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*An Eastern Diamondback Rattlesnake (*Crotalus adamanteus*) from the Florida Keys in Monroe County, Florida, USA. .(Photographed by Brian K. Mealey).*

The Herpetology of Southern Florida

Monograph 5.

Walter E. Meshaka, Jr. and James N. Layne

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Dedication

WEM- To the forgotten ancient peoples of Florida, their culture, their ways, and the bounteous Eden they knew.

JNL- To Richard Archbold for his foresight in establishing the ABS to protect and study one of the biologically most interesting areas of Florida and to the many staff members, students, and visiting investigators at the Station who have provided data on its herpetofauna.

Please cite this monograph as follows:
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Preface: The Herpetology of Southern Florida

Malcolm L. McCallum

Environmental Studies, Green Mountain College, Poultney, Vermont, USA 05764

Natural history (a.k.a. life history) studies are the rock on which conservation theory is built. Consequently, it was with great interest that we agreed to consider *The Herpetology of Southern Florida* for publication in *Herpetological Conservation and Biology*. The manuscript underwent critical peer review by regional and national experts on the amphibians and reptiles of Florida. It then underwent the review and editing by the Special Publications Section Editor (Stanley E. Trauth) and a managing editor (MLM).

The Herpetology of Southern Florida introduces a fauna for the region that is as unique as it is amazing. The work that these authors put into this monograph is staggering and the photography exquisite. I frequently found myself reading sections while constructing the layout for this massive contribution to the natural history of Florida. Works like this that are focused on regional herpetology bring to light the incredible diversity of species in this region. First the authors introduce the general ecology and habitat diversity of southern Florida. Then they provide a thoroughly referenced account of each species, allowing one to identify missing gaps in the life history of each organism. Finally, the provide a synthesis that provides the over-all conclusion derived from their delving into this regions fauna

I believe this monograph will prove to be the seminal work on southern Florida herpetofauna. It should be of interest to both professionals and laypersons who have interest in Florida amphibians and reptiles. In a time when biodiversity losses are escalating, environmental policy is eroding, and public interest seems to be paltry, providing a contribution such as this free via open access may help to turn this tide. The Governing Board of HCB is proud to make *The Herpetology of Southern Florida* available to anyone who has access to the internet.

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The Herpetology of Southern Florida

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***Abstract*.—A combination of literature, museum specimens, and field data was used to evaluate the morphological and ecological aspects of the 81 species of native non-marine amphibians, reptiles, turtles, and crocodilians of southern Florida. Taking place in a slightly expanded region, the goal of this study was to serve as an update of an earlier treatment of this segment of the southern Florida herpetofauna that was published 56 years ago. Findings from our analysis were interpreted within the context of regional distinction of a herpetofaunal community caught in the midst of peripatric speciation and most recently subjected to the effects of radical human-mediated disturbance to their both ancient and youthful environments, altering for all their evolutionary trajectories.**

Introduction

This work represents the synthesis to two large ecological datasets emanating from two opposite ends of southern Florida. The first dataset by JNL was longterm in scope and was centered at the Archbold Biological Station (ABS) at the southern end of the lake Wales Ridge and the surrounding areas. This area comprises the northern end of southern Florida and is centered on ancient eastern desert. The second dataset by WEM was intensive in its scope and centered in the southern Everglades and its surrounding areas. This area anchored the southern end of southern Florida and, in further contrast, is centered on extremely young wetlands. A third site, a bridge as it were, connected the two areas-Buck Island Ranch (BIR), which abuts the ABS due east in the “little Everglades” region of the Kissimmee prairie. The ranch provided its own contrast by being much more similar to the southern Everglades more than 161 km away than it was to the Lake Wales Ridge only eight km away. This curious part of Florida from around the north shore of Lake Okeechobee southward is a region whose biota we love dearly and whose future we care much about. For these reasons, we set out on this project in the mid-1990s with two goals in mind. First, we wanted to produce a progress report on what is known regarding the ecologies of the southern Florida herpetofauna, one that has not been updated since the study of Duellman and Schwartz (1958) almost one half century ago. Second, we wanted to quantify regional distinction of the southern Florida herpetofauna with respect to their life histories through the lens of historically recognized forms.

How is the southern Florida herpetofauna unique with respect to morphology and ecology? More specifically, what species and what traits changed most and the least? Taken together, what does the regionally-differentiated fauna look like as species have evolved to some point in being a distinctive community from which to jump off and colonzie new areas?

Hopefully, future researchers interested in the southern Florida herpetofauna, will have a useful base upon which to contribute by adding new data and testing ideas concerning these species and their life histories.

Area of Study

Southern Florida represents a harsh contrast of subtropical climate and neotropical, West Indian, and north temperate species existing on terrain ranging from a few thousand years in age to more than one million years in age: One that is an archipelago of eastern desert with interdunal pools, and one that is an ocean of marsh with rocky upland fragments, an archipelago of islands forming the Florida Keys, and disturbed habitat throughout (Figure 1a-z).

As a way to better understand the biology of the region we direct the reader to several very useful sources. *Ecosystems of Florida* (Myers and Ewel, 1990) provides a thorough overview of habitats and their components that include our area of study. With respect to the Everglades, Lodge’s (2005) *Everglades Handbook: Understanding the Ecosystem* provides a superb resource for understanding the dynamics of that ecosystem. Lazell’s (1989) *Wildlife of the Florida Keys* ties together its wildlife, its geology, and future. The Keys are about 60,000 years old and have since steadily become smaller as water levels rise, even today. The adjoining

