The CHA has thus far been a highly successful, citizen science-based project to document the distribution of reptiles and amphibians in South Carolina. The collection of 4,930 reptile and amphibian records in South Carolina (and 16,958 total records submitted from both South and North Carolina) during the first 3.5 years suggests that the CHA has the potential to surpass many other citizen science-based herpetological atlas projects. For example, the Georgia Herp Atlas collected a total of 7,452 records during the 5 years of operation. Thus far, the CHA represents a significant step towards the development of a better understanding of the distributions of reptiles and amphibians in the Carolinas. An overriding goal of the CHA is to promote conservation and understanding of reptiles and amphibians in South Carolina. The interactive nature of the CHA appears to appeal to a wide variety of people, including school teachers, professional herpetologists, and those generally interested in wildlife.

Mink Restoration and Monitoring Development Project (Federal Grant #: T-38-R, Duration 2007-2012) PI and Author Jay Butfiloski, SCDNR

The goal of this project was to develop a monitoring program that would minimize staff time and effort by establishing alternative methods of mink survey techniques to be used to monitor the success of mink restoration along the coast of South Carolina. Track boards appeared to have the most promise as the boards could be set out and checked at a later date using one person.

However, many of the same issues that previously plagued track board work such as tidal fluctuations, wave action, and other environmental factors hampered track board implementation. Once again, track boards were dismissed as a feasible tool in this instance. Previous mink survey work depended on spotlight surveys that required significant high tides occurring a few times per year. The exact heights of these tides were undetermined as to which would be sufficiently high enough for survey work, often leading to poor surveys and wasted manpower. Thus, emphasis was placed on perfecting spotlight surveys in an effort to evaluate which environmental factors were most significant in surveying mink. The project determined that tide heights 6.05 ft. above Mean Lower Low Water (MLLW) level as measured at the Charleston station and adjusted for local areas was the best predictor for when to use spotlight surveys.

During the course of this study, two family groups of mink (5 total) were relocated into the Hog Inlet portion in the northernmost coastal march in the State. This area was the last remaining significant portion of coastal marsh where mink had not been reintroduced. Moving captured mink to this marsh would be the last location along the coast where mink needed to be reintroduced to complete mink reintroduction that was begun in the late 1990s. However, during the course of this project, mink depredation in the original mink restoration site of Cape Romain National Wildlife Refuge (CRNWR) became a concern for refuge staff. As the reintroduced mink into CRNWR began to thrive, concerns from staff at the refuge centered on the impacts mink may be having on nesting shorebirds. Therefore, much of the emphasis of this project became the assessment of reintroduced mink impacts in the original reintroduction site.

A total of 9 mink were implanted with transmitters to assess impacts their activity may be having with other species. Radioed mink did not venture far from initial capture sites and most of their activity appeared to be tide dependent. In addition, diet analysis from mink taken from the CRNWR in an effort to increase shorebird nesting success found that out of 45 mink stomachs collected, 7.4 % contained avian material of unknown species. A bioenergetics model developed from this estimated that an individual mink would consume 8.5 avian prey items per month based on the sampled diet. It is still undetermined to what extent mink predation is affecting shorebird success at CRNWR, as other predators and mortality factors still plague nesting efforts on the refuge.

Prescribed Burning Crew for SC Department of Natural Resources Lands (Federal Grant #: T-39-M-1 F08AF0008, Duration: 2008-2013) PI and Author: Tim Ivey, SCDNR

The objective of this grant was to facilitate and increase prescribed burning on Wildlife Management Areas and Heritage Preserves for wildlife habitat enhancement. SCDNR contracted with the South Carolina Forestry Commission to perform the fire management activities of the grant. During 2009, growing season prescribe burning was conducted on 8 DNR properties. A total of 3,830 acres were prescribe burned and 49.25 miles of firelanes were disced. During 2010, dormant and growing season prescribe burning was conducted on 18 DNR properties. A total of 10,312 acres were prescribe burned and 81.15 miles of firelanes were disced. During 2011, dormant and growing season prescribe burning was conducted on 23 DNR properties. A total of 7,906 acres were prescribe burned and 120.9 miles of firelanes were disced. During

2012, dormant and growing season prescribe burning was conducted on 19 DNR properties. A total of 6,322 acres were prescribe burned and 44.65 miles of firelanes were disced.

Conservation of Belfast Plantation, Phase I (Federal Grant #: T-40-L, Duration: 2008-2009)
Author: Emily Cope [*T-50-L is Phase II and is covered by this synopsis.*]

SCDNR utilized \$1,188,654 from the USFWS (of which \$1,063,654 was Wildlife Restoration funding and \$125,000 was State Wildlife Grant funds) to acquire the southern half of the Belfast Tract totaling 2,436 acres (also known as Belfast Phase II). The total land acquisition cost for Phase II was \$7,710,440. This completes the Belfast acquisition project by protecting a total of 4,664 acres. The Belfast Tract has long been managed to support a diverse range of wildlife species. The hardwood drains, creeks, and beaver ponds support waterfowl management objectives. In addition, the age-class diversity of the pine stands provides valuable wildlife habitat. The property supports excellent populations of deer and turkey, and the uplands provide excellent habitat for Bobwhite Quail. Improved timber thinning and a more aggressive prescribed burning regime will increase the already existing quail population. This will expand the ongoing efforts on the nearby Sumter National Forest to increase the Piedmont quail population. Mudlick Creek, the beaver ponds, and the man-made pond provide many fishing opportunities for sunfish and bass.

The property provides habitat for many priority bird species such as Acadian Flycatcher, American Woodcock, Great Blue Heron, Kentucky Warbler, Little Blue Heron, Louisiana Waterthrush, Rusty Blackbird, Wood Duck, Wood Thrush, and Yellow-crowned Night Heron. The wetlands associated with the river corridor and its tributaries provide habitat for many reptiles and amphibians including but not limited to the black swamp snake, common snapping turtle, and yellow-belly turtle. Little River, which traverses the Belfast Tract and is the Southern boundary for Phase I, is comprised of Carolina Slatebelt geology. This specific geology is known to be associated with the federally-endangered mussel, the Carolina heelsplitter. While initial survey work has not detected the heelsplitter on the Belfast Tract, it has been located in the nearby area. Further survey work could find the heelsplitter on the tract or the tract may also serve as a restoration/reintroduction area for the species. In addition, several rare species of burrowing crayfish have been found in nearby areas.

Use of GIS to Assess the Demographic Isolation of Red-Cockaded Woodpecker Groups in SC (Federal Grant # T-42-R-1, Duration: 2008-2009) PI: Jason Craig and Drew Lanham (Clemson University); Author: Derrell Shipes, SCDNR

This project was sub-contracted to Clemson University. Jason B. Craig (graduate student) and Dr. J. Drew Lanham were the Principal Investigators and Ralph Costa and Dr. Robert Baldwin were collaborators. Eight km (5 mi.) and 25 km (15.5 mi.) radius circles were drawn around known active and inactive Red-Cockaded Woodpecker (RCW) cluster locations in SC in an effort to determine the occurrence of Demographically Isolated Groups (DIGs). These analyses concluded that there are 20 isolated clusters using 8 km (6 active, 14 inactive) and 3 isolated clusters using 25 km (1 active, 2 inactive). Habitat evaluation associated with isolated and non-isolated clusters was conducted. The concept of "isolation" and the location of isolated clusters are essential to the future management of this endangered species. It may be necessary to

relocate isolated birds to larger populations in order for the relocated birds to reproduce and contribute genetically. There is a tendency for isolated clusters with small numbers of birds to “blink out”.

Least Tern Reproductive Success on Roof-tops (Federal Grant # T-44-R-1, Duration: 2008-2010) PI: Felicia Sanders, SCDNR; Author: Mary Catherine Martin, SCDNR

Nesting of Least Terns (*Sternula antillarum*) on flat, gravel-covered roofs was followed at colony sites in Georgetown and Horry Counties in coastal South Carolina. Colony success and failure were documented. Incubation duration was determined at 5 roof colony sites by encasing temperature data loggers in clay eggs. Successful colonies were characterized by incubation temperatures at a constant range except for periods of heavy rainfall, while unsuccessful colonies had incubation temperatures with cooling ranges of 14-20°C (57-68°F) that occurred at night with repeated nest abandonment attributed to possible predators. Movements of fledged Least Terns were tracked by attaching radio transmitters to the legs of the young. Injuries resulted from the transmitter attachments complicating methods of this part of the study. A very limited number of fledged Least Terns were tracked and results were inconclusive. An assessment of fish samples found at colony sites indicated that the more inland the site, the more freshwater fish species present. In addition, observations indicated that adults and fledged young foraged at sites within a 5-10 km (3-6 mi.) radius from the colony site. Inland storm water retention ponds have become a valuable foraging site for Least Terns. Finally, eggs from colony sites were tested for heavy metal contaminants usually found in storm water retention ponds. No contaminants were present in amounts detrimental to hatching or the development of young.

American Shad Culture and Stocking in the Edisto River (Federal Grant #: T-45-R-1, Duration: 2008-2011) PI and Authors: Bill Post and Chad Holbrook, SCDNR

Historically, the Edisto River in SC had one of the State's larger American Shad fisheries. Overfishing between the 1940s to 1980s led to a dramatic decline in shad landings and decreased abundance over time. These declines led to added restrictions to the shad fishery beginning in 1998. More recently, in an effort to augment wild production, South Carolina Department of Natural Resources (SCDNR) and the United States Fish and Wildlife Service (USFWS) formed a partnership to create a hatchery program. Over a 4-year period (2008-2011), the feasibility of on-river broodfish collections, hatchery production, young-of-year relative abundance, annual hatchery contribution, movements of adult American Shad, genetic analysis of stock enhancement, and genetic uniqueness were evaluated for the Edisto River population. Collecting broodfish using electro-fishing gear proved to be successful with 347 adult American Shad caught over 3 years of sampling. Of the 347 collected fish, 235 have been used as broodfish; 92 had fin clip samples taken, were implanted with acoustic tags, and returned to the river; and the remaining 20 had fin clip samples taken and were returned to the river.

Collection efficiency of adult American Shad improved each year allowing us to increase the number of broodfish used each year as well as balancing the male/female ratio (2009 N=63; M 51, F 12; 2010 N=75; M 48, F 27; and 2011 N=97; M 57, F 36). Annual egg production has been variable and variability was independent of the number of females collected (2009 – 205,238; 2010 – 600,987; and 2011 – 184,677). From 2009-2011 a total of 39,688 fry were released,

ranging from a high in 2010 of 22,209 to a low in 2011 of 4,836. Out-migrating young-of-the-year American Shad were successfully sampled with electrofishing gear in 2010 (601) and 2011 (1,291).

All collected fish were kept to determine hatchery contribution via OTC detection and genetic detection using microsatellite markers. Detection rates for hatchery fish varied between the two methods with OTC indicating a hatchery contribution of 6.8% in 2010 and 0.3% in 2011, while genetic testing indicated a hatchery contribution of 3.6% in 2010 and 0.0% in 2011.

Additionally, this project provided the opportunity to generate baseline genetic data which had not previously been determined for this stock, finding that genetic diversity for the Edisto River American Shad population is high. An initial evaluation of our stocking program detected no difference in genetic composition between the broodstock and field collections in any of our production years ($p > 0.692$), indicating the appropriateness of our broodstock collection process in minimizing potential negative impacts of stocking on the wild population. However, significant spatial genetic differentiation was detected between the Santee River and Edisto River ($X^2 = \infty$, $p = 0.000$). Therefore, broodstock for stock enhancement purposes in the Edisto River should originate only from the Edisto River itself.

Our study was a comprehensive look at the potential of using responsible stock enhancement as an effective management tool. Broodfish collections and hatchery production was a success; however we hope to improve fry/egg ratio with more experience. Telemetry results were somewhat inconclusive; however, it did appear mature shad were congregating in areas near Givhans Ferry State Park around river mile 60. Young-of-the-year collections improved throughout the study and were efficient in 2010 and 2011. Although contribution was relatively low, we were able to detect hatchery individuals in the Edisto River population prior to out-migration. The results of this project, along with future work, will provide valuable information which can be incorporated into management plans to aid in the recovery of this important species in the Edisto River in South Carolina.

Conservation of Breeding Painted Buntings and Other Songbird Indicators in Early-Successional Shrub-Scrub Habitat (Federal Grant #: T-47-R-1 F08AF00109, Duration: 2008-2011) PI: Derrell Shipps, SCDNR; Author: Mary Catherine Martin, SCDNR

Objectives of this study were to determine: (1) abundance of breeding Painted Buntings (*Passerina ciris*) and other indicator songbird species in paired CP-33 and non-CP-33 fields; (2) nest location and success of Painted Buntings in paired CP-33 and non-CP-33 fields; and (3) a landscape/GAP analysis model which tracks seasonal crop rotation and predicts a pattern of habitat occupancy and breeding distribution of Painted Buntings and other early-successional shrub-scrub songbird species. CP-33 is a conservation program established by the Department of Agriculture to provide habitat for upland birds through landowner incentives to plant native grass buffers along row crop field margins.

Eight fields of 4 CP-33 and 4 non-CP-33 were study sites. In each field, habitat types were classified as agriculture, forest, CP-33 border, and cut (recently cut forest area). To determine the abundance of Painted Buntings, 3 survey types were utilized: spot maps, transect counts, and

telemetry. The results of each type of survey indicated more Painted Buntings and other species were found in mature (≥ 10 years of growth) forest edges than in any other habitat, and there was no difference in species abundance between CP-33 and non-CP-33 fields. In addition, vegetation data gathered per protocols developed by the Breeding Biology Research and Monitoring Database (BBIRD) in the forested edges of agricultural fields, in the CP-33 strips, and in the crop fields indicated that wheat is preferred forage by Painted Buntings. Second, 3 types of fields (paired CP-33, non-CP-33, and a field managed for doves) were searched for Painted Bunting nests. Twenty-two nest sites were found in forest edge habitat, and none were found in the CP-33 and dove field habitats.

Finally, a landscape/GAP analysis map was created from the data obtained in the spot map, transect count, and radiotelemetry surveys. Results of the landscape/GAP analysis map indicated high priority habitats as: 25 m or less from the edge of mature forest; CP-33 strips, wheat fields, and early growth forests (≤ 10 years of growth) for foraging; and use of CP-33 strips, all agricultural fields, and early growth forests by Painted Buntings was limited to the edges of these habitats. Based on the completion of the study objectives, recommendations for Painted Bunting conservation in central rural South Carolina are: (1) mature forest edge habitat is essential; (2) painted buntings prefer to occupy and nest in the outermost edges of forests and/or thin forest strips (25 m or less from the edge); and (3) a source of food in the form of a wheat field or other grass seed as well as a source of insects when rearing young is necessary.

Effects of Predation on Seabird Nests in Cape Romain (Federal Grant # T-48-R, Duration: 2009-2010) PI and Author: Felicia Sanders, SCDNR

The goal of this project was to monitor seabird nesting in Cape Romain National Wildlife Refuge to guide management that can benefit seabird species nesting at natural sites. Nesting chronology, reproductive success, and causes of colony abandonment and nest loss were documented for Least Terns and Black Skimmers in 2009-2010. Although species of conservation concern, little is known about the reproductive success of Least Terns and Black Skimmers throughout the Southeastern US.

Nest monitoring occurred at Raccoon Key, Lighthouse Island, Middle White Banks, and Cape Island. Each island was checked every 2-7 days depending upon weather and logistical constraints. Least Tern and Black Skimmer nests were randomly selected across all 4 study sites. Nests were marked by wooden stakes 0.5 m from the nest scrape. Eggs were floated to estimate initiation date. At each visit, researchers recorded the number and condition of eggs or young and when possible, and determined the cause of failure by visual observation. Chick survival was determined at select sites by banding 1-2 day-old chicks with a unique, 2-color leg band combination. Researchers conducted re-sighting surveys every 2-4 days for Least Terns until no fledglings were observed. To determine the minimal survival of Black Skimmer chicks, an island-wide fledgling count was conducted at the end of the season.

Peak nesting for Least Terns occurred from mid-May to mid-June and for Black Skimmers in mid-June. Predation and over-wash were the primary cause of nest failure based on visual cues at or near the nest. Collectively, these ecological stressors attributed to 65% of nest loss for Least Terns and Black Skimmers. Video cameras installed at colonies documented disturbance to

colonies by Black Vulture, American mink, and Great Horned Owl. Of the 60 Least Tern chicks monitored, 13 (22%) were re-sighted at ≥ 17 days post hatch. Of the 52 Black Skimmer chicks monitored, 22 (42%) were re-sighted at ≥ 28 days post hatch. Nest success of Least Terns and Black Skimmers within CRNWR was variable among colonies and between years, suggesting that factors at the local level influenced reproductive success. Management techniques within the study area directed toward predator control to decrease nest loss of near-shore seabirds and shorebirds needs to focus on both the avian and mammalian predators identified in this study in order to be effective.

Conservation of Belfast Plantation, Phase II (Federal Grant #: T-50-L, Duration: 2009-2010)-
See synopsis under T-40-L.

Ecology and Impacts of Coyotes on Loggerhead Sea Turtles, Least Terns, and Other Wildlife: Implications for Management (Federal Grant #: T-51-R-1 F09AF00159, Duration: 2009-2011) PI and Author: Jamie Dozier, SCDNR

Control of abundant mammalian predators is a common element of management programs aimed at increasing reproductive and recruitment success of many threatened ground-nesting turtle and bird species. Recent colonization of coyotes (*Canis latrans*) in South Carolina, however, is changing traditional community dynamics governing and impacting wildlife populations in coastal and barrier island systems. Coyotes have become a major nest predator on federally threatened loggerhead sea turtles (*Caretta caretta*) having devastating impacts on nest survival. For example, in 2009 on the Tom Yawkey Wildlife Center Heritage Preserve (TYWCHP) in Georgetown, South Carolina, extensive coyote depredation on turtle nests was documented with over 50% (21 of 40 nests; 1,208 eggs) of loggerhead sea turtle nests either completely or partially destroyed. The purpose of this project was to attempt to understand coyote ecology and impacts at the TYWCHP as it relates to loggerhead sea turtle and least tern nesting success. A major portion of the study attempted to examine coyote home range, habitat use, and diet composition on the island complex.

A total of 8 coyotes were trapped and fitted with radio-transmitters during the study period. Unfortunately, a combination of equipment failure and extreme difficulty in locating collared coyotes provided a low sample size of locations and data unreliable to support any reasonable estimations of coyote home range, movements, or habitat use on TYWCHP. Over 400 coyote scat samples were collected during the study periods on TYWCHP; 370 samples were usable for analysis. A total of 234 scats were collected on Cat Island and 136 on South Island. *Sigmodon* spp. were the most common food item found in Cat Island scats, followed by birds, vegetation, and *Peromyscus* spp. Birds were the most common item found in South Island samples, followed by *Sigmodon* spp., vegetation, and *Neotoma* spp. Cat Island samples comprised a larger percent of scats containing wild hog, lagomorphs, *Diospyros* spp., and soricomorphs, while South Island samples contained more birds, crabs, *Mephitis mephitis* (striped skunk), and mustelids. There was a significant difference between coyote diet on the two islands ($A = 0.0090$, $p < 0.0001$). Test results yielded significant indicator values for three animal groups and one plant genus (birds, lagomorphs, wild hogs and *Ilex* spp.). Although birds were a component of coyote diets, samples did not provide enough evidence to determine which species of birds or age class.

Observation of Least Tern nesting colonies did not reveal coyote presence during the study period.

An additional component added to the project was the question of coyote impacts on mesopredators, in particularly raccoons, in suppressing depredation/predation on prey items. Three experiments were conducted to examine coyote-raccoon interactions: 1) space use of radio-collared raccoons (10-18) to test avoidance of coyote urine, 2) avoidance of captured raccoons (8) in enclosures to coyote scat, and 3) avoidance of free-ranging raccoons to monitored feeding sites containing coyote scat. Summary results of all 3 experiments revealed that raccoons did not avoid areas where coyote presence was artificially induced; therefore, this suggested that the threat of coyotes was not a deterrent in raccoon use of areas in space and time. From a management perspective, the most significant finding was from a companion study conducted on TYWCHP during the same time period as this study revealing that selective trapping of coyotes and beach night patrols significantly reduced coyote depredation of sea turtle nests from 52% in 2009 to 15% in 2010.

Monitoring Impacts of Yellow Pine Restoration on Avifauna in the SC Mountains (Federal Grant #: T-54-R-1 F10AF00443, Duration: 2010-2013) PIs: Curtis Walker, M.S. and J. Drew Lanham, PhD [Clemson University]; Author: Mark Hall, SCDNR

Note: The thesis name of this project is *Avian Community Response to Prescribed Fire in Yellow Pine Stands in the Jocassee Gorges Region of South Carolina*.

Comparisons of avian communities were made between the burned treatment sites and reference control sites to examine community and priority species response to prescribed fire in the Jocassee Gorges in the mountains of SC. To assess the impacts of fire disturbance management on the avian community, 10-minute, 50 m radius point counts were conducted in treatment and control plots during the spring breeding seasons of 2011 and 2012. Values of species diversity, richness, and total number of individuals were found to be significantly higher in the burned treatment plots than in the control plots as a result of differences in structural complexity and the distribution of resources. The occurrence of focal species, as well as other species, was found to vary between sites. Species associated with early-successional and more open habitats—such as Eastern Wood-Pewees and Indigo Buntings—were observed more often in burned sites, while species requiring shrubbery and broad-leaved foliage on which to forage—such as Black-throated Green and Hooded Warblers—were observed more often in control sites. Models created using structural vegetation data identified characteristics of vegetation and landform that were found to be useful in predicting the occurrence of 6 of the 7 priority species at Jocassee. Differences in the occurrence of nesting and foraging guilds were related to differences in complexity of habitat structure and composition. This research suggests that fire management can be a useful tool to create wider variation across the landscape, providing increased opportunities for nesting and foraging resources for an array of bird species.

Using Citizen Science in the Study and Conservation of Breeding Painted Buntings (Federal Grant #: T-55-R-1 F10AF00444, Duration: 2010-2012) PIs: John Gerwin, NCNMS; Author: Derrell Shipes, SCDNR

This project was sub-contracted to Dr. John A. Gerwin of the North Carolina Museum of Natural Sciences in Raleigh, North Carolina. Collaborators included Dr. Jamie Rotenberg of the University of North Carolina – Wilmington and Laurel Barnhill formerly of SCDNR, now USFWS, Athens, Georgia.

Painted Buntings (PABU) were banded at 45 sites during 135 banding sessions across NC/SC including 15 in NC, 15 in Coastal SC, and 15 in “interior” SC. Birds were banded with a unique USFWS aluminum band on one leg and a unique combination of 3 plastic color bands on the other leg. Age, sex, and breeding condition was determined and recorded. An internet-based reporting system for reporting of sighted birds was developed, and reporters were recruited using workshops, short newspaper articles, word of mouth and through the website. Volunteers were encouraged to report sightings of birds—banded and un-banded—to the website. A total of 1,379 PABUs (454 females, 395 males, 231 unknown) were captured and banded in South Carolina. Following banding, 34,705 reports of PABUs—banded and un-banded—were received at the website. Researchers found that PABUs appear to survive an average of 5-6 years and appear to exhibit philopatry. They did not find an over-abundance of Brown-headed Cowbirds at the feeder sites or in agricultural areas nearby. Habitat preference, management guidelines, and productivity information is contained in the larger report of the project.

Decision Support Tools for Stream Conservation (Federal Grant #: T-61 F12AF01417, Duration: 2012-2013) PI and Author: Mark Scott, SCDNR

Identifying and communicating the relationships between natural gradients, human activities, and aquatic habitat integrity is crucial to aquatic conservation. The South Carolina Department of Natural Resources (SCDNR), in conjunction with Clemson University, has developed a novel, web-based South Carolina Stream Conservation Planning Tool that enables a spatially explicit understanding of how human activities affect the biological condition of wadeable streams. This is intended to support decisions about aquatic conservation actions. The web mapping application communicates findings from the South Carolina Stream Assessment (SCSA) to a broad audience, allowing users to visualize predicted biological conditions based on their status and severity across all South Carolina wadeable stream catchments. Additionally, an interactive catchment management tool allows users to explore and forecast the impacts of customized land management scenarios on aquatic resource indicators at any user-specified location across South Carolina, and so engages users in the process of modeling and forecasting stream conditions.

We selected stream condition metrics from over 200 measurements taken at approximately 700 streams locations sampled during the SCSA from 2006 to 2011. Metrics were related to spatial predictor data created under the National Fish Habitat Assessment. We generated prediction models using the Random Forest machine-learning technique from the sample data, and applied the predictions to the entire population of wadeable stream reaches in the State. The mapping application provides users with a browser-based interface to modify predictors at the catchment (local) scale. A web service dynamically generates predictions based on these user inputs, and results are mapped at watershed (network) scales to display cumulative effects of the changes. The dynamic execution of models broadens the utility of the application and opens the forecasting process to a non-technical audience. By providing an accessible means of forecasting the effects of management decisions, the tool encourages a watershed perspective towards

aquatic conservation. The application is targeted to stakeholders at the policy making and conservation planning levels. The approach described has been set up for South Carolina but is applicable to assessment programs at the regional and national levels.