Southeast Amphibian Research & Monitoring Initiative
2005 Annual Report

Barking Treefrog (*Hyla gratiosa*), Harris Neck NWR, May 2005

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Overview of Southeast ARMI Accomplishments in 2005

Inventory and Monitoring:

- Completed drift fence study at St Marks NWR, data analysis and preparation of manuscript currently underway.
- Completion of inventory at Harris Neck and Savannah NWRs
- Transition from drift fence upland sampling to wetland sampling at St Marks and Lower Suwannee NWRs
- Initiation of new inventory efforts at St Vincent NWR and Ordway Preserve

Research:

- Completed preliminary analysis of tadpole disease at fish hatcheries
- Conducted an analysis of effectiveness of seven aquatic sampling methods
- Initiation of research project on population demography of siren and amphiuma

Publications:

- Produced a new field guide: Tadpoles of Southeastern United States Coastal Plain
- Outreach materials produced in collaboration with Hannah Hamilton:

  Southeast ARMI factsheet

  2006 Reptile and Amphibian Downloadable Desktop Calendar
- 20 scientific papers and book chapters
- 11 oral and 5 poster presentations at meetings and invited presentations

Introduction

Amphibian Declines

At the First World Congress of Herpetology in 1989, participants presented scientific papers and exchanged personal accounts of amphibian declines and disappearances. Based on the magnitude and geographic extent of documented declines and local extinctions of amphibian populations, the herpetologists concluded that amphibian declines represented a potential global environmental crisis. Research conducted by many scientists since the meeting has shown a variety of factors have contributed to the global amphibian decline, including acid precipitation, environmental contaminants, introduction of nonindigenous predators, disease agents, parasites, ultraviolet radiation, and unsustainable harvest and trade of amphibians. Habitat loss has been and continues to be a major factor contributing to declines and extinctions.

In the United States, amphibian declines of unknown origin were first reported on Puerto Rico and in the western states, where many populations tend to be small and isolated. In addition, malformed amphibians were observed in high numbers in the upper Midwest, Great Lakes region, and northern New England. Declines in the southeastern U.S. have been linked directly to habitat loss. Although all regions of the U.S. are not affected to the same degree, the scope of declines and malformations suggests vigilance is needed throughout the Nation to ensure the conservation of amphibian populations.

USGS Amphibian Research and Monitoring Initiative (ARMI)

In 1998 an international meeting of herpetologists convened by the National Science Foundation concluded that significant amphibian declines have occurred in protected areas not subjected to obvious changes in habitat, such as National Parks, National Wildlife Refuges, and wilderness areas. In 2000, the President of the United States and the Congress directed the Department of the Interior (DOI) agencies to develop a plan to initiate monitoring of trends in amphibian populations on DOI lands and conduct research into causes of declines. The DOI has stewardship responsibilities over vast land holdings in the US, much of which is occupied by or is potential habitat for amphibians. The U.S. Geological Survey (USGS), the science and research bureau for

DOI, was given lead responsibility for planning and organizing this program, named the Amphibian Research and Monitoring Initiative (ARMI), in cooperation with the National Park Service, US Fish and Wildlife Service (USFWS), and Bureau of Land Management. USGS is uniquely qualified to develop and provide scientific leadership for such an effort. It has a long history of employing research scientists who have pioneered studies on amphibian life history, sampling techniques, toxicology, and health-related issues, and it has responsibility for many natural resource monitoring programs at regional, national, and continental scales.

ARMI Objectives

1) Establish a network designed to monitor the status and changes in the distributions and abundance of amphibian species and communities in the United States.

2) Identify and monitor environmental conditions known to affect amphibians and document their differences across the Nation.

3) Conduct research that identifies causes of amphibian population change and malformations.

4) Provide information to managers, policy makers and the general public in support of amphibian conservation.

ARMI Framework

Studies by USGS scientists will concentrate on DOI and other federal lands, but ARMI will provide the framework for incorporating data collected on non-federal lands to encourage participation by states, universities, and non-governmental organizations. The framework can be conceptualized as a pyramid, with extensive and necessarily coarse measurements at many monitoring sites across the country (the base of the pyramid), mid-level efforts at a moderate number of sites to provide a regional perspective on the status of amphibians (the middle portions of the pyramid), and intensive research efforts at a relatively small number of index sites throughout the

country (the top of the pyramid). Activities at the different levels of the framework are integrated by:

- Research on causes of change, which at all levels is guided by monitoring results
- Synthesis across ecological regions, scientific disciplines, and governmental and institutional boundaries
- Comparable protocols, analytical tools, training, and planning
- Common databases and reporting
- Ecological modeling

Monitoring efforts, the primary focus of ARMI, are conducted at all levels of the pyramid, but there is an emphasis at the middle level. Monitoring conducted at this level of the pyramid is carried out at mid-level monitoring areas, such as National Wildlife Refuges. Monitoring studies are designed to detect change in occurrence and abundance of species across the mid-level monitoring areas. There is an emphasis on estimating well-defined parameters using statistical approaches that are applicable across species, monitoring areas, and ARMI regions. One such approach is to use detection/non-detection data to estimate a population level parameter, proportion of area occupied (PAO), on a species by species basis, as well as a community level parameter, species richness.

The Southeast ARMI (SEARMI) Program

For the purposes of the ARMI program implementation, the United States is divided into seven blocks of States that are the focus of regional herpetological investigations. The Southeast Region encompasses the states of Florida, Georgia, Alabama, Tennessee, South Carolina, and North Carolina, as well as Puerto Rico and the U.S. Virgin Islands, an area approximately 1300 x 1660 kilometers (800 x 1000 linear miles), excluding the Caribbean territories. Within this area, DOI land holdings are numerous, ranging in size from “postage stamp” historical sites to extremely large ecosystem-wide parks and preserves. Most lands are administered by the National Park Service and the U.S. Fish and Wildlife Service; the Bureau of Land Management has

certain responsibilities for oversight in coal mining areas (such as in northern Alabama), but there are no land holdings. SEARMI research and monitoring efforts are conducted from the Center for Aquatic Resource Studies of the Florida Integrated Science Center, Gainesville, Florida. Additional ARMI related research has been conducted by USGS biologists with the Miami-based Center for Water and Restoration Studies, although they have not received ARMI funding.

The southeastern U.S. far exceeds any other region of the Nation in the diversity and abundance of amphibians. With at least 144 species of amphibians, it has well over half of all the species known from the U.S. Habitat diversity is likewise great, ranging from the high mountain peaks of the Great Smoky Mountains, to the humid forested lowlands of the coastal plain, and to the vast marshes of South Florida. Southeastern amphibians have diverse life histories, from aquatic salamanders that never leave the water and a great variety of salamanders and frogs that spend portions of their life cycle in both aquatic and terrestrial environments, to terrestrial salamanders that never enter the water. Some species are widespread and abundant, whereas others are rare, localized, and highly vulnerable to extirpation.

As in other regions, SEARMI monitors amphibians based on a three-tiered approach involving sites with intensive research (apex sites), sites that form the basic areas for the core of monitoring activities (mid-level sites), and sites where inventories are conducted (base sites). With few exceptions, federal lands in the southeast have not been surveyed for amphibians or their habitats, thus requiring inventories before proceeding to more intensive study. For this reason, most current research focuses on mid-level and base sites. Another emphasis has been on the development of appropriate sampling techniques and in understanding the biases associated with their use. Information from SEARMI's inventory and monitoring program (data collected from the mid-level and apex sampling sites) will be used to assess the status of amphibians on DOI lands using PAO analyses. By making probabilistic arguments, PAO uses an estimation of site occupancy rate to measure species detection probabilities. More information on PAO appears in the scientific literature. SEARMI biologists are collecting extensive data on species and their habitats that will allow for an assessment of distribution patterns and trends, and the initiation of research on declines or problem areas should they be

identified. Finally, we are developing partnerships and collecting data on amphibian distribution, available literature, and the extent of previous amphibian surveys on DOI lands.

Sampling Methods

Amphibian Sampling

Most species of amphibians of the southeastern U. S. coastal plain region breed in wetlands (e.g., ponds, streams, lakes), we focused our 2005 sampling in aquatic habitats to inventory amphibian species richness, identify appropriate sites for long-term monitoring, and determine the distribution of breeding sites. Focusing long-term amphibian monitoring at wetlands will allow us to maximize species detection probabilities and identify important covariates (e.g., pH, fish predators) influencing detection and proportion of area occupied. We used a variety of methods to sample amphibians at each refuge (Table 1). Terrestrial sampling techniques included field searches (i.e., visual encounter surveys) for animals in the open and under cover objects (e.g., logs, rocks) and road cruises (i.e., making opportunistic observations while driving roads, typically at night). Aquatic sampling consisted of the use of dip nets (Memphis Net and Twine Co., HDD-2 with 3/16" sq. Delta mesh), crayfish traps (Johnson and Barichivich, 2004), aural surveys (incidental observations and using automated frog-call data loggers, Barichivich, 2003), and visual encounter observations.

Water Quality Data

We collected standard abiotic field parameters likely to influence amphibian species distribution at most of the wetlands sampled. Using a Hydrolab® Quanta® water-quality meter we measured water temperature (ºC), conductivity (mS/cm), pH, dissolved oxygen (mg/l), and % dissolved oxygen. More detailed water quality parameters were measured at selected wetlands in St Marks NWR by USGS Water Resources Discipline (WRD) personnel in Aug 2005. Field parameters, major ions, nutrients, trace metals, and suspended/particulate organic carbon from these sites were analyzed by WRD.

Voucher Specimens and Disease Monitoring

We collected limited numbers of animals for voucher specimens, to confirm species identification, and for disease screening. Many voucher specimens were collected as dead-on-road (DOR) individuals, and turtle shells were collected when found. Because of difficulty in positively identifying amphibian eggs and small larvae,

live specimens were occasionally collected and reared at the USGS lab in Gainesville, FL, to confirm species identifications. These specimens were preserved as vouchers once identifications were confirmed. All voucher specimens were (or will be) deposited in the herpetology collection of the Florida Museum of Natural History at the University of Florida, Gainesville.

We collected amphibian larvae at several wetlands at St Marks, Harris Neck, and Savannah NWRs for disease screening by the National Wildlife Health Center. We also collected amphibian larvae from several sites in Florida where die-off events were observed, including the Withlacoochee State Forest and the Katharine Ordway Preserve – Swisher Memorial Sanctuary.

Inventory and Monitoring Activities: St Marks National Wildlife Refuge

Background

Located in Florida's panhandle approximately 25 km south of Tallahassee (Fig. 1), St. Marks National Wildlife Refuge (SMNWR) encompasses 27,500 hectares of diverse upland and wetland habitats (Fig 1). Established in 1931 to provide wintering habitat for migratory birds, SMNWR extends along the Gulf coast in Taylor, Jefferson, and Wakulla Counties (Fig. 2A). For management purposes the refuge is divided into three major units. The easternmost of these, the St. Marks Unit, is generally bounded by the Aucilla River to the east and by the Wakulla and St. Marks Rivers to the west. The Wakulla Unit runs west from the Wakulla and St. Marks Rivers to Spring Creek Hwy (CR 365). The westernmost section, the Panacea Unit, extends west from Spring Creek Hwy to the Ochlockonee River and Ochlockonee Bay.

SMNWR has a diversity of upland and wetland habitats which potentially support 40 species of amphibians (21 frogs and 19 salamanders) and 68 species of reptiles (13 lizards, 34 snakes, 20 turtles, and one crocodilian). The Flatwoods Salamander (*Ambystoma cingulatum*), a federally threatened species, has been documented from many sites on SMNWR. In the late 1970's, data on presence of amphibians and reptiles were collected by the USFWS during a study which quantified the relationships among forestry management practices and diversity and abundance of non-game wildlife (USFWS, 1980). This previous study included 14 upland drift fence arrays which were monitored for 2 years, although some of the arrays were not as extensively monitored during the second year. SEARMI research at SMNWR began in May 2002.

Effort in 2005

ARMI made three visits to SMNWR in 2005: 14-21 Feb, 2-8 Jun, and 24-30 Aug (Table 2). We visited a total of 40 wetland sites (Tables 3, 4, 5). Our Water Resources Division collaborator, Brian Hughes (USGS WRD), collected water samples during our Aug visit to SMNWR.

Results

We have detected a total of 80 species of amphibians and reptiles at SMNWR through Dec 2005 (Tables 4, 5). This includes captures and observations made with all of the methods used, including incidental observations of animals on roads. The 31 species of amphibians were comprised of 20 frog and 11 salamander species. The 48 species of reptiles were comprised of 10 lizard, 27 snake, one crocodilian, and 11 turtle species (Table 4). Our detection rate of species previously unrecorded in our sampling has decreased, indicating we have probably recorded most species for this refuge we are likely to capture using our sampling techniques (Figs. 3, 4). We detected 17 frog and four salamander species among the 40 wetlands sampled during 2005 (Table 5). The most commonly encountered species were *Acris gryllus*, *Hyla femoralis*, and *Rana sphenocephala*.

Water Quality Data

In Aug 2005 we assisted USGS WRD personnel in the collection and field processing of water samples from 16 sites. Sampling was concentrated in the Panacea Unit and was co-located with amphibian monitoring sites (Table 3). Field parameters (pH, conductance, dissolved oxygen, temperature), major ions, nutrients, trace metals (including mercury), and suspended/particulate organic carbon were analyzed from all sites. To view WRD water quality data for this refuge from 2005, please see the USGS NWISWeb Data site, which can be found at the USGS Water Resources home page (http://waterdata.usgs.gov/fl/nwis/qw). For more information on WRD water quality results contact Brian Hughes, Southeast Regional Hydrologic Research Coordinator for ARMI (US Geological Survey, 3039 Amwiler Road, Atlanta, GA 30360; Phone: 770-903-9162; E-mail: wbhughes@usgs.gov).

We collected water-quality field parameters (pH, conductance, dissolved oxygen, temperature) at 39 ponds sampled in 2005 (Table 6). We measured these parameters at 17 of the ponds more than once. These wetland sites varied from small isolated wetlands to large lakes. Several sites were overwashed by storm surge during Hurricane Dennis. Values for pH were acidic, with a mean among all samples of 4.46 and range from 3.51 to 7.39. Conductivity was generally low, only exceeding 1.06 mS/cm at six sites which

were apparently subjected to hurricane overwash. Dissolved oxygen (DO, mg/l) and % DO varied considerably, ranging from 0.23 mg/l and 2 % to 13.1 mg/l and 131%. Water temperatures ranged from 9 ºC to 35 ºC (Table 6).

Disease monitoring

During our survey activities at SMNWR we looked for diseased or malformed amphibians (Table 7). One Oak Toad (*Bufo quercicus*) was collected which appeared to have an abnormal patch of skin on its dorsum. No other animals exhibiting malformations or obvious disease symptoms were observed during 2005. In Jun and Aug of 2005, we submitted apparently healthy amphibian larvae for disease screening from Perkinsus Pond, a site in which a previous tadpole die-off was observed in 2002. The results of the analysis of these specimens are still pending. During 2005 SMNWR personnel and volunteers participated in a USFWS survey of amphibian disease and malformation. We assisted in this survey when possible by providing information on collection sites and species identification.

Future Plans

ARMI has received a USGS Bureau Venture Capital Fund grant to study the effects of saltwater overwash from hurricane storm surge at SMNWR. We plan to visit at least 30 sites approximately every six weeks to collect amphibian and water chemistry data. Our goal for this study is to determine what effects the salt water overwash of Hurricane Dennis had on amphibian species richness and abundance, to evaluate the change in salinity of wetlands over time, and to monitor the potential recovery of amphibians at sites affected by overwash. In addition, we will begin repeated collections of tadpoles for disease analysis from at least five sites (including Perkinsus Pond) during at least three visits each year to lead to a establish more complete dataset on the dynamics of disease occurrence on this refuge.

SMNWR supports a relatively large population (at least 44 breeding sites) of the federally threatened Flatwoods Salamander (*Ambystoma cingulatum*). Management recommendations for *A. cingulatum* include burning of uplands with growing season fires and increasing the herbaceous edge vegetation around breeding ponds. Beginning in

2006 ARMI will assist managers at SMNWR in evaluating the effects of management activities on *A. cingulatum* populations. ARMI will begin by evaluating larval habitat use in ponds to determine the extent to which *A. cingulatum* larvae use the sawgrass interior of ponds relative to the herbaceous edge area. Potential future research includes evaluation of upland habitat use by juvenile and adult *A. cingulatum*.

Our drift fence arrays will be left in place but will remain closed during completion of the analysis collected thus far. Long-term drift fence data is valuable, but funding and personnel constraints prevent ARMI from adequately sampling these fences every year. Thus the drift fences may be monitored on a 5-7 year cycle to build a long-term dataset without having to monitor the fences every year.

Inventory and Monitoring Activities: Lower Suwannee National Wildlife Refuge

Background

Located along Florida's Big Bend region on the Gulf of Mexico, approximately 80 km WSW of Gainesville (Fig. 1), Lower Suwannee National Wildlife Refuge (LSNWR) encompasses approximately 21,425 hectares of upland and wetland habitats (Fig. 2B). Established in 1979 to preserve unique coastal, flood plain, and upland ecosystems at the lower reach of the Suwannee River, the refuge stretches 42 km north to south in Levy and Dixie Counties. The refuge includes lands along both banks of the Suwannee River from Yellow Jacket landing southwest to the Gulf of Mexico. The Dixie Co. portion extends north along the coast to Shired Island. The main Levy Co. portion runs south along the coast almost to the mouth of Ericson Creek. The Shell Mound Unit of LSNWR is just south of Ericson Creek and adjacent to Cedar Keys National Wildlife Refuge (administered and managed by LSNWR staff). Cedar Keys NWR is a complex of 13 islands (approx. 310 hectares) around the municipality of Cedar Key and was established in 1929 as a refuge for colonial wading birds.

LSNWR protects a diversity of aquatic and upland habitats including floodplain forest, salt marsh, hardwood swamp, cypress swamp, cabbage palm hammock, sandhill, scrub, and pine flatwoods. This refuge potentially supports 37 species of amphibians (21 frogs and 16 salamanders) and 66 species of reptiles (one crocodilian, one amphisbaenid, 15 lizards, 34 snakes, and 15 freshwater turtles). Historical information on the herpetofauna of the refuge is scant. Florida Museum of Natural History records included voucher specimens for only 18 species (three amphibians and 15 reptiles) from the refuge proper, most of which dated from the 1970's or earlier. SEARMI research began at LSNWR in May 2002.

Effort in 2005

ARMI made three visits to Lower Suwannee NWR in 2005: 31 Jan-4 Feb, 25-29 Apr, and 8-12 Aug (Table 2). We visited a total of 30 wetland sites (Tables 3, 4, 5).

Results

We have detected a total of 61 species of amphibians and reptiles at LSNWR through Dec 2005. This includes captures and observations made with all of the methods used. The 23 species of amphibian were comprised of 19 frog and four salamander species. The 38 species of reptiles were comprised of eight lizard, 18 snake, one crocodilian, and 11 turtle species (Table 4). Our detection rate of species previously unrecorded in our sampling has decreased, indicating we have probably recorded most species for this refuge we are likely to capture using our sampling techniques (Figs. 3, 4). We detected 12 frog species and three salamander species among the 30 wetlands sampled during 2005 (Table 5). The most commonly detected species were *Rana sphenocephala*, *R. clamitans*, and *Acris gryllus.*

Water Quality Data

We collected water-quality field parameters (pH, conductance, dissolved oxygen, temperature) at 30 ponds sampled in 2005 (Table 6). We measured these parameters at 6 ponds on two visits. Values for pH were less acidic than at SMNWR, with a range from 3.38 to 7.42 and a mean among all samples of 5.91. Conductivity was generally low, less than 0.57 mS/cm at all sites. Dissolved oxygen (DO, mg/l) and % DO varied considerably, ranging from 0.64 mg/l and 7.5% to 8.4 mg/l and 93.1%. Water temperatures ranged from 16.9 ºC to 26.1 ºC (Table 7).

Future Plans

ARMI will continue to monitor amphibians at LSNWR with the goal of continuing to expand into more wetland sites. Our drift fence arrays will be left in place but will remain closed during completion of the analysis of the data collected thus far. Long-term drift fence data is valuable, but funding and personnel constraints prevent ARMI from adequately sampling these fences every year. Thus these fences may be monitored on a 5-7 year cycle to build a long-term dataset without having to monitor the fences every year. Our treefrog PVC arrays will be removed in 2005-2006.

Inventory and Monitoring Activities: Savannah and Harris Neck National Wildlife Refuges (Savannah Coastal Refuges complex)

Harris Neck:

Harris Neck NWR (HNNWR) is located ca. 46 km south of Savannah and 31 km north of Darien, in McIntosh Co., Georgia (Fig. 1). The refuge comprises 1,255 hectares of mostly coastal deciduous and oak woodlands, grasslands, former cropland, and some pine (Fig. 2C) and is surrounded by salt marshes and tidal creeks, limiting amphibian colonization. Harris Neck has a long history of human occupation (Amerindian, with plantations prior to the Civil War, a series of many small farms in the late 1800's-early 1900's, an airfield, a military base during World War II [Harris Neck Air Base], and under the ownership and management of several county, state, and federal government agencies after the war; see Sullivan, 1997) which certainly affected herpetofaunal species richness and distribution as a result of extensive habitat modification. Harris Neck became a National Wildlife Refuge in 1962, and is managed primarily for waterfowl and wading birds, including the wood stork. Nearly all the wetlands at Harris Neck are either man-made impoundments, modified former tidal creeks, or ditches and borrow pits.

HNNWR supports 13 amphibians (11 species of frogs and one species of salamander) and at least 17 species of reptiles (one crocodilian, five lizards, seven snakes, and four freshwater turtles). It is likely that additional reptile species, particularly snakes, occur on the refuge. Historical information on the herpetofauna of HNNWR is apparently nonexistent, as we have been unable to locate any museum specimens from the refuge. SEARMI research began at Harris Neck in April 2004.

Savannah NWR

Savannah National Wildlife Refuge (SNWR) (Fig. 1) comprises 11,320 hectares in Georgia and South Carolina immediately upstream along the Savannah River from the city of Savannah (Fig. 2D). As with Harris Neck, it is part of the Savannah Coastal Refuges Complex. The refuge has an extensive history of human occupation and use, from Amerindian through the plantation era, when the bottomlands and freshwater tidal marshes were extensively diked and modified for rice production (constructed from the

mid to late 1700's). Designated in 1927, the refuge is primarily managed for waterfowl, and water levels within the former rice fields (1,364 hectares) are carefully controlled. The refuge occasionally clears vegetation from the impounded areas, resulting in a variety of marsh habitats of different depths, vegetation structure, and species composition.

The northern part of the refuge (upstream from the freshwater tidal marshes) consists mostly of extensive islands of bottomland hardwoods (cypress, gum, maple) that may or may not be periodically flooded. These islands contain creeks and an extensive number of woodland pools and channels which hold water for varying amounts of time. There is only one large pond on the refuge (Kingfisher Pond, =DT2, an old borrow pit) not associated with the bottomlands. River bluffs and upland terraces on the refuge are few, as the refuge boundary often terminates at the base of the river bluff. However, some uplands and slope are present along Dodge Tram Road on the north side of the river, and more extensive upland and swamp habitats are found on the south side of the river east of O'Leary (as marked on the USGS 7.5' Port Wentworth topographical map). This area, the Solomon Tract, and is one of the most recent additions to SVNWR. This is also the location for sampling in connection with the USFWS malformed frog survey.

To date, 21 species of amphibians (15 species of frogs and six species of salamanders) and at least 11 species of reptiles (one crocodilian, two lizards, five snakes, and three turtles) have been reported from SVNWR. Undoubtedly, many more species will be found as sampling continues, especially among the reptiles. We are currently examining historical information on the herpetofauna of the refuge, as well as the field notes from early collectors. SEARMI research began at Savannah National Wildlife Refuge in April 2004.

Effort in 2005

ARMI made three visits to Harris Neck and Savannah NWRs in 2005: 21-25 Mar, 16-22 May, and 25-29 Jul (Table 2).