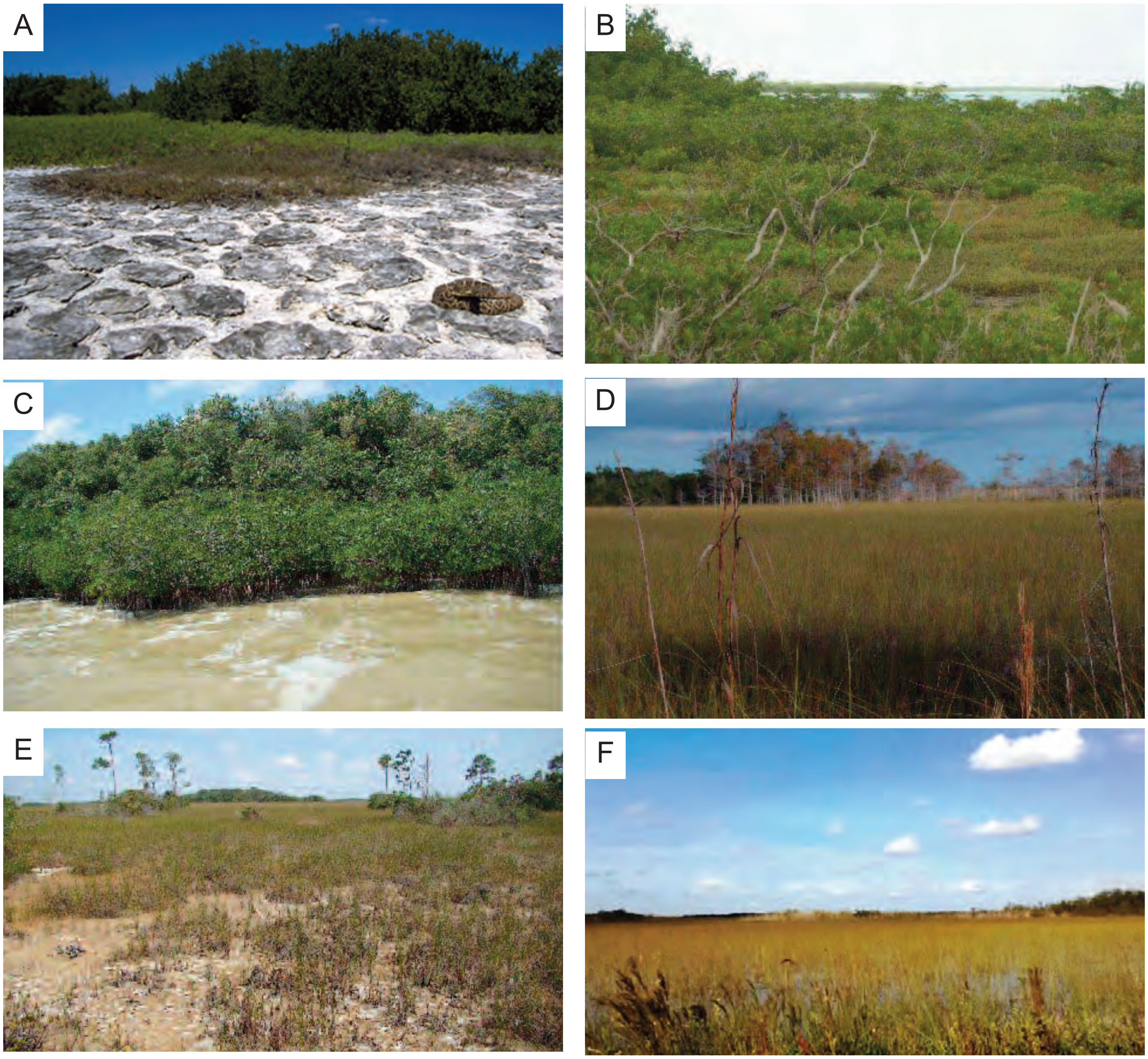

Figure 1. Figure 1a-z. A = Buoy Key. Photographed by B.K. Mealey. B = coastal prairie in Everglades National Park (ENP), C = mangrove fringe in ENP, C = cypress dome in ENP, E = dry season prairie in ENP, F = Muhly Grass prairie in ENP. *Continued on next page*

Everglades are but 3,000 years old, coastally shifting from salt marsh to mangrove as water levels rise. One of two main upland habitats of the keys and the southern Everglades is pineland, which sits on the exposed oolitic limestone bedrock. Most extensively, it occurred on the eastern rim of southern Florida. Nearly all of it was logged out by World War II, and much of the remaining habitat has been developed. In ENP, it appears in archipelago form on Long Pine Key. It is seasonally very dry with various potholes and larger solution holes filling seasonally. The pinelands are bisected by interdigitating finger glades through which water flows southward, mostly southwestward through Shark River Slough and also southeastward through Taylor Slough into Florida Bay. The second upland habitat is the tropical hardwood hammock. This is a mesophytic forest of predominantly West Indian flora. They exist as islands imbedded in pineland or in an ocean of marsh and are often called tree islands. Sandy uplands are present at Cape Sable and sporadically so in extreme southern mainland Florida. Mangroves occur along the coastal fringe in southern Florida, including the Keys.

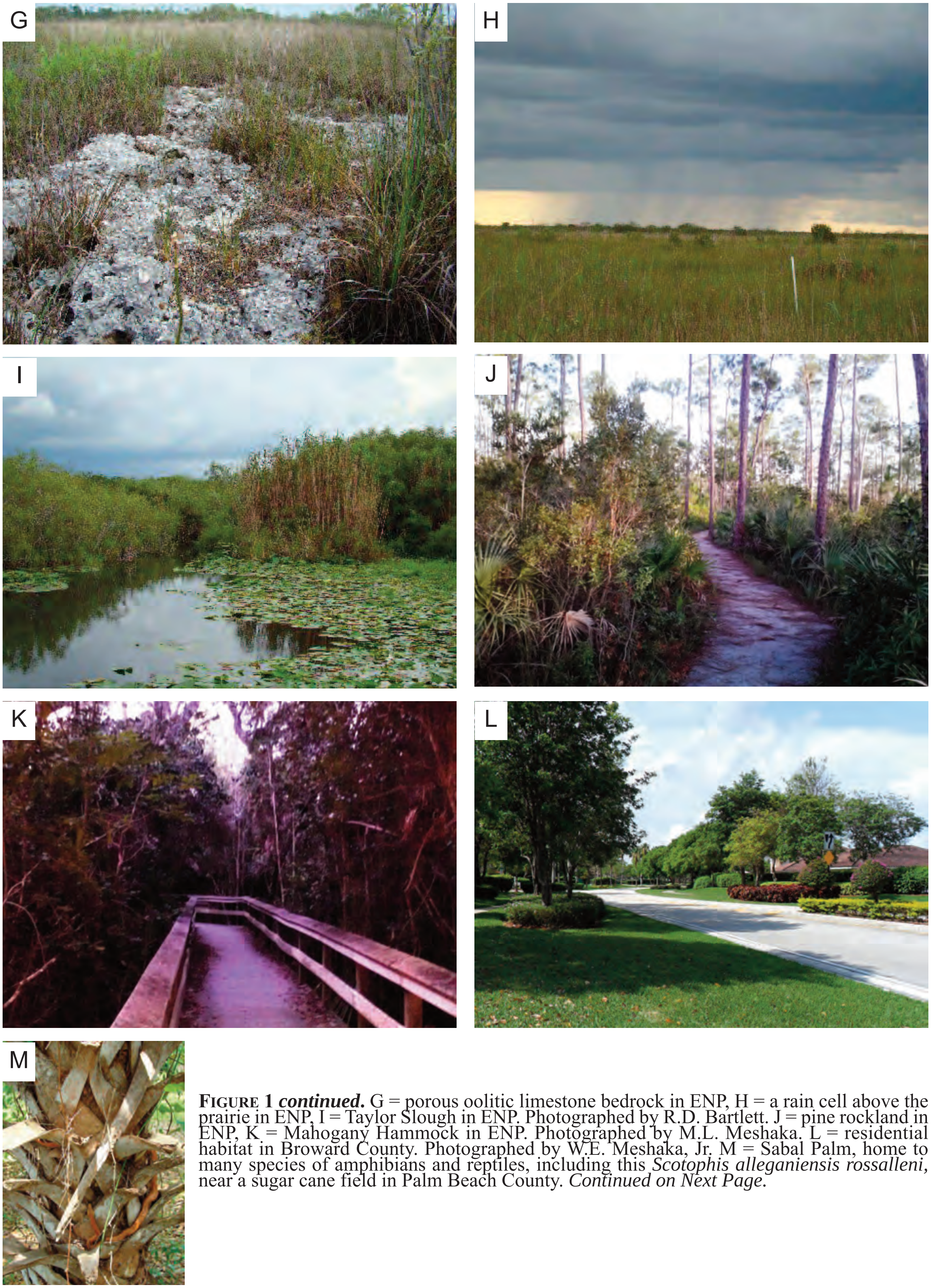

Figure 1 *continued*. G = porous oolitic limestone bedrock in ENP, H = a rain cell above the prairie in ENP, I = Taylor Slough in ENP. Photographed by R.D. Bartlett. J = pine rockland in ENP, K = Mahogany Hammock in ENP. Photographed by M.L. Meshaka. L = residential habitat in Broward County. Photographed by W.E. Meshaka, Jr. M = Sabal Palm, home to many species of amphibians and reptiles, including this *Scotophis alleganiensis rossalleni*, near a sugar cane field in Palm Beach County. *Continued on Next Page.*

