

# A Herpetofaunal Survey of the Santee National Wildlife Refuge

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Prepared by:  
Stephen H. Bennett  
Wade Kalinowsky  
South Carolina Department of Natural Resources

## **Introduction**

The lack of baseline inventory data of herpetofauna on the Santee National Wildlife Refuge, in general and the Dingle Pond Unit specifically has proven problematic in trying to assess priority species of concern and direct overall management needs in this system. Dingle Pond is a Carolina Bay which potentially provides unique habitat for many priority reptiles and amphibians including the federally threatened flatwoods salamander, the state endangered gopher frog, state threatened dwarf siren and spotted turtle and several species of conservation concern including the tiger salamander, upland chorus frog (coastal plain populations only), northern cricket frog (coastal plain populations only), many-lined salamander, glossy crayfish snake and black swamp snake. The presence or abundance of these and other priority species in this large Carolina Bay is not known. This project will provide for funds for South Carolina DNR to conduct baseline surveys to census and assess the status of the herpetofauna in and adjacent to the Dingle Pond Carolina Bay. Surveys will involve a variety of sampling techniques including funnel traps, hoop traps, cover boards, netting and call count surveys to identify herpetofauna diversity and abundance.

Herpetofauna are particularly vulnerable to habitat changes including climate change and human development activities. Many unique species are endemic to Carolina Bays, a priority habitat that has been greatly diminished across the coastal plain of South Carolina. These species can serve as indicator species of habitat quality and climate changes and baseline data is critical at both the local and regional level. The combination of loss of habitat and increasing temperatures poses major risks to these species.

## **Objectives**

The objective is for the USFWS to obtain a comprehensive baseline inventory of reptiles and amphibians present on the Santee National Wildlife Refuge with a focus on the Dingle Pond Unit. This inventory will partially accomplish approved CCP Goal 3, Objective 3.1 for herpetological inventories, and Goal 4, Objective 4.9 for managed wetlands. This data will also help SCDNR address data voids and monitoring needs in the USFWS approved South Carolina Comprehensive Wildlife Conservation Strategy.

## **Methods**

SCDNR will implement baseline herpetological survey of the Santee National wildlife Refuge, with a focus on Dingle Pond including:

- SCDNR will provide, deploy and monitor a minimum of 100 small traps (minnow type traps) in Dingle Pond during each survey period. SCDNR will provide glow-sticks for use in traps.
- SCDNR will provide, deploy and monitor a minimum of 12 large hoop traps (turtle traps) in Dingle Pond during each survey period.

- SCDNR will deploy a minimum of 100 cover board (50 2' x 2' and 50 2' x 4' plywood provided by the USFWS), GPS locations and monitor at least once per period during each of the survey periods.
- SCDNR will deploy a minimum of 2 automated frog call data loggers for deployment during each of the survey periods and analyze and report data from automated call loggers.
- SCDNR will conduct frog call surveys for a minimum of one night per survey period.
- SCDNR will conduct area constrained searches (aquatic netting and cover board checks) during each survey period.
- SCDNR will identify and report all Herpetofauna captured during survey periods

SCDNR completed 34 days of survey and preparation for survey at Santee National Wildlife Refuge during 2010-2011 and 25 days of survey during 2012. One day, December 21, 2010 was spent scouting the refuge for sites to place coverboards and aquatic traps. On January 20, 2011 fifty coverboards were placed at 5 different locations on the refuge, 4 on the Dingle Pond Unit and 1 on the Pine Island unit (Figure 1).

Following our initial visits to the refuge it was determined that the survey would be expanded to include some effort on all units. Throughout the text and tables we separate the survey effort and results by unit. The following abbreviations will be used: Bluff Unit-BU, Dingle Pond Unit-DU, Pine Island Unit-PI, Cuddo Unit-CU.

The actual survey effort began on March 1, 2011 and continued until July 27, 2011. Table 1 summarizes the survey effort at the refuge by date, duration and activity. During this period 32 days of survey effort were billed to the project by SCDNR. This does not include time contributed to the project by SCDNR (Steve Bennett) or by volunteers which was not billed to the project.

Typical field survey periods combined a number of survey techniques, as indicated in Table 1. The type of survey techniques varied across survey periods dependent upon weather conditions, water levels in wetlands and duration of survey period. One primary survey technique, aquatic trapping was carried out at several sites within each unit. Table 3 provides the latitude and longitude of all sites sampled using aquatic traps. Figures 2-5 are location maps for all trapped sites.

In addition to the field survey effort three automated recorders were deployed at nine sites, primarily ponds, throughout the refuge to survey for frog species, using vocalizations (mating calls) of males. At each deployment the recorder was set to record for ten minute samples, on the hour, beginning at 6 PM (1800 hrs) and ending at 3 PM (0300 hrs) during a 24 hour cycle. Recorders were deployed for 1 to 2 weeks at a time

dependent on rainfall and condition of pond. To date we have completed analysis of recording samples from 6 of the 9 ponds. The remaining three ponds will be completed this winter. Table 3 summarizes the number of 10 minute samples for the six sites that have been analyzed to date and the total sample hours at each site. A total of 1,244 ten minute samples were recorded for these sites comprising a total of 207 hours of recordings. The location of recorder sample sites is given in Figures 6-8.

## Results

During the 2011 survey effort SCDNR personnel documented the presence of 41 species of amphibians and reptiles on the Santee National Wildlife Refuge (Table 4). Two additional species, the eastern garter snake and the eastern hognose snake were recorded offsite, by road-cruising, in the vicinity of the refuge. One of these species, the eastern hognose snake, was also observed by refuge personnel (M. Epstein) on the Pine Island Unit in 2011. It is highly likely that the eastern garter snake occurs on the refuge proper, as it is a relatively common species in our state. Observations for two additional species were reported to SCDNR personnel by current or former refuge personnel, the eastern diamondback rattlesnake, on the Bluff Unit (M. Purcell) and the scarlet snake, on the Dingle Pond Unit (S. Heisey). Additionally, a spiny softshell turtle was reported from the vicinity of Harry's Fish Camp, near Pineville S.C., during the sampling period. It is highly likely that this aquatic turtle species also occurs within the refuge proper.