Results

Harris Neck NWR

We have detected 13 species of amphibians (12 frogs, one salamander) through the end of July 2005 (Fig 3). *Hyla gratiosa* was added this year, at Leopard Frog Pond (=Borrow Pit Pond). A total of 15 wetland sites was examined in March, 12 in May, and nine in July. Three new wetland sites were identified: Church Ditch (along main road across from Friendship Baptist Church); Goose Meadow (adjacent to the dirt road along the southeast side of Goose Pond); and Snake Bog (a seepage boggy habitat along the main road near Friendship Baptist Church). Church Ditch only held water after heavy rains in March, and *Pseudacris ocularis* was heard calling from its margins. Goose Meadow is an extensive shallow water area, but it only holds water after extensive rains. *Bufo terrestris* bred successfully there in March in large numbers. Water remained in May, but no tadpoles were seen; by July, the area was dry. Snake Bog had choruses of *P. ocularis, Hyla femoralis, H. cinerea*, and *Acris gryllus* during night surveys in May, but no tadpoles were seen. On 17 May, two small venomous snakes (*Agkistrodon contortrix* and *Crotalus horridus*) were seen on the way into this site from the road, hence our tentative name for this site.

Night surveys on the paved roads were conducted several times during our stays on the refuge. Amphibians are particularly abundant after heavy rains, and many species can be detected calling; all wetland sites at Harris Neck can be visited within 2 hrs. As a result, we found several species (e.g. *Bufo terrestris, Hyla cinerea*) distributed essentially everywhere on the refuge. Detailed field notes from CKD are provided from all 3 visits (see Appendix VI).

Savannah NWR

We have detected 22 species of amphibians (15 frogs; seven salamanders) through 2005, with *Eurycea quadridigitata* being added this year on the river bluffs along Dodge Tram Road in South Carolina (DT-4, 24 Mar) (Fig 3). In 2005, we sampled ten sites (four wetland, six terrestrial) in Mar; 15 sites in May (11 wetland, four terrestrial), including additional sites on Bear Island; and nine sites in July (five wetland, four terrestrial). The most amphibian species-rich wetland continues to be Kingfisher

Pond (DT-2), and this year we observed huge numbers of *Rana heckscheri* tadpoles at this site in late Jul (662 tadpoles in four traps on 28 July; 470 the next day). Tadpoles of this species form large schools, and we easily observed a large number of tadpoles gulping air as we set and picked up our traps. The rice fields are depauperate in species, although biomass is undoubtedly quite high. These are the only areas where *Siren lacertina* and *Amphiuma means* are found. Bear Island was rather dry during our visit, and only a few individuals were heard calling (see field notes).

In March, we were joined by Steve Bennett of the South Carolina Department of Natural Resources, who collected *Desmognathus auriculatus* for genetic studies from a few sites along Dodge Tram Road. Preliminary evidence suggests that this may represent a new species of lowland dusky salamander. Detailed field notes from CKD are provided from all 3 visits (see Appendix VI).

Water Quality Data

Harris Neck NWR

We collected water-quality field parameters (pH, conductance, dissolved oxygen, temperature) at 12 ponds sampled in 2005 (Table 6). We measured these parameters at 10 ponds on more than one visit. Values for pH were generally acidic, with a range from 3.92 to 8.65 and a mean among all samples of 5.95. Conductivity was generally low, less than 0.397 mS/cm at all sites. Dissolved oxygen (DO, mg/l) and % DO varied considerably, ranging from 0.11 mg/l and 1.4% to 14.87 mg/l and 159%. Water temperatures ranged from 13.8 ºC to 28.9 ºC (Table 7).

Savannah NWR

We collected water-quality field parameters (pH, conductance, dissolved oxygen, temperature) at 10 ponds sampled in 2005 (Table 6). We measured these parameters at 4 ponds on more than one visit. Values for pH were less acidic than at HNNWR, with a range from 5.08 to 7.03 and a mean among all samples of 6.16. Conductivity was generally low, less than 1 mS/cm in all but four samples. Dissolved oxygen (DO, mg/l) and % DO varied considerably, ranging from 0.21 mg/l and 2.5% to 5.11 mg/l and 52.6%. Water temperatures ranged from 15.3 ºC to 28.9 ºC (Table 7).

Future Plans

In 2006 ARMI will be transitioning from inventory to monitoring at Harris Neck and Savannah NWRs, and we tentatively have two visits planned for 2006, during spring/summer breeding season. Collections for disease screening will be conducted.

Inventory and Monitoring Activities: St. Vincent National Wildlife Refuge

Background

St Vincent NWR (SVNWR) is barrier island located at the mouth of the Apalachicola River in Franklin Co., Florida. Primary habitat types on SVNWR include ridge and swale topography with coastal pine scrub uplands and pine flatwood wetlands, and estuarine salt marsh. The island has a rich history of human habitation and was logged and used as an exotic game hunting reserve and cattle ranch in the early 1900s. SVNWR was established in 1968. Current access to the island is by boat only, and the island is one of the few reintroduction sites for red wolves. Extensive amphibian and reptile inventory data for this island has been collected by Joe Collins and associates and voucher specimens from this survey work are deposited in the Sternberg Museum of Natural History, Hays, Kansas (Irwin et al., 2003). A total of 12 species of amphibians and 47 species of reptiles have been previously documented from St Vincent NWR. St Vincent Island presents a unique opportunity for biogeographical studies because it was never connected to the mainland of Florida, rather it arose due to deposition of sand at the mouth of the Apalachicola River. Thus all freshwater fishes and terrestrial vertebrates reached the island via dispersal from the mainland. Among amphibians, it appears that anurans have been more successful at colonizing this island than caudates, as there are eleven species of frogs and only one species of salamander documented thus far. The lack of salamander predators (Ambystomatidae and Salamandridae) typical of ephemeral pond communities on the mainland may influence anuran community structure.

Effort in 2005

ARMI made one visit to St Vincent NWR from 16-18 Aug 2005.

Results

We sampled a total of nine wetlands at SVNWR and documented five species of anurans (*Hyla cinerea, H. femoralis, H. squirella, Rana grylio, R. sphenocephala*), one caudate species (*Amphiuma means*), seven fish species (*Gambusia holbrooki, Heterandria formosa, Poecilia latippina, Fundulus chrysotus, Lucania goodei, Lepomis gulosus, Elassoma* sp.), and seven reptile species (*Apalone ferox, Kinosternon*

subrubrum, Coluber constrictor, Sistrurus miliarus, Thamnophis sauritus, Anolis carolinensis, Cnemidophorus sexlineatus)

Future Plans

ARMI hopes to continue to perform inventory and monitoring of amphibians at St Vincent NWR as time and resources permit.

Research Activities: The Potential for Fish Stocking to Spread Disease to Aquatic Amphibians

Background

Amphibian populations and species are declining or disappearing from many regions and habitats world wide (Stuart et al., 2004). No single cause has been demonstrated, although acid precipitation, environmental contaminants, introduction of nonindigenous species, disease agents, climate change, parasites, and the effects of UV-B radiation have been suggested as factors causing amphibian declines. Indeed, several factors may interact in such a manner as to threaten species and populations locally or regionally (Carey and Bryant, 1995). However, the impacts of disease can be especially devastating, and declines due to disease, particularly from chytrid fungus and ranaviruses (Berger et al., 1998; Chinchar, 2002), are well documented from many disparate regions, including North America (Daszak et al., 2003; Kiesecker et al., 2004). In addition to the more well-known fungi and viruses, a disease of undetermined affinity (*Anuraperkinsus*) is now known to have had serious effects on populations of ranid frogs in the southeast (*Rana sevosa* in Mississippi; R. Seigel, C.K. Dodd, Jr., unpublished data). Of additional relevance, the spread of pathogens has been linked specifically with the introduction of nonindigenous amphibians (Mazzoni et al., 2003; Hanselmann et al., 2004; Beard and O'Neill, 2005; Jancovich et al., 2005).

The primary objective of this research is to determine whether diseases which could have a detrimental effect on southeastern amphibians (primarily chytrids, ranaviruses, *Anuraperkinsus*, saprolegniasis) are present in amphibian larvae living in warm-water National Fish Hatcheries (NFHs) in the southeastern U. S. Second, we want to make a preliminary assessment of the potential for amphibian larvae in stocking locations to have a higher incidence of disease than non-stocked locations. This research will provide a foundation for an ongoing assessment of the extent of disease in southeastern amphibians, and the role fish hatcheries may play in disease spread. An examination of hatchery records also will allow a preliminary assessment of the extent to which hatchery shipments could contribute to the mixture of amphibian genotypes from very different habitats on the southeastern coastal plain. Although the results may not

demonstrate that hatchery shipments have spread disease in the past, they will help in the prevention of future disease outbreaks by allowing researchers to make recommendations to minimize such threats. In order to carry out this research, we partnered with the National Wildlife Health Center (NWHC) and various southeastern USFWS entities (NWRs and NFHs). Larvae were (and are being) screened at the NWHC for pathogens.

In the southeastern U. S., warm water fish hatcheries supply National Wildlife Refuges and other land management agencies with stock for sport fishing, ecological restoration, and as food vital in endangered species management. Several million fish may be transported from one region to another across state lines in a single restocking event. For example, three million bluegills were stocked at HNNWR in 2004 in order to provide food for a nesting colony of endangered Wood Storks. With the fish come a host of other aquatic invertebrates and vertebrates, including tadpoles and potentially salamander larvae. Shipments are not screened for amphibian larvae or amphibian diseases. Moving large numbers of non disease-screened amphibian larvae throughout a region has the potential to transfer disease pathogens quickly and with serious consequences to resident amphibian populations. For example, chytrid fungi can remain virulent for seven days in contaminated water, thus offering the potential for disease transmission even without direct contact with infected amphibians (Johnson and Speare, 2003). In South Carolina, chytrids were first reported in bullfrogs in 1978 from the Savannah River Site, not far from the USFWS Orangeburg NFH, a source of fish stock for the southeastern Atlantic Coastal Plain. Chytrid infections in amphibians also have been reported from the coastal plain of North Carolina.

Methods

We sampled tadpoles at four warm water NFHs (Welaka, FL., Warm Springs, GA., Orangeburg, SC, Edenton, NC) and at HNNWR (a fish stocked site) from May to July, 2005. The species of most interest *a priori* were ranid frogs (*R. catesbeiana, R. clamitans, R. grylio, R. sphenocephala*) which are easily captured by dip-netting or in crayfish traps, and which have been shown to be susceptible to chytrid, ranavirus and other pathogens in the southeast. Other species were collected as they were encountered (see Results and Appendix III). We sampled a variety of ponds in order to secure a

representation of species, securing usually five tadpoles per species (as per NWHC instructions). Tadpole samples were housed separately, and packed and shipped within 4-hr to Madison WI using the packing equipment and standard operating procedures developed by the NWHC (http:www.nwhc.usgs.gov/research/amph_dc/ sop_ mailing. html).

Necropsy: Amphibians that were dead on arrival at NWHC were necropsied the same day as they are received. Live larvae were euthanized in 1:500 solution of MS222 (methanesulfonate salt, Sigma Chemical Co., St. Louis, Missouri. External and internal examinations were performed using a dissecting microscope equipped with a 35 mm camera.

Virus isolation:Samples of the liver, mesonephros ("kidney") and spleen were pooled for virus cultures and isolations will be attempted on fathead minnow cell lines (Docherty et al., 2003, *Journal of Wildlife Diseases* 39:556-566).

Bacterial and fungal cultures: Samples of liver, urine, mesonephros, bile, spleen or lung were submitted for aerobic bacterial cultures. A 2 mm × 3 mm segment of cloaca and a 2-4 mm segment of distal toe (when available) were submitted for fungal cultures. Tissues and body fluids for routine aerobic bacterial cultures (approximately 1 mm^3) were placed directly into vials of 2 ml tryptic soy broth with glycerine (TSB) and incubated at room temperature (25-27°C). Cultures for *Salmonella* spp. were done in Rappaport-Vassiliadis R10 broth (Becton, Dickinson & Co., Cockeysville, Maryland). Subcultures were performed on 5 % sheep blood agar plates and eosin methylene blue plates. Biochemical identifications of bacterial isolates were performed using the Biolog MicroStation Microbial Identification System (Hayward, California). Fungal cultures were performed on Sabouraud dextrose agar plates with chloramphenicol and tetracycline (Hardy Diagnostics, Santa Maria, California). Fungal isolates were identified morphologically by features of their hyphae and spores.

Parasitology: Parasites were identified to phylum during necropsies by a pathologist. Some helminths and insects were archived in hot buffered formalin or 70 % ethanol. Identifications to genus were based on external morphology of the live helminths at a dissecting microscope, tissue location in the host and histological features. Representative insects and helminths were identified by collaborating parasitologists and aquatic ecologists.

Histology: Portions of ventral skin, digits, heart, liver, lung, spleen, mesonephros, stomach, intestine, pancreas, urinary bladder and gonads were fixed in 10 % buffered neutral formalin, processed routinely, sectioned at 5 microns, and stained with hematoxylin and eosin. Portions of liver, ventral skin, muscle, lung and mesonephros were placed in 1.8 ml cryovials and archived at –70°C at NWHC (Madison, Wisconsin USA).

Results

Tadpoles were found in large number at all the NFHs, and included a variety of taxa in various stages of development. Most species were what one might expect in large open-air ponds, such as bullfrogs and leopard frogs. However, a number of species associated with temporary ponds (*Hyla femoralis, H. gratiosa, Gastrophryne carolinensis*) also were collected. We sent the following specimens to the NWHC for disease screening:

Edenton NFH 20 tadpoles of 3 species; 15 Jun

Bufo terrestris, Hyla cinerea, Rana catesbeiana [large and small tadpoles]

Warm Springs NFH 20 tadpoles of 4 species; 13 Jun

Bufo terrestris, Hyla cinerea, Rana catesbeiana, Rana clamitans

Orangeburg NFH 25 tadpoles of 5 species; 14 Jun

Bufo terrestris, Hyla cinerea, Hyla femoralis, Gastrophryne carolinensis, Rana sphenocephala

Welaka NFH 85 tadpoles of 4 species; 26 May

Hyla cinerea (2), *Hyla gratiosa* (5), *Hyla squirella* (30), *Rana sphenocephala* (48)

Harris Neck NWR 10 tadpoles of 1 species; 26 Jul

Rana catesbeiana (two different phenotypes, however). This is a location where fish have been stocked.

We have received a preliminary report of the initial disease-screening results, covering virus cultures, bacterial cultures, some parasitological exams and gross examinations. This report (see Appendix III) indicated that no positive indications of disease had been detected as yet from any of the tadpoles collected.

Histological examinations still are in progress. Preliminary results, however, confirm the presence of a chytrid infection of the oral cavity in four of five *R. catesbeiana* examined from Warm Springs NFH. As soon as the final report is available, we will provide the results to ARMI and the USFWS.

Research Activities: Sampling Methods Evaluation

Background

The goal of ARMI is to monitor amphibian populations using a probabilistic approach that will allow use of proportion area occupied statistical methods which incorporate detection probabilities. Thus each species is analyzed separately across repeated visits to multiple localities within each season, and across seasons.

Because of the vast scope of amphibian diversity and life-history in the Southeastern US, SEARMI is challenged to develop a monitoring protocol that will include as many species as possible. Previous ARMI inventory and monitoring included terrestrial sampling (drift fences, coverboards, PVC pipes, time constrained litter searches) and wetland sampling (dipnets, frogloggers, crayfish traps, minnow traps). Because most amphibian species in the Coastal Plain region spend at least some portion of their life cycle in wetland habitats, focusing sampling on these habitats is likely to yield the most information about amphibian populations.

In order to design our sampling protocol, we must understand the capabilities of our various sampling methods, including which species are likely to be captured, and whether or not we can collect accurate count data. The objective of this study was to compare the primary seven aquatic sampling techniques used by SEARMI in terms of the number and identity of species detected and abundance of individuals detected.

Methods

We sampled 10 wetlands at the Katharine Ordway Preserve-Swisher Memorial Sanctuary from 2-11 May 2005 using seven aquatic sampling methods. The methods included 10 samples at each site with four methods which allow counts of individuals, including box trap (0.5 m^2 aluminum quadrat), metal dipnet, D-frame wooden dipnet, and crayfish trap. Three additional methods provided presence/absence data: visual encounter (animals observed during daytime sampling), froglogger (automated audio recording device), and aural (calls heard during daytime sampling).

Results

The results of this study are currently being analyzed and prepared for publication in a peer-reviewed scientific journal. Preliminary analysis reveals that more amphibian species are detected with frogloggers than the other six methods.

Method	$\bar{x}$ # Species		$\bar{x}$ Time/trap	Count of amphibians
	Anurans	Caudates	(min)	($\bar{x} \pm$ SE)
Box trap	7	2	14	50 ± 15
Crayfish trap	5	2	2.1	-
D-frame dipnet	5	1	3.5	10 ± 5
Metal dipnet	6	1	3.5	15 ± 6
Froglogger	10	-	-	-
Visual encounter	5	0	-	-
Aural	8	-	-	-

The results of this study will help refine SEARMI's aquatic sampling protocol. Southeast ARMI is in the process of transitioning to a revised wetland sampling protocol. Previous wetland sampling typically consisted of 1-day, 2-day, or 3-day or visits to each site; 1-3 visits/site/season; sampling methods: froglogger, crayfish traps (4-5), time constrained dipnetting, visual encounter, aural, and covariate (water chemistry, fish, invertebrates) sampling at each visit. However, not all methods were used each day during a visit, covariates were not measured each day, and count data for each sampling method was not always consistently recorded. This sampling protocol does not allow inclusion of sufficient sites (at least 25) at each refuge to use PAO models. Our proposed revised sampling protocol is shorter visits to sites (2-day visits) in which repeat observers are counted as repeat visits, with the goal of achieving at least two replicate visits each year. Methods used will be frogloggers, crayfish traps (4-5), sweep constrained dipnetting, visual encounter, aural, and covariate sampling at each visit. Count data will be recorded for crayfish traps and dipnetting.

Research Activities: *Siren* and *Amphiuma* Population Demography

Background

Apex-level studies are critical components of the ARMI program which include research on population estimates, demographic rates, and other long-term research on focal species. In 2005 SEARMI began an apex mark-recapture study on the large aquatic salamanders *Siren lacertina* and *Amphiuma* means. These large aquatic salamanders are often abundant in aquatic ecosystems in the southeastern U. S., but their life history is poorly known.

This study is being conducted at Lake Suggs on the Katharine Ordway Preserve-Swisher Memorial Sanctuary, a property jointly owned by the Nature Conservancy and the University of Florida and managed by the UF Department of Wildlife Ecology and Conservation. This research project is a continuation of a project conducted from Aug 2001 – Jul 2002 by then ARMI biologist Kristina Sorensen (Sorensen, 2004). In the initial study 58 *A. means* and 66 *S. lacertina* were marked using Passive Integrated Transponder (PIT) tags. Due to the low recapture rate, calculation of growth rates in the initial study was difficult.

The objectives of the current study are to: (1) evaluate the population size and demographic structure for *A. means* and *S. lacertina* at Lake Suggs, (2) obtain growth rate and survival estimates for each species, and (3) understand activity and movement patterns of these species.

Methods

Sirens and amphiumas are collected at Lake Suggs using 20 mesh-lined crayfish traps which are set 5 m apart on permanent trap poles for four nights each month. Data collected for all captured sirens and amphiumas includes snout vent length (SVL), total length (TL), and weight. Animals larger than approximately 150 mm TL are marked by injecting a PIT tag into the lateral tail muscle. Data are also collected on the number of other animals captured in each trap, including fish and invertebrates.

Results

ARMI began this project in Jun 2005, for a total of 380 trap nights through Nov 2005. Thus far we have 45 captures of sirens and amphiumas. Most of the animals we have caught thus far are relatively large in size, although we have caught more small sirens than amphiumas. Our recapture rate of amphiumas appears to be higher than that of sirens. Preliminary data are as follows:

	Amphiuma means	*Siren lacertina*
Number of captures	21	24
Number marked	10	16
Number recaptured from 2001-2002 study	2	1
Total number recaptured	6	2
$\bar{x}$ Snout vent length (mm)	496	274
$\bar{x}$ Total length (mm)	665	409
$\bar{x}$ Weight (g)	360	313

Future Plans

This mark-recapture study will continue through 2006 and beyond as time and funds are available. We are encouraged by our recaptures from the initial study in 2001-2002, which provides new data on longevity of these species in nature.

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Southeast ARMI research and monitoring is conducted under the following permits:
SMNWR: USFWS Special Use Permit 41640-02011
LSNWR: USFWS Special Use Permit 41515-05-005
Savannah Coastal Refuges complex (HNNWR and SNWR): USFWS Special Use Permit 41620-04016
SVNWR: USFWS Special Use Permit 05-41650-4
Ordway Preserve: OR-05-07

Table 1. Sampling methods utilized by USGS-SEARMI at St. Marks, Lower Suwannee, Harris Neck, and Savannah National Wildlife Refuges during 2005.

Refuge	Drift Fence w/funnel traps	Drift Fence w/pitfalls	PVC	Crayfish Trap	Froglogger	Dip net	Visual Encounter Survey
St. Marks	X	X		X	X	X	
Lower Suwannee	X		X	X	X	X	
Harris Neck				X	X	X	X
Savannah				X	X	X	X

Table 2. USGS-SEARMI 2005 sampling dates and effort by sampling site at St. Marks, Lower Suwannee, Harris Neck, and Savannah National Wildlife Refuges.

Site	Feb		Mar	Apr	May	Jun		Jul	Aug		Number of days sampled
SMNWR											
405 Borrow						3	4				2
407 Pond						3	4				2
Biggins Pond	16	18				2	3		26	27	7
Chicky Pond						7	8				2
Cingulatum Pond						5	6		29		3
Corner Pond	16	18				4	5		26	27	7
Fat Nerodia Pond						4	5		26	27	4
FL Trail Pond						6	7		29	30	4
Gator Ditch						6	7				2
Gum Forest Pond						4	5				2
Hawk Pond						3	4				2
Headquarters Pond						5	6		29	30	4
Jennifer's Sink									27	28	2
Kingfisher Pond	16	18				2	3		26	27	7
Near Burnt Pond						7	8				2
ORSP Borrow	19										1
Otter Lake						7	8		25	26	4
Perkinsus Pond						8			27	28	3
Plum Orchard Pond						5	6		29	30	4
Pond 2	18	20									3
Pond 8	18	20									3
Printiss Pond	19										1
Printiss 2 Pond	19										1
PRS Pond						6	7				2
Ring Pond						4	5		27	28	4
Shepard Spring						6	7		29	30	4
Small Prairie Pond						3	4				2
Streetlight Pond									27		1
Talpoideum Pond	16	18				3	4		27	28	7
UBF Pond						5	6				2
W1	17										1
W2	17										1
W3	17										1
W4	17										1
Wakulla Field Pond						6	7		29	30	4
WBF Pond	19										1
Wpt 103						7	8				2
Wpt 150									26	27	2
Wpt 19	18	20				2	3		25	26	7
Wpt 192	18	20				4	5		27	28	7
Wpt 68									25	26	2
Wpt 69	16	18				2	3		25	26	7
Wpt 79	18	20				2	3		25	26	7
Yellow Fly Swamp						5	6				2

Site	Feb		Mar	Apr		May	Jun	Jul	Aug		Number of days sampled
BSF	14	21									8
CLH	14	21									8
EYR	13	20									8
HYR	13	20									8
LPH	14	21									8
NAT	13	20									8
PRS	14	21									8
SBL	13	20									8
SPC	13	20									8
SYR	13	20									8
UBF	14	21									8
WBF	13	20									8
LSNWR											
BW1									10	11	2
BW2									10	11	2
Cabin Marsh									11	12	2
DC1 Pond				26	27				8	9	4
DC2 Pond				26	27				8	9	4
DC3 Pond	3			25	26				8	9	5
DC4 Pond	3			25	26				8	9	5
DC5 Pond	3			25	26				8	9	5
DM1									9	10	2
DM3									9	10	2
DM4									9	10	2
DM5									9	10	2
Gate 15 Borrow				27	28						2
Gate 18 Borrow				27	28						2
Gate 19 Swamp									10	11	2
Gate 25 Pond									11	12	2
Gate 31 Creek									11	12	2
Gate 39 Creek									11	12	2
HQ Pond				28	29						2
HQ Rd Pond				27	28						2
LC2 Swamp				28	29						2
LC3 Pond	3			27	28				10	11	5
LC5 Pond				28	29						2
Limpkin Pond									10	11	2
Main Loop Dome				28	29						2
Salt Point Pond									9	10	2
Sandfly Creek									11	12	2
Sulphur Spring				25	26						2
Triangle Loop Pond				26	27						2
Yellow Jacket Beaver Pond				26	27						2
DC1	1	4									4
DC2	1	4									4
DC3	1	4									4
DC4	1	4									4
DC5	1	4									4

Site	Feb		Mar		Apr	May		Jun	Jul		Aug	Number of days sampled
LC1	1	4										4
LC2	1	4										4
LC3	1	4										4
LC4	1	4										4
LC5	1	4										4
HNNWR												
Borrow Pond			21	23		16	18		25	27		9
Church Ditch			22									1
Culvert Pond			22			17			26			3
Goose Meadow			23			17						2
Goose Pond			21	23		16	18		25	27		9
Greenhead Pond			21	23		16	18					6
Lucas Borrow			21	23		16	18		26			7
Lucas Pond			21	23		16	18		25	27		9
N Runway Ditch			22			17			26			3
Plantation Fountain			22			17						2
Snake Bog						16	17					2
Snipe Pond 1						17			25	27		4
Snipe Pond 2									25	27		3
Snipe Pond 3			21									1
Teal Pond			21									1
Wigeon Pond			21	23		16	18		25	27		9
Woody Pond			21	23		16	18		25	27		9
SVNWR												
BI-1						19						1
BI-4						19						1
BI-5						19						1
BI-6						19						1
BI-7						19						1
DT-1			24						28			2
DT-2			23	25		18	21		27	29		10
DT-3			24						28			2
DT-4			24									1
DT-5			24						28			2
DT-6			24						28			2
HQ-1						18	21					4
ND-3									27	29		3
ND-4						18	21					4
SCL1			24									1
ST-1						20						1
ST-3						20						1
ST-4						20						1
ST-5						20						1
ST-6						20						1
WD-3			23	25		18	21		27	29		10
WD-6			23	25								3
WD-7			23	25					27	29		6
WD-8						18	21		27	29		7

Table 3. Coordinates for sites and methods used by USGS-SEARMI at St. Marks, Lower Suwannee, Harris Neck, and Savannah National Wildlife Refuges.

Site Name	UTM-E	UTM-N	UTM zone	Aural	Collapsible funnel trap	Crayfish trap	Dip-net	Drift fence	Froglogger	PVC	Visual	WRD sample	Datalogger
SMNWR													
BSF	777716	3337735	16	X				X			X		
UBF	776608	3337911	16	X				X			X		
LPH	765767	3338562	16	X				X			X		
PRS	765790	3338989	16	X				X			X		
CLH	767730	3337878	16	X				X			X		
EYR	749814	3324508	16	X				X			X		
NAT	750125	3323984	16	X				X			X		
SPC	750729	3324137	16	X				X			X		
SYR	749070	3327336	16	X				X			X		
SBL	747418	3327553	16	X				X			X		
WBF	744888	3326039	16	X				X			X		
HYR	742317	3324648	16	X				X			X		
405 Borrow	745567	3325766	16	X		X	X		X		X		
407 Pond	743647	3325573	16	X		X	X		X		X	X	
Biggins Pond	746570	3323072	16	X		X	X		X		X	X	X
Buckhorn Creek	744691	3326914	16									X	
Buckhorn Woods Pond	744400	3327064	16	X		X	X		X		X		
Burnt Pond	749915	3327630	16	X			X				X		
Burnt Sink Pond	749819	3327548	16	X			X				X		
Chicky Pond	750336	3324395	16	X		X	X		X		X	X	
Cingulatum Pond	774260	3338757	16	X		X	X		X		X	X	
Corner Pond	747034	3327586	16	X		X	X		X		X	X	X
Corner Sink	746940	3327532	16	X			X				X		
Ditched Pond	741490	3322532	16	X			X				X		
Eagle Nest Pond	750376	3327682	16	X			X				X		
Fat Nerodia Pond	746057	3324407	16	X		X	X		X		X	X	X
FL Trail Pond	766100	3338932	16	X		X	X		X		X	X	
Gator Ditch	766377	3336679	16	X		X	X		X		X		
Goose Pond (Renfro)	748788	3322398	16	X		X					X	X	
Gum Forest Pond	751363	3327852	16	X		X	X		X		X	X	
Hawk Pond	744874	3325324	16	X		X	X		X		X	X	
Headquarters Pond	773370	3332137	16	X		X	X		X		X	X	
Jamie Pond	749859	3325877	16	X			X				X	X	
Jennifer's Sink	747990	3327929	16	X		X	X		X		X	X	
Kingfisher Pond	747354	3322146	16	X		X	X		X		X	X	X
Near Burnt Pond	749894	3327596	16	X		X	X		X		X		
No Name Strand	745140	3324966	16	X			X				X		
ORSP Borrow	742592	3322592	16	X			X				X		
ORSP Sink	741811	3321768	16	X							X		
Otter Creek	748080	3328005	16									X	

Site Name	UTM-E	UTM-N	UTM zone	Aural	Collapsible funnel trap	Crayfish trap	Dip-net	Drift fence	Froglogger	PVC	Visual	WRD sample	Datalogger
Otter Lake	748835	3323966	16	X		X	X		X		X	X	
Perched Pond	743245	3324488	16	X			X				X		
Perkinsus Pond	751035	3328377	16	X		X	X		X		X	X	X
Plum Orchard Pond	774826	3338857	16	X		X	X		X		X	X	
Pond 10	749834	3323024	16	X		X	X		X		X		
Pond 2	749184	3322169	16	X		X	X		X		X		
Pond 7	749608	3322158	16	X		X	X		X		X		
Pond 8	749682	3322086	16	X		X	X		X		X		
Prairie Pond	750401	3323961	16									X	
Printiss Pond	744431	3325997	16	X		X	X		X		X		
Printiss 2 Pond	741688	3322542	16	X			X				X	X	
PRS Pond	765790	3338989	16	X		X	X		X		X		
Ring Pond	751315	3326573	16	X		X	X		X		X	X	
Shepard Spring	761521	3335747	16	X		X	X		X		X	X	
Small Prairie Pond	746380	3324168	16	X		X	X		X		X		
Smooth Oak Pond	750710	3328380	16	X			X				X		
SPC Prairie Pond	750401	3323961	16	X			X		X		X		
Spear Top Pond	752328	3330012	16	X			X				X		
Spike Buck Pond	744780	3326461	16	X		X	X				X	X	
Stony Bayou 1	774951	3335733	16	X		X					X		
Stony Bayou 2	775916	3334716	16	X		X					X		
Streetlight Pond	748010	3328282	16	X			X		X		X	X	X
SYR Creek	749518	3327019	16	X		X	X				X		
SYR Pond	749104	3327398	16	X			X				X		
Talpoideum Pond	747248	3327146	16	X		X	X		X		X	X	
Tin Pile Pond	748893	3322018	16	X			X				X		
UBF Pond	776608	3337911	16	X		X			X		X		
W1	746638	3327185	16	X			X				X		
W2	746677	3326959	16	X			X				X		
W3	746832	3326971	16	X			X				X		
W4	746748	3326775	16	X			X				X		
Wakulla Field Pond	760638	3336611	16	X		X	X		X		X		
WBF Pond	744806	3325943	16	X		X	X		X		X	X	
Wpt 103	745998	3324492	16	X		X	X		X		X		
Wpt 127	753471	3326208	16	X			X				X		
Wpt 128	753012	3326212	16	X			X				X		
Wpt 144	744290	3326973	16	X	X	X	X		X		X		
Wpt 150	746654	3327182	16	X	X	X	X		X		X		
Wpt 151	751940	3327248	16	X			X				X		
Wpt 19	750312	3321070	16	X	X	X	X		X		X	X	X
Wpt 192	752419	3330376	16	X		X	X		X		X	X	X
Wpt 200	757098	3332928	16	X			X				X		
Wpt 57	749843	3322120	16	X							X		
Wpt 68	750151	3322421	16	X	X	X	X		X		X		
Wpt 69	747479	3322471	16	X		X	X		X		X	X	X
Wpt 79	749872	3322969	16	X	X	X	X		X		X	X	X

Site Name	UTM-E	UTM-N	UTM zone	Aural	Collapsible funnel trap	Crayfish trap	Dip-net	Drift fence	Froglogger	PVC	Visual	WRD sample	Datalogger
Yellow Fly Swamp	775380	3338386	16	X		X	X		X		X		
LSNWR													
DC1	297263	3249618	17	X				X		X	X	X	
DC2	298122	3252207	17	X				X		X	X	X	
DC3	300352	3253869	17	X				X		X	X	X	
DC4	303992	3259872	17	X				X		X	X	X	
DC5	304089	3260116	17	X				X		X	X	X	
LC1	300686	3251156	17	X				X		X	X		
LC2	300290	3249875	17	X				X		X	X		
LC3	301026	3249530	17	X				X		X	X		
LC4	299408	3243511	17	X				X		X	X		
LC5	304468	3239672	17	X				X		X	X		
Barnett Creek	299904	3242042	17									X	
BW1	301488	3251761	17	X		X	X		X		X		
BW2	301559	3251559	17	X		X	X		X		X		
Cabin Marsh	300523	3239418	17	X		X	X		X		X		
DC1 Pond	297163	3249618	17	X		X	X		X		X		
DC2 Pond	298149	3252214	17	X		X	X		X		X		
DC3 Pond	300352	3253869	17	X		X	X		X		X		
DC4 Pond	303992	3259872	17	X		X	X		X		X		
DC5 Pond	304089	3260116	17	X		X	X		X		X		
DM1	293462	3249432	17	X		X	X		X		X		
DM3	291268	3254428	17	X		X	X		X		X		
DM4	288303	3258871	17	X		X	X		X		X		
DM5	288149	3258648	17	X		X	X		X		X		
Gate 15 Borrow	300916	3248607	17	X		X	X		X		X		
Gate 18 Borrow	301228	3247926	17	X		X	X		X		X		
Gate 19 Swamp	300237	3247453	17	X		X	X		X		X		
Gate 25 Pond	300453	3244854	17	X		X	X		X		X		
Gate 31 Creek	299446	3243873	17	X		X	X		X		X		
Gate 39 Creek	300357	3240424	17	X		X	X		X		X		
Grid 1	300946	3249509	17							X			
Grid 2	301712	3251035	17							X			
HQ Pond	301560	3251274	17	X		X	X		X		X		
HQ Rd Pond	302078	3251205	17	X		X	X		X		X		
LC2 Swamp	300428	3250315	17	X		X	X		X		X		
LC3 Pond	301026	3249530	17	X		X	X		X		X		
LC5 Pond	304381	3239647	17	X		X	X		X		X		
Limpkin Pond	302349	3251390	17	X		X	X		X		X		
Main Loop Dome	301599	3250179	17	X		X	X		X		X		
McCormick Creek	298715	3243812	17									X	
Salt Point Pond	292867	3248936	17	X		X	X		X		X		
Sandfly Creek	300935	3246114	17	X		X	X		X		X	X	
Sulphur Spring	302268	3256238	17	X		X	X		X		X		
Suwannee River	301478	3251786	17									X	

Site Name	UTM-E	UTM-N	UTM zone	Aural	Collapsible funnel trap	Crayfish trap	Dip-net	Drift fence	Froglogger	PVC	Visual	WRD sample	Datalogger
Triangle Loop Pond	296566	3248774	17	X		X	X		X		X		
Yellow Jacket Beaver Pond	304436	3260412	17	X		X	X		X		X		
HNNWR													
Blue Bill Pond			17	X							X		
Borrow Pond	473461	3499861	17	X		X	X		X		X		
Church Ditch	473059	3498732	17	X							X		
Culvert Pond	473391	3500445	17	X			X				X		
Goose Meadow	474752	3500968	17	X			X				X		
Goose Pond	474660	3500905	17	X		X	X		X		X		
Greenhead Pond	474587	3500632	17	X		X			X		X		
Lucas Borrow	473751	3498331	17	X		X	X				X		
Lucas Pond	473590	3498216	17	X		X			X		X		
Lucas Seepage	473622	3498262	17	X							X		
N Runway Ditch	474569	3501066	17	X			X				X		
Plantation Fountain	475508	3500751	17	X			X				X		
Red Maple Swamp	474886	3499361	17	X							X		
Snake Bog	472989	3498830	17	X							X		
Snipe Pond 1	473990	3500432	17	X		X	X				X		
Snipe Pond 2			17	X		X					X		
Snipe Pond 3	474001	3500256	17	X		X			X		X		
Teal Pond			17	X		X					X		
Wigeon Pond	475034	3499460	17	X		X			X		X		
Woody Pond	473713	3499346	17	X		X	X		X		X		
Woody Swamp			17	X							X		
SVNWR													
Bear Is	487409	3574055	17	X			X				X		
BI-1	488378	3574540	17	X							X		
BI-4	486799	3578842	17	X			X				X		
BI-5	486145	3578551	17	X							X		
BI-6	486906	3576095	17	X			X				X		
BI-7	487260	3577658	17	X							X		
DT-1	490933	3565184	17	X							X		
DT-2	492492	3561681	17	X		X	X		X		X		
DT-3	491968	3563503	17	X							X		
DT-4	491846	3562316	17	X							X		
DT-5	491592	3564442	17	X							X		
DT-6	489975	3566022	17	X							X		
HQ-1	488878	3559112	17	X		X			X		X		
ND-1	490757	3560655	17	X		X			X		X		
ND-2	490685	3561563	17	X		X			X		X		
ND-3	490076	3561532	17	X		X			X		X		
ND-4	489667	3560003	17	X		X			X		X		
ND-5	489075	3561628	17	X		X					X		

Site Name	UTM-E	UTM-N	UTM zone	Aural	Collapsible funnel trap	Crayfish trap	Dip-net	Drift fence	Froglogger	PVC	Visual	WRD sample	Datalogger
SCL1	493949	3558634	17	X							X		
ST-1	484422	3564331	17	X							X		
ST-2	484593	3562642	17	X			X				X		
ST-3	484456	3563367	17	X			X				X		
ST-4	483936	3563874	17	X							X		
ST-5	484464	3563164	17	X			X				X		
ST-6	484106	3562910	17	X			X				X		
WD-1	489800	3557575	17	X		X			X		X		
WD-2	491164	3557083	17	X		X			X		X		
WD-3	491572	3558678	17	X		X			X		X		
WD-4	489806	3557350	17	X		X			X		X		
WD-5	491286	3556628	17	X		X			X		X		
WD-6	489240	3558398	17	X		X			X		X		
WD-7	490416	3556912	17	X		X			X		X		
WD-8	491129	3556549	17	X		X					X		

Table 4. Amphibian and reptile species documented by USGS-SEARMI at St. Marks, Lower Suwannee, Harris Neck, and Savannah National Wildlife Refuges through 2005. Counts including subspecies in parentheses.

Scientific Name	Common Name	SMNWR	LSNWR	HNNWR	SVNWR
Frogs					
Acris gryllus dorsalis	Florida Cricket Frog	X	X	X	
Acris gryllus gryllus	Coastal Plain Cricket Frog				X
Bufo fowleri	Fowler's Toad				X
Bufo quercicus	Oak Toad	X	X		
Bufo terrestris	Southern Toad	X	X	X	X
Eleutherodactylus planirostris	Greenhouse Frog (introduced)	X	X		
Gastrophryne carolinensis	Eastern Narrow-mouthed Toad	X	X	X	X
Hyla avivoca ogechiensis	Eastern Bird-voiced Treefrog				X
Hyla chrysoscelis	Cope's Gray Treefrog	X	X		X
Hyla cinerea	Green Treefrog	X	X	X	X
Hyla femoralis	Pine Woods Treefrog	X	X	X	X
Hyla gratiosa	Barking Treefrog	X	X	X	
Hyla squirella	Squirrel Treefrog	X	X	X	X
Osteopilus septentrionalis	Cuban Treefrog (introduced)		X[1]		
Pseudacris crucifer bartramiana	Southern Spring Peeper	X	X	X	
Pseudacris crucifer crucifer	Northern Spring Peeper				X
Pseudacris nigrita nigrita	Striped Southern Chorus Frog	X	X		
Pseudacris ocularis	Little Grass Frog	X	X	X	
Pseudacris ornata	Ornate Chorus Frog	X			
Rana catesbeiana	American Bullfrog	X	X	X	X
Rana clamitans clamitans	Bronze Frog	X	X		X
Rana grylio	Pig Frog	X	X	X	X
Rana heckscheri	River Frog	X			X
Rana sphenocephala sphenocephala	Florida Leopard Frog	X	X		
Rana sphenocephala utricularia	Southern Leopard Frog			X	X
Scaphiopus holbrookii	Eastern Spadefoot	X	X		
Number of frog species observed		20	19	12	15
Salamanders					
Ambystoma cingulatum	Flatwoods Salamander	X			
Ambystoma opacum	Marbled Salamander				X
Ambystoma talpoideum	Mole Salamander	X			
Amphiuma means	Two-toed Amphiuma	X	X		X
Desmognathus auriculatus	Southern Dusky Salamander	X			X
Eurycea quadridigitata	Dwarf Salamander	X	X		X
Notophthalmus viridescens ssp.	Eastern Newt		X		
Notophthalmus viridescens louisianensis	Central Newt	X		X	X
Plethodon grobmani	Southeastern Slimy Salamander	X			
Plethodon variolatus	South Carolina Slimy Salamander				X
Pseudobranchus striatus spheniscus	Slender Dwarf Siren	X			
Siren intermedia intermedia	Eastern Lesser Siren	X			
Siren lacertina	Greater Siren	X	X		X
Siren sp. (undescribed species)	Undescribed	X			
Number of salamander species observed		11	4	1	7
Number of amphibian species observed		31	23	13	22

Scientific Name	Common Name	SMNWR	LSNWR	HNNWR	SVNWR
Lizards					
Anolis carolinensis carolinensis	Northern Green Anole	X	X	X	X
Aspidoscelis sexlineata sexlineata (=Cnemidophorus sexlineatus sexlineatus)	Eastern Six-lined Racerunner	X	X	X	
Eumeces egregius similis	Northern Mole Skink	X			
Eumeces fasciatus	Common Five-lined Skink	X	X		
Eumeces inexpectatus	Southeastern Five-lined Skink	X	X	X	X
Eumeces laticeps	Broad-headed Skink	X	X		
Ophisaurus attenuatus longicaudus	Eastern Slender Glass Lizard	X			
Ophisaurus ventralis	Eastern Glass Lizard	X	X	X	
Sceloporus undulatus	Eastern Fence Lizard	X	X		
Scincella lateralis	Little Brown Skink	X	X	X	X
Number of lizard species observed		10	8	5	3
Snakes					
Agkistrodon contortrix contortrix	Southern Copperhead			X	X
Agkistrodon piscivorus ssp.	Cottonmouth				X
Agkistrodon piscivorus conanti	Florida Cottonmouth	X	X		
Cemophora coccinea copei	Northern Scarletsnake	X	X		
Coluber constrictor priapus	Southern Black Racer	X	X	X	X
Crotalus adamanteus	Eastern Diamond-backed Rattlesnake	X	X		
Crotalus horridus	Timber Rattlesnake			X	
Diadophis punctatus punctatus	Southern Ring-necked Snake	X	X		X
Drymarchon couperi	Eastern Indigo Snake		X		
Elaphe alleghaniensis (=*E. obsoleta*)[2]	Eastern Ratsnake	X	X	X	X
Elaphe guttata	Red Cornsnake	X			X
Farancia abacura abacura	Eastern Mudsnake	X[1]	X		
Heterodon platirhinos	Eastern Hog-nosed Snake	X			
Heterodon simus	Southern Hog-nosed Snake		X		
Lampropeltis getula getula	Eastern Kingsnake	X[1]		X	
Lampropeltis triangulum elapsoides	Scarlet Kingsnake	X	X		
Masticophis flagellum flagellum	Eastern Coachwhip	X		X	
Micrurus fulvius	Harlequin Coralsnake	X			
Nerodia clarkii clarkii	Gulf Saltmarsh Snake	X			
Nerodia erythrogaster erythrogaster	Red-bellied Watersnake				X
Nerodia fasciata ssp.	Southern Watersnake		X		
Nerodia fasciata fasciata	Banded Watersnake	X		X	X
Nerodia floridana	Florida Green Watersnake	X			
Nerodia taxispilota	Brown Watersnake	X			X
Opheodrys aestivus	Rough Greensnake	X		X	
Pituophis melanoleucus mugitus	Florida Pinesnake	X			
Regina alleni	Striped Crayfish Snake	X	X		
Regina rigida rigida	Glossy Crayfish Snake	X	X		
Seminatrix pygaea pygaea	Northern Florida Swampsnake	X			
Sistrurus miliarius barbouri	Dusky Pygmy Rattlesnake	X	X		
Storeria dekayi wrightorum	Midland Brownsnake	X			
Storeria occipitomaculata ssp.	Red-bellied Snake				X
Storeria occipitomaculata obscura	Florida Red-bellied Snake		X		
Storeria victa (=*Storeria dekayi victa*)	Florida Brownsnake		X		
Thamnophis sauritus nitae	Blue-striped Ribbonsnake	X	X		
Thamnophis sauritus sackenii	Peninsula Ribbonsnake	X		X	

Scientific Name	Common Name	SMNWR	LSNWR	HNNWR	SVNWR
Thamnophis sirtalis similis	Blue-striped Gartersnake	X	X		
Thamnophis sirtalis sirtalis	Eastern Gartersnake	X		X	
Virginia valeriae valeriae	Eastern Smooth Earthsnake	X			
Number of snake species observed		27(29)	18	10	10
Crocodilians					
Alligator mississipiensis	American Alligator	X	X	X	X
Number of crocodillian species observed		1	1	1	1
Turtles					
Apalone ferox	Florida Softshell	X	X		
Chelydra serpentina osceola	Florida Snapping Turtle	X	X		
Deirochelys reticularia reticularia	Eastern Chicken Turtle	X	X	X	
Gopherus polyphemus	Gopher Tortoise	X	X	X	
Kinosternon baurii	Striped Mud Turtle	X	X		
Kinosternon subrubrum subrubrum	Eastern Mud Turtle	X		X	X
Malaclemys terrapin macrospilota	Ornate Diamond-backed Terrapin	X			
Pseudemys concinna concinna	Eastern River Cooter	X			
Pseudemys concinna floridana	Coastal Plain Cooter	X			
Pseudemys nelsoni	Florida Red-bellied Cooter		X		
Pseudemys peninsularis	Peninsula Cooter		X		
Pseudemys suwanniensis	Suwannee Cooter		X		
Sternotherus odoratus	Stinkpot	X	X		X
Terrapene carolina bauri	Florida Box Turtle		X		
Terrapene carolina carolina	Eastern Box Turtle				X
Terrapene carolina major	Gulf Coast Box Turtle	X			
Trachemys scripta scripta	Yellow-bellied Slider	X	X	X	
Number of turtle species observed		11(12)	11	4	3
Number of reptile species observed		49(52)	38	20	17
Total number of species observed		80(83)	61	33	39

1 - record for this species from near, not within, refuge boundary.
2 - *Elaphe alleghaniensis=E. obsoleta obsoleta, E. o. quadrivitatta, E. o. spiloides*

Table 5. Amphibian and reptile species documented during wetland and time constrained surveys at St. Marks, Lower Suwannee, Harris Neck, and Savannah National Wildlife Refuges during 2005.