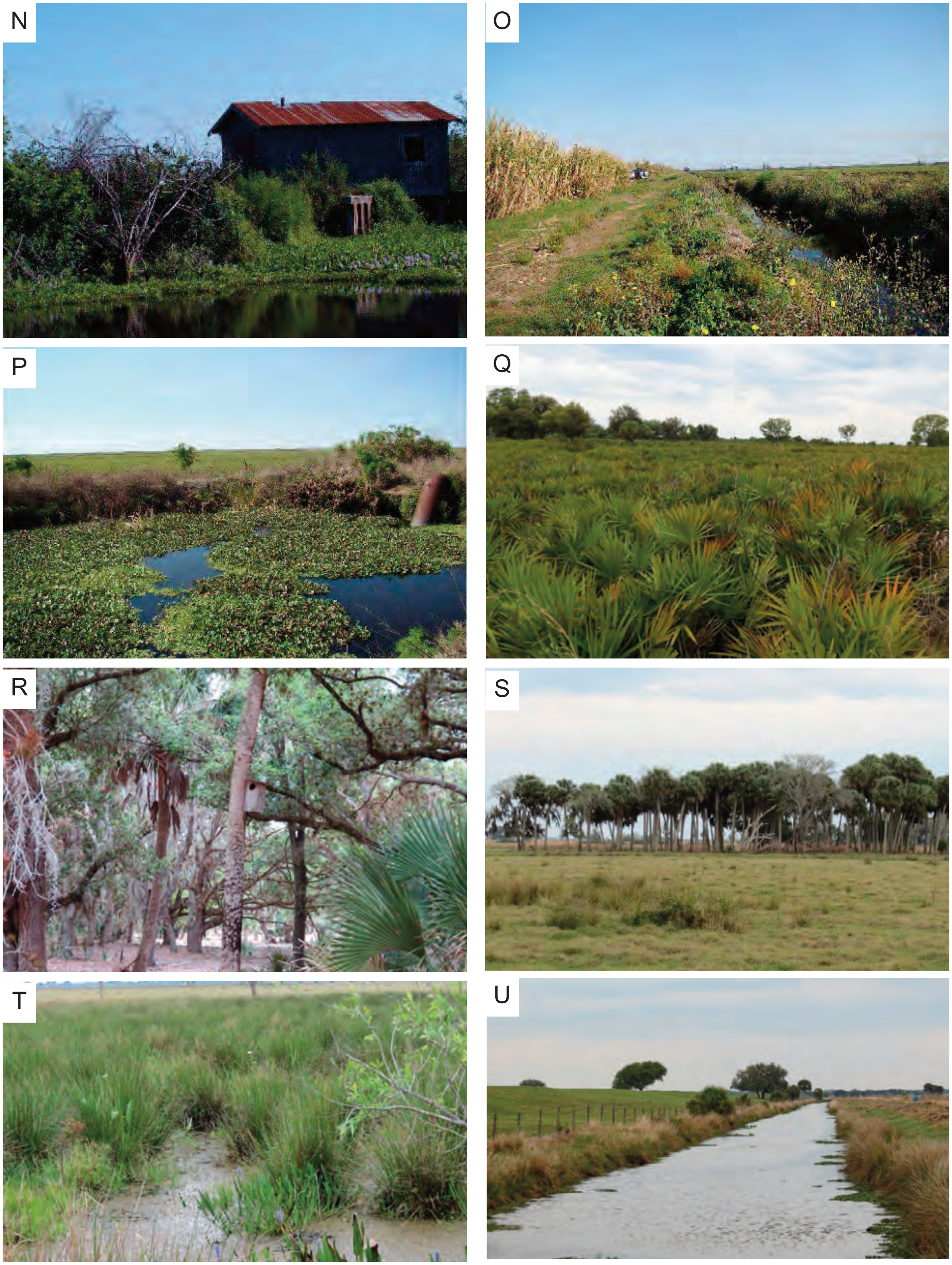

Figure 1 ***continued.*** , N = deep water canal along US-27, O = sugar cane field with a drainage ditch, P = sugar cane field alongside a canal with Water Hyacinth. Photographed by R.D. Bartlett. Q = scrubby flatwoods on Buck Island Ranch (BIR), R = palm-oak hammock on BIR, S = palm head on BIR, T = wetland depression on BIR, U = long hydroperiod ditch on BIR. *Continued on next page*.

Figure 1 ***continued***. V = Harney Pond Canal on BIR, W = a bar ditch common on BIR. Photographed by M. McMillian. X = Frequently-burned scrub on the Archbold Biological Station (ABS), Y = scrub habitat on the ABS. Photographed by P.R. Delis. Z = seasonally flooded interdunal depression on (ABS). Photographed by R.D. Bartlett.

The wetlands of the southern Everglades ranges from saline glades in the extreme south to long hydroperiod saw-grass marsh, in the interior, short hydroperiod muhly grass-dominated prairie around the pinelands to semi-permanent deep water slough. In the saw-grass marsh of ENP and Big Cypress Preserve and west to the Fakahatchee exist cypress domes and strands. Further north towards Lake Okeechobee, the once expansive saw-grass marsh has been modified through innumerable ditches, canals, and a dike around the lake to maintain the sugar industry. Pollution in Lake Okeechobee and agricultural runoff compromise the health of the biota and the chemistry of what is otherwise an oligotrophic system. In this region of the Everglades and north to the so-called "Little Everglades" of the Istokpoga-Indian Prairie Basin that connects Lake Istokpoga and Lake Okeechobee, saw-grass marsh is interspersed with tree islands of a different kind than the tropical hardwood hammock of the south. The hammocks of this region are dominated by live oak and sable palm. Much of this interesting system has been ditched and drained primarily for cattle ranching and to a lesser extent for citrus groves. It is in this area, just east of the southern tip of the ancient Lake Wales Ridge, that Buck Island Ranch is situated. The ranch, in existence since the early 1920s, is a 4168.3 ha operating cattle ranch that was leased longterm to the ABS in 1988. Its vegetation was described by Layne (1993), and a herpetofaunal list was provided by Meshaka (1997). Extensive studies by Babbitt (e.g., Babbitt, 1996, 2000; Babbitt et al., 2005, 2009; Babbitt and Tanner, 1997, 1998, 2000) examined tadpole assemblage dynamics.

Acknowledgments.—Many people contributed to the work in a variety of ways, and to all we are most grateful. In particular, we note the assistance and insights of Robert D. Aldridge, Daniel B. Childs, Joseph T. Collins, Mark Deyrup, Betty Ferster, Dan Foxen, Fred Lohrer, O'Gene Lollis, Samuel D. Marshall, Ernst Mayr, Max A. Nickerson, Raymond Porter, William B. Robertson, Todd M. Steiner, Chester Winegarner, and Glen E. Woolfenden. Henry Fitch kindly shared hand-transcribed reproductive data for selected Kansas species for statistical comparison. Superb photographs were kindly and generously shared most especially by WEM's friend, Richard D. Bartlett, but also by other dear friends, Gary Busch, Suzanne L. Collins, Pablo R. Delis, Samuel D. Marshall, Mike McMillian, and Brian K. Mealey, as well as Dick Brewer, Molly L. Meshaka, Karen Relish. Maxwell L. Meshaka assisted in retrieval of electronic files on a failed disc. Thanks also are due to the two long-suffering reviewers that took the time to read over this work. Production quality of this monograph would not have been possible without the skills and time commitment of Malcolm L. McCallum, Bruce Bury, Stanley Trauth and Andrew Walde of Herpetological Conservation and Biology to whom we are cheerfully in debt.

Procedures and Organization

Species accounts are presented in the following order: Salamanders, anurans, turtles, lizards, amphisbaenians, snakes, and crocodilians. Within those groupings, families are presented in alphabetical order, as are the species within them. Among the venomous species, the single elapid snake precedes the vipers, which are in turn presented in alphabetical order. Species descriptions in the Species Accounts provide scientific and common names for the species. Taxonomically, we speak to the forms that have been recognized as occurring in southern Florida. These are presented in light of historical context of regional distinction, allopatry, and nearest relative. They are not presented as a taxonomic revision on our part, but rather as targets, as it were, for future comprehensive revisions to accept or reject as species after considering the ecological data we present and the taxonomic literature we summarize concerning regional distinction. Likewise, our use of the most recent taxonomic revisions should be taken in neutrality. Common names follow the organization of Collins and Taggart (2009) and are used subsequently to reference the species in the rest of the sections. Our use of the literature stopped at December 2008. Thus, any citations from years beyond 2008, represent works in review or in press prior to December 2008.