During the 2012 survey effort SCDNR and refuge personnel documented the presence of 23 species of amphibians and reptiles, all but one of which had been documented in the previous year. The only new species documented was the mud snake (*Farancia abacura*), by one specimen, found dead on US 15 approximately 130 meters north of the refuge entrance road. While this specimen was technically not on refuge property it should be considered to occur on the refuge.

The numbers of individuals observed for the following species represent minimum counts due to the difficulty of estimating the number of calling male frogs and, in the case of larval amphibians, basking turtles and alligators, the large number of individuals observed: American alligator, yellow-bellied turtle, southern leopard frog, pig frog, bullfrog, southern toad, green treefrog, gray treefrog, spring peeper, southern chorus frog, eastern narrowmouth toad, marble salamander, spotted salamander.

During the survey effort a minimum of 4,764 observations of amphibians and reptiles documented. This data does not include any data from the automated recorders, as that will be addressed separately. The southern leopard frog, southern toad, green treefrog and pig frog were the most commonly observed species on the refuge (Table 5). Ten of the eleven most commonly observed species were frogs, attributable to observations of

vocalizing males, which can call in very large numbers during their breeding seasons, when weather conditions are favorable.

The number of species observed and number of individual observations for many species was lower in 2012 than in 2011. It is likely that the drought played a major role in these results. Many of the ponds that were full, and used by amphibians as breeding sites in 2011 never filled in 2012, or filled late in the season, with increased summer rain. With the late rains in 2012 many summer breeding frog species, such as green treefrogs, squirrel treefrogs, pine woods treefrogs and narrow-mouthed toads were able to breed in a few of the isolated ponds on the refuge.

One species of conservation concern, the spotted turtle, was documented on the refuge during this survey. This species had been previously observed by refuge staff as occurring on the Cuddo Unit. The spotted turtle is listed as a Species in Need of Management under the South Carolina Endangered Species Act, a designation which is equivalent to Threatened status under the Federal Endangered Species Act. The spotted turtle is a small, colorful species that inhabits temporary ponds and other small wetlands. While the species is not extremely rare it is somewhat uncommon and is vulnerable to illegal take for the pet trade. We recommend not widely publicizing the presence of this species on the refuge as it might attract attention from collectors.

#### Automated Recorders

All of the frog species documented through the use of automated recorders were also observed during the surveys, but use of the recorders has provided a measure of relative abundance for breeding frogs at the refuge. During the 2011 survey season recorders were deployed at 8 wetlands on the refuge. The sample effort at each pond varies, so the relative abundance of species must be taken as a coarse indication at this time.

For all ponds there was a total of 1538 10-minute samples recorded in 2011. Each sample was analyzed to determine what frog species vocalized during that particular sample. A species was counted as present in the sample if it was heard to vocalize once. If a call or spectrographic pattern could not be accurately identified to species it was not counted. It is likely that some species, such as the southern toad and eastern narrow-mouthed toad, are under-represented in the sample, as their calls and spectrographic patterns can be masked by large choruses of other species.

Table 6 presents the rankings for frog species recorded during the automated recorder surveys. The number of observations is the number of 10 minute samples, across all samples, that the species was heard calling, regardless of site. The percentile ranking is the percentage of 10 minute samples across all samples that the species was heard calling. The southern cricket frog, spring peeper and southern leopard frog were the most commonly recorded species at the refuge, across all ponds.

There is significant variability in recorder observations of vocalizing frogs across season and ponds. In general frog species at the refuge are either late-winter to early spring breeders or late-spring to summer breeders, with some overlap. Spring peepers, southern chorus frogs and leopard frogs are typically calling most actively in late winter through early spring, whereas green treefrogs, pig frogs and American bullfrogs tend to be late spring to summer breeders.

Breeding habitat requirements also vary among frog species. Some species, such as spring peepers, Cope's gray treefrogs and leopard frogs prefer smaller, temporary wetlands and ponds. Other species such as green treefrogs, carpenter frogs and pig frogs prefer deeper, more permanent wetlands. Table 7 presents the number of 10-minute samples that each species was recorded in, by sample pond. The board site 4 (bdsite 4) was abandoned after the first sampling period due to excessive road noise from I-95 and other roads in the vicinity. Bluff Unit pond 3 (bupond 3) is a small, ephemeral pond that did support a big chorus of spring peepers and later in the year green treefrogs, identified by vocalization surveys, not automated recorder. The remaining 4 ponds, for which data has been analyzed, had 6 or more species of frogs.

Due to the lack of rain automated recorders were deployed at only four wetlands during 2012. Three of the sites, BUpond3, CU pond 2 and CU pond3 are isolated wetlands that held small amounts of water when the recorders were deployed, but did not fill completely until later in the summer. The fourth site, banding pond, is a man-made pond with water control structures, and held water throughout the sample period. Banding pond does support populations of predatory fish, but also has shallow margins with abundant grasses and sedges that provide adequate breeding habitat for frog species that are most typically associated with isolated ponds. Three different sites, all located at the banding pond were used during this survey and locations are given on Figure 9. Results for the automated recorder frog surveys are presented in Table 8.

## **Summary**

During the 2011 survey effort 43 species of amphibians and reptiles were observed on or in the vicinity of the refuge by SCDNR staff and refuge personnel. Three additional species were reported from the refuge by refuge personnel and others, and the investigators believe these reports to be credible. This brings the total to 46 species of amphibians and reptiles documented on, or in the vicinity of the refuge. This first-year total accounts for approximately 50% of the 97 species that potentially occur on the refuge and approximately.

During the 2012 survey effort 23 species of amphibians and reptiles were documented, with only one species, the mud snake representing a new species for the refuge. It is possible that the drought, which began in late summer 2011 and extended into the

summer of 2012, played a role in the decreased species diversity and numbers of observations for some species.

Table 9 compares the amphibian and reptile species which possibly occur on Santee NWR to the number of species actually observed during the survey, by taxa groups. Alligators were excluded from this analysis as there is only one species possibly occurring on the refuge and they are common to abundant.

The number of species possibly occurring was determined based on the geographic distribution (range) of each species and some species whose ranges, indicated by several sources were close to the refuge were included. This list is an approximation of the species that might occur on the refuge and should not be considered as definitive. While many of these species may have ranges that include, or are close to the refuge the lack of suitable habitat may preclude a particular species from occurring on the refuge.

Three taxa groups, frogs, lizards and turtles are well represented on the refuge, with 50 percent, or greater of the possible species having been documented for the refuge. It is the author's opinion that frogs are actually under-represented, with 54 percent of the possible species documented. It is possible, even likely, that the extended drought in the second year of the survey hampered our effort to document frog species that occur on the refuge. There are at least five species of frogs, the eastern spadefoot toad, oak toad, barking treefrog, Brimley's chorus frog and little grass frog, which possibly occur on the refuge that are relatively common, yet were not observed during the study period. All of these species breed in ephemeral ponds, which did not fill during the second year of the study. It is possible that, given additional survey effort these species, and some of the other frog species not observed during the study may be documented.

Two taxa groups, snakes and salamanders are under-represented, by observations, on the refuge (26% of possible salamander species and 30% of possible snake species documented). One possible and highly likely explanation for the low diversity of salamander species is lack of appropriate habitat, in particular seepage wetland and hill-side seep or spring habitat. These habitat types are known to support a number of salamander species of the lungless salamander family (Plethodontidae), which includes the red salamander, mud salamander, three-lined salamander, two-lined salamander and Chamberlain's dwarf salamander. None of these species were observed on the refuge and each one of them requires, or at least prefers some type of seepage wetland habitat. During the survey we searched for this type of habitat but, to date, have not found any examples on the refuge, though these habitat types are found within the vicinity of the refuge.

The other under-represented taxa group on Santee NWR is snakes, with only 30 percent of the possible species observed during the survey. This percentage increases to 39

percent with the addition of two species, the timber (canebrake) rattlesnake and corn snake, recently documented by refuge staff and a historic record from the eastern diamondback rattlesnake. Only one individual of each of these three species has been observed at the refuge. In the author's opinion, this is still less than the snake species, or numbers we expected for such a large and diverse property. Two functional groups or guilds of snakes that are not well represented are small, fossorial species and rodent eating species. There are 10 species of small fossorial snakes that could possibly occur on the refuge, but only one species, the scarlet snake, has been documented (refuge staff). These species are difficult to survey, but can be found under fallen woody debris and cover objects. It is likely that the drought was partially responsible for this group of snakes being under-represented in the survey. In general when conditions are dry for a prolonged period these species are less likely to be found under cover. During these periods they are typically deeper in the substrate, in rodent burrow, root channels etc. to avoid desiccation. It is possible that additional species may be observed under cover if surveys are conducted during periods of normal or above normal rainfall.

The majority of larger snake species observed, by the authors, during the survey are either specialized feeders on something other than rodents e.g. the hognose snake preys on toads, the mud snake preys on aquatic salamanders, or they are non-specific feeders, such as watersnakes, the cottonmouth, the copperhead and garter snake for example. Even the rat snake, despite its name, feeds on birds and lizards along with rodents, when they are available. During the survey the authors observed little evidence of rodent activity, either under boards and other cover objects or as trails through the forest, in particular recently burned areas of pine forest. Our experience on other sites with a greater diversity and number of rodent-eating snakes is that these areas are typically open-canopied pine forests with a history of prescribed fire. These areas support a diversity of seed-bearing legumes, grasses and sedges along with other herbaceous plants that can support robust rodent populations. A growing body of evidence suggests that these systems were shaped historically by natural fires that occurred during the late spring and early summer (growing season). The authors strongly recommend growing season prescribed fire, in the uplands, as a means of achieving a greater overall herpetofaunal diversity on the refuge.

### **Taxonomy and Nomenclature**

Several species and genera of amphibians and reptiles are currently under taxonomic review, or have undergone recent changes. The genus for toads, *Bufo*, has been changed to *Anaxyrus*, and the genus for "true" frogs, *Rana*, has been changed to *Lithobates*, for example. Many of these changes have not been adopted completely and some are still in contention. One species observed on the refuge, the slimy salamander, is problematic.



Formerly all slimy salamanders were considered one species, *Plethodon glutinosus*. This single species has been split into a complex of related species that are morphologically indistinguishable. Three of these species occur in South Carolina, and two of them occur within the vicinity of the refuge, which is located near the proposed boundary for the geographic distribution of these two species. However, this “split” is not accepted by all experts and remains somewhat controversial. For now we will treat this species as *Plethodon glutinosus* as further identification would require genetic analysis.

### **Colclough Pond**

The authors were asked to visit Colclough, a classic Carolina bay, which is adjacent to the Pine Island Unit of the refuge and being considered for acquisition. During these visits the pond was completely dry, except for a small amount of water in a central ditch. We were not able to accomplish any meaningful survey effort at this site due to the drought conditions. It is the authors recommendation, based on substantial experience with Carolina bays that, if this site is acquired the hydrology of the bay should be restored. We would recommend plugging the existing ditch, at a minimum but preferably filling the ditch entirely throughout the bay and restoring the bottom profile of the bay. This bay, with restored hydrology could become excellent habitat for the numerous amphibian species that require of favor isolated temporary wetlands.

# Figures and Tables

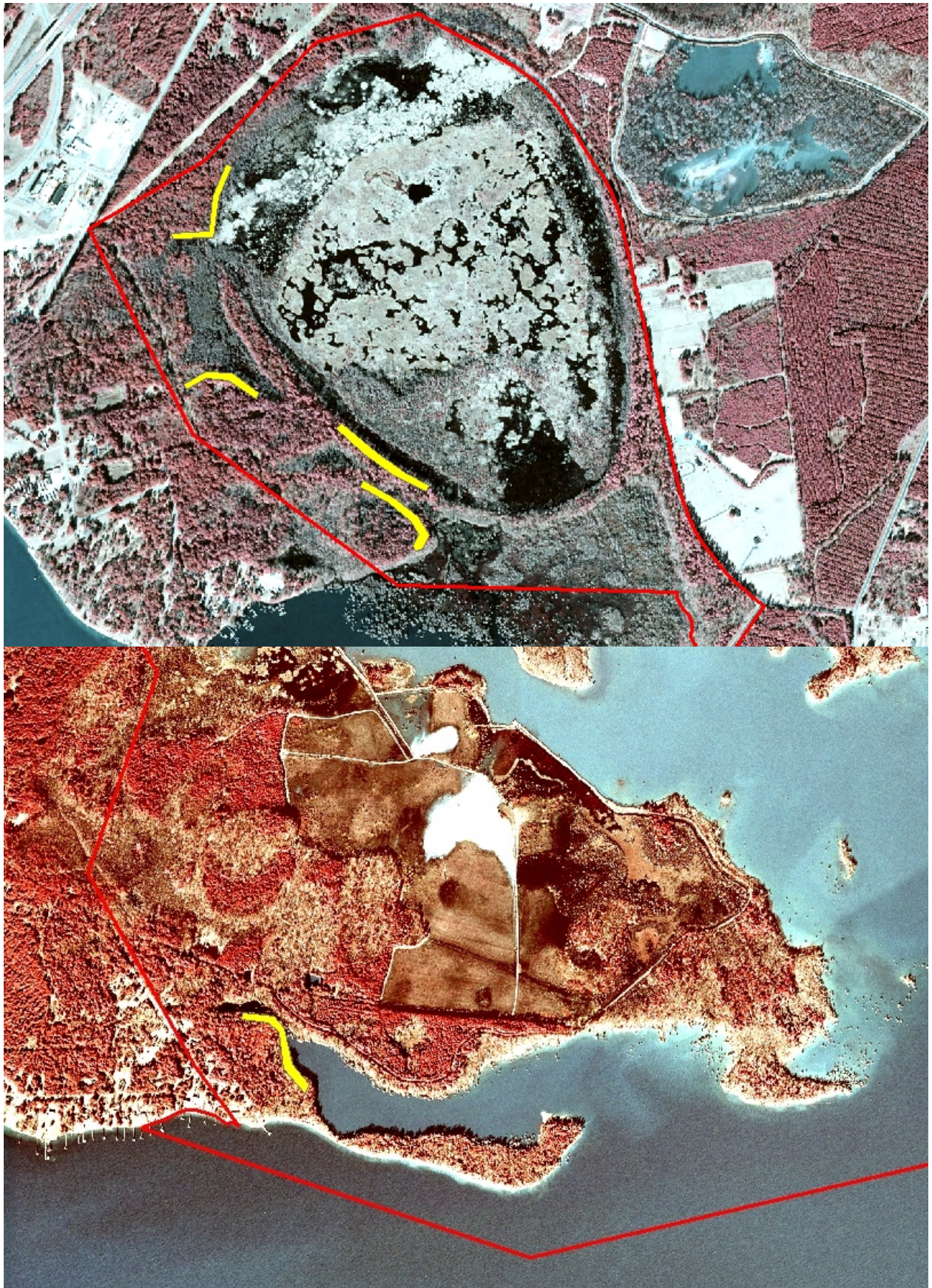


Figure 1. Location of Dingle Pond and Pine Island coverboard sites – in yellow

Table 1. Survey Effort at Santee National Wildlife Refuge—2011 and 2012

Begin Date	End Date	Dip Net	Units	# Minnow traps set	Units	# Hoop traps set	Units	Bd. Sites checked	Field survey-units	Road Cruising
3/1	3/4	Yes	BL-DP-CU	10	BU			DPBT#1-2-3&4	PI-DP-CU-1	BL , PI ,CU
3/17	3/18			15	DP			DPBT#2	PI,BL&DP	BL,PI&CU
3/21	3/21								PI,BL	PI,BL
3/31	3/31								BL,PI	BL
4/6	4/8	Yes	CU , BL	30	BL	4	BL	DPBT#2 & DPBT#4	DP,CU,BL	BL&CU
4/20	4/22	Yes	BL,PI	30	BL				BL , PI , CU	BL , PI
4/26	4/28								DP , BL , CU	DP , CU , BI
5/4	5/6	Yes	CU , BL	40	BL , DP	4	DP	DPBT#1	DP,CU,BL,PI	CU,BL,PI
5/17	5/18	Yes	PI,BL,CU	25	BL , CU			PIBT#1	BL , PI , CU	BL,PI&CU
6/1	6/2	Yes	CU , BL	20	BL				BL,CU	CU,BL
6/6	6/8	Yes	BL						BL	BL , PI
7/5	7/5	Yes	BL						BL	BL
7/11	7/12	Yes	BL						BL , CU	BL,CU
7/26	7/27			47	BL , CU	5	BL,DP		BL,CU	BL,CU

Date	Species	# ind	Unit	method of cap	Effort/ Hrs	# Traps	Location
11-Apr-12	L.getula	1	BU	CO	0.50		Water pump on Bluff Unit
	L.getula	1	BU	CO	"		
	L.getula	1	BU	CO	"		Tin at Banding Pond
	N.fasciata	1	CU	OB	0.25		In canal at Owl House dike
	Field Herping Cuddo				5.00		
12-Apr-12	R.sphenocephala	1	PI	AT	0.50	5	PI#1
	R.sphenocephala	1	PI	AT	0.50	5	PI Borrow pit
	A.opacum	3	PI	CO	1.25		Left of PI Gate - SHB
	H.femoralis	1	PI	CO	"		Under Log
	E.faciatus	1	PI	CO	"		Under Log
	T.carolina	1	PI	CO	"		partly buried in leaves
	R.sphenocephala	5+	PI	AT	0.50	5	PI #2
	R.sphenocephala	400+	BU	AT	2.00	10	BUP#3 (
	P.crucifer	10+	BU	AT	0.25		BUP#3
	L.getula	1	BU	CO	0.25		Banding Pond tin
19-Apr-12	A.carolinensis	2	CU	OB			Off wildlife drive
	R.sphenocephala	150+	BU	AT	1.25	10	BUP#1(Field Pond)
	R.sphenocephala	250+	BU	AT	1.25	10	BUP#3
20-Apr-12	R.sphenocephala	80+	BU	AT	2.00	20	BUP#1(Field Pond)
	S.lateralis	6	BU	OB	1.50		Boat ramp on Bluff
	H.chrysocelis	4+	BU	VO	"		Boat ramp on Bluff
	H.squirella	6+	BU	VO	"		Boat ramp on Bluff
	T.scripta	1	DP	OB	1.50		Dingle Pond edges
	S.lateralis	12+	DP	OB	"		Dingle Pond edges
26-Apr-12	A.opacum	1	CU	CO	3.50		100 acre is. Under log
3-May-12	R.sphenocephala	65+	BU	DN	1.25		BUP#3
	G.carolinensis	1	BU	DN	"		BUP#3
	T.carolina	1	BU	HC	"		BUP#3
	C.sexlineatus	2	BU	OB	0.25		Tin building at BUP#3
11-May-12	R.sphenocephala	50+	BU	DN	0.50		BUP#3
17-May-12	A.carolinensis	1	CU	OB			CUP#1 -entire pond complex dry
23-May-12	H.chrysocelis	15+	CU	VO	1.50		Wildlife Drive
	H.cinerea	10+	CU	VO	"		Wildlife Drive
	B.terrestris	5+	CU	VO	"		Wildlife Drive
	N.erythrogaster	1	CU	OB	"		C.guttata ditch
	R.gryllio	15+	BU	VO	0.25		Banding Pond
	H.cinerea	25+	BU	VO	"		Banding Pond
	G.carolinensis	50+	BU	VO-DN	0.50		BUP#2
	H.cinerea	15+	BU	VO			BUP#2

24-May-12		0	0	AT	1.25		Dingle Pond DRY
	H.femoralis	20+	CU	DN	0.50		CUP#1
	R.gryllio	5+	BU	VO	0.25		Banding Pond
	S.lacertina	1	BU	AT	0.75	10	BUP#1(
	R.sphenocephala	1	BU	AT	"		BUP#1
	R.sphenocephala	30+	BU	AT	1.25	15	BUP#2
	R.sphenocephala	80+	BU	AT	1.25	15	BUP#3
30-May-12	R.sphenocephala	3	BU	DN	0.25		BUP#3
	R.sphenocephala	5	BU	DN	0.25		BUP#2
	H.cinerea	50+	BU	VO	0.25		BUP#3
	A.gryllus	80+	PI	VO	0.75		Ditches along drive into Pine Island
	G.carolinensis	50+	PI	VO-DN	"		Ephemeral pond on right as you reach field on left
	A.gryllus	40+	PI	VO-DN	"		Ephemeral pond on right as you reach field on left
	H.cinerea	60+	PI	VO-DN	"		Ephemeral pond on right as you reach field on left
	G.carolinensis	15+	BU	VO	0.50		BUP#3
	A.gryllus	60+	BU	VO	"		BUP#3
	H.cinerea	25+	BU	VO	"	30	BUP#3

31-May-12	R.sphenocephala	110	BU	AT	1.50	30	1 adult dead 109 alive
	Field Herping	0			2.00		
5-May-12	R.sphenocephala	20+	BU	DN	0.50		BUP #3
	T.scripta	5	CU	OB	0.25		lake edges Cuddo Unit
7-May-12	G.carolinensis	5+	CU	VO	0.50		BUP#3
	H.cinerea	10+	CU	VO	"		BUP#3
	H.chrysocelis	20+	CU	VO	"		BUP#3
	R.catesbiena	2	CU	VO	"		BUP#3
	R.clamitans	2	CU	VO	"		BUP#3
	A.gryllus	20+	CU	VO	"		BUP#3
	Field Herping	0			4.00		
8-May-12	R.sphenocephala	100+	CU	AT	3.00	30	BUP#3
	Field Herping	0			1.50		
12-May-12		0	BU	DN	0.25		BUP#1
		0	BU	DN	0.25		BUP#2
	Field Herping	0			3.25		
	R.sphenocephala	1	BU	DN	0.25		BUP#3
22-May-12	R.sphenocephala	10	BU	DN	0.25		BUP#3
25-May-12	R.sphenocephala	5	BU	DN	2.50		BUP#3
	G.carolinensis	40+	BU	DN	"		BUP#3
	H.chrysocelis	10+	BU	DN	"		BUP#3
	H.cinerea	5+	BU	DN	"		BUP#3
	H.femoralis	20+	BU	DN	"		BUP#3
	N.fasciata	1	BU	OB	"		BUP#3
	T.scripta	2	BU	OB	0.25		Banding pond dike
	R.gryllio	4+	BU	OB	"		Banding pond
	A.picivorus	1	CU	OB	1.25		At lake edge on Cuddo Unit
	T.scripta	3	CU	OB	"		Cuddo
28-Jun-12	A.gryllus	75+	CU	VO	0.50		Cuddo Unit
	E.obsoleta	1	CU	OB	3.50		Cuddo Unit
2-Jul-12	R.sphenocephala	5	BU	OB	2.00		BUP#3
	A.gryllus	10+	BU	VO	"		BUP#3
	B.terrestris	50+	BU	OB	"		BUP#3
3-Jul-12	R.sphenocephala	5+	BU	AT	3.50	45	BUP#3
	H.cinerea	2+	BU	AT	"		BUP#3
	G.carolinensis	5+	BU	AT	"		BUP#3
12-Jul-12	H.cinerea	7	BU	DN	2.00		BUP#3
	R.sphenocephala	8+	BU	DN	"		BUP#3
	G.carolinensis	4+	BU	DN	"		BUP#3
13-Jul-12	H.chrysocelis	15+	BU	DN	1.00		BUP#3
	G.carolinensis	11+	BU	DN	"		BUP#3
	H.cinerea	10+	BU	DN	0.50		Pond between the Maint. Shop and lake
18-Jul-12	A.gryllus	20+	CU	DN	2.00		CUP#1 Gator Hole
	H.squirella	10+	CU	DN	"		CUP#1 Gator Hole
	G.carolinensis	25+	CU	DN	"		CUP#1 Gator Hole
	F abacura	1					DOR 130 m. N. of refuge entrance US Hwy 15

Table 2. Latitude and Longitude of Aquatic Trap sites

<b>Unit</b>	<b>Trap site ID</b>	<b>Latitude DD</b>	<b>Longitude DD</b>
<b>Bluff</b>	<b>BUP#1</b>	<b>33.550397</b>	<b>80.443991</b>
	<b>BUP#2</b>	<b>33.543647</b>	<b>80.438953</b>
	<b>BUP#3</b>	<b>33.541554</b>	<b>80.437786</b>
	<b>Banding Pond #1</b>	<b>33.551900</b>	<b>80.438338</b>
	<b>Banding Pond #2</b>	<b>33.554016</b>	<b>80.441613</b>
	<b>Banding Pond #3</b>	<b>33.554153</b>	<b>80.440366</b>
	<b>Hidden Field #1</b>	<b>33.544866</b>	<b>80.445127</b>
	<b>Hidden Field #2</b>	<b>33.546711</b>	<b>80.446179</b>
	<b>Snapper Canal</b>	<b>33.552402</b>	<b>80.446959</b>
	<b>East Dike</b>	<b>33.556401</b>	<b>80.440017</b>
	<b>Weather Station Canal</b>	<b>33.558006</b>	<b>80.441743</b>
	<b>North Dike</b>	<b>33.560967</b>	<b>80.447821</b>
	<b>North Dike Canal</b>	<b>33.562019</b>	<b>80.450153</b>
	<b>Dingle Pond</b>	<b>DP #1</b>	<b>33.512603</b>
<b>DP #2</b>		<b>33.513928</b>	<b>80.420931</b>
<b>DP #3</b>		<b>33.514210</b>	<b>80.419209</b>
<b>DP #4</b>		<b>33.513271</b>	<b>80.412878</b>
<b>DP #5</b>		<b>33.516007</b>	<b>80.423122</b>
<b>DP #6</b>		<b>33.513396</b>	<b>80.417779</b>
<b>Pine Island</b>	<b>PI Borrow</b>	<b>33.491326</b>	<b>80.353480</b>
	<b>PI #1</b>	<b>33.488028</b>	<b>80.350246</b>
	<b>PI #2</b>	<b>33.489173</b>	<b>80.351668</b>
<b>Cuddo</b>	<b>CUP #1</b>	<b>33.522144</b>	<b>80.295701</b>
	<b>CUP #2</b>	<b>33.517864</b>	<b>80.297015</b>
	<b>CUP #3</b>	<b>33.511171</b>	<b>80.275588</b>
	<b>CUP #4</b>	<b>33.510209</b>	<b>80.274282</b>
	<b>CUP #5</b>	<b>33.495416</b>	<b>80.301181</b>
	<b>Round Island #1</b>	<b>33.493886</b>	<b>80.276117</b>
	<b>Round Island #2</b>	<b>33.493958</b>	<b>80.277011</b>
	<b>Owl House Canal</b>	<b>33.509911</b>	<b>80.287812</b>
	<b>Lake Set #1</b>	<b>33.518217</b>	<b>80.302076</b>



Figure 2. Bluff Unit Aquatic Trap Sites

Figure 3, Pine Island Unit Aquatic Trap sites



Figure 4. Dingle Pond Unit Aquatic Trap sites

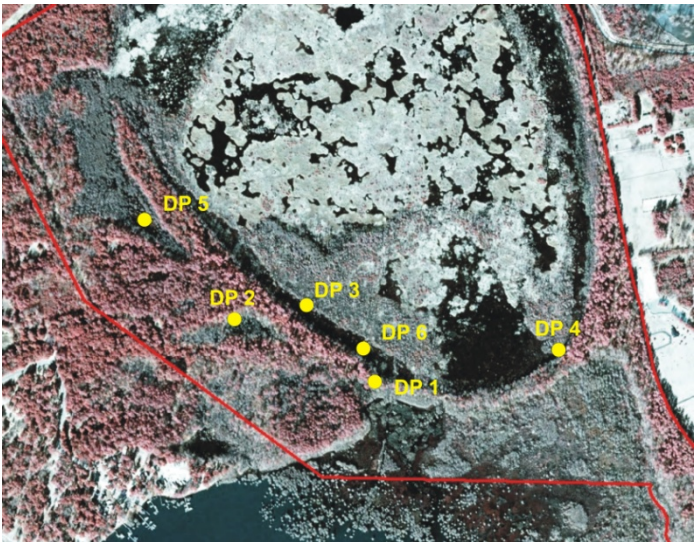
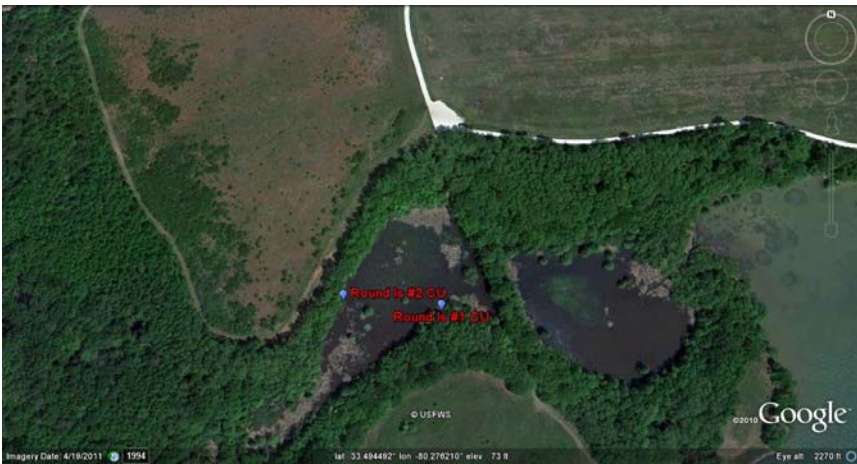






Figure 5. Cuddo Unit Aquatic Trap sites (4 views)



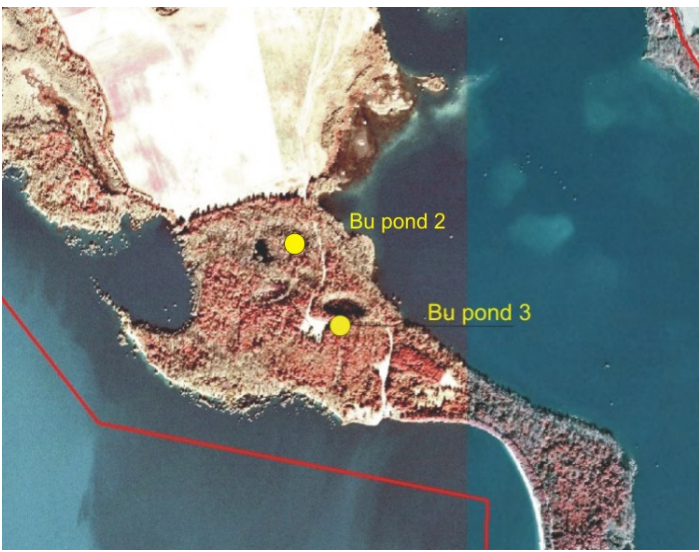


Figure 6. Bluff Unit Recorder Deployment Sites

Figure 7. Dingle Pond Unit Recorder Deployment Sites

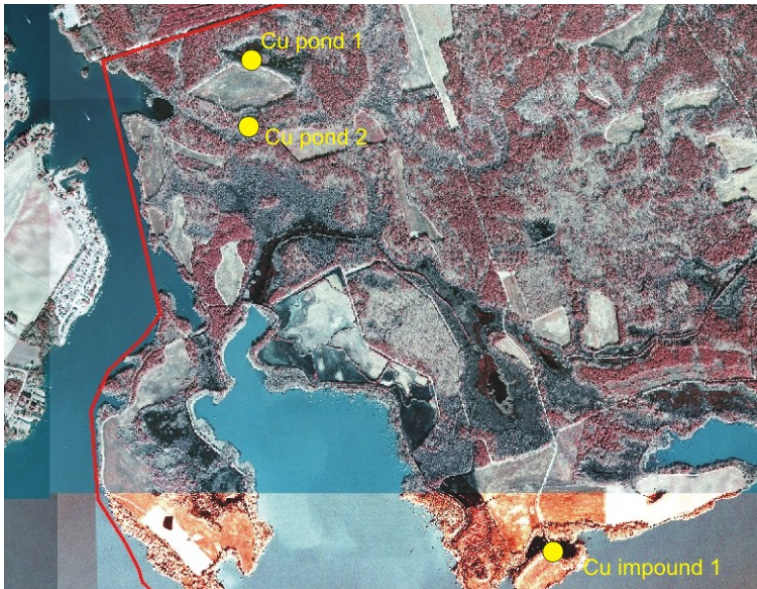


Figure 8. Cuddo Unit Recorder Deployment Sites

Table 3. Automated Recorder Deployment Effort-2011

	board site1	board site4	bu pond3	cu pond1	dp pond1	cu pond2	cuimpound1	bupond2	
10 min smpl	276	35	149	343	343	217	116	59	1538
smpltimehrs	46	6	25	57	57	36	19	10	256

Table 4. Amphibian and Reptile Species Observed by Unit and Number Observed -2011

Latin Name	Common Name	bluff	cuddo	dingle	pineisland	offsite	total
<i>A.carolinensis</i>	Carolina anole	5	8		11		24
<i>A.contortrix</i>	copperhead			1		1	2
<i>A.gryllus</i>	southern cricket frog		1	17			18
<i>A.maculatum</i>	spotted salamander		5				5
<i>A.mississippiensis</i>	American alligator		21	4			25
<i>A.opacum</i>	marbled salamander		23	1			24
<i>A.piscivorus</i>	cottonmouth	10	3				13
<i>B.terrestris</i>	southern toad	130	230	15	40		415
<i>C.constrictor</i>	black racer		1				1
<i>C.guttata</i>	spotted turtle		5				5
<i>C.nemidophorus</i>	six-lined racerunner	2					2
<i>C.serpentina</i>	common snapping turtle	1					1
<i>E.fasciatus</i>	five-lined skink		1		1		2
<i>E.laticeps</i>	broad-headed skink				1		1
<i>E.obsoleta</i>	rat snake	4	1				5
<i>E.quadridigitata</i>	dwarf salamander	2	1	6	5		14
<i>G.carolinensis</i>	Eastern narrow-mouthed toad	56					56
<i>H.chrysocelis</i>	Cope's gray treefrog	25	45		15		85
<i>H.cinerea</i>	green treefrog	242	12	32			286
<i>H.femoralis</i>	pine woods treefrog		5				5
<i>H.platyrrhinus</i>	eastern hognose snake				*1	1	2
<i>H.squirella</i>	squirrel treefrog	1			1		2
<i>K.subrubrum</i>	eastern mud turtle	3	1				4
<i>L.getula</i>	eastern kingsnake	4			1	1	6
<i>N.fasciata</i>	banded watersnake	2		1			3
<i>P.crucifer</i>	spring peeper	62					62
<i>P.glutinosus</i>	slimy salamander	1					1
<i>P.nigrita</i>	southern chorus frog				30		30
<i>R.catesbeiana</i>	American bullfrog	3	8	5			16
<i>R.clamitans</i>	bronze frog		4				4
<i>R.grylio</i>	pig frog	91	17				108
<i>R.hecksheri</i>	river frog	1					1
<i>R.sphenocephala</i>	southern leopard frog	1038	45	36	77		1196
<i>R.virgatipes</i>	carpenter frog			6			6
<i>S.intermedia</i>	lesser siren		1				1
<i>S.lateralis</i>	ground skink		1				1
<i>S.lacertina</i>	greater siren	3					3
<i>S.undulatus</i>	eastern fence lizard		1				1
<i>T.carolina</i>	eastern box turtle		4		9	1	14
<i>T.sauritus</i>	ribbon snake			1			1
<i>T.scripta</i>	yellow-bellied turtle	32	51	1			84
<i>T.sirtalis</i>	eastern garter snake					1	1

Table 5. Species Ranked by Number of Observations

Common Name	total obs 2011	total obs 2012
southern leopard frog	1196	1159
southern toad	415	55
green treefrog	286	209
pig frog	108	24
Cope's gray treefrog	85	89
yellow-bellied turtle	84	11
spring peeper	62	10
Eastern narrow-mouthed toad	56	265
southern chorus frog	30	
American alligator	25	not counted
Carolina anole	24	3
marbled salamander	24	5
southern cricket frog	18	305
American bullfrog	16	2
dwarf salamander	14	
eastern box turtle	14	2
cottonmouth	13	1
eastern kingsnake	6	4
carpenter frog	6	
spotted salamander	5	
spotted turtle	5	
rat snake	5	1
pine woods treefrog	5	57
eastern mud turtle	4	
bronze frog	4	2
banded watersnake	3	1
greater siren	3	1
copperhead	2	
six-lined racerunner	2	2
five-lined skink	2	1
eastern hognose snake	2	
squirrel treefrog	2	
black racer	1	
common snapping turtle	1	
broad-headed skink	1	
slimy salamander	1	
river frog	1	24
lesser siren	1	
eastern fence lizard	1	
ribbon snake	1	
eastern garter snake	1	

<b>eastern garter snake</b>	<b>1</b>	
<b>ground skink</b>	<b>1</b>	<b>18</b>
<b>eastern diamondback rattlesnake</b>	<b>1</b>	
<b>scarlet snake</b>	<b>1</b>	
<b>spiny softshell turtle</b>	<b>1</b>	<b>1</b>
<b>eastern mud snake</b>		<b>1</b>

Table 6. Observation Rankings for Frog Species from Automated Recorders - 2011

Species	number of observations	percentile ranking
southern cricket frog	507	0.32
spring peeper	343	0.22
southern leopard frog	333	0.22
green treefrog	322	0.21
carpenter frog	276	0.18
pig frog	209	0.13
bullfrog	153	0.1
Cope's gray treefrog	116	0.07
southern toad	115	0.07
bronze frog	72	0.05
eastern narrowmouth toad	52	0.03
southern chorus frog	35	0.02

Table 7. Observations of Frog Species by Site for Automated Recorder Samples - 2011

Species	bupond 3	bdsite 1	bdsite4	dppond 1	cupond 1	cupond 2	cuimpound1	bupond2	total
southern leopard frog	14	95	4	96	73	19	21	11	333
carpenter frog		153		123					276
bullfrog	41				2	52	55	3	153
pig frog		90		81		26	12		209
bronze frog						72			72
spring peeper	28	59		132	115	9			343
southern chorus frog					35				35
southern cricket frog		242		150	26	17	72		507
green treefrog	75	8		17	7	73	93	49	322
Cope's gray treefrog					12	104			116
southern toad	12			18	10	36	2	37	115
eastern narrow-mouth toad						34		18	52



Table 8. Observations of Frog Species by Site for Automated Recorder Samples – 2012

Site	Pc	Hc	Hch	Ag	Gc	Rs	Rcl	Rc	Rg	Bt
Banding Pond	x	x		x		x		x	x	
BU pond 3		x	x	x	x					x
CU pond 2		x	x		x	x	x	x		x
CU pond 3	x		x			x				

Pc – spring peeper

Hc – green treefrog

Hch – Cope’s gray treefrog

Ag – southern cricket frog

Gc – narrow-mouthed toad

Rs – southern leopard frog

Rcl – bronze frog

Rc – bullfrog

Rg – pig frog

Bt – southern toad

Figure 9. Recorder sites for Banding Pond, Bluff Unit, 2012



Table 9. Comparison of amphibian and reptile species possibly occurring on Santee NWR and species observed, by taxa groups.

Taxa	# species possible	# species observed	%
frogs	24	13	54%
salamanders	19	5	26%
lizards	9	6	67%
snakes	36	11	30%
turtles	9	6	67%