St. Marks Amphibian Species	Species name	Acris gryllus	Ambystoma talpoideum	Bufo quercicus	B. terrestris	Hyla chrysoscelis	H. cinerea	H. femoralis	H. gratiosa	H. squirella	Notophthalmus viridescens	Pseudacris crucifer	P. ocularis	P. ornate	Rana catesbeiana	R. clamitans	R. grylio	R. heckscheri	R. sphenocephala	Scaphiopus holbrookii	Siren intermedia	S. lacertina	No. of species observed
Site																							
405 Borrow		X		X				X											X				4
407 Pond		X						X											X				3
Biggins		X						X	X										X		X		5
Chicky		X						X	X										X				4
Cingulatum											X		X				X						3
Corner		X	X		X			X	X								X		X	X			8
Fat Nerodia		X						X									X		X				4
FL Trail						X	X				X				X				X				5
Gator Ditch										X	X				X							X	4
Gum Forest		X															X						2
Hawk		X		X			X	X			X		X						X				7
HQ																	X		X			X	3
Jennifer's Sink															X	X			X				3
Kingfisher		X	X	X				X	X										X		X		7
Near Burnt		X	X		X			X			X		X						X				7
ORSP Borrow		X																X					2
Otter Lk		X			X		X												X				4
Perkinsus		X						X	X										X				4
Plum Orchard		X				X	X				X				X	X	X		X				8
Pond 2		X	X																				2
Pond 8																			X				1
Printiss																			X				1
Printiss 2		X																					1
PRS						X				X										X			3
Ring		X		X				X									X		X				5
Shepard Spg						X													X				2
Small Prairie		X		X				X	X								X						5
Streetlight		X						X											X				3
Talpoideum		X	X					X	X										X				5
UBF							X	X															2
W2		X	X																				2
W3		X	X																				2
W4			X																X				2
Wakulla Field		X								X	X				X	X	X		X		X		8
WBF														X					X				2

St. Marks Amphibian Species (cont.)	Acris gryllus	Ambystoma talpoideum	Bufo quercicus	B. terrestris	Hyla chrysoscelis	H. cinerea	H. femoralis	H. gratiosa	H. squirella	Notophthalmus viridescens	Pseudacris crucifer	P. ocularis	P. ornate	Rana catesbeiana	R. clamitans	R. grylio	R. heckscheri	R. sphenocephala	Scaphiopus holbrookii	Siren intermedia	S. lacertina	No. of species observed
Wpt 103	X		X				X	X										X				5
Wpt 150	X						X	X						X				X				5
Wpt 19	X							X		X								X			X	5
Wpt 192	X	X	X											X		X		X				6
Wpt 68	X						X															2
Wpt 69	X	X	X				X	X			X							X		X		8
Wpt 79	X						X											X				3
Yellow Fly Swamp						X								X		X						3
No. of sites w/ observations	30	10	8	3	4	6	20	11	3	8	1	3	1	8	3	11	1	30	2	4	3	

St. Marks Reptile Species / Site	Species Name	Anolis carolinensis	Apalone ferox	Alligator mississipiensis	Agkistrodon piscivorus	Coluber constrictor	Deirochelys reticularia	Nerodia fasciata	N. floridana	Ophisaurus sp.	Regina rigida	Sternotherus odoratus	Thamnophis sauritus	Trachemys scripta	No. of species observed
405 Borrow								X							1
Chicky								X							1
Cingulatum									X						1
Corner				X			X								2
FL Trail												X			1
Gator Ditch				X											1
Gum Forest														X	1
HQ				X											1
Near Burnt								X					X		2
Otter Lk												X			1
Perkinsus			X												1
Pond 2								X			X				2
Shepard Spg								X							1
Talpoideum								X							1
UBF								X		X					2
W4				X											1
Wakulla Field					X								X		2
Wpt 103													X		1
Wpt 150						X									1
Wpt 69		X											X		2
No. of sites w/ observations		1	1	4	1	1	1	7	1	1	1	2	4	1	

Lower Suwannee Amphibian Species / Site	Species name	Acris gryllus	Amphiuma means	Bufo quercicus	B. terrestris	Hyla cinerea	H. femoralis	H. squirella	Notophthalmus viridescens	Pseudacris crucifer	P. ocularis	Rana catesbeiana	R. clamitans	R. grylio	R. sphenocephala	S. lacertina	No. of species observed
BW2			X										X		X	X	4
Cabin Marsh						X						X			X	X	4
DC1 Pond													X		X		2
DC2 Pond		X	X		X		X				X				X		6
DC3 Pond		X				X	X				X	X			X		6
DC4 Pond		X					X	X		X			X		X		6
DC5 Pond		X	X				X	X	X	X			X				7
DM1		X												X	X	X	4
DM3						X							X		X		3
DM4						X									X		2
DM5						X									X		2
Gate 15 Borrow			X						X						X		3
Gate 18 Borrow		X						X	X						X		4
Gate 19 Swamp													X				1
Gate 25 Pond									X						X	X	3
Gate 31 Creek						X			X			X			X		4
Gate 39 Creek												X	X				2
HQ Pond		X	X		X		X								X	X	6
HQ Rd Pond		X					X				X	X			X	X	6
LC2 Swamp								X							X		2
LC3 Pond		X		X					X				X		X		5
LC5 Pond							X								X		2
Limpkin Pond													X				1
Main Loop Dome		X					X		X						X		4
Salt Point Pond														X		X	2

Lower Suwannee Amphibian Species (cont.)	Acris gryllus	Amphiuma means	Bufo quercicus	B. terrestris	Hyla cinerea	H. femoralis	H. squirella	Notophthalmus viridescens	Pseudacris crucifer	P. ocularis	Rana catesbeiana	R. clamitans	R. grylio	R. sphenocephala	S. lacertina	No. of species observed
Sandfly Creek												X				1
Sulphur Spring					X		X				X				X	4
Triangle Loop Pond	X			X		X				X				X		5
Yellow Jacket Beaver Pond				X			X				X	X		X	X	6
No. of sites w/ observations	11	5	1	4	7	9	6	7	2	4	7	11	2	22	9	

Lower Suwannee Reptile Species Site / Species name	Alligator mississipiensis	Anolis carolinensis	Deirochelys reticularia	Eumeces sp.	Kinosternon baurii	Nerodia fasciata	Scincella lateralis	Sternotherus odoratus	Thamnophis sauritus	No. of species observed
Cabin Marsh	X									1
DC1 Pond							X			1
DC3 Pond			X							1
DC4 Pond		X								1
DC5 Pond							X			1
DM5						X				1
Gate 18 Borrow					X					1
Gate 25 Pond		X						X		2
Sandfly Creek				X						1
Triangle Loop Pond									X	1
No. of sites w/ observations	1	2	1	1	1	1	2	1	1	

Harris Neck Amphibian Species Site / Species name	Acris gryllus	Bufo terrestris	Gastrophryne carolinensis	Hyla cinerea	H. femoralis	H. gratiosa	Notophthalmus viridescens	Pseudacris crucifer	P. ocularis	Rana catesbeiana	R. grylio	R. sphenocephala	No. of species observed
Borrow Pond	X			X	X	X	X	X	X			X	8
Church Ditch									X				1
Culvert Pond												X	1
Goose Meadow		X							X			X	3
Goose Pond		X		X			X	X	X	X	X	X	8
Greenhead Pond				X			X	X	X			X	5
Lucas Borrow							X					X	2
Lucas Pond				X				X			X	X	4
N Runway Ditch			X		X			X					3
Plantation Fountain							X						1
Snake Bog	X			X	X				X			X	5
Snipe Pond 1				X						X			2
Snipe Pond 2										X			1
Snipe Pond 3		X						X	X			X	4
Teal Pond		X										X	2
Wigeon Pond				X			X	X	X				4
Woody Pond	X			X			X	X		X	X	X	7
No. of sites w/ observations	3	4	1	8	3	1	7	8	8	4	3	11	

Harris Neck Reptile Species Site / Species name	Agkistrodon contortrix	Alligator mississipiensis	Coluber constrictor	Crotalus horridus	Elaphe alleghaniensis	Eumeces inexpectatus	Nerodia fasciata	Ophisaurus ventralis	Scincella lateralis	Trachemys scripta scripta	No. of species observed
Borrow Pond		X				X					2
Goose Pond							X				1
Greenhead Pond							X			X	2
Lucas Borrow								X	X		2
N Runway Ditch			X								1
Snake Bog	X			X							2
Wigeon Pond		X			X		X				3
Woody Pond		X			X		X			X	4
No. of sites w/ observations	1	3	1	1	2	1	4	1	1	2	

Savannah Amphibian Species	Species name	Acris gryllus	Amphiuma means	Bufo terrestris	Desmognathus auriculatus	Eurycea quadridigitata	Gastrophryne carolinensis	Hyla avivoca	H. chrysoscelis	H. cinerea	H. femoralis	H. squirella	Notophthalmus viridescens	Plethodon variolatus	Pseudacris crucifer	Rana catesbeiana	R. clamitans	R. grylio	R. heckscheri	R. sphenocephala	Siren lacertina	Siren sp.	No. of species observed
Site																							
BI-1									X								X						2
BI-4									X								X			X			3
BI-5									X			X											2
BI-6				X					X								X						3
BI-7									X														1
DT-1		X		X	X										X		X			X			6
DT-2		X		X												X	X	X	X	X			7
DT-3		X		X	X												X			X			5
DT-4		X				X				X										X			4
DT-5		X			X			X	X		X	X			X		X						8
DT-6		X													X		X			X			4
HQ-1																		X			X		2
ND-3			X															X				X	3
ND-4																		X			X		2
SCL1		X																					1
ST-1												X											1
ST-3													X		X		X						3
ST-4		X												X			X						3
ST-5													X										1
ST-6							X			X				X			X						4
WD-3										X							X	X		X	X		5
WD-6																				X			1
WD-7													X					X		X			3
No. of sites w/ observations		8	1	4	3	1	1	1	6	3	1	3	3	2	4	1	12	6	1	9	3	1	

Savannah Reptile Species	Species name	Agkistrodon contortrix	A. piscivorus	Alligator mississipiensis	Anolis carolinensis	Coluber constrictor	Diadophis punctatus	Elaphe alleghaniensis	Eumeces inexpectatus	Eumeces sp.	Nerodia erythrogaster	N. fasciata	Scincella lateralis	Sternotherus odoratus	Terrapene carolina	No. of species observed
Site																
BI-1					X											1
BI-6					X											1
BI-7				X												1
DT-1			X													1
DT-2				X	X	X										3
DT-3			X						X				X			3
DT-4					X								X		X	3
DT-5					X				X				X			3
DT-6												X				1
HQ-1														X		1
ND-3				X												1
SCL1		X					X	X								3
ST-1							X									1
ST-4					X											1
ST-6										X	X					2
WD-3														X		1
No. of sites w/ observations		1	2	3	6	1	2	1	2	1	1	1	3	2	1	

Table 6. Abiotic field parameters of wetlands sampled at St. Marks, Lower Suwannee, Harris Neck, and Savannah National Wildlife Refuges in 2005. Measurements were made with a Hydrolab® Quanta handheld meter.

Date	Site Name	Water Temperature (°C)	SpC (ms/cm)	DO (mg/L)	pH	% DO
SMNWR						
6/4/2005	405 Borrow	27.94	0.018	4.26	3.9	54.40%
6/4/2005	407 Pond	24.13	0.04	1.66	3.59	19.70%
2/16/2005	Biggins Pond	24.04	0.028	7.64	4.58	89.20%
6/3/2005		30.67	0.027	6.92	3.73	92.70%
8/26/2005		34.56	10.67	10.31	3.54	152.50%
6/8/2005	Chicky Pond	24.33	0.033	6.29	3.66	82.90%
6/6/2005	Cingulatum Pond	28.45	0.057	3.08	5.53	40.80%
8/29/2005		28.05	0.049	3.61	5.98	49.20%
2/16/2005	Corner Pond	21.8	0.026	8.48	3.73	96.40%
6/5/2005		26.46	0.03	4.55	3.74	54.90%
8/27/2005		27.95	0.034	5.88	3.57	74.70%
6/5/2005	Fat Nerodia Pond	23.82	0.036	2.45	3.64	29.10%
8/26/2005		26.65	0.103	3.29	3.81	41.10%
6/7/2005	FL Trail Pond	22.56	0.283	0.59	6.65	7.00%
8/29/2005		26.58	0.381	1.49	6.44	17.90%
6/7/2005	Gator Ditch	25.01	0.821	0.87	7.08	10.60%
6/5/2005	Gum Forest Pond	27.35	0.023	5.74	3.87	72.80%
6/4/2005	Hawk Pond	25.21	0.03	2.97	4.05	36.00%
6/6/2005	Headquarters Pond	25.63	0.343	0.23	5.8	2.80%
8/29/2005		31.4	15.9	0.75	6.23	10.70%
8/27/2005	Jennifer's Sink	27.18	0.025	0.68	4.23	8.50%
2/16/2005	Kingfisher Pond	21.99	0.028	7.78	3.93	88.90%
6/3/2005		30.02	0.028	5.04	3.69	66.90%
8/26/2005		32.4	5.27	4.04	3.82	58.20%
6/8/2005	Near Burnt Pond	29.94	0.038	2.69	3.64	35.50%
2/19/2005	ORSP Borrow	15.55	0.018	9.19	7.39	91.30%
6/8/2005	Otter Lake	29.55	0.068	4.96	4.21	65.20%
8/26/2005		30.1	0.086	3.61	3.74	47.80%
8/27/2005	Perkinsus Pond	28.43	0.026	3.06	3.88	39.30%
6/6/2005	Plum Orchard Pond	28.11	0.057	3.12	5.32	39.80%
8/29/2005		27.35	0.156	0.98	5.84	12.40%
2/19/2005	Pond 2	12.72	0.032	7.9	4.35	74.50%
2/19/2005	Pond 8	13.87	0.037	7.41	3.85	72.10%
2/19/2005	Printiss Pond	9.92	0.048	5.69	4.46	50.20%
6/7/2005	PRS Pond	22.69	0.157	1.45	6.44	16.90%
6/5/2005	Ring Pond	28.1	0.029	3.4	3.68	43.40%
8/27/2005		32.11	0.077	4.87	3.51	64.60%
6/7/2005	Shepard Spring	20.59	0.7	1.47	6.85	16.40%
8/29/2005		20.75	1.14	1.28	6.6	14.30%
6/4/2005	Small Prairie Pond	28.13	0.028	5.32	3.77	68.10%
8/27/2005	Streetlight Pond	25.85	0.037	4.99	3.65	61.30%
2/16/2005	Talpoideum Pond	18.57	0.026	4.58	3.73	48.90%
6/4/2005		27.49	0.027	5.12	3.64	64.60%
8/28/2005		27.92	0.031	4.18	3.61	53.40%

Date	Site Name	Water Temperature (°C)	SpC (ms/cm)	DO (mg/L)	pH	% DO
6/6/2005	UBF Pond	27.09	0.059	3.19	5.93	42.20%
6/7/2005	Wakulla Field Pond	22.93	0.058	0.62	5.26	7.00%
8/29/2005		27.67	0.33	1.5	4.28	19.20%
2/19/2005	WBF Pond	12.36	0.042	8.48	4.65	79.30%
6/8/2005	Wpt 103	28.35	0.023	2.55	3.73	32.90%
8/27/2005	Wpt 150	27.17	0.02	2.71	4.15	33.70%
2/19/2005	Wpt 19	16.41	0.029	5.71	4.32	58.30%
6/3/2005		27.11	0.033	3.83	3.8	45.00%
8/26/2005		29.47	1.452	0.53	4.12	6.40%
2/19/2005	Wpt 192	11	0.032	13.1	4.11	131.40%
6/5/2005		26.4	0.031	6.38	3.66	79.40%
8/27/2005		27.06	0.034	2.06	3.7	25.90%
8/26/2005	Wpt 68	32.87	11.2	4.78	3.9	69.90%
2/16/2005	Wpt 69	19.45	0.026	6.26	4.07	67.50%
6/3/2005		29.29	0.027	3.7	3.74	48.70%
8/26/2005		31.09	0.035	3.76	3.71	50.40%
2/19/2005	Wpt 79	17.61	0.047	8.49	3.78	89.20%
6/3/2005		26.16	0.043	3.75	3.59	46.50%
8/26/2005		30.44	0.063	3.6	3.64	48.00%
6/6/2005	Yellow Fly Swamp	24.71	0.185	0.52	6.25	6.30%
LSNWR						
8/11/2005	BW1	25.71	0.166	4.13	6.78	50.80%
8/11/2005	BW2	25.07	0.234	1.14	6.61	13.20%
8/12/2005	Cabin Marsh	27.04	0.245	2.61	6.72	30.30%
4/27/2005	DC1 Pond	18.05	0.063	1.92	4.18	20.40%
8/9/2005		26.28	0.08	0.64	3.5	7.50%
4/27/2005	DC2 Pond	23.07	0.062	4.8	3.38	57.00%
8/9/2005		29.06	0.047	5.98	3.38	78.00%
4/26/2005	DC3 Pond	20.42	0.043	8.4	3.95	93.10%
8/9/2005		27.81	0.036	4.55	3.61	57.00%
4/26/2005	DC4 Pond	18.12	0.031	3.92	5.95	41.50%
8/9/2005		25.61	0.023	2.76	4.7	34.50%
4/26/2005	DC5 Pond	16.99	0.04	3.09	6.45	32.00%
8/9/2005		24.94	0.029	1.98	5.41	22.80%
8/10/2005	DM1	26.69	0.099	1.74	4.24	22.20%
8/10/2005	DM3	25.68	0.217	1.57	6.24	19.20%
8/10/2005	DM4	26.44	0.213	1.2	6.63	14.90%
8/10/2005	DM5	26.5	0.201	1.57	6.51	19.50%
4/28/2005	Gate 15 Borrow	20.67	0.047	4.96	6.46	55.30%
4/28/2005	Gate 18 Borrow	21.72	0.296	5.61	6.98	64.40%
8/11/2005	Gate 19 Swamp	25.87	0.242	1.48	6.53	16.90%
8/12/2005	Gate 25 Pond	28.51	0.306	3.8	7.37	49.10%
8/12/2005	Gate 31 Creek	26.37	0.572	1.36	7.18	16.90%
8/12/2005	Gate 39 Creek	26.85	0.5	1.67	7.17	20.20%
4/29/2005	HQ Pond	18.29	0.078	1.17	6.71	12.40%
4/28/2005	HQ Rd Pond	19.42	0.046	4.93	4.41	53.30%
4/29/2005	LC2 Swamp	18.81	0.062	1.65	6.67	17.40%
4/28/2005	LC3 Pond	18.08	0.219	4.25	6.76	44.50%
8/11/2005		28.16	0.216	5.13	6.6	64.30%

Date	Site Name	Water Temperature (°C)	SpC (ms/cm)	DO (mg/L)	pH	% DO
4/29/2005	LC5 Pond	22.35	0.3	3.24	7.06	39.80%
8/11/2005	Limpkin Pond	25.72	0.122	1.77	6.41	21.20%
4/29/2005	Main Loop Dome	18.16	0.299	1.9	7.42	19.70%
8/10/2005	Salt Point Pond	27.25	0.148	2.17	5.53	27.50%
8/12/2005	Sandfly Creek	27.06	0.354	2.2	7.32	27.50%
4/26/2005	Sulphur Spring	17.67	0.097	1.74	7.01	18.10%
4/27/2005	Triangle Loop Pond	19.74	0.049	3.88	4.79	40.90%
4/27/2005	Yellow Jacket Beaver Pond	18.5	0.246	2.07	6.21	22.00%
HNNWR						
3/22/2005	Borrow Pond	14.55	0.031	5.19	5.1	50.90%
5/17/2005		24.29	0.03	6.7	3.92	80.00%
7/27/2005		27.84	0.028	2.37	4.01	30.70%
3/22/2005	Culvert Pond	14.61	0.134	0.83	5.5	8.20%
5/17/2005		20.84	0.158	0.79	5.51	8.80%
7/26/2005		24.7	0.204	0.44	5.44	4.80%
3/22/2005	Goose Pond	16.49	0.353	5.06	6.54	51.90%
5/17/2005		26.03	0.186	4.21	6.33	51.90%
7/27/2005		28.86	0.134	0.51	5.95	8.10%
3/22/2005	Greenhead Pond	15.09	0.287	3.34	6.67	33.20%
5/17/2005		26.99	0.156	9.73	6.54	122.30%
3/22/2005	Lucas Borrow	14.76	0.065	3.09	5.49	30.50%
5/17/2005		21.77	0.074	0.26	5.19	2.90%
7/26/2005		25.75	0.09	0.36	5.16	4.10%
3/22/2005	Lucas Pond	14.54	0.074	1.51	6.43	14.80%
5/17/2005		21.99	0.041	0.39	4.91	4.50%
7/27/2005		26.6	0.071	0.13	5.14	1.70%
3/22/2005	N Runway Ditch	13.8	0.281	2.04	6.52	20.00%
5/17/2005		21.67	0.122	2.16	6.14	24.50%
7/26/2005		25.76	0.136	0.42	6.11	4.80%
3/22/2005	Plantation Fountain	18.67	0.112	14.87	8.65	159.30%
5/17/2005	Snipe Pond 1	27.47	0.31	8.93	6.6	113.30%
7/27/2005		27.65	0.315	0.11	6.49	1.40%
7/27/2005	Snipe Pond 2	28.44	0.397	2.03	6.5	26.40%
3/22/2005	Wigeon Pond	15.75	0.297	2.95	6.49	29.10%
5/17/2005		23.66	0.188	0.94	5.82	10.50%
7/27/2005		26.25	0.264	0.23	5.99	2.90%
3/22/2005	Woody Pond	16.8	0.388	4.59	6.71	47.20%
5/17/2005		23.57	0.269	0.29	6.45	3.30%
7/27/2005		25.53	0.267	0.26	6.08	3.10%
SVNWR						
3/24/2005	DT-2	16.79	0.037	5.11	6.94	52.60%
5/20/2005		22.46	0.027	0.91	5.53	10.50%
7/28/2005		28.6	0.027	0.38	5.08	4.90%
5/20/2005	HQ-1	24.24	0.168	0.21	5.72	2.50%
7/28/2005	ND-3	28.89	0.113	0.31	5.97	3.90%
5/20/2005	ND-4	22.74	0.219	0.35	5.66	4.00%
5/20/2005	ST-3	22.55	0.092	3.92	6.02	45.00%
5/20/2005	ST-5	20.76	0.065	0.47	5.52	5.10%
3/24/2005	WD-3	15.98	1.24	3.67	6.54	37.30%

Date	Site Name	Water Temperature (°C)	SpC (ms/cm)	DO (mg/L)	pH	% DO
5/20/2005		22.54	0.958	1.39	6.3	16.00%
7/28/2005		27.48	0.877	0.25	6.38	3.10%
3/24/2005	WD-6	15.28	0.853	2.27	7.01	22.80%
3/24/2005	WD-7	18.87	1.004	2.58	7.03	27.50%
7/28/2005		26.3	0.705	0.44	6.25	5.40%
5/20/2005	WD-8	22.96	1.83	0.34	6.21	3.80%
7/28/2005		27.84	2	0.32	6.34	4.30%

Table 7. Amphibian and reptile specimens collected at St. Marks, Lower Suwannee, Harris Neck, and Savannah National Wildlife Refuges by USGS-SEARMI during 2005.

Date	St.	Co.	UTM-E	UTM-N	Zone	Locality	Collector(s)	Species	FLMNH#
17-Feb-05	FL	Wakulla	747034	3327586	16	St. Marks NWR; Panacea Unit, pond on N side of RR338 at corner of refuge boundary (USGS-ARMI site Corner Pond)	WJB, MSG, JSS, ALS, LMS	*Ambystoma talpoiduem* (larva)	A
4-Apr-05	FL	Wakulla	744806	3325943	16	St. Marks NWR; Panacea Unit, pond on E side of RR406 just S of USGS-ARMI site WBF (USGS-ARMI site WBF Pond)	WJB, MSG, JSS, ALS, LMS	*Pseudacris ornata* (larva)	144927
16-May-05	GA	McIntosh	473461	3499861	17	Harris Neck NWR; USGS-ARMI site Borrow Pond; found lethargic, w/ lesion on side	CKD, WJB, MSG, JSS, DRG	*Notophthalmus viridescens*	144883
17-May-05	GA	McIntosh	474569	3501066	17	Harris Neck NWR; USGS-ARMI site N Runway Ditch	CKD, WJB, DRG	*Pseudacris crucifer* (2 metamorphs)	144931
20-May-05	SC	Jasper	492492	3561681	17	Savannah NWR; USGS-ARMI site DT-2 (Kingfisher Pond)	CKD, WJB, DRG	*Rana spenocephala* (larva)	144960
20-May-05	SC	Jasper	492492	3561681	17	Savannah NWR; USGS-ARMI site DT-2 (Kingfisher Pond); found w/ lesion	CKD, WJB, DRG	*Rana clamitans* (larva)	144877
21-May-05	SC	Jasper	492492	3561681	17	Savannah NWR; USGS-ARMI site DT-2 (Kingfisher Pond)	CKD, WJB, DRG	*Rana sphenocephala* (2 larvae)	144961
8-Jun-05	FL	Wakulla	749894	3327596	16	St. Marks NWR; Panacea Unit, pond off E side of RR314 just N of jct w/ RR317 (USGS-ARMI site Near Burnt Pond); found dead in trap (killed by belostomatid beetle)	WJB, MSG, JSS, DRG	*Notophthalmus viridescens*	144949
8-Jun-05	FL	Wakulla	745998	3324492	16	St. Marks NWR; Panacea Unit, borrow pit on E side of CR372, N of jct w/ RR401 ca halfway btwn RR401 and 405 (USGS-ARMI site Wpt 103); found w/ abnormal patch of skin on dorsum (fungal infection?)	WJB, MSG, JSS, DRG	*Bufo quercicus*	B
8-Jun-05	FL	Wakulla	751035	3328377	16	St. Marks NWR; Panacea Unit, pond on W side of RR314 N of Long Lk (USGS-ARMI site Perkinsus Pond)	WJB, MSG, JSS, DRG	*Hyla femoralis* (5 larvae), *Acris gryllus* (2 larvae)	144971
8-Jun-05	FL	Wakulla	751035	3328377	16	St. Marks NWR; Panacea Unit, pond on W side of RR314 N of Long Lk (USGS-ARMI site Perkinsus Pond)	WJB, MSG, JSS, DRG	*Hyla femoralis* (5 larvae), *Acris gryllus* (5 larvae), *Hyla gratiosa* (4 larvae)	B
28-Jul-05	SC	Jasper	492492	3561681	17	Savannah NWR; USGS-ARMI site DT-2 (Kingfisher Pond); found dead in trap	CKD, WJB, DRG	*Rana grylio* (3 larvae)	144959
28-Jul-05	SC	Jasper	492492	3561681	17	Savannah NWR; USGS-ARMI site DT-2 (Kingfisher Pond); found dead in trap	CKD, WJB, DRG	*Rana heckscheri* (5 larvae)	144975
28-Jul-05	SC	Jasper	492492	3561681	17	Savannah NWR; USGS-ARMI site DT-2 (Kingfisher Pond); found dead in trap	CKD, WJB, DRG	*Rana heckscheri* (several larvae)	144857
10-Aug-05	FL	Dixie	291549	3252159	17	Lower Suwannee NWR; DOR on Dixie Main Line ca 3.5 mi NW of jct w/ CR349	WJB, MSG, DRG	*Ophisaurus ventralis*	144792
26-Aug-05	FL	Wakulla	749872	3322969	17	St. Marks NWR; Panacea Unit, pond at NE corner of jct of RR320, 321, 322 (USGS-ARMI site Wpt 79)	MSG, JSS, DRG	*Rana sphenocephala* (larva)	144943
27-Aug-05	FL	Wakulla			16	St. Marks NWR; Wakulla Unit, DOR on Wakulla Bch Rd just S of RR200	WJB	*Crotalus adamanteus*	C

Collectors:
WJB - W.J. Barichivich, USGS
CKD - C.K. Dodd, Jr., USGS
DRG - D.R. Gregoire, USGS
MSG - M.S. Gunzburger, USGS
ALS - A.L. Sheldon, USFWS volunteer
LMS - L.M. Sheldon, USFWS volunteer
JSS - J.S. Staiger, USGS

Codes:
A: kept live for research/education purposes at USGS lab
B: sent to USGS National Wildlife Health Center (NWHC), Madison, WI
C: not sent to Florida Museum of Natural History (FLMNH), Gainesville, FL (kept at USGS lab)

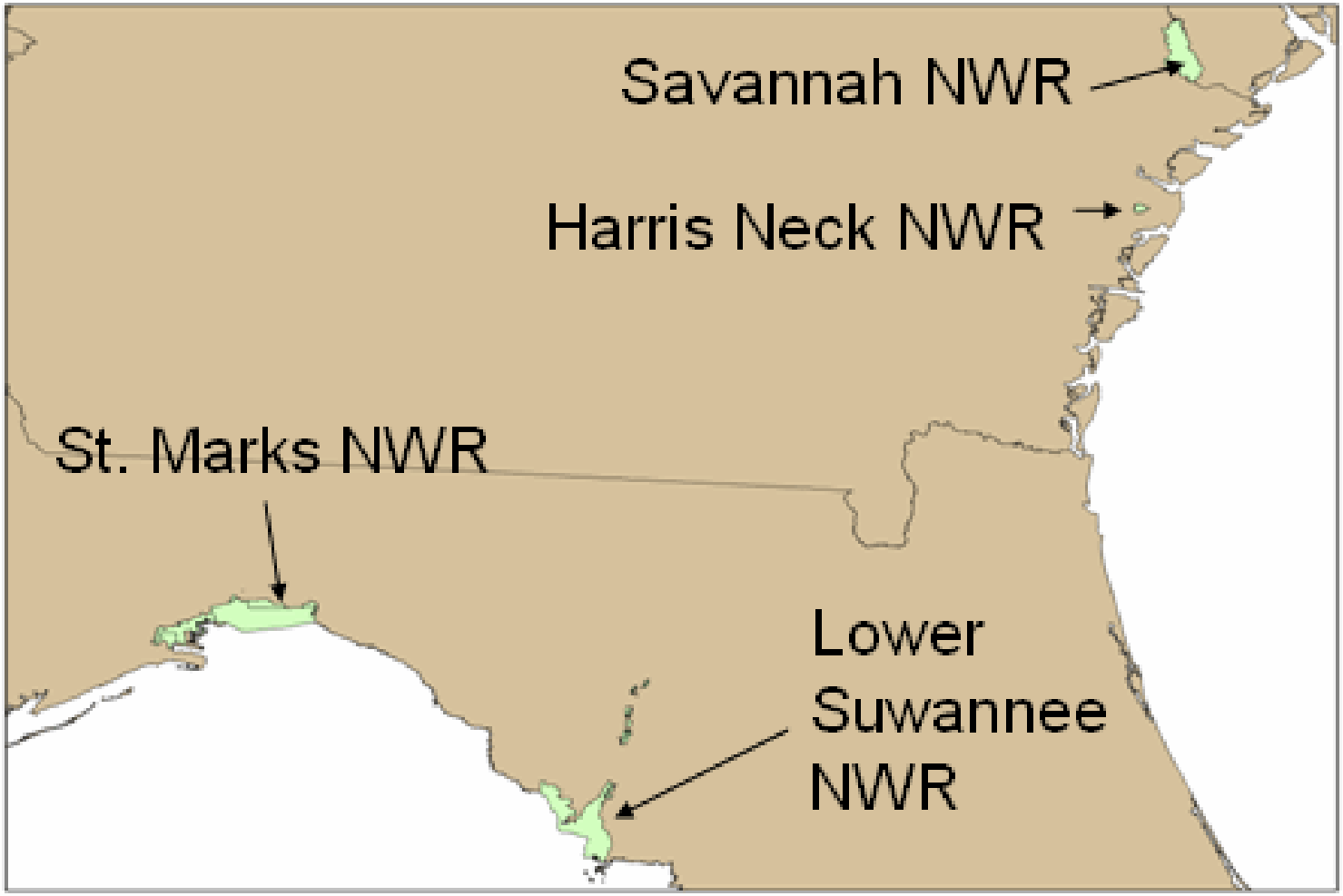

Fig. 1. General locations of St Marks, Lower Suwannee, Harris Neck, and Savannah National Wildlife Refuges.

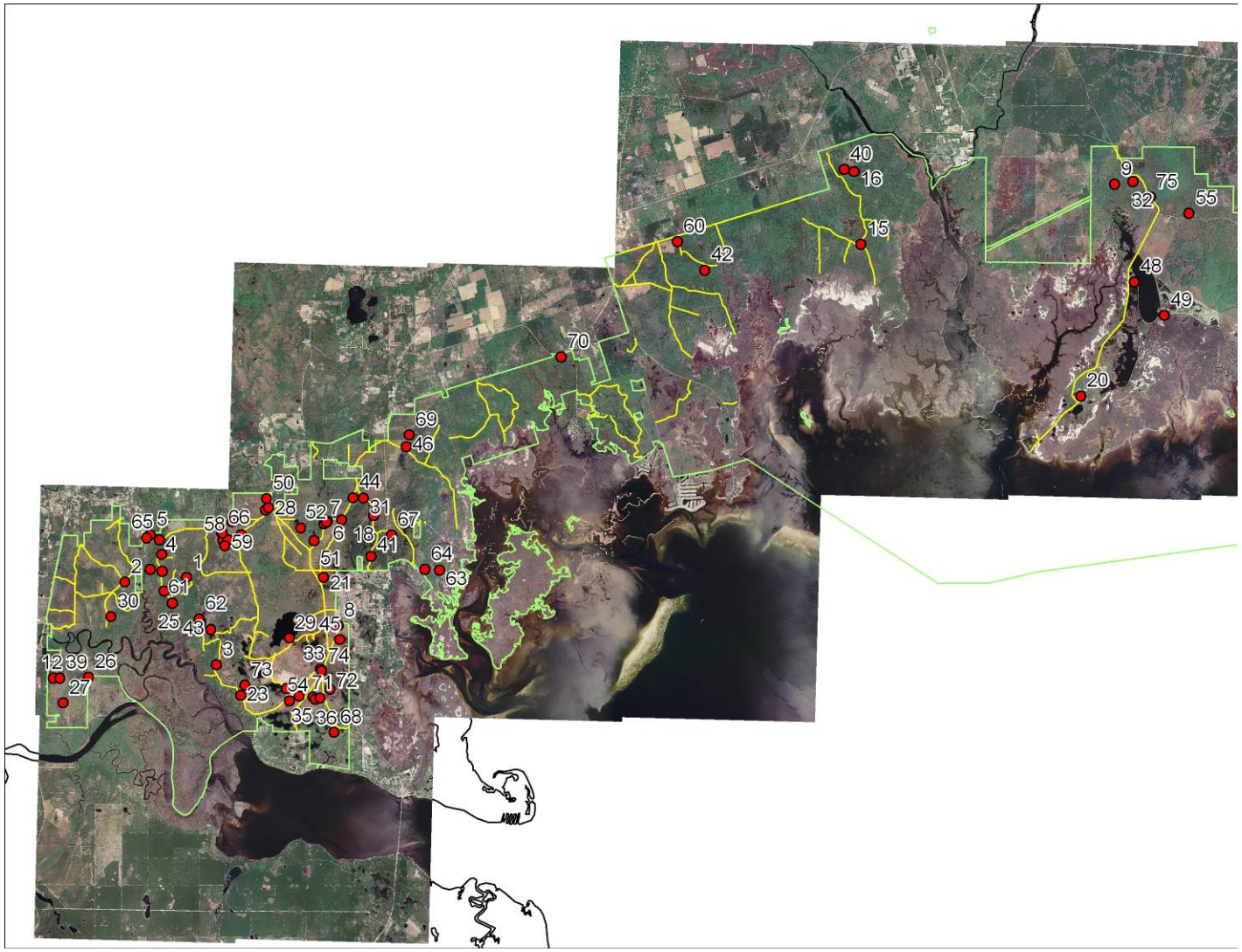

Fig. 2A. Locations of ARMI sampling sites at St Marks NWR.

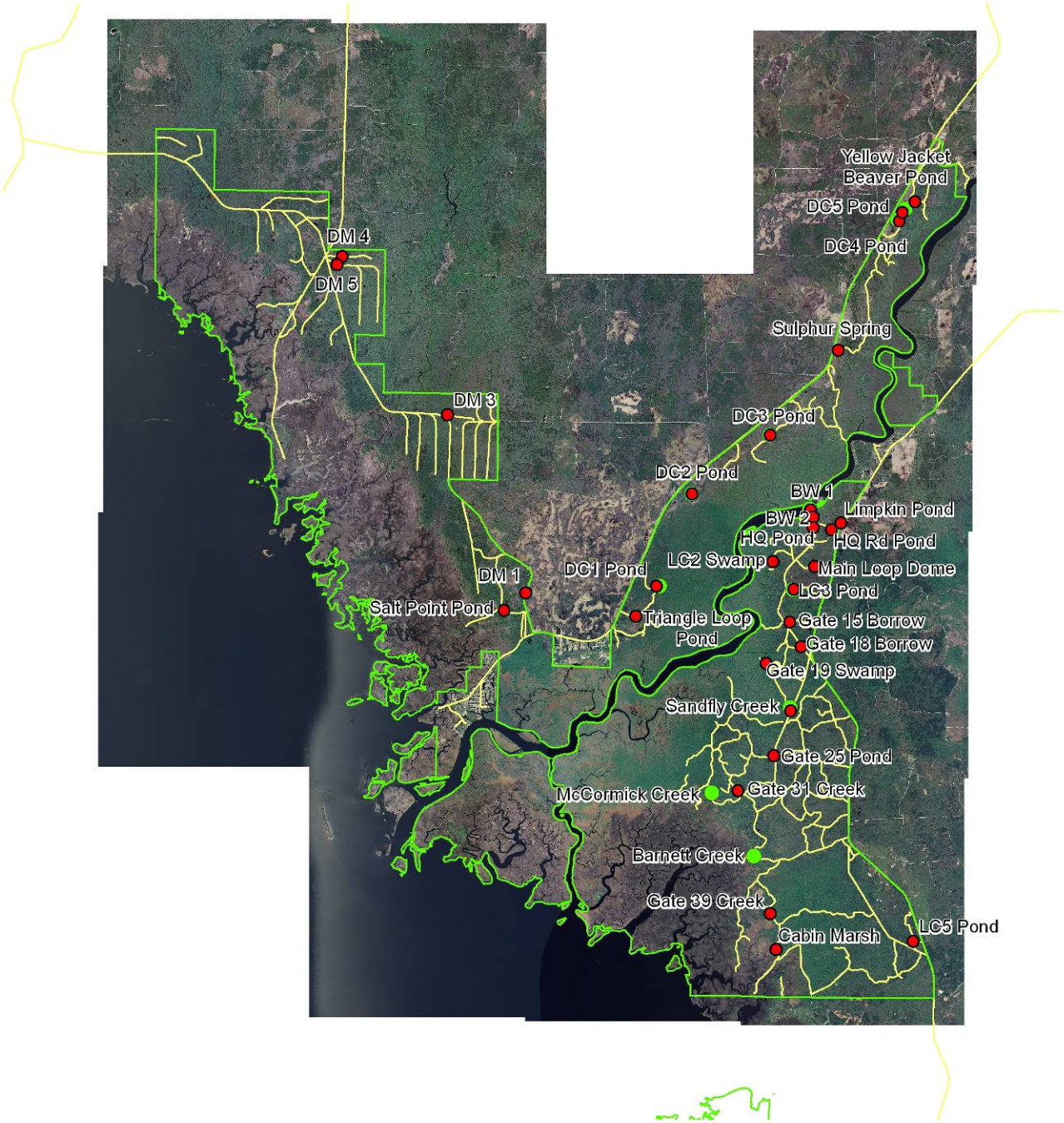

Fig. 2B. Locations of ARMI sampling sites at Lower Suwannee NWR.

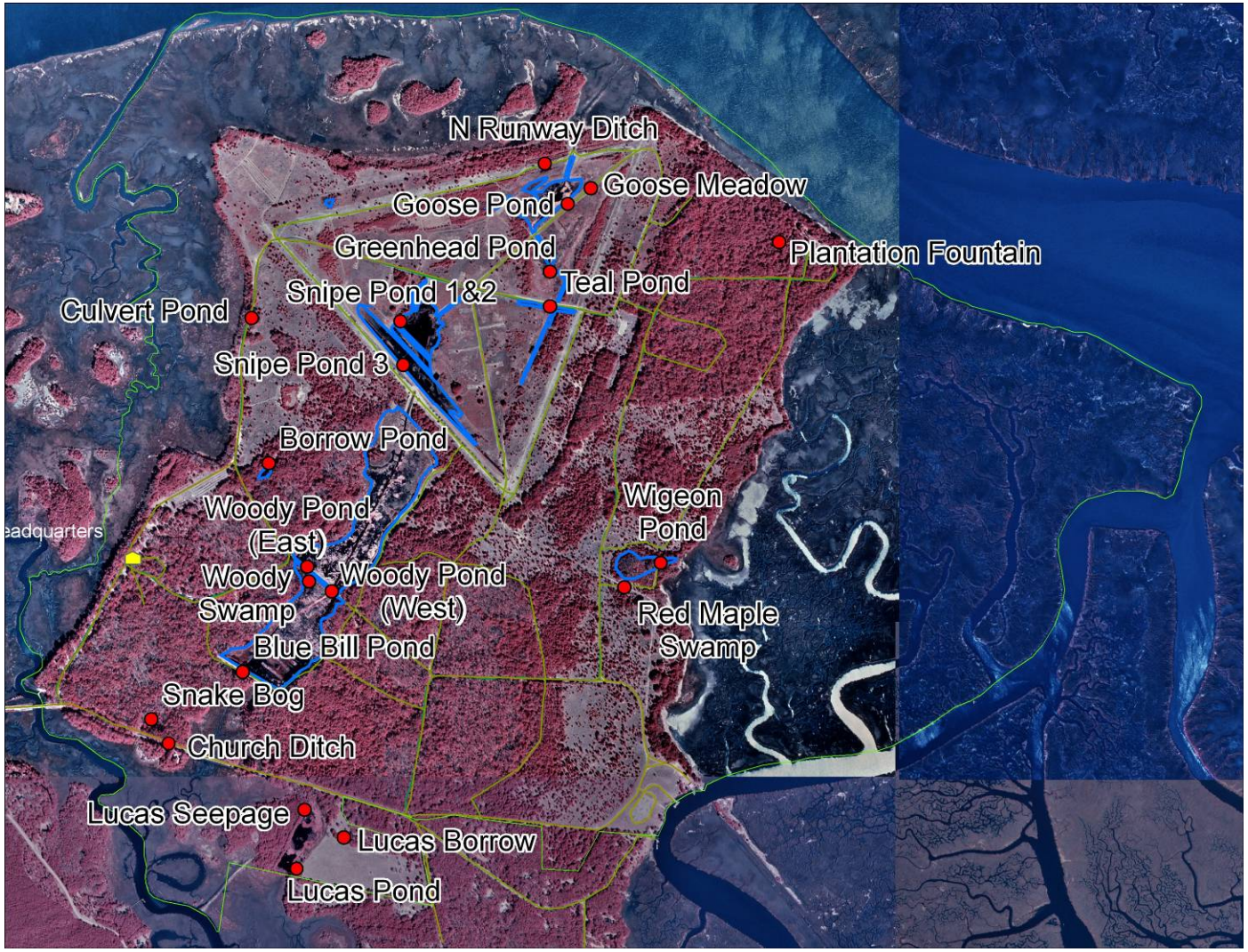

Fig. 2C. Locations of ARMI sampling sites at Harris Neck NWR.

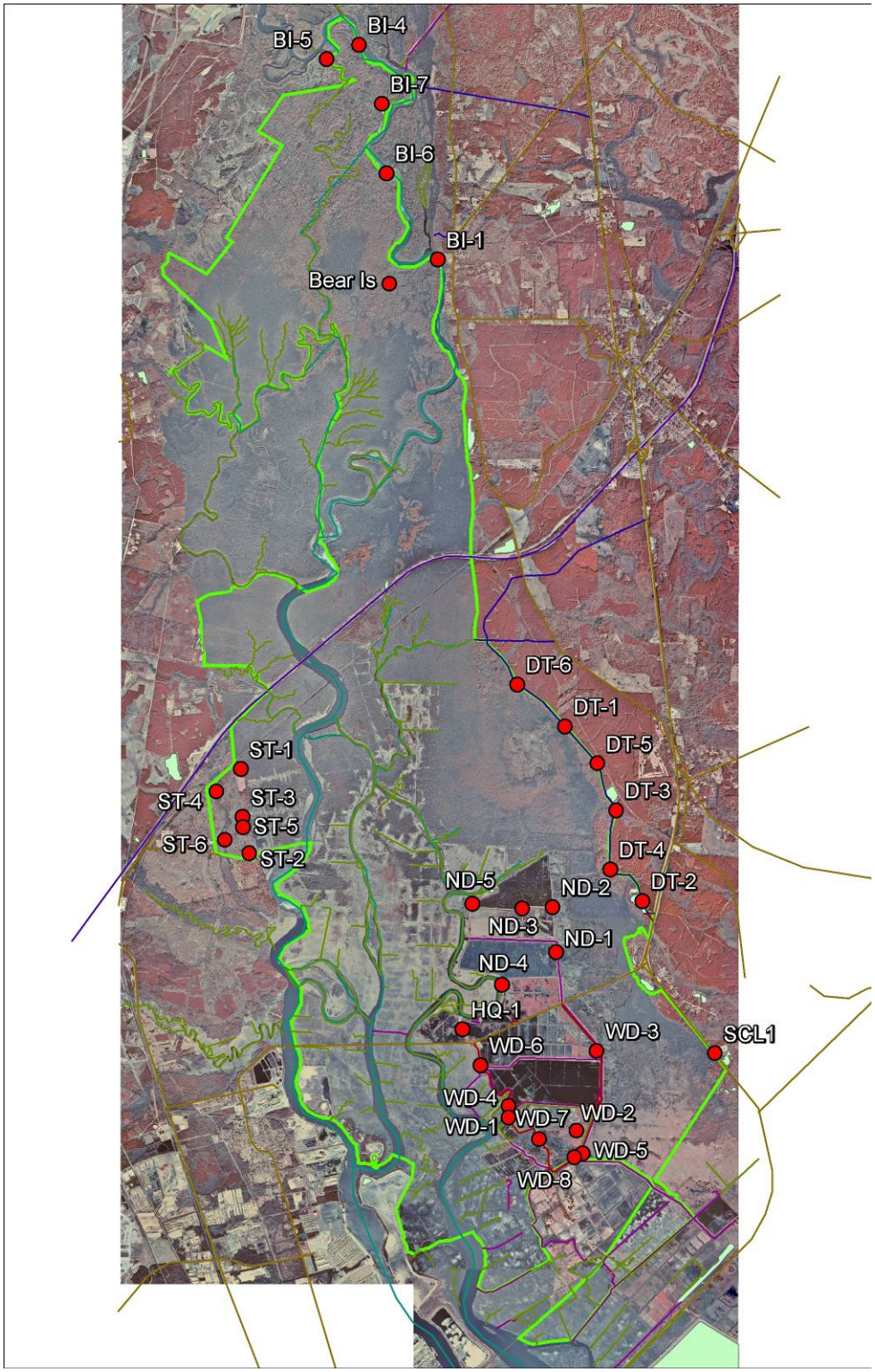

Fig. 2D. Locations of ARMI sampling sites at Savannah NWR.

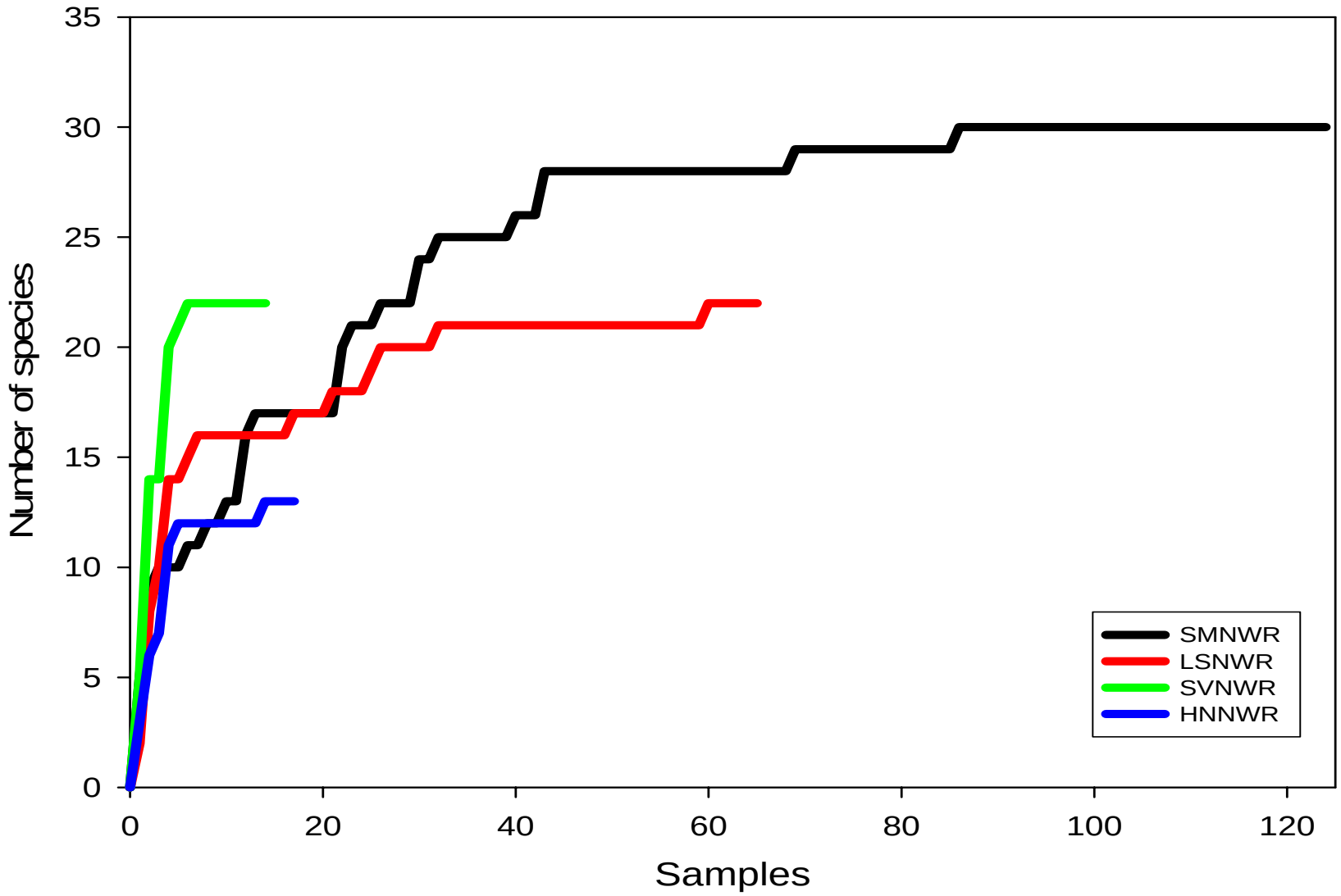

Fig. 3. Cumulative number of species of amphibians detected at each refuge relative to sampling effort (total number of days).

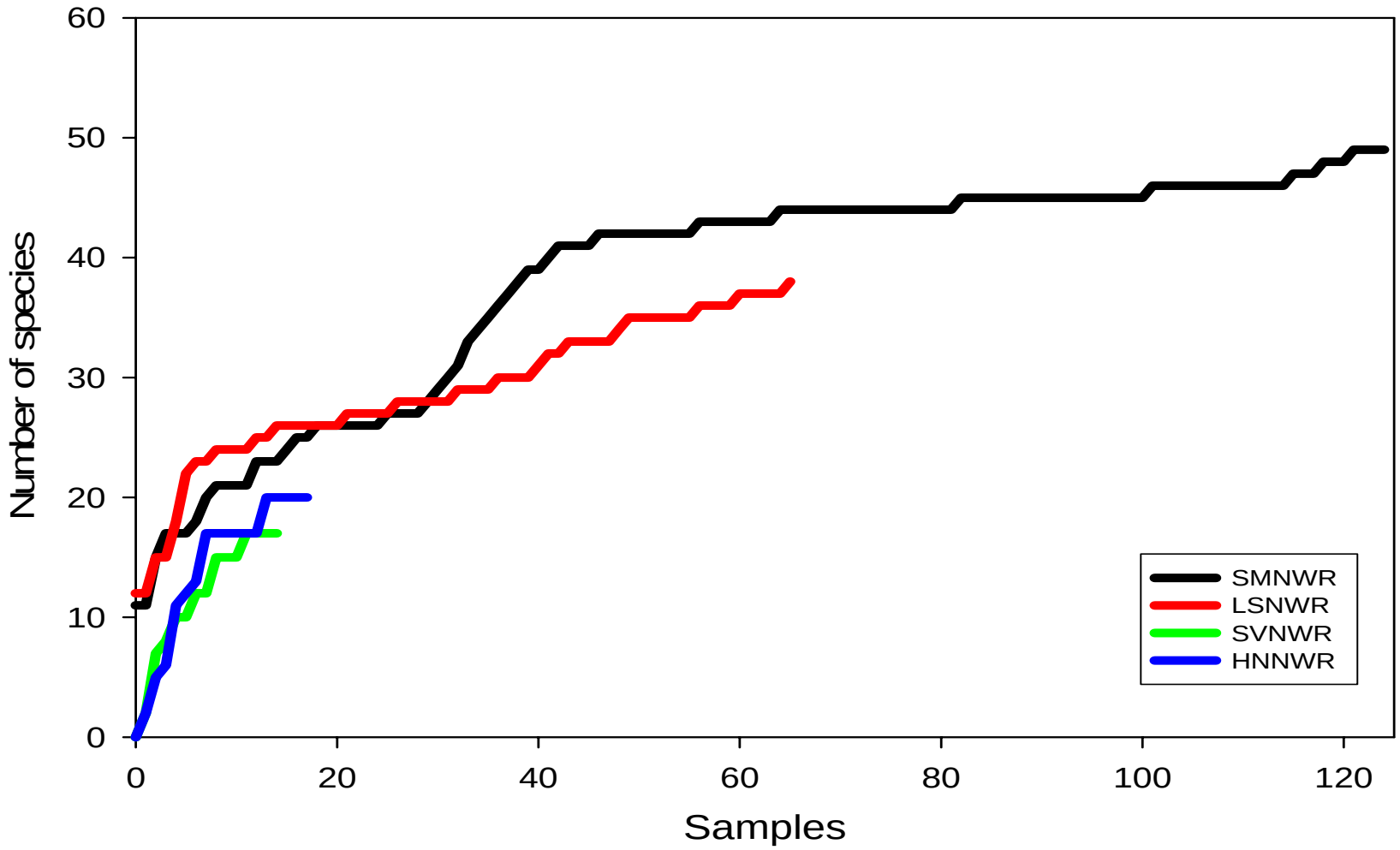

Fig. 4. Cumulative number of species of reptiles detected at each refuge relative to sampling effort (total number of days).

Appendix I. Summary of Southeast ARMI monitoring sites and species 1998-2005.

Location	State	Agency/Collaborator	Period	Primary Species
Apex Monitoring Sites				
Great Smoky Mountains NP	NC, TN	NPS	1998 - 2003	*Desmognathus conanti, D. imitator, D. marmoratus, D. monticola, D. ocoee, D. quadramaculatus, D. santeetlah, D. wrighti, Eurycea wilderae, Gyrinophilus porphyriticus, Hemidactylium scutatum, Plethodon glutinosus, P. jordani, P. metcalfi, P. serratus, P. teyahalee*
Okefenokee NWR	GA, FL	USFWS	2000 - 2002	*Hyla cinerea, H. femoralis, H. squirella, Amphiuma means, Siren lacertina*
Katharine Ordway Preserve – Swisher Memorial Sanctuary	FL	Univ. of Florida/The Nature Conservancy	2001 – 2002, 2005 – ongoing	*Amphiuma means, Siren lacertina*
Mid-level Monitoring Sites				
Okefenokee NWR	GA, FL	USFWS	2000 – 2002	*Acris gryllus, Bufo quercicus, B. terrestris, Hyla cinerea, H. femoralis, H. squirella, Pseudacris ocularis, Rana c. clamitans, R. grylio, R. heckscheri, R. sphenocephala utricularia, R. virgatipes, Amphiuma means, Eurycea quadridigitata, Pseudobranchus striatus, Siren lacertina*
St. Marks NWR	FL	USFWS	2002 – ongoing	*Acris gryllus dorsalis, Bufo quercicus, B. terrestris, Eleutherodactylus planirostris, Gastrophryne carolinensis, Hyla chrysoscelis, H. cinerea, H. femoralis, H. gratiosa, H. squirella, Pseudacris crucifer bartramiana, P. n. nigrita, P. ocularis, P. ornata, Rana catesbeiana, R. c. clamitans, R. grylio, R. heckscheri, R. s. sphenocephala, Scaphiopus holbrookii, Ambystoma cingulatum, A. talpoideum, Amphiuma means, Eurycea quadridigitata, Notophthalmus viridescens louisianensis, Plethodon grobmani, Pseudobranchus striatus spheniscus, Siren i. intermedia, S. lacertina*.

Location	State	Agency/Collaborator	Period	Primary Species
Lower Suwannee NWR	FL	USFWS	2003 – ongoing	*Acris gryllus dorsalis, Bufo quercicus, B. terrestris, Eleutherodactylus planirostris, Gastrophryne carolinensis, Hyla chrysoscelis, H. cinerea, H. femoralis, H. gratiosa, H. squirella, Pseudacris crucifer bartramiana, P. ocularis, Rana catesbeiana, R. c. clamitans, R. grylio, R. s. sphenocephala, Scaphiopus holbrookii*
Base level Inventories				Inventories target all species at each location
Great Smoky Mountains NP	NC, TN	NPS	1998 - 2000	*Bufo a. americanus, B. fowleri, Gastrophryne carolinensis, Hyla chrysoscelis, Pseudacris c. crucifer, P. f. feriarum, Rana catesbeiana, R. clamitans melanota, R. palustris, R. sylvatica, Scaphiopus holbrookii, Ambystoma maculatum, A. opacum, A. talpoideum, Cryptobranchus a. alleganiensis, Desmognathus aeneus, D. conanti, D. imitator, D. marmoratus, D. monticola, D. ocoee, D. quadramaculatus, D. santeetlah, D. wrighti, Eurycea guttolineata, E. junaluska, E. l. longicauda, E. lucifuga, E. wilderae, Gyrinophilus porphyriticus, Hemidactylium scutatum, Necturus m. maculosus, Notophthalmus v. viridescens, Plethodon glutinosus, Pl. jordani, Pl. metcalfi, Pl. serratus, Pl. teyahalee, Pl. ventralis, Pseudotriton montanus, Ps. ruber*

Location	State	Agency/Collaborator	Period	Primary Species
Okefenokee NWR	GA, FL	USFWS	2000 – 2002	*Acris gryllus, Bufo quercicus, B. terrestris, Gastrophryne carolinensis, Hyla cinerea, H. femoralis, H. squirella, Pseudacris crucifer bartramiana, P. ocularis, Rana capito aesopus, R. c. clamitans, R. grylio, R. heckscheri, R. sphenocephala utricularia, R. virgatipes, Amphiuma means, Eurycea quadridigitata, Pseudobranchus striatus, Siren lacertina*
St. Marks NWR	FL	USFWS	2002 – ongoing	20 frog, 10 salamander spp. documented to date
Lower Suwannee NWR	FL	USFWS	2003 – ongoing	18 frog, 4 salamander spp. documented to date
Savannah NWR	GA, SC	USFWS	2004 – ongoing	15 frog, 7 salamander spp. documented to date
Harris Neck NWR	GA	USFWS	2004 – ongoing	12 frog, 1 salamander spp. documented to date

Appendix II. Publications and presentations by Southeast ARMI researchers in 2005.

Publications:

Corn, P.S., E. Muths, M.J. Adams, and C.K. Dodd, Jr. 2005. The U.S. Geological Survey's Amphibian Research and Monitoring Initiative. Alytes 22(3-4):65-71.

Dodd, C.K., Jr. 2005. Population manipulations. Pp. 265-270 In: M.J. Lannoo (ed.), Declining Amphibians: The Conservation Status of United States Species. Univ. California Press, Berkeley.

Dodd, C.K., Jr. 2005. Red Hills salamander. *Phaeognathus hubrichti* Highton, 1961. Pp. 785-787 In: M.J. Lannoo (ed.), Declining Amphibians: The Conservation Status of United States Species. Univ. California Press, Berkeley.

Dodd, C.K., Jr. and M.L. Griffey. 2005. The conservation of box turtles on public lands in Florida. Pp. 103-110 In: W. E. Meshaka Jr. and K. J. Babbitt (eds.), Amphibians and Reptiles. Status and Conservation in Florida. Krieger Publ., Malabar, Florida.

Dodd, C.K., Jr., D. B. Means, and S.A. Johnson. 2005. Striped newt. *Notophthalmus perstriatus* (Bishop), 1941. Pp. 887-889 In: M.J. Lannoo (ed.), Declining Amphibians: The Conservation Status of United States Species. Univ. California Press, Berkeley.

Dodd, C. K., Jr. (ed.). 2005. The Amphibian Research and Monitoring Initiative. Proceedings of a Symposium held in Norman, Oklahoma, USA, 2004. Alytes 2005 22(3-4):65-167.

Dodd, C.K., Jr. 2005. (Review of) *The Musk Turtle Book*, by John Iverson, *with a Section on Husbandry*, by Richard Cary Paull. Herpetol. Rev. 36: 348-349.

Dodd, C.K., Jr. 2005. Dilemma of the common species: Florida Box Turtles. Iguana. 12(3): 152-159.

Dodd, C. K., Jr., J. Loman, D. Cogălniceanu, and M. Puky. 200_. Monitoring Amphibian Populations. Pp. – H.H. Heatwole and J. W. Wilkenson (eds.), Conservation and Decline of Amphibians, Amphibian Biology, Volume 9A, Surrey Beatty & Sons, Chipping Norton, New South Wales, Australia., in press.

Geis, A.A., W.J. Barichivich, T. Wibbels, M. Coyne, A.M. Landry Jr., and D. Owens. 2005. Predicted sex ratio of juvenile Kemp's Ridley sea turtles captured near Steinhatchee, Florida. Copeia 2005:393-398.

Gregoire, D. R. 2005. Guide to Tadpoles of the Southeastern Coastal Plain. United States Geological Survey Report. Florida Integrated Science Center. 60 pp.

Gunzburger, M. S. 2005. Differential predation on tadpoles influences the potential effects of hybridization between *Hyla cinerea* and *Hyla gratiosa.* Journal of Herpetology 39:682-687.

Gunzburger, M. S. and J. Travis. 2005. Critical literature review of the evidence for unpalatability of amphibian eggs and larvae. Journal of Herpetology 39:547-571

Gunzburger, M. S. and J. Travis. 2005. Effects of multiple predator species on green treefrog (*Hyla cinerea*) tadpoles. Canadian Journal of Zoology 83:996-1002.

Kuzmin, S. L. and C. K. Dodd, Jr. 200_. Commonwealth of Independent States. Pp. – In: H.H. Heatwole and J. W. Wilkenson (eds.), Regional Assessment of Decline in Amphibians, Amphibian Biology, Volume 9B. Surrey Beatty & Sons, Chipping Norton, New South Wales, Australia., in press.

Muths, E., R.E. Jung, L. Bailey, M.J. Adams, P.S. Corn, C.K. Dodd, Jr., G. Fellers, W.J. Sadinski, C. Schwalbe, S. Walls, R.N. Fisher, A.L. Gallant, W.A. Battaglin, and D.E. Green. 2005. The U.S. Department of Interior's Amphibian Research and Monitoring Initiative (ARMI): a successful start to a national program. Applied Herpetol., in press.

Schlaepfer, M.A., C. Hoover, and C. K. Dodd, Jr. 2005. Challenges in evaluating the impact of the trade in amphibians and reptiles on wild populations. BioScience 55(3):256-263.

Schmid, J.R. and W.J. Barichivich. 2005. Developmental biology and ecology of the Kemp's ridley sea turtle. *Lepidochelys kempii*, in the eastern Gulf of Mexico. Chelonian Conservation and Biology 4(4):828-834.

Smith, K. G. 2005. Effects of nonindigenous tadpoles on native tadpoles in Florida: Evidence of competition. Biological Conserv. 123:433-441.

Smith, K. G. 2005. An exploratory assessment of Cuban Treefrog (*Osteopilus septentrionalis*) tadpoles as predators of native and nonindigeneous tadpoles in Florida. Amphibia-Reptilia 26:571-575.

Smith, L. L., K. G. Smith, W.J. Barichivich, C. K. Dodd, Jr, and K. Sorensen. 2005. Roads and Florida's herpetofauna: a review and mitigation case study. Pp. 32-40 In: W. E. Meshaka Jr. and K.J. Babbitt (eds.), Amphibians and Reptiles. Status and Conservation in Florida. Krieger Publ., Malabar, FL.

Oral Presentations:

Dodd, C.K., Jr. 2005. Challenges in evaluating the impact of trade on wild populations. 11th Annual Public Interest Environmental Conference, University of Florida College of Law. Invited panelist in session entitled "Slip Sliding Away: Conservation Status of Reptiles and Amphibians," Gainesville, Florida. Feb 24-26.

Dodd, C.K., Jr. 2005. Remembering 'common' species during restoration: a lesson from Egmont Key. Annual meeting of the Florida Chapter of The Wildlife Society and Coastal Plain Chapter of the Society for Ecological Restoration, Tarpon Springs, Florida. Mar 16-18. [Plenary Speaker]

Dodd, C.K., Jr., A. Ozgul, and M. Oli. 2005. Survival and dispersal rates of Florida Box Turtles affected by multiple disturbance events. Joint Meeting of Ichthyologists and Herpetologists, Tampa, Florida. Jul 6-11.

Dodd, C.K., Jr. 2005. Remembering 'common' species during restoration: lessons from Egmont Key. Invited seminar, Alabama A & M University, Huntsville, AL. Oct 28.

Dodd, C. K., Jr. 2005. Southeast ARMI: Tracking amphibians across the southern landscape. USGS ARMI national meeting, Tucson, AZ. 2 Nov.

Dodd, C. K., Jr. 2005. National treasures: the box turtles of Egmont Key. Friends of Chassahowitzka National Wildlife Refuge. Crystal River, FL. 18 Nov.

Dodd, C.K., Jr. 2005. Declining amphibians and emerging disease issues. Invited lecture in *Impact of Disease on Wildlife* (WIS 5323c), College of Veterinary Medicine, Univ. Florida. 21 Nov.

Gunzburger, M. S. and M. J. Aresco. 2005. Effects of large-scale sediment removal on populations of herpetofauna in Florida lakes. 28th Annual Herpetology Conference, Gainesville, Florida. 26 Mar 2005.

Gunzburger, M. S. 2005. The role of predation in the habitat distribution of a wide-ranging prey species, the green treefrog (*Hyla cinerea*). University of Florida, Department of Wildlife Ecology and Conservation, Gainesville, Florida. 7 Feb 2005.

Gunzburger, M. S. 2005. The relative roles of predation and competition in the habitat distribution of two sister taxa of Hylid treefrogs. Joint Meeting of Ichthyologists and Herpetologists, Tampa, Florida. Jul 2005.

Gunzburger, M. S. 2005. Southeast ARMI: tracking amphibians across the southern landscape. Gopher Tortoise Council Meeting, Palatka, Florida. Oct 2005.

Poster Presentations:

Aresco, M. J. and M. S. Gunzburger. 2005. Ecology of the snapping turtle, *Chelydra serpentina*, in northwestern Florida. Poster presentation, Joint Meeting of Ichthyologists and Herpetologists, Tampa, Florida. Jul 2005.

Barichivich, W. J. 2005. Factors affecting Southern Leopard Frog, *Rana sphenocephala*, distribution and detection in five coastal plain refuges. Poster presentation, Joint Meeting of Ichthyologists and Herpetologists, Tampa, Florida. Jul 2005.

Dodd, C. K., Jr. 2005. Postcards from the Edge: A Tourist's View of the Key West Turtle Fishery. Poster presention, 25th Annual Symposium on Sea Turtle Conservation and Biology, Savannah, Georgia. 16-22 Jan.

Dodd, C.K., Jr., M.S. Gunzburger, J.S. Staiger and W.J. Barichivich. 2005. Amphibian research and monitoring on National Wildlife Refuges in the Southeastern United States. Poster presentation, Joint Meeting of Ichthyologists and Herpetologists, Tampa, Florida. July 6-11.

Staiger, J. S. 2005. An evaluation of three aquatic sampling techniques for amphibians: implications for inventory and monitoring project design. Poster presentation, Joint Meeting of Ichthyologists and Herpetologists, Tampa, Florida. Jul 2005.

Appendix III: National Wildlife Health Center Pathology Reports

NATIONAL WILDLIFE HEALTH CENTER
6006 SCHROEDER ROAD
MADISON, WI 53711-6223
PHONE: (608) 270-2400 FAX: (608) 270-2415

PRELIMINARY PATHOLOGY REPORT on AMPHIBIANS from NATIONAL FISH HATCHERIES in SOUTHEASTERN UNITED STATES, 2005

Submitter:
Ken Dodd & Jamie Barichivich
USGS Florida Caribbean Science Center
7920 Northwest 71st Street
Gainesville FL 32653

Date of Report: 14 October 2005

Case No.: **4912 (012-162)**

Capture Dates: May & June 2005

Specimens:

State	Fish Hatchery	Capture Date	Species	n=	Life Stage	NWHC Acsn No.	Primary Diagnoses
FL	Welaka	26 May 05	*H. cinerea*	2	Larva	096-097	VI-2, S-2, M2/2, A2
FL	Welaka	26 May 05	*H. gratiosa*	5	Larva	035-039	VI-5, S-4, M3/3, OD3, A1
FL	Welaka	26 May 05	*H. squirella*	30	Larva	040-049, 076-095	VI-27, S-13, M9/9, OD3, A1
FL	Welaka	26 May 05	*R. sphenocephala*	48	Larva	012-034, 050-075	VI-31, S-9, M10/13, OD2, A3
GA	Warm Springs	13 June 05	*H. cinerea*	5	Larva	123-127	VI-3, S-1, OD1
GA	Warm Springs	13 June 05	*R. catesbeiana*	5	Larva	153-157	VI-5, S-1, M3/3, OD2
GA	Warm Springs	13 June 05	*R. clamitans*	5	Larva	133-137	VI-3, S-1, M1/2, A1
GA	Warm Springs	13 June 05	*B. terrestris*	5	Larva	128-132	VI-3, S-0, M1/2, OD3
NC	Edenton	15 June 05	*B. terrestris*	5	Larva	118-122	VI-3, S-1, M0/2, A1
NC	Edenton	15 June 05	*R. catesbeiana*	5	Larva	138-142	VI-3, S-1, M0/2
NC	Edenton	15 June 05	*H. cinerea*	5	Larva	143-147	VI-3, S-1, M2/2
NC	Edenton	15 June 05	*R. catesbeiana*	5	Larva	148-152	VI-3, S-1, M4/4
SC	Orangeburg	14 June 05	*B. terrestris*	5	Larva	113-117	VI-3, S-1, M0/2, OD3, A1
SC	Orangeburg	14 June 05	*G. carolinensis*	5	Larva	103-107	VI-3, S-2
SC	Orangeburg	14 June 05	*H. cinerea*	5	Larva	098-102	VI-2, S-1, OD3
SC	Orangeburg	14 June 05	*H. femoralis*	3	Larva	108-110	VI-3, S-1, OD3
SC	Orangeburg	14 June 05	*R. sphenocephala*	5	Larva	158-162	VI-3, S-1, M1/1

Abbreviations in the last (right) column of the specimen table are as follows: **VI**-5 indicates virus isolation and the number of tadpoles in which virus cultures were attempted; **S**-2 indicates salmonella bacterial cultures and the number of tadpoles in which intestinal cultures were attempted; **M**2/2 indicates myxozoan parasites (***Myxidium*** sp) in the gall bladders; the first number indicates number of tadpoles with the parasite and the number after the back-slash indicates number of tadpoles examined; **OD**-2 indicates depigmentation of the oral disc and the number indicates the number of affected tadpoles; **A**3 indicates isolations of *Aeromonas hydrophila* from the intestines and the number represents the number of tadpoles with the bacterium.

Preliminary Diagnoses:

1. Oral discs: Depigmentation of jaws or toothrows in 8 of 85 tadpoles from Welaka NFH, 6 of 20 tadpoles from Warm Springs NFH, and 9 of 23 tadpoles from Orangeburg NFH.

2. Gall bladders: Myxozoan parasite (*Myxidium* sp.) in 24 of 27 tadpoles from Welaka NFH, 5 of 7 tadpoles from Warm Springs NFH, 6 of 10 tadpoles from Edenton NFH, and 1 of 3 tadpoles from Orangeburg NFH.
3. Skin ectoparasite: *Gyrodactylus* sp (monogean trematode) in 11 tadpoles from Welaka NFH, 5 tadpoles from Warm Springs NFH, no tadpoles from Edenton NFH, and no tadpoles from Orangeburg NFH.
4. Intestinal pinworms: *Gyrinicola batrachiensis* in 9 of 85 tadpoles from Welaka NFH, 1 of 20 tadpoles from Warm Springs NFH, and no tadpoles from Edenton and Orangeburg NFH.
5. Bacterial culture result: *Aeromonas hydrophila* was isolated from the intestines only of 7 of 8 tadpoles from Welaka NFH, 1 of 3 tadpoles from Warm Springs NFH, 1 of 4 tadpoles from Edenton NFH, and 1 of 6 tadpoles from Orangeburg NFH.

Background:
One hundred fifty larval anurans of 11 species were collected from 4 national fish hatcheries in the months of May and June, 2005, for health screening (diagnostic examinations). The main purposes of this study were to determine whether any diseases of fish could be detected in amphibians from fish hatcheries and whether hatchery-associated amphibians had any important amphibian diseases that could be transported to new sites when hatchery-raised fish were shipped. The 4 national fish hatcheries, amphibian species and numbers of amphibians are shown above.

Preliminary Results:
This preliminary report includes results of virus cultures, bacterial cultures, external parasite examinations (for ectoparasites) and partial parasitology results. Histological examinations are in progress and will be reported later.

Virus cultures were done on 105 tadpoles. Fathead minnow cell lines were used for all virus cultures in order to increase chances of isolating fish viruses. No viruses were isolated in cultures.

Bacterial cultures were done on 42 tadpoles. *Salmonella* spp. were not isolated from any tadpoles. Recognized bacterial fish pathogens, such as *Yersinia* spp, *Edwardsiella* sp., *Flavobacterium* spp, *Vibrio* spp. and *Aeromonas salmonicida* were not isolated from these tadpoles. Coliform (sewage) bacteria such as *Escherichia coli* were not isolated from these tadpoles. The bacterium, *Aeromonas hydrophila*, which may cause secondary or opportunistic infections in fish and amphibians, was isolated from the intestines only (not from livers) of 10 of 21 tadpoles; this bacterium was isolated from the intestines of at least one tadpole from each of the 4 fish hatcheries. Because *A. hydrophila* was not isolated from the livers of any tadpoles, it is likely the organism was a normal, non-pathogenic inhabitant of the amphibian gut. *Aeromonas hydrophila* is ubiquitous in wetlands and has been isolated frequently from the intestines of normal-appearing amphibians nationwide.

Parasite examinations were done on the gall bladders of 47 tadpoles and many intestinal nematodes and ectoparasites. Thirty-six (76.6%) of 47 tadpoles had myxozoan parasites in their gall bladders; these myxozoa were identified as *Myxidium* sp. At least one tadpole from each fish hatchery had myxozoan parasites in their gall bladders. Very little is known about the myxozoan parasites of amphibians; for example, it is unknown whether fish and amphibians share this parasite, and the complex life cycle of all amphibian myxozoans has not been investigated. Illness and death have not been associated with infection by this parasite, but it is important to note that the intermediate life stages and route of infection to the gall bladder remain unknown. Furthermore, it is likely that a second common and presumably innocuous myxozoan parasite of

the mesonephroi ("kidneys") of amphibians, *Leptotheca ohlmacheri*, will be detected in these tadpoles in histological examinations at a later date.

Intestinal parasites in these tadpoles were limited to the common and geographically widespread amphibian pinworm, *Gyrinicola batrachiensis*. Nine tadpoles from Welaka NFH had pinworms and only one tadpole from Warm Springs NFH had pinworms. It is likely additional small or immature pinworms will be found in these tadpoles in histological examinations. Pinworms are considered innocuous, even in massive infections of the intestine. Cestodes and adult trematodes were not found in these tadpoles, but it is possible these parasites will be found in histological examinations. Immature trematodes (metacercariae) were found at dissections in a few tadpoles (n= 11) from these fish hatcheries; this suggests that few aquatic snails (the first intermediate host for metacercaria that infect amphibians) were present at the hatcheries and sites where the tadpoles were collected and that the final hosts of these parasites (usually fish- and amphibian-eating birds and mammals) also were present. Metacercariae were observed in the skin, muscles, body cavity and mesonephroi ("kidneys") of 11 tadpoles. Because most encysted metacercaria are too small to be seen with the naked eye, it is likely more tadpoles will be found to have metacercaria in histological examinations.

The skin of many tadpoles was examined microscopically with the animal submerged in water in order to detect minute ectoparasites. Protozoa resembling Epistylis and Trichodina were found in many tadpoles, but because these protozoa tend to increase in numbers in captive situations, and because many tadpoles were held alive for up to 10 days before being euthanized and examined, the significance of these protozoa is uncertain. Illness and death in amphibians have not been linked to these two genera of protozoa. However, an uncommon monogean ectoparasite of amphibians was detected in 11 tadpoles from Welaka NFH and 5 tadpoles from Warm Springs NFH. These numbers do not represent infection rates in tadpoles from these 2 hatcheries, because examinations for the parasites usually were halted when 1-3 tadpoles in each group were found to be infested. The monogean trematodes in a few tadpoles were identified by a parasitologist as *Gyrodactylus* sp. This genus is principally an ectoparasite of fish, but it is infrequently detected in aquatic amphibians in southeastern USA and California. Light or mild infestations, as were found in these tadpoles, probably are innocuous, but heavy infestations can cause skin irritation and may result in secondary or opportunistic bacterial or fungal skin infections. It is unclear why this fish-associated ectoparasite was not detected in tadpoles from Orangeburg and Edenton NFHs.

Oral discs of these tadpoles were carefully examined and the toothrows were sketched. Special attention was given to the black, keratinized portions of the jaw sheaths and toothrows because loss of black pigment may indicate infection by the pathogenic amphibian chytrid fungus, *Batrachochytrium dendrobatidis*. Other causes for loss of black pigment (depigmentation) are possible, but oral chytridiomycosis is probably the most common cause of depigmentation of the oral disc. A total of 23 tadpoles from 3 of 4 fish hatcheries had partial depigmentation of their oral discs. Histological examinations will be necessary to confirm whether any of these abnormal oral discs were due to infection by *Batrachochytrium dendrobatidis*.

Discussion & Conclusions:

Viruses. All virus cultures are complete. No viruses were isolated from tadpoles in this study. It is unlikely but possible that viral infections will be detected by histological examinations at a later date. But at present, there is no evidence for common or widespread viral infections in amphibians from southeastern national fish hatcheries.

Bacteria. All bacterial cultures are complete. Important bacterial diseases of fish, such as those caused by *Yersinia* spp, *Vibrio* spp, *Edwardsiella* sp, *Streptococcus iniae*, and *Aeromonas*

salmonicida were not detected in these tadpoles. In addition, coliform bacteria were not isolated from the intestines and internal organs of the tadpoles. Routine and special bacterial cultures for *Salmonella* spp. also were negative in all tadpole specimens. Absence of bacteria ("no growth") in the livers of all sampled tadpoles indicates there was no evidence of bacterial septicemias in the amphibians and that appropriate sterile technique was maintained during the dissections of these frequently tiny tadpoles.

Fungi. There was no overt external evidence of watermold infections in the tadpoles, hence, no specimens were submitted for watermold cultures. Cultures for chytrid fungi are not done at our Center. Histological examinations will be completed at a later date and may provide confirmed diagnoses of oral chytridiomycosis in some tadpoles. Other fungal infections also may be detected in histological examinations.

Protozoa. No specific tests for protozoa were attempted on these tadpoles. While many tadpoles were examined microscopically for ectoparasites while submerged in water, most of the observed protozoa were considered innocuous. About 35% of tadpoles had *Epistylis*-like protozoa attached to their skin; however, this number probably is the minimum infection rate because once the parasite was detected in 1 to 3 tadpoles of each species from a site, submerged examinations on remaining individuals from the group were not done. About 22% of the 105 tadpoles from Welaka and Warm Springs NFHs had mild numbers of *Trichodina*-like protozoa on their skin (and in their mouths and spiracles). Again, this protozoa is generally considered innocuous. Additional protozoa, such as intestinal coccidia, may be detected later in histological examinations.

Myxozoa. Perhaps the most unexpected finding in these tadpoles was the high infection rates by the myxozoan parasite, *Myxidium* sp. in the gall bladders. A total of 36 (76.6%) of 47 tadpoles had myxozoan parasites in their gall bladders. At least one tadpole from each of the 4 fish hatcheries had this parasite. Because so little is known about amphibian myxozoans, the significance of this parasite to the amphibian hosts and the susceptibility of fish at each hatchery are unknown. While the parasite probably is innocuous in amphibians, the effects of heavy or massive infections remain unknown. It is likely a second common and generally innocuous myxozoan parasite, *Leptotheca ohlmacheri*, will be found in the mesonephroi ("kidneys") of some tadpoles in histological examinations at a later date.

Helminths. Encysted metacercariae were present in various body regions in these tadpoles, and a few had innocuous pinworms in their intestines. It is likely that 3 or 4 different genera or species of metacercaria were found in these tadpoles, since each species usually has a preferred body region or organ. Hence, the metacercaria in the mesonephroi probably are *Echinostoma* sp. (or Family: Echinostomatidae) while the very tiny metacercaria in the skin of the ventrum, vent tube and hindlimbs probably are *Ribeiroia* sp. The identity of the metacercaria in the skeletal muscles and body cavity is unknown. It is possible additional helminthic parasites will be detected later in histological examinations.
While all helminthic parasites appeared to be present in sparse or very mild numbers, it should be noted that until recently most metacercariae were considered innocuous. Recent experimental studies with metacercariae of the malformation-inducing parasite, *Ribeiroia* sp., indicate that as few as 5 metacercaria may kill very young tadpoles.

Ectoparasites. At least 3 types of parasites were found on the skin of these tadpoles. Two were protozoa and were previously discussed. The third ectoparasite was the monogean trematode, *Gyrodactylus* sp. All infested tadpoles had mild numbers of these parasites and were from Welaka and Warm Springs NFHs. Again, rates of infection in each species of amphibian and each

hatchery were not determined, because examinations were halted after 1-3 tadpoles in each group were found to be infested. It is not clear whether these ectoparasites are host-specific for amphibians or are generalists capable of infesting fish and amphibians. Identifications of some preserved monogeans to species may be attempted later. Although pathology reports generally avoid lists of diseases and organisms that were **not** found, it should be noted that anchorworms (*Lernaea* sp.) and leeches were not detected in any tadpoles.

Summary

Viruses were not isolated from any tadpoles from the 4 national fish hatcheries. Well known bacterial diseases of fish were not detected in cultures in any tadpoles. *Salmonella* spp and *E. coli* were not isolated from any tadpoles. In external examinations under a dissecting microscope, several tadpoles had loss of pigment (depigmentation) on their oral discs; while these abnormalities may have multiple causes, the most common cause is infection by the pathogenic chytrid fungus, *Batrachochytrium dendrobatidis*. Histological examinations are still in progress and will be necessary to confirm chytridiomycosis. A few ectoparasites were found in tadpoles from Welaka and Warm Springs NFHs; it is possible the monogean trematode, *Gyrodactylus* sp., represents transmission of a fish parasite to amphibians, but this ectoparasite has been detected in amphibians in other states and may be a fairly common parasite of aquatic amphibians. Although a high rate of infection by the myxozoan parasite, *Myxidium* sp., was found in the gall bladders of tadpoles from all 4 fish hatcheries, the significance of this parasite to fish and amphibian health is uncertain. Additional parasites and infectious diseases may be detected in these tadpoles in histological examinations that are still in progress.

_____

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DIAGNOSTIC SERVICES CASE REPORT

CASE: 18267 | Final Report | 10/20/2005

EPIZOO:

Legal ☐ **INV#:** | **Declassified** ☐

Submitter:
DR. STEVE A. JOHNSON
FLORIDA CARIBBEAN SCIENCE CENTER
7920 N.W. 71ST STREET
GAINESVILLE FL 32653

Date Submitted: 7/23/2002

Specimen description/identification/Location:

ACC	SPECIES	SPECIMEN TYPE	BAND NUMBER	SUBMITTER's ID	COUNTY	STATE
001	Bullfrog	CARCASS			ALACHUA	FL
002	Bullfrog	CARCASS			ALACHUA	FL
003	Bullfrog	CARCASS			ALACHUA	FL
004	Bullfrog	CARCASS			ALACHUA	FL
005	Frog, Southern Leopard	CARCASS			ALACHUA	FL

DIAGNOSIS

1. Skin of ventrum: Large fluid-filled cysts with supernumerary hindlimbs (polymelia) in one of four larval bullfrog (004)
2. Body cavity: Hydrocoelom ("ascites") of undetermined etiology in two of five tadpoles (001 & 005)
3. Lymphatic sacs: Subcutaneous edema (effusion) in two of five tadpoles (003 & 004)
4. Liver: Necrosis of sinusoidal and liver cells of unknown etiology in one larval bullfrog (001)
5. Stomach: Gastritis due to an unidentified protozoa in one larval bullfrog (002)
6. Intestine: Enteritis due to an unidentified microsporidia-like protozoa in three of four larval bullfrogs (002-004)
7. Jaw sheaths: Depigmentation and loss of cutting edge of undetermined etiology in two of four larval bullfrogs (001 & 003)

Comment:

EPIZOO:

Legal ☐ **INV#:** **Declassified** ☐

The precise cause of illness in these tadpoles was not determined in numerous cultures and histological examinations. The accumulation of excessive fluid in the body cavities and lymphatic sacs of these tadpoles is a non-specific abnormality that can have multiple causes, but often is associated with infection by ranaviruses. While infection by *Ranavirus* remains the leading suspected cause for these abnormalities, no viruses were isolated in separate virus cultures of multiple organs from these five tadpoles. One additional piece of evidence in support of ranaviral infection in these tadpoles was necrosis in the liver and small blood vessels of one (001) bullfrog; these histological abnormalities commonly are found in tadpoles with ranaviral infections. There are two or three possible explanations for our failure to isolate any viruses from these tadpoles: first---and most likely---the tadpoles were in late stages of viral infection in which their immune systems had eliminated the virus from their bodies but tissue abnormalities had not yet resolved; second, the cause of the excess fluid accumulation was a non-viral disease, and third, negative virus cultures in all five tadpoles was a failure of our culture methods (false-negative results due to an undetermined laboratory error). While the latter explanation seems likely for tadpole 001, which had active lesions in the liver and blood vessels, similar culture-negative results have been observed in bullfrog tadpoles with excessive fluid accumulations from other states. Hence, the first and second explanations are more likely.

The first explanation could be verified by serological testing for the presence of antibodies to ranaviruses. However, our Center is not currently performing serological tests on amphibians. Serum samples from these five tadpoles have been archived and will receive high priority when serological methods for amphibians are developed.

A variety of other diseases were found in these tadpoles, but none are known to induce the malformations and fluid accumulations seen in these tadpoles. Three larval bullfrogs had intracellular protozoan infections of intestinal cells; in multiple special histological stains of one frog, these tiny protozoa were acid fast-positive, indicating they were microsporidia. The significance of this protozoan parasite in amphibians is largely unknown, but the infections in these larvae were mild and probably were incidental findings.

Inflammatory nodules were detected histologically in the stomach and cloaca of two tadpoles. The cause of the stomach granulomas in one frog was not detected histologically; it is suspected the nodules were healing migration tracts of nematodes or metacercariae (larval trematodes). The cloacal nodule contained unidentified elongate bacillus bacteria; this type of infection has not been observed previously in any amphibians in the USA. Again, the identity of the bacterium is unknown.

Bacterial cultures of all four bullfrogs resulted in three isolations of only one organism, *Acinetobacter* sp., from two tadpoles (002 & 004). This bacterium was isolated from both livers and one spleen of these two tadpoles, but was not isolated in cultures of either gall bladder, the other spleen, or the excess subcutaneous fluid. No bacteria were isolated from five internal organs of two other tadpoles (001 & 003). In histological examinations of the livers of culture-positive tadpoles 002 and 004, no bacteria were seen and there was no evidence of inflammation. Therefore, the isolations of this bacterium are interpreted as contaminants of the dissections, or possibly, bacteria that entered the circulation a few minutes or a few hours prior to euthanasia of the tadpoles. It is unlikely this bacterium, which is common in the gut contents of tadpoles and common in marshy environments, contributed to the illness and clinical signs of these tadpoles.

The one southern leopard frog tadpole arrived alive but died within 24 hours of receipt. While the precise cause of death was not determined, the significant findings were an almost empty intestinal tract and the absence of fat bodies; hence, simple starvation may have been a major factor in the tadpole's death.

In summary, this group of five tadpoles had multiple interesting infectious diseases, but the precise cause of the excessive fluid accumulation was not determined. Although all virus cultures were negative, one frog had histological abnormalities typical of ranaviral infection. Three frogs had intestinal microsporidial infections, and the stomach infection in one frog also may have been due to microsporidia. One frog had an infection in the cloaca associated with a large, unidentified bacillus bacterium.

As these frogs were captured on the property of the Florida Caribbean Science Center, additional submissions of larvae from this site would be welcomed. Live amphibians are recommended for additional submissions so that virus cultures, serum banking, and microsporidial examinations can be done.

DAVID EARL GREEN, DVM, DACVP
Staff Diagnostic Pathologist

If you have questions regarding this case, contact:

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Diagnostic findings may not be used for publication without the pathologist's knowledge and consent.

Copies To:

PRINTED October 20, 2005

Appendix IV: Images of Amphibians and Reptiles from 2005 Sampling, Harris Neck and Savannah NWRs

Crotalus horridus	Timber Rattlesnake	CHOR.JPG
Eurycea quadridigitata	Dwarf Salamander	EQUA.JPG
Hyla gratiosa	Barking Treefrog	HGRA.JPG
Nerodia erythrogaster erythrogaster	Red-bellied Watersnake	NEYR.JPG

CHOR.JPG 2005/05/17 15:21:12

EQUA.JPG 2005/03/24 12:49:23

HGRA.JPG 2005/05/18 09:21:25

NEYR.JPG 2005/05/20 14:59:13

Appendix V: Images of Localities from 2005 Sampling, St Marks NWR

Biggins Pond	Biggins SMNWR Aug05.JPG
Corner Pond	corner pond SMNWR Aug05.JPG
Fat Nerodia Pond	Fat Nerodia SMNWR Aug05.JPG
Florida Trail Pond	FL Trail pond SMNWR Aug05.JPG
Headquarters Pond	HQ pond SMNWR Aug05.JPG
Jennifer Sink	Jennifer Sink SMNWR Aug05.JPG
Kingfisher Pond	Kingfisher SMNWR Aug05.JPG
Otter Lake	Otter Lake SMNWR Aug05.JPG
Perkinsus Pond	Perkinsus pond SMNWR Aug05.JPG
Plum Orchard Pond	Plum orchard SMNWR Aug05.JPG
Ring Pond	Ring pond SMNWR Aug05.JPG
Shepard Spring	Shepard Spring SMNWR Aug05.JPG
Streetlight Pond	Streetlight pond SMNWR Aug05.JPG
Talpoideum Pond	Talpoideum pond SMNWR Aug05.JPG
Wakulla Field Pond	Wakulla field pond SMNWR Aug05.JPG
Wpt 19	Wpt 19 SMNWR Aug05.JPG
Wpt 68	Wpt 68 SMNWR Aug05.JPG
Wpt 69	Wpt 69 SMNWR Aug05.JPG
Wpt 79	Wpt 79 SMNWR Aug05.JPG
Wpt 150	Wpt 150 SMNWR Aug05.JPG
Wpt 192	Wpt 192 SMNWR Aug05.JPG

Biggins SMNWR Aug05.JPG 2005/08/26 14:50:09

corner pond SMNWR Aug05.JPG 2005/08/26 16:17:50

Fat Nerodia SMNWR Aug05.JPG 2005/08/26 15:30:04

FL Trail pond SMNWR Aug05.JPG 2005/08/29 15:12:26

HQ pond SMNWR Aug05.JPG 2005/08/29 13:38:12

Jennifer Sink SMNWR Aug05.JPG 2005/08/27 13:18:35

Kingfisher SMNWR Aug05.JPG 2005/08/26 14:04:43

Otter Lake SMNWR Aug05.JPG 2005/08/26 09:59:23

Perkinsus pond SMNWR Aug05.JPG 2005/08/27 17:02:39

Plum orchard SMNWR Aug05.JPG 2005/08/29 13:00:15

Appendix VI: C. K. Dodd's field notes for research conducted at Harris Neck and Savannah NWRs.

Field Notes 2005

March (CKD, WJB)

21. High overcast clouds and mild temperatures. Much warmer than last year. Drove up to Harris Neck and checked into the travel trailer. After lunch, we ventured out to set traps and to install automatic frog calling recorders. The water levels are much higher than last year.

–Borrow Pit. Large chorus of *P. ocularis* calling during mid-day. 2 traps
–We heard more *P. ocularis* calling from the north shore of Goose Lake in the very shallow grassy areas. Obviously, the water has been higher here, although it is much higher than last year (they have refilled the lake, coupled with the heavy rains of late). We also saw a Rana sp. Hop into the water, probably *R. sphenocephala*.
–There are also *P. ocularis* calling from the shallow grassy areas adjacent to Greenhead Pond between the south side of the pond and the adjacent road that divides Greenhead from Teal. Collected a *Kinosternon* shell.
–Widgeon Pond: more *P. ocularis* as well as the very large alligator and a large number of juveniles, all making a distress call.
–Lucas Pond. Found a *E. inexpectatus* under one of the boards in the field near the pond.
–Woody Pond. A great many alligators, especially of the smaller size classes. Also saw several at Greenhead.

8:00 PM. Took a drive around the refuge. Very bright moon despite the high clouds – a definite ring around it.
Woody. *R. sphenocephala* calling; one small one seen on the dike; *P. crucifer* calling from Woody Swamp near the canal; a few alligator eyeshines despite the cool temperatures; Great Horned Owl calling.

8:15 PM. Borrow Pit Pond. *P. crucifer* and *P. ocularis* calling.

Goose. *R. sphenocephala*; *P. crucifer* calling from the shallow grassy areas where we heard *P. ocularis* calling earlier in the day.

Greenhead. *P. crucifer*; *P. ocularis*; *R. sphenocephala* calling.

Teal. *R. sphenocephala*; *B. terrestris* (one individual calling in distance).

Widgeon. *P. crucifer* and *P. ocularis* calling. Lots of alligator eyes.

Lucas. *P. crucifer* and *R. sphenocephala* calling.

Snipe. *P. crucifer, P. ocularis, R. sphenocephala,* and *B. terrestris* (SW side) calling.

22. Mostly cloudy and quite breezy; mild. Air feels unstable. Weather service says severe storms are possible today or tonight. Gray and mostly windy all day. Became darker and darker during the day, and thunderstorms with heavy rain began by late afternoon (5 PM). Constant thunder and lightning from 3 PM onwards, but rain held off till later. Cool, kind of a chill in the air.

Trachemys scripta: large female along the road near Snipe Pond. Photographed.

Picked up the traps and checked Runway Pond (including water in the ditch on the the other side of the road), Culvert Pond, and at the Fountain. Nothing at all in Runway and Culvert. We again found *N. viridescens* in the scum of the Fountain Pool. One recommendation we would have it to clear out the muck in this pool. We just finished the Fountain Pool when the sky really became ominous, so we returned to the trailer to wait it out. Very nasty until about 8 PM

8:15 PM Still raining heavily, but thunderstorm slacking off a little. Drove the refuge wildlife drive, but it was generally too noisy to hear chorusing frogs (rain hitting the truck). Noted:

On Wildlife Drive between Woody Pond and back entrance to HQ compound – very large female *B. terrestris* (kept for photography).
Wildlife Drive near junction to Goose and Snipe – *R. sphenocephala* hopping across open ground.
WD, with Greenhead Pond on left – *B. terrestris*
WD, at Teal – *B. terrestris* and *R. sphenocephala* both in chorus, *B. terrestris* especially midway down Teal on its left hand (south) side.
WD and intersection with Thomas Landing Loop – *B. terrestris*
Halfway to Thomas Landing from above – *B. terrestris*
WD, from turnoff to Thomas Landing to Woody turnoff – ca. 6 more *B. terrestris*
WD, near turnoff to Woody Pond – *Hyla cinerea*.
Headquarters area – 2 more *H. cinerea* crossing the road.

We finished the drive about 9:45 PM. Basically, *B. terrestris* might be expected on the wet road just about anywhere. On the main highway, we recorded a large chorus of *P. ocularis* across the road from the Friendship Baptist Church in a roadside ditch. The rain had finally stopped, but it started up again later and rained in the night.

23. Cloudy and overcast, giving way eventually to partly cloudy/sunny conditions. Windy. By evening, it was clear and sunny. Stayed quite windy all day.

Set traps around the Wildlife Drive. The water was quite high and the rice fields were easily accessible, which made for many choices for setting. Saw a *Nerodia fasciata* on the WD near WD-3, and chased it off the road.

At Kingfisher Pond, *Bufo* were calling, but it did not seem to be the same species as last year. These guys had definite cranial crests and patterns of *B. terrestris*. We set 8 traps this time in the pond, one set at each end. Found a large very freshly dead *R. heckscheri* of the eastern side and preserved it. Had dinner at Mi Tierrita and called it a night.

24. Bright clear and beautiful day all day. We were joined by Steve Bennett (SC DNR) and Joe Mitchell (Mitchell Ecological Associates) all day as we checked traps (2 *Siren* and a hatchling *Sternotherus odoratus*) and surveyed 6 sites along the Dodge Tram Road. Kingfisher yielded more *R. heckscheri* tadpoles, and we confirmed the *Acris* at Kingfisher as *A. gryllus*. We picked up *Desmognathus auriculatus* at a number of new sites, as well as from DT-1 again. Steve kept several for the DNR collection, and confirmed them as *auriculatus* as opposed to the *fuscus*-like animal found in the ravines further north. Also a *T. carolina* (photographed) at DT-4. After Steve departed (late), with the remaining light left we surveyed a nice patch of upland woods at the corner of US 17 and the Seaboard Coast Line tracks. We did not find any salamanders, but we did find a juvenile *Elaphe guttata* and a bright new hatchling *Agkistrodon contortrix*.

After dinner at the Cripple Crab, we drove back to the rice fields. Downright cool temperatures (AT 16.1 C; RH 51%).

8:15 PM. Junction of SC 170 and end of the Wildlife Drive – *R. sphenocephala* calling from nearly all fields.

8:25 PM. Swamp between the location above and the northeastern rim where SC 170 leaves the river bottom – *R. sphenocephala*

Then we drove up Dodge Tram Road listening as we went. Not much!

Kingfisher Pond – only 1 *B. terrestris* calling; *R. sphenocephala;* a few *P. crucifer* calling here, but others calling in the distance.

DT-3 – *R. sphenocephala* and a few *P. crucifer*.

60 m NW of DT-6 – *R. sphenocephala* and a few *P. crucifer*

DT-6 – a few *P. crucifer* down toward the river.

As we left Union Creek landing and the refuge, we passed a pond on the right side of the road about 0.5 mile from the landing that was <u>reverberating</u> with frog sounds: *P. crucifer, P. ocularis, P. nigrita, H. chrysoscelis, B. terrestris, R. sphenocephala.* Quite loud! Jamie recorded several minutes of it.

25. Overcast and cool to start, which gave way to treacherous thunderstorms and lightening as we tried to retrieve our traps. Even though they were close to the road, the curtains of torrential rain and lightening caused us to be stuck in the truck sitting on the

dike for about 80 minutes. As I noted on a piece of paper "...then heavy thunderstorms and darkness ruled the land."

Before leaving, we photographed the *Pseudacris nigrita, P. brimleyi, P. ornata*, and *Scaphiopus holbrooki* that Joe had brought down with him. They were collected

Even got stuck in Easter traffic on I-95 going south. Tractor trailer and roadwork (three lanes to two) will stop the flow every time. Fortunately, the rain and storms stopped shortly after we departed.

May (CKD, WJB, DRG; MSG, JS at HN)

16. Drive to Harris Neck. Margaret and Jennifer will take the boating safety course, and Jamie, Denise and I will sample amphibian populations. Generally nice day, as we set traps at Woody, Borrow Pit, Goose, Greenhead, Widgeon, Lucas, and Lucas Borrow Pit. Water levels are still higher than I expected, and it appears that this has been a good wet spring on the Georgia coast.

After the ladies left for their hotel, Jamie and I cruised around the refuge looking for animals on the road. We found a juvenile *Elaphe guttata* on the road between the HQ and Woody Pond (feisty, photographed). Two *Bufo terrestris* (1 near HQ and the other on the raised gravel bed on the Wildlife Drive between Greenhead and Teal ponds). At Woody Pond, we heard *A. gryllus, H. cinerea* (very large and loud chorus), *R. grylio*, and *R. catesbeiana*. Many many alligator eye shines. Spectacular night: bright clear skies and moon overhead, lightning bugs flashing along the dike, distant lightning flashes on the horizon lighting up the sky, tremendous green treefrog chorus.

Out on the main Harris Neck Road opposite the Friendship Baptist Church, we heard a chorus of *Hyla femoralis*, *Pseudacris ocularis, Hyla cinerea*, and *Acris gryllus*. This represents a new refuge location for *H. femoralis*, and the discovery of a new freshwater breeding site. We called this place Snake Bog because of our later encounters.

17. Clear in the morning, giving way to partly cloudy with high overhead clouds as the day wore on. We checked the traps and dipnetted, but found nothing at Woody and Culvert Pond. At Borrow Pit Pond, we captured the usual newts, cricket frogs, leopard frogs and little grass frogs. All newts appeared to be adults in breeding condition. Goose Pond is the only location where we got large tads in the traps – all southern leopard frogs. Jamie saw an adult *Nerodia fasciata* in the grass. North Runway Pond seemed sterile despite plenty of water, but in one small shallow cove we captured 3 *P. crucifer* metamorphs. We kept them to ensure identity. On the way to the next site, we saw a large adult *Coluber constrictor* on the road (to the east) that quickly made its escape. No amphibians were trapped at Greenhead or Widgeon (we did not see the large gator). Only green treefrogs were calling at Lucas, and newts were present at Lucas Borrow Pit. We also chased an adult *Ophisaurus ventralis* and *Scincella lateralis* near the little cinder block building, but they escaped (the glass lizard without its tail, unfortunately).

After lunch, we checked Snipe Pond via dipnetting at the location where they released 2 million bluegill, but no tadpoles. We heard *R. catesbeiana* calling, so maybe we'll try and hit this location later in the year. We checked the shallow water remaining in the field beside the road on the southeast side of the road across from Goose Pond ("Goose Meadow") but found no tadpoles. Yesterday as we set traps we saw a very tiny *B. terrestris*, suggesting successful metamorphosis from the March breeding event. We dipnetted the Lorillard Fountain, and captured a single newt. Thunderstorms were brewing in the area. One way to benefit amphibian populations at Harris Neck would be to clean out this fountain of all the mud and muck. It would not take long, and would help the amphibians. Although it was rumbling, we went back to Snake Bog to see what the site looked like (a low lying boggy area), take photos and get a GPS reading. As we went back to get the GPS reading, Jamie spotted a coiled *Agkistrodon contortrix* in hunting posture, and I saw a juvenile *Crotalus horridus*. They were within about 2 minutes of walking between one another. We got pictures of both using the digital camera (too dark for mine).

After dinner, all of us drove around the Wildlife Drive, but we saw no snakes. Found a few *H. cinerea* and *B. terrestris* on the road – it had (was) raining a little, but not too hard. We were surprised at not seeing more.

18. Rained some last night, but clear in the morning. This quickly gave way to clouds, rain squalls and thunderstorms which followed us up to Savannah. Again nothing in the traps at Woody, although *R. grylio, R. catesbeiana*, and *H. cinerea* were calling. The Borrow Pit Pond produced a welcome surprise – a *Hyla gratiosa* calling from high in the wax myrtle trees bordering the pond. We captured him and took many photos before releasing him back to his tree. We also caught or heard more newts, cricket frogs, a pinewoods treefrog, and leopard frogs. We again caught leopard frog tads at Goose, with *H. cinerea* calling in the distance. We saw a large female *Trachemys scripta* on the way to Greenhead; she looked like she was getting ready to nest? Got photos. We also caught a nice *N. fasciata* in a trap at Greenhead (plus a leopard frog tadpole). Only a newt at Widgeon, with green treefrogs occasionally calling. At Lucas Pond, we caught *R. grylio* tads, and more newts at Lucas Borrow Pit. Partly cloudy and threatening to storm, then dumping on us at Lucas Borrow Pit.

We had to rebattery the weather station, as for some reason the previous batteries malfunctioned. We were late getting away from Harris Neck, and then hit traffic associated with an accident at the Port Wentworth exit. Finally got to Savannah and checked in – everything was ready for us. As many of the rice fields were dry or lacked hardly any water, we set around the Wildlife Drive and northern dikes, three locations of which we had previously sampled. The unpredictability of water at sampling locations makes it difficult to pre-determine sites, even from one trip to the next. We only set 4 traps at Kingfisher this time because the traps will be out on a Friday night.

We met Jennifer and Margaret (and her brother and his girlfriend) at an Indian restaurant in Savannah. Not our normal routine, but I enjoyed the food.

19. Beautiful clear morning. We picked up the boat FWS (Russ Webb) kindly lent us, and launched from Beck's Ferry. We went upriver around Hickory Bend to the mouth of muddy Bear Creek, then down the creek 100 m or so before we ran into an impassible log jam. The creek looked navigable beyond the jam, but there was no way we were getting through it. We docked and surveyed the high ground and a shallow (now dry) wetland channel running in to the interior (45 min) (site BI-5). Great huge trees of sycamore and ??? towered overhead, with diameters of 1.5 m and more, and thick stands of canebreak lined the banks and some of the sunny interior sites. Plenty damp under logs and litter (yesterday's rain), but no amphibians or reptiles seen. *H. squirella* and *H. chrysoscelis* were calling occasionally from high in the trees. Lots of mosquitos, as there would be everywhere we went on Bear Island and later on the Solomon Tract. As I later found out, the ticks and chiggers also were pretty abundant.
We then went back out to the river channel and surveyed a series of pools and channels (60 min) (BI-4). We found a few of what appeared to be leopard frog tadpoles in remaining pools, but not many of them. I caught a very large *R. clamitans* (photo), and gray treefrogs were again calling occasionally high in the trees. No reptiles.

We continued down river to FWS transect 1, and followed it for 471 m inland (BI-6) (50 min). Again there were many pools and channels paralleling the river, but again most were empty of amphibians. We saw both adult and metamorphosing *R. clamitans*, a single clutch of *Bufo terrestris* eggs (photo; at least I assume it was southern toad eggs), and heard *H. chrysoscelis* calling from the trees. This time, Jamie spotted a lone *Anolis carolinensis* on a tree. Lots of mossies and poison ivy everywhere. The temps weren't too bad (the thermometer's battery had died) and the humidity tolerable. Too many bitees however.

We again stopped at FWS transect 2 (BI-1) but we did not venture very far inland (45 min). There was much more water than when we were here last year, and it somewhat difficult to remember exactly where we collected because of the different water levels. When we stopped, there was a fairly large chorus of *R. clamitans* and *H. chrysoscelis* calling, but they stopped abruptly upon our arrival and remained quiet while we looked around. Found metamorph *R. clamitans* and another anole, but that's it. I kept expecting to see a toad or a snake, but no luck. Lots of inverts in the pools might inhibit the production of amphibian larvae. Collected a raccoon skeleton for Scott.

Finally, we cruised down river to an old river meander channel (BI-7), which was an isolated beautiful spot with open forest and good sized cypress. We spent looking 30 min there, but only heard gray treefrogs despite outstanding availability of coarse woody debris and loose bark. As we were preparing to leave (ca. 17:30), the shade was covering the meander, an alligator cruised the water, and a great blue heron watched our noisy boat. I am sure they were happy to have their quiet returned. I collected a few shells of freshwater mussels for Jim.

We got the boat back (collected another valve at the landing), but it wasn't until late that we finally got to the Cripple Crab. Slept hard and deep until very early AM.

20. Generally cloudy to partly cloudy all day, until about 17:00 when a cold front moved through dropping temps and bringing heavy rain. We were supposed to go frog call listening that night, but the thunderstorms and rain (severe t'storm warnings) caused us to bail out.

Spent the morning checking traps. At Kingfisher, the usual cricket frogs, calling bull and pig frogs, a possible *R. sphenocephala* (retained), and metamorphosing bronze frogs. Saw a large *Coluber constrictor* sunning itself (or trying to) at the south end of the pond on plant debris. Dipped the shallow end to supplement trapping/frog logger, but no toads. There were no amphibians seen or heard at WD-8, and a little stinker (*S. odoratus*) and a larval leopard frog at WD-3. However, we got two *Siren lacertina* at ND-4, including the largest one I have ever seen (got photos). Pig frogs were calling both here and at HQ-1, where we also got two more *Siren*. Real good day for them. After collecting our data, we drove over to the Solomon Tract to spend the rest of the afternoon. Very large numbers of mossies, and some distant thunder as the afternoon wore on.

At a little puddle (ST-5), we got more transforming bronze frogs and a single newt. This pond was drying rapidly. Surprisingly, they had bulldozed "Malformation Pond," and nothing was left of this site. AT ST-3, more of the same, but with *Hyla chrysoscelis* tads (we think; collected and photo). The slope at ST-1 had moisture, but the river floodplain had drastically receded since March. Jamie saw a *Diadophis punctatus* sunning itself, and a lone *H. squirella* called. Pretty depauperate. At ST-4 and ST-6, the mosquitos got serious. However, we turned up good numbers of *Plethodon variolatus*, a *Gastrophryne carolinensis* (new refuge record; ST-6), and a nice adult *Nerodia erythrogaster* (photographed). Captured a small armadillo (one of 4 with its adult mom) to show Denise, then let it scamper to safety (and mom waiting) in its nearby den. Saw a large *Eumeces* at ST-6, but could not capture it.

Dinner at Los Magueyes – really good authentic Mexican food. Then lots of rain.

21. Picked up the traps in very cool (cold?), misty and heavily overcast, and windy weather. Felt more like March. Virtually no amphibians in any traps or even calling, where yesterday they had been common. Got a little stinkpot at HQ-1. Locked up the FWS compound, and boogied home to arrive in another thunderstorm in Gainesville. At least it was warmer.

July (CKD, WJB, DG)

25. Drive from Gainesville to Harris Neck NWR. Cloudy to clear, depending on time, with temperatures in the low to mid-90's. White heat over the marsh.

Deb gave us the fish stocking information - millions of fish stocked over the last two years.

We set at:

Borrow Pit (2): *Rana sphenocephala* and *Acris gryllus* calling/seen. The small alligator was present and, as usual, quite curious. Saw a subadult *Hyla femoralis* along the shore.
Woody (4): Traps set on east side. A few alligators, but not many considering the intense heat and sun. Many fledgling wood storks.
Snipe 1 and 2: Very drawn down, but put 4 traps out in each in an effort to catch tadpoles for the disease study.
Goose (3): Saw a school of large ranid tadpoles gulping air in the center.
Widgeon (2): Very low. Heard a small pod of baby gators, and saw the head of the attending female. Subadult *Hyla cinerea* observed.
Lucas (3): Saw a *Coluber constrictor*.

Drove wildlife drive about 20:00. Saw nothing, but took photo of the red boiling sun descending over the marsh.

About 20:45, Jamie and I walked over to Borrow Pit Pond. Saw the juvenile alligator, and called him to the shoreline where he just hung in the water. Saw *H. cinerea* juvenile on the willows, and heard *Acris* calling. Nothing else. We then walked over to Woody Pond, and heard *R. grylio, R. catesbeiana, H. cinerea,* and *A. gryllus* calling. Nothing serious though. Very large numbers of alligators everywhere in the pond. Lightning bugs still making quite a show for so late in the year. Saw nothing on the road walking back to the trailer. Very humid with lots of stars, and the temperatures somewhat bearable.

26. Cloudy in the morning, but shortly clearing completely; promises to be the hottest day of the year. We recorded 98 F in the shade behind the refuge headquarters at about 14:30 as we were heading out. Bloody hot. White shimmering heat.

Drove around the circuit, and checked traps. Nothing much at Woody; newt larvae at Borrow Pit (also photographed a nice *A. gryllus* tadpole) and while dipnetting at Lucas Borrow Pit (some medium sized to ca. 30 mm total length); *R. sphenocephala* at Culvert, but no tadpoles; *H. femoralis* and *G. carolinensis* at North Runway Ditch - the GC transforming (photo); nothing at Snipe 1, but tons of catfish (bullheads) and 8 *R. catesbeiana* at Snipe 2; lots of gulping tads at Goose, but nothing in the traps; a newt and *H. cinerea* tads at Widgeon (lots of banana spiders!); nothing at all at Lucas Pond. Didn't see the gators at Widgeon (but heard a few juvenile grunts). Tremendous numbers of gators in Snipe 2.

We wanted to get tadpoles at Goose, so we went back and got a cast net from Deb. Jamie tried many times without success before getting a tadpole. Then he hit the jackpot and got about 10 very large *R. catesbeiana* tads. The interesting thing is that the RC tads from Goose and those from Snipe 2 are very different in size and appearance. In Goose, they are large, dark green dorsally, yellow-colored ventrally, and slightly mottled. In Snipe, they are medium-sized, olive green dorsally, cream-colored ventrally, and heavily mottled. As such, the RC from Snipe 2 match those of Orangeburg NFH, and those from Goose match the Coastal Plain variety. This is not surprising, perhaps, because of the origin of the fish shipments (Deb gave us the records). In any case, we spent the hottest

part of the hottest day standing in the direct sun trying to catch tadpoles. Took photos of both types.

We packed up 5 RC from each location, and took them to the FedEx office in Brunswick to be sent to David Green in Madison. He should have them tomorrow morning.

We drove over to Snipe Pond to see how the wood stork netting was going (it wasn't; the birds were not cooperating). Lots of wood storks, egrets, and white and glossy ibis. Stood around talking for a while before giving up and heading to the morgan for dinner. On the way to Snipe, we surprised a 5 foot alligator walking down the middle of wildlife drive between Woody and Borrow Pit. Took photo, but have no clue where it was heading. Still quite warm, but the setting sun has calmed the day's fire.

Ticks are pretty common; deer flies are still around. Mosquitoes and noseeums seem to be giving us a break. Maybe it's too hot for them. Saw a single deer this morning out by the runway, and a cotton rat over by Lucas Borrow Pit. Lots of *R. sphenocephala* at the borrow pit too.

27. Definitely the hottest day of the year, with temps predicted about 100 and a heat index of 115. Not a cloud in the sky for much of the day, especially all morning. The heat turned completely white out over the marsh and in distant horizons. Looked like smoke at times, with a milky film covering the horizon. Not a day for intensive field work, but we had trapping to do.

Started by collecting the traps. Not too much of interest. A few *R. catesbeiana* tads for the most part (at Goose, Snipe 1 and 2) and another *H. cinerea* tad at Widgeon; most of the traps were devoid of amphibians. Even the fish were largely dead, inasmuch as the % DO was very pitiful in most of these highly eutrophic systems. Not a single snake seen, and no turtles basked. However, there were lots of alligators virtually everywhere, and we saw the female and her year-old brood at Widgeon again (one was guarding the trap).

While we were at Harris Neck, a group from FWS and SREL were trying to "gun" for mature wood storks to apply satellite transmitters. They only caught 1 while we were there (Tues night and Wed morning). Very hot out on the dikes. Two grad students were involved: one from UF (Peter Fredericks' student) and the other from Florida A&M. very hot out there, and we quickly tired of the wait.

Moved on to Savannah, and set traps along Wildlife Drive, northern dikes (at the waterfowl net site) and Kingfisher Pond. Hazy hot out over the marshes. Russ told us they did not stock Kingfisher, but had stocked the marshlands with the "leftovers" from Orangeburg. More bells ringing. Nothing moving on the marsh, but alligators seem to prefer "put in" sites (where small boats can be launched) along the marsh banks. We often saw heads of pretty good-sized animals waiting at these sites.

Dinner at Mi Tierrita. Seafood chimichanga. Yum.

28. Another very hazy and hot day. All morning the haze fell over the marsh in white heat while we checked the traps. We had set mostly along the Wildlife Drive where the water was accessible. Most of the time it was either too shallow, or completely blocked by very dense stands of cutgrass stems. Looks like sawgrass but not that sharp. Still, it is not an option to try and hack through the vegetation and wade through deep mud to set at a steep-walled canal. The alligators would eat up the traps anyway, and it would be damn dangerous.

We captured another *Siren lacertina* (WD-3) and two *Amphiuma means* (at ND-3). Also another *Sternotherus odoratus* (not much larger than a hatchling, but very feisty). Pig frogs called from the marsh during the heat of the day.

At the farthest north point on the northeast dikes, we hiked through a beautiful swamp forest directly east along a high dike. It went toward Dodge Tram Road, and we intersected it near the Garret Cemetery (the location of which is incorrect on the topo map). We could not find the sugar mill ruins mentioned by Russ Webb, but we got to see the old "lost" cemetery in the woods (most graves in the early 1920's) and a forest we never would have otherwise seen. *Rana clamitans* were heard occasionally calling from the swamps - mostly "clunks."

A few alligators patrolled the canals, but I think it was even too hot for them. We hit gold at Kingfisher Pond - 2 traps had 333 and 321 *Rana heckscheri* tads (all told, 662 tads in the 4 traps). Only 2 *R. grylio*. Unfortunately, a number died, so we got a nice collection for disease screening and the museum. A softshell turtle nest was destroyed along the road. Bloody hot as we tried to photograph a heckscheri tad.

As we got up to DT-3, a series of thunderstorms rolled through, dropping the temperature but not causing the mosquitoes to let up. Some rain (but not torrential) which caused us to sit and wait and sweat until it ended. Then we did time constrained surveys at DT-3, DT-5, DT-1 and DT-6. The mosquitoes were most unnerving at the first three in the wet and still darkened forest. At DT-6, however, there was no sign of rain and the mosquitoes were not so bad. We saw 2 cottonmouths (DT-3; DT-1) and I saw 2 *Desmognathus auriculatus* under a single log at DT-1. Hot and thoroughly drenched with sweat. Denise has earned the nickname "bumps" because of all her welts.

Dinner at the Cripple Crab.

29. Picked up the traps and headed back to Gainesville. Collected a DOR *C. constrictor* just on the other side of the causeway leading into Georgia (Port Wentworth).