Taxonomically, we focused on the native non-marine herpetofauna of southern Florida. Like Duellman and Schwartz (1958) our treatment of the five marine turtles is nominal. However, for an excellent review of the status of the marine turtles in Florida, we refer the reader to Meylan's (2006) Biology and Conservation of Florida Turtles. Specimens examined come from the research collections of the ABS, the Everglades Regional Collections Center in ENP, and the Florida State Museum.

South-central Florida refers to the surrounding area of the ABS and includes BIR, from the area just above SR-70 southward including the region of Lake Okeechobee. South Florida refers to sites within the region south of Lake Okeechobee. Southern Florida refers collectively to south-central and south Florida. This definition of southern Florida extends farther north than that of Duellman and Schwartz (1958), whose northern boundary stretched from Ft. Lauderdale to Naples, which approximates the latitude of Alligator Alley. Thus, our study incorporates the following counties: Broward, Charlotte, Collier, DeSoto, Glades, Hardy, Hendry, Highlands, Lee, Manatee, Martin, Miami-Dade, Monroe, Okeechobee, Palm Beach, Sarasota, and St. Lucie.

Topically, we made habitat and geographic comparisons only if we or the literature provided those data for southern Florida. Therefore, if no southern Florida data were available for a particular topic, exclusive of the species description, the topic was not mentioned in the account. For each topic in the Species Account, data were presented in a northerly direction beginning with the southernmost location for which data were available. Comparisons were then made among habitats if available and then with increasingly northerly populations.

Many sources of natural history information from southern Florida and specific sites within were available to us. From ENP, wet specimens, both historical and those derived from intensive collection by WEM during 1995-2000, and field observations provided data for body sizes, reproduction, and seasonal activity. From BIR, two herp arrays each comprised of a single 33.3 m drift fence with eight pairs of double-sided funnel traps were set alongside an 11-month hydroperiod ditch and a six-month hydroperiod ditch. The arrays were opposite of one another and separated by a road traversing the pastures near the Harney Pond Canal. Traps were checked each day during January-December 1994. Animals were cohort-marked by toe or scale clips. Herp arrays and field notes provided data for body size and habitat preference. Daily records of frog calls provided data for calling seasons during October 1993 - September 1994. From the ABS, natural history cards provided data for seasonal and diel activity, diet, and predation during 1979-1994.JNL field notes during 1957-1997 and JNL necropsy records during 1941-1997 provided data for seasonal and diel activity, diet, and predation from on and off of the ABS. A pitfall grid in sandhill habitat (Meshaka and Layne, 2002) provided data for seasonal activity that were standardized from 558 trapping days during 1979-1994. Data from the pitfall grid were also used in topics of habitat preference, body size, growth, and survivorship.

Four herp arrays were installed in the Southeast tract of the ABS. Each array consisted of four aluminum drift fences in the shape of a plus. A marker stake was at the center. Each of the four aluminum fences was equipped with a can trap at either end and with a double-sided funnel trap at the midway point on either side. Thus, each array had eight can traps and eight funnel traps. Two arrays were located on either side of a north-south firelane. Array 3 (NW) was paired with array 4 (NE) located on the other side of the firelane. South of them, array 1 (SW) was paired with array 2 (SE) on the other side of the firelane. The section encompassing the four arrays was burned in 1929. The area of array 1 was burned in 1986 and that of array 3 to its north was burned in 1985. Arrays 2 and 4 served as controls. Arrays were visited for 668 days during 1984-1988 and 1994-1996. The mark-recapture data from these arrays provided data for seasonal activity that were standardized from 668 trapping days. Data from the arrays were also used in topics of habitat preference, body size, growth, and survivorship.

Small mammal trapping grids from which herpetofaunal records were gleaned served as a source of data for habitat associations. In each of six sites of four habitats, 10 3.79 L tin cans were sunken into the ground at approximately 15.24 m. Each can was equipped with a raised plywood cover. Data recorded were the number of days a given species was seen each month. For each species, encounter data were standardized to no. of days seen/no. traps/ no. months sampling. Two bayheads were sampled, each in a different tract. The habitat for each was dense palmetto/gallberry flatwoods. Five can were set on each side of the bayhead in the northwest tract. In the bayhead of the southeast tract, five cans were set on each side of Bayhead Road, from east to north firelane. Trapping took place over 73 months during July 1968-April 1991. Data were combined for both bayheads in our analysis. Mature sand pine scrub- oak phase was sampled with 10 cans (five cans until 16 October 1968, five more added 17 October 1968) along the west side of north firelane opposite the sand pine scrub grid in the southeast tract. Trapping took place over 60 months during July 1968-April 1991. Scrubby flatwoods- inopina oak phase was sampled with 10 cans in the southwest tract, five cans on each side along Scrubby Flatwoods Road beginning approximately 45.72 m grid station F1. Trapping took place over 48 months during July 1968-April 1991. Two low flatwoods sites were sampled in the southwest tract. A low flatwoods-palmetto habitat was sampled with 10 cans set along the edge of the west boundary firelane at the intersection of the east-west firelane. Trapping took place over 63 months during June 1968-April 1997. The other low flatwoods site was dominated by cutthroat grass and dense shrubs (fetterbush, gallberry, and saw palmetto). Ten cans were set along the north firelane and continuing along the east firelane. Trapping took place over 80 months during April 1970-April 1994.

For southern Florida, our field observations and museum specimens from the Florida Museum of Natural History provided data for body sizes, reproduction, and seasonal activity.

Calling data were available from ENP, the ABS, and BIR. Calling data for ENP were collected opportunistically (N = 648 records during 1991 - 1998) and in standardized (N = 539 records during 1991 - 1996) fashion as per Meshaka 2001. Calling data from ABS were collected opportunistically as entered on natural history cards. Calling data from BIR were recorded daily during October 1993 - September 1994. For most species, air temperatures, volume of rainfall, and relative humidity associated with nightly calling were available most abundantly from ENP. Monthly values of mean maximum and mean minimum air temperatures and volume of rainfall associated with seasonal calling were used from ENP, and, with the exception of the former value, were used from BIR because of the abundance of calling records for both sites. Exceptionally, those data were used for the Florida Gopher Frog from the ABS because of its absence in ENP, near absence on BIR, and because of sufficient calling records available from the ABS, where it was abundant. As done elsewhere (Meshaka and Woolfenden, 1999; Meshaka, 2001, Meshaka and Layne, 2005; Meshaka et al., 2006), the lowest threshold values for each of the monthly air temperature records± 0.3 ^{0}C and the monthly rain volumes± 1.3 cm in which calling was heard were compared to respective historic monthly values across the geographic ranges of those species as a method to predict calling seasons. These predictions, in turn, were compared to findings in the literature. We tended to avoid, when possible, literature accounts for breeding/calling seasons that were not presented in monthly ranges, and references concerning seasonal trends in an activity, such as calling, are presented for comparison at the level of the month. Thus, for example, a citation noting calling from mid-March through April is presented and compared as during March−April.

We did not geographically compare body sizes at larval transformation or hatchling size because of the high intersite and temporal variability associated with transformation and hatchling size.

Non-herpetofaunal species are first mentioned using both scientific and common name. Subsequent mention of the species is with common name only. For certain studies, where specific location is important, the town or city, county, and region of Florida is presented when the study is first mentioned. Any subsequent mention of its location is restricted to the town or city or region. For example, the first time we mention the location of extensive herpetofaunal conducted by Bancroft et al. (1983), we noted Orlando, Orange County, in central Florida. Subsequently, when citing Bancroft et al. (1983) we simply noted Lake Conway in Orlando, a central Florida lake, or central Florida.

A summary of findings for each taxonomic group is provided after the last species account for that group. A synthesis relating changes in traits among the taxonomic groups is presented after the last taxonomic summary, and is, in turn, followed by the Literature Cited.

Class Amphibia

Order Caudata

Family Amphiumidae

Amphiuma means Two-toed Amphiuma

Family Plethodontidae

Eurycea quadridigitata
Coastal Plain Dwarf Salamander

Family Salamandridae

Notophthalmus viridescens Eastern Newt

Family Sirenidae
Pseudobranchus axanthus
Southern Dwarf Siren
Siren intermedia Lesser Siren
Siren lacertina Greater Siren

Order Anura

Family Bufonidae
Anaxayrus quercicus Oak Toad
Anaxyrus terrestris Southern Toad

Family Hylidae
Acris gryllus Southern Cricket Frog
Hyla cinerea Green Treefrog
Hyla femoralis Pinewoods Treefrog
Hyla gratiosa Barking Treefrog
Hyla squirella Squirrel Treefrog
Pseudacris nigrita Southern Chorus Frog
Pseudacris ocularis Little Grass Frog

Family Microhylidae
Gastrophryne carolinensis
Eastern Narrowmouth Toad

Family Ranidae
Lithobates capito Carolina Gopher Frog
Lithobates catesbeianus Bullfrog
Lithobates grylio Pig Frog
Lithobates sphenocephalus
Southern Leopard Frog

Family Scaphiopodidae (= Pelobatidae)
Scaphiopus holbrookii Eastern Spadefoot

Class Chelonia

Order Cryptodeira

Family Chelydridae
Chelydra serpentina Common Snapping Turtle

Family Emydidae
Deirochelys reticularia Chicken Turtle
Malaclemys terrapin Diamondback Terrapin
Pseudemys peninsularis Peninsula Cooter
Pseudemys nelsoni Florida Redbelly Turtle
Terrapene carolina Eastern Box Turtle

Family Kinosternidae
Kinosternon baurii Striped Mud Turtle
Kinosternon subrubrum Eastern Mud Turtle
Sternotherus odoratus Common Musk Turtle

Family Testudinidae
Gopherus polyphemus Gopher Tortoise

Family Trionychidae
Apalone ferox Florida Softshell

Class Reptilia

Order Lacertilia

Family Anguidae
Ophisaurus attenuatus Slender Glass Lizard
Ophisaurus compressus Island Glass Lizard
Ophisaurus ventralis Eastern Glass Lizard

Family Gekkonidae
Sphaerodactylus notatus Reef Gecko

Family Phrynosomatidae (= Iguanidae)
Sceloporus woodi Florida Scrub Lizard

Family Polychrotidae (= Iguanidae)
Anolis carolinensis Green Anole

Family Scincidae
Scincella lateralis Ground Skink
Plestiodon egregius Mole Skink
Plestiodon inexpectatus Southeastern Five-lined Skink
Plestiodon reynoldsi Florida Sand Skink

Family Teiidae
Aspidoscelis (= Cnemidophorus) sexlineata
Six-lined Racerunner

Order Amphisbaenia

Family Rhineuridae (= Amphisbaenidae)
Rhineura floridana Florida Worm Lizard

Order Serpentes

Family Colubridae
Cemophora coccinea Scarlet Snake
Coluber constrictor Eastern Racer
Drymarchon couperi Eastern Indigo Snake
Pantherophis (= Elaphe) guttatus (= *guttata*)
Eastern Corn Snake
Scotophis (= Elaphe) alleghaniensis (= obsoleta) Eastern Rat Snake
Farancia abacura Mud Snake
Farancia erytrogramma Rainbow Snake

Heterodon platirhinos Eastern Hognose Snake
Lampropeltis calligaster Prairie Kingsnake
Lampropeltis getula Eastern Kingsnake
Lampropeltis triangulum Milk Snake
Masticophis flagellum Coachwhip
Opheodrys aestivus Rough Green Snake
Pituophis melanoleucus Eastern Pine Snake
Stilosoma extenuatum Short-tailed Snake
Tantilla oolitica Rimrock Crowned Snake
Tantilla relicta Florida Crowned Snake

Family Dipsadidae (= Colubridae)
Diadophis punctatus Ringneck Snake
Rhadinaea flavilata Pine Woods Snake

Family Elapidae
Micrurus fulvius Eastern Coral Snake

Family Natricidae (= Colubridae)
Nerodia clarkii Salt Marsh Snake
Nerodia fasciata Southern Water Snake
Nerodia floridana Florida Green Water Snake
Nerodia taxispilota Brown Water Snake
Regina alleni Striped Crayfish Snake
Seminatrix pygaea Black Swamp Snake
Storeria dekayi Brown Snake
Virginia valeriae Smooth Earth Snake
Thamnophis sauritus Eastern Ribbon Snake
Thamnophis sirtalis Common Garter Snake

Family Viperidae
Agkistrodon piscivorus Cottonmouth
Crotalus adamanteus
Eastern Diamondback Rattlesnake
Sistrurus miliarius Pigmy Rattlesnake

Family Xenodontidae (=Colubridae)
Farancia abacura Mud Snake
Farancia erytrogramma Rainbow Snake
Heterodon platirhinos Eastern Hognose Snake
Heterodon simus Southern Hognose Snake

Order Crocodylia

Family Alligatoridae
Alligator mississippiensis American Alligator

Family Crocodylidae
Crocodylus acutus American Crocodile

Species Accounts

Caudata:
Amphiumidae

Amphiuma means Garden, 1821
Two-toed Amphiuma

Description.—The body is eel-like with two pairs of vestigial limbs with two toes (Ashton and Ashton, 1988a). Individuals from southern Florida we have found in general to be very dark brown. (Figure 2). For Florida, the species is described as dark gray above and light gray below (Ashton and Ashton, 1988a). In Miami-Dade County, the number of costal grooves average 57.6 (range = 51−61) (Duellman and Schwartz, 1958). Tail length varies along a geographic cline, with the longest tails found in southern populations (Duellman and Schwartz, 1958).

Distribution.— Southern Florida populations of the Two-toed Amphiuma represent the southern terminus of the species' geographic range (Conant and Collins, 1998; Johnson and Owens, 2005). It occurs statewide on mainland Florida (Ashton and Ashton, 1988a; Conant and Collins, 1998; Meshaka and Ashton, 2005).

Body Size.—In ENP (Machovina, 1994), males were larger than females and mean body size (SVL) of the sexes were similar to those of the respective sexes (males: mean = 40.5 cm; females: mean = 39.8 cm) reported for the population in Lake Conway, a 737.1 ha urban lake in Orlando, Orange County, in central Florida (Bancroft et al., 1983).

Habitat and Abundance.—In southern Florida, the Two-toed Amphiuma was found strictly in freshwater often associated with Water Hyacinths (*Eichornia crassipes*) in canals and sloughs (Duellman and Schwartz, 1958). In ENP, it was found in canals, willow heads, cypress heads, and prairies in decreasing order of abundance (Machovina, 1994), and it was also found in prairies (Dalrymple, 1988). The relative degree of utilization of these habitats was related to the length of their hydroperiods and the need for access to subterranean sources of water

FIGURE 2. Two-toed Amphiumas, *Amphiuma means,* from Broward (top) and Glades (bottom) counties, Florida. Photographed by R.D. Bartlett.

during the dry season (Machovina, 1994). In ENP, this species also occurred in canal and marsh habitats (Meshaka et al., 2000). On the ABS, the Two-toed Amphiuma was recorded in ditches and permanent ponds, and at a farm adjoining the station where it occurred in irrigation ditches. Specimens were collected from moist soil in the bottom of a concrete-lined ditch with no standing water and under moist vegetation in a dry ditch. On one occasion, Richard Archbold (pers. comm.) unearthed a large number of individuals when plowing up the bottom of a pond; and one was caught on hook and line in a water-filled ditch (L. Penner, pers. comm.). On BIR, the Two-toed Amphiuma was found in ditches with long hydroperiods (Table 1). Its abundance in this habitat was only about half that of the Greater Siren, the capture rate was high nonetheless because all of the captures occurred during one month when the traps were

Table 1. Number of new individuals captured in two 33.3 m drift fences with eight pairs of double-sided funnel traps checked daily at two nearby sites on Buck Island Ranch during January - December 1994.

Species	11 mo. hydroperiod	6 mo. hydroperiod	Sum
Florida Cricket Frog	3	1	4
Southern Toad	2	0	2
Eastern Narrowmouth Toad	3	2	5
Green Treefrog	1	0	1
Squirrel Treefrog	0	4	4
Florida Chorus Frog	0	3	3
Pig Frog	3	2	5
Southern Leopard Frog	73	8	81
Two-toed Amphiuma	3	1	4
Narrow-striped Dwarf Siren	1	0	1
Greater Siren	7	4	11
Green Anole	1	0	1
Island Glass Lizard	0	4	4
Eastern Glass Lizard	0	1	1
Ground Skink	0	1	1
Southern Black Racer	4	3	7
Corn Snake	0	2	2
Eastern Mud Snake	2	1	3
Florida Water Snake	9	0	9
Florida Green Water Snake	2	0	2
Striped Crayfish Snake	0	0	0
South Florida Swamp Snake	2	1	3
Florida Cottonmouth	2	0	2
Dusky Pigmy Rattlesnake	0	1	1
Peninsula Ribbon Snake	4	10	14
Eastern Garter Snake	20	8	28
Total Individuals	142	57	199

flooded. The general association with shallow lentic freshwater habitats in southern Florida by this species was similar to its habitat associations elsewhere. For example, in Hernando County, individuals were most abundant in basin swamp and dome swamp (Enge and Wood, 2000). In Lake Conway, Orange County, adults were most numerous in areas of Pickerel Weed (*Pontederia lancolata*) and Cattails (*Typha latifolia*) with a detritus layer of 16−20 cm, whereas juveniles preferred Water Hyacinth mats and detrital depths greater than 20 cm (Bancroft et al., 1983). For Florida, this salamander was noted in drainage ditches, bayhead streams, and sphagnum bogs as habitat (Carr, 1940a). In Alabama (Mount, 1975) and Louisiana (Dundee and Rossman, 1989), the species was likewise found to inhabit shallow, weedy freshwater systems.

Diet.—In ENP (Machovina, 1994) and Lake Conway (Bancroft et al., 1983), the diet of the Two-toed Amphiuma was dominated by crayfish, aquatic insects, and fishes, with no seasonal shift in the diet having been detected in ENP. At both sites, the composition of the diet shifted from aquatic insects in small individuals to crayfish and fish in larger size-classes. An ontogenetic shift in diet from small invertebrates and aquatic insects in the young to larger prey, including soft crayfish, salamanders, and small frogs in adults was noted for the species in Florida generally (Carr, 1940a). Crayfish were also included in the diet in Louisiana (Dundee and Rossman, 1989).

Reproduction−Fertilization could precede oviposition by up to six months during the extended breeding season of July−March (Machovina, 1994). As in the case of plethodontid salamanders (Houck, 1977), the male breeding season of the Two-toed Amphiuma in southern latitudes was expanded and the reproductive cycle of females showed a greater dependence on climatic factors (Machovina, 1994). Bite marks were present on males more frequently and in more months than females, with the highest incidence of bite marks on both sexes having occurred during December−May (Machovina, 1994). In Florida, adults were found to be aggressive and capable of inflicting a painful bite (Carr, 1940a). In ENP, eggs were laid during February−March on a biennial cycle (Machovina, 1994), and in central Florida most clutches were thought to have been laid during March−May (Bancroft et al., 1983). Nests were found in cavities attended by the female (Weber, 1944), and in ENP, females laid 31−124 eggs (Machovina, 1994). In southern Florida, this species lived and bred in the same habitats, and these in turn were similar to those found elsewhere (Carr, 1940a; Mount, 1975; Dundee and Rossman, 1989).

Growth and Survivorship.—Approximately five months after eggs were laid, presumably during July−August, hatchlings dispersed with rising water levels (Weber, 1944; Machovina, 1994). Young were thought to have hatched and dispersed during July−October in a central Florida Lake (Bancroft et al., 1983). The body size at sexual maturity was reached at 250 mm SVL in males and 260 mm SVL in females (Machovina, 1994). Based on data from central Florida, those body sizes coincided with an age of two or three years (Bancroft et al., 1983).

Activity.—In ENP, activity of males, but not females, was closely associated with rainfall and air temperature, and both sexes were trapped less often during the dry season (Machovina, 1994). The scarcity of females in ENP during the wet season reflected their nesting habits (Machovina, 1994). In southern Florida, we saw individuals moving about only at night. In Lake Conway, activity occurred throughout the year, with an increase in summer because of warmer water temperatures (Bancroft et al., 1983). Less than 5% of captures, even in thick, dark mats of Water Hyacinth occurred during the day (Bancroft et al., 1983).

Predators.—The Eastern Mud Snake has been a well-documented predator of this species in southern Florida (Duellman and Schwartz, 1958) and elsewhere (Meade, 1934). In ENP, this salamander was eaten by the Florida Water Snake and the Great Blue Heron (*Ardea herodias*) (Machovina, 1994) as well as the American Alligator (Barr, 1997). The Sandhill Crane (*Grus canadensis*) was reported as a predator of the Two-toed Amphiuma (Dye, 1982) Florida. A River Otter (*Lutra canadensis*) was observed feeding on a large adult in a roadside ditch in Highlands County (JNL, personal obs.), and on BIR several Crested Caracaras (*Polyborus cheriway*) were observed gathered on the bank of a ditch being cleaned out with a dragline apparently feeding on the “eels” being dredged up and deposited on the bank (F. Langford and B. Thomas, pers. comm.). The Florida Water Snake, primarily a fish-eater, also consumed amphiumas (Allen, 1938a). In North Carolina, it was depredated by the Barred Owl (*Strix varia*) (Beane, 2005).

Threats.—Reduction of suitable aquatic refugia during the harsh dry season in southern Florida as a result of lowering dry season water tables by human activity is a limiting factor in the distribution and abundance of this species. Consequently, conservation efforts for this species must address the question of minimum dry season water depth in the system-wide restoration effort of the southern Everglades.

Plethodontidae

Eurycea quadridigitata (Holbrook, 1842)
Coastal Plain Dwarf Salamander

Description.—The dorsum is olive gray to yellow (Figure 3) and some individuals have middorsal thin black v-shaped markings (Ashton and Ashton, 1988a). The dorsum is tan, occasionally with a complete or incomplete row of dark spots, and a dorsolateral stripe ranges from black to brown (Conant and Collins, 1998). Four toes are present on both hind and fore-limbs (Conant and Collins, 1998).

Distribution.—Southern Florida populations of the Coastal Plain Dwarf Salamander represent the southern terminus of the species' geographic range (Conant and Collins, 1998; Bonett and Chippendale, 2005). It occurs on mainland Florida, exclusive of the eastern rock rim, the southern mainland coast, and much of the western area of the mainland up to central Florida (Ashton and Ashton, 1988a; Conant and Collins, 1998; Meshaka and Ashton, 2005).

Habitat and Abundance.—On the ABS, the Coastal Plain Dwarf Salamander has been recorded in bayhead habitat; beneath a board in moist sphagnum moss in a dug water hole without standing water in scrubby flatwoods; and, as a larva, in a heavily-vegetated ditch bordering a railroad track. One was collected beneath litter along the shore of Lake Red Water north of Lake Placid in Highlands County. In northern and central Florida, the species was reported from sphagnum beds, bayheads, swamp streams, hammock ponds (Carr, 1940a), pine savannah ponds (Ashton and Ashton, 1988a), and "in all sorts of wet places" (Carr and Goin, 1955). Individuals have been encountered moving about in the open at night, but it was typically found under logs and bark in proximity to water, although it may be found at some distance from water in summer and fall (Carr, 1940a). In Alabama, this species was abundant in low pine flatwoods and often found on land (Mount, 1975).

Growth and Survivorship.—On the ABS, a large larva was collected in April. Hatchlings were found December−March in Louisiana (Dundee and Rossman, 1989), larvae were found during March in Arkansas (Trauth et al., 2004),

Figure 3. A Coastal Plain Dwarf Salamander, *Eurycea quadridigitata,* from Glades County, Florida. Photographed by R.D. Bartlett.

and the smallest larvae were found during early February in South Carolina (Semlitsch, 1980).

Threats.—Knowledge of the natural history of this species in Florida remains sketchy, and has scarcely increased in the past 50 years. Its secretive habits make it difficult to obtain the data needed to assess the current status and predict future trends of its populations in the state.

SALAMANDRIDAE

Notophthalmus viridescens (Rafinesque, 1820)- Eastern Newt

Description.—One form of the Eastern Newt has been described that occurs in southern Florida: The Peninsula Newt, *N. v. piaropicola* (Schwartz and Duellman, 1952). In southern Florida, the dorsum is uniformly dark and the yellow venter is mottled in black (Duellman and Schwartz, 1958) (Fig. 4).

Distribution.—Southern Florida populations of the Peninsula Newt represent the southern terminus of the species' geographic range (Conant and Collins, 1998; Hunsinger and Lannoo, 2005). As a Florida endemic, the Peninsula Newt is restricted in its geographic range to peninsular mainland Florida, north to about Citrus County (Ashton and Ashton, 1988a; Conant and Collins, 1998; Meshaka and Ashton, 2005).

Body Size.—Mean adult body size in southern Florida was slightly smaller in males than females and was general similar to those other Eastern Newt populations (Table 2). This species exhibited relatively little sexual dimorphism in body size.

Habitat and Abundance.—In the Everglades generally, this species inhabited canals, sloughs, cypress ponds, and willowheads (Duellman and Schwartz, 1958) and in ENP it was reported from marshes and solution holes (Meshaka et al., 2000). Elsewhere in south Florida, WEM found it in shallow vegetated ditches and ponds bordering Krome Avenue. It was apparently rare on the ABS, known only from a single specimen collected from a semi-permanent pond in low flatwoods in 1956 (W. Riemer, pers. comm.). In Hernando County, 114 individuals came from

FIGURE 4. A Penninsula Newt, *Notophthalmus viridescens piaropicola,* from Lee County, Florida. Photographed by R.D. Bartlett.

basin swamp, 33 individuals from dome swamp, and a single individual from hydric hammock (Enge and Wood, 2000). These findings speak to a preference for lentic shallow systems. A wide range of generally permanent aquatic habitats typified other populations farther north (Hulse et al., 2001; Minton, 2001).

Diet.—In south Florida, the diet was comprised of aquatic invertebrates (Duellman and Schwartz, 1958) and these findings were in general agreement with those provided for the genus (Bishop, 1941).

Table 2. Body size (mm SVL) and body size dimorphism of adult Eastern Newts, *Notophthalmus viridescens piaropicola*, subspecies from selected sites. For literature values, means are followed by range.

Location	Male	Female	M:F Ratio
Southern Florida (Duellman and Schwartz 1958	41.4	43.5	0.95
Pennsylvania (Hulse et al. 2001)	48.2; 41 - 52	49.3; 42 - 56	0.98
Ohio (Pfingten and Downs 1989)	42.1	41.4	1.02
Connecticut (Klemens 1993)	40.0; 31 - 47	43.1; 37 - 51	0.93
Indiana (Minton 2001)	42.8; 37 - 52	44.3; 37 - 53	0.97

Reproduction.—In southern Florida, females with eggs were found in spring and early summer (Duellman and Schwartz, 1958), and the breeding season of its nearest relative, the Central Newt, *N. v. louisianensis* (Wolterstorff, 1918), was extended to January in northern Florida (Goin, 1951). We do not know if egglaying began as early as January in southern Florida as well, although it would seem likely. In the North, egglaying began later in spring and ended in mid-summer (Petranka, 1998). In southern Florida, this species lived and bred in the same habitats, which in turn were similar to those elsewhere in its geographic range (Hulse et al., 2001; Minton, 2001).

Growth and Survivorship.—No evidence existed for the occurrence of the red eft stage in southern Florida (Duellman and Schwartz, 1958; this study). Elsewhere, the eft stage could last several years (Petranka, 1998), thereby extending generation times. The eft stage has been found to be absent in coastal populations. To that end, coastal populations in Massachusetts also omitted the eft stage altogether and reproduced earlier than inland populations (Healy, 1973). Consequently, the apparent absence of an eft stage in southern Florida could significantly shorten the time to sexual maturity.

Activity.—In south Florida, the species was active throughout the year, and individuals were active day and night (WEM, pers. obs). No evidence existed for terrestrialism in southern Florida populations.

Threats.—This species is subject to impacts of drainage and other activities that deleteriously affect aquatic environments. However, its tolerance of a wide range of aquatic habitats, both natural and man-made, suggests that presently the Eastern Newt is not seriously threatened by habitat loss.

Sirenidae

Pseudobranchus axanthus Netting and Goin, 1942, Southern Dwarf Siren

Description−Two forms of the Southern Dwarf Siren have been described that occur in southern Florida: The Narrow-striped Dwarf Siren (*P. a. axanthus* Netting and Goin, 1942) and the Everglades Dwarf Siren (*P. a. belli* Schwartz, 1952) (Figure 5). The body of the Narrow-Striped Dwarf Siren is gray, its bands and stripes not as well-defined as those of the Everglades Dwarf Siren, and usually 34−37 costal grooves (Petranka, 1998). The body of the Everglades Dwarf Siren is brown with a pale gray underside, laterally banded, has three lines within the middorsal stripe, usually 29−33 costal grooves. The body shape of both forms is fusiform, with external gills and small fore-legs, each with three toes (Petranka, 1998).

Distribution.—Southern Florida populations of the Southern Dwarf Siren represent the southern terminus of the species' geographic range (Conant and Collins, 1998; Moler, 2005). The Everglades Dwarf Siren is the southernmost of the two endemic subspecies of Southern Dwarf Siren (Ashton and Ashton, 1988a; Conant and Collins, 1998; Meshaka and Ashton, 2005). Its geographic range includes all of southern peninsular Florida to the north shore of Lake Okeechobee, whereas the Narrow-striped Dwarf Siren occupies most of the remainder of the state

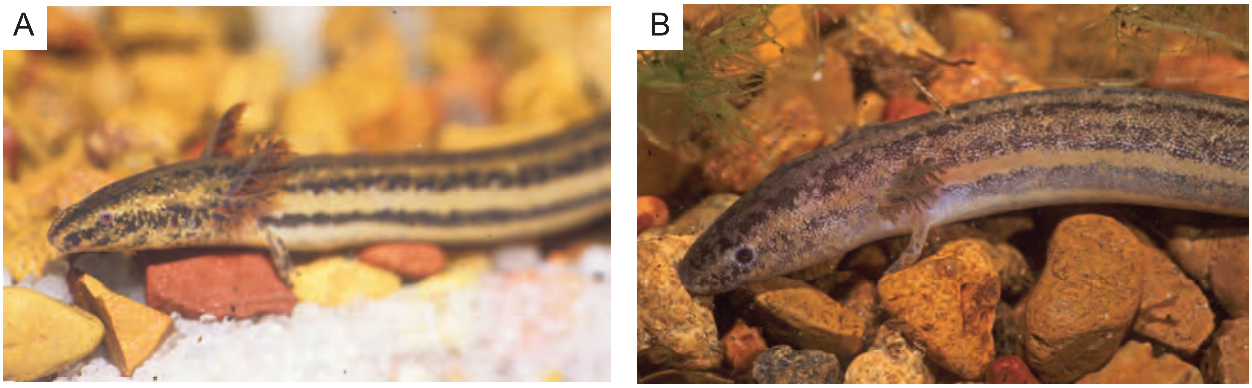

FIGURE 5. Everglades Dwarf Sirens, *Pseudobranchus axanthus belli*, from Glades (A, B) County, Florida. Photographed by R.D. Bartlett.

exclusive of the Gulf Hammock region and the panhandle (Moler and Kezer, 1993; Conant and Collins, 1998; Meshaka and Ashton, 2005).

Body Size−Adults ranged 10−25 cm in total length, with females having averaged larger than males (Netting and Goin, 1942).

Habitat and Abundance.—Prior to the introduction of the Water Hyacinth to Florida, the habitat of Dwarf Sirens was probably the muddy bottoms of pools (Neill, 1951a; Duellman and Schwartz, 1958). The species has subsequently become strongly associated with the presence of this plant, often having been found in inhabiting its suspended root systems. In south Florida, the Everglades Dwarf Siren was captured most easily in mats of decaying Water Hyacinths (Duellman and Schwartz, 1958). In ENP, this subspecies occurred uncommonly in marsh habitats (Meshaka et al., 2000). It was also collected rarely on the ABS, although more intensive sampling effort would determine actual abundance. The species was thought to be an inhabitant of open marsh and prairie ponds (Moler and Kezer, 1993). For the state generally, the species was locally common in Water Hyacinth beds in shallow water, marshes, in submerged vegetation in ponds and canals, and grassy roadside ditches (Carr, 1940a; Ashton and Ashton, 1988a).

Diet.—In southern Florida, the Everglades Dwarf Siren consumed oligochaetes (Duellman and Schwartz, 1958), and in northern Florida the diet included amphipods, chironomids and ostracods (Freeman, 1967). For the state generally, chironomids and amphipods were in the diet of the Southern Dwarf Siren (Carr, 1940a).

Reproduction.—Egglaying of the Southern Dwarf Siren occurred during November−March, and eggs were laid on Water Hyacinth roots (Goin, 1947). In Florida, breeding occurred in the spring, with eggs having been attached singly to the roots of Water Hyacinths and the leaves of Fanwort (*Cabomba*) and Hornwort (*Ceratophyllum*) (Carr, 1940a). In southern Florida, the habitat in which it bred and lived was the same and typical of populations elsewhere (Carr, 1940a; Ashton and Ashton, 1988a; Moler and Kezer, 1993).

Activity.—Dwarf Sirens were reported to hibernate in deep mud (Carr, 1940a)

Threats.—Although the ecology, including mortality factors, of this species is poorly known, it is probably safe to assume, given its close association with Water Hyacinths, that broad-scale spraying or mechanical methods of hyacinth control probably have a detrimental effect on local populations.

Siren intermedia Barnes, 1826
Lesser Siren

Description.—One form of the Lesser Siren has been described that occurs in southern Florida: The Eastern Lesser Siren, *S. i. intermedia* Barnes, 1826. Its dorsum is usually dark to slate gray with dark spots on the head and upper portion of the body (Ashton and Ashton, 1988a). The Eastern Lesser Siren has 31−34 costal grooves (Ashton and Ashton, 1988a). The body shape is fusiform with external gills and two small fore-legs, each with four toes (Ashton

Figure 6. An Eastern Lesser Siren, *Siren intermedia intermedia*, from Glades County, Florida. Photographed by R.D. Bartlett.

and Ashton, 1988a) (Figure 6).

Distribution.—Southern Florida populations of the Eastern Lesser Siren represent the southern terminus of this species' geographic range, but not that of the species (Conant and Collins, 1998; Leja, 2005a). The Eastern Lesser Siren occurs southward through peninsular Florida to near the north shore of Lake Okeechobee (Ashton and Ashton, 1988a; Conant and Collins, 1998; Meshaka and Ashton, 2005).

Habitat and Abundance.—This species has not been recorded from ENP (Meshaka et al., 2000). We have recorded it on the ABS. On BIR, WEM captured much fewer individuals than the Greater Siren and the Two-toed Amphiuma from backhoes during ditch cleaning. In Florida, generally, this species was outnumbered by the Greater Siren (Carr, 1940a). Large numbers of individuals were secured from Water Hyacinth-choked Rainey Slough, Glades County, approximately 22 km SSW of the ABS (Godley, 1983). In Hernando County, 10 of 12 individuals were captured in dome swamp (Enge and Wood, 2000). Elsewhere in Florida, the species was recorded from flatwoods ponds and ditches (Carr, 1940a) and in cypress heads, ponds, ditches, and Water Hyacinth mats (Ashton and Ashton, 1988a). A similar range of habitats was noted for the species throughout its geographic range (Petranka, 1998).

Reproduction.—Males, with their enlarged masseter muscles, bit females in association with courtship and perhaps other males in agonistic encounters (Godley, 1983). In south-central Florida, eggs were laid during December−March (Godley, 1983). In Louisiana, eggs were laid during January−May (Raymond, 1991), and egg-laying began later in northern and western populations (Noble and Marshall, 1932; Collette and Gehlbach, 1961; Gehlbach and Kennedy, 1978; Trauth et al., 1990). In south-central Florida, eggs were laid in clumps, numbering 206 and perhaps 381 eggs in two cases, within aquatic vegetation, and the nests were attended by the female (Godley, 1983). In southern Florida, this species lived and bred in the same habitats, which in turn were similar to those habitats found elsewhere in its geographic range (Petranka, 1998).

Predators.—In southern Florida, a Siren or Two-toed Amphiuma was seen struggling with an Eastern Mud Snake (Duellman and Schwartz, 1958).

Threats.—Lack of life history data prevents detailed assessment of threats. Interestingly, its well-known boon associated with the exotic Water Hyacinth, may be waning with aggressive control measures in Florida waterways.

Siren lacertina Linnaeus, 1766
Greater Siren

Description.—In southern Florida, the dorsum is grayish, and the venter is irregularly spotted with pale green (Duellman and Schwartz, 1958)

FIGURE 7. A Greater Siren, *Siren lacertina*, from Lee County, Florida. Photographed by R.D. Bartlett.

(Figure 7). The number of costal grooves averages 37 (range = 33−40) (Duellman and Schwartz, 1958). Ashton and Ashton, 1988a) noted a range of 36−39 costal grooves. The Greater Siren is fusiform in shape with external gills and small fore-legs, each with four toes (Ashton and Ashton, 1988a).

Distribution.—Southern Florida populations of the Greater Siren represent the southern terminus of the species' geographic range (Conant and Collins, 1998; Hendricks, 2005). The Greater Siren occurs throughout mainland Florida (Ashton and Ashton, 1988a; Conant and Collins, 1998; Meshaka and Ashton, 2005).

Body Size−The largest individual taken in Florida was a female that measured 45.2 cm SVL, but most others captured were much smaller (Duellman and Schwartz, 1958).

Habitat and Abundance.—In southern Florida, the Greater Siren was found in both temporary and permanent freshwater habitats during the rainy season, but was restricted to sloughs and canals during the dry season (Duellman and Schwartz, 1958). In such habitats, adults occurred in deeper water than juveniles (Duellman and Schwartz, 1958). Along canal banks in southern Florida, individuals were found in downward slanting tunnels (Duellman and Schwartz, 1958). The Everglades was thought to be the principal habitat of the species in southern Florida (Duellman and Schwartz, 1958), and in ENP it occurred in marshes and ponds (Meshaka et al., 2000). On BIR, the species was found in pasture depressions, ponds, canals, and ditches (Meshaka, 1997). On the ABS, we found individuals in a semi-permanent pond (*Neofiber* Pond) in low flatwoods, and a specimen was captured in a small mammal live trap in a flooded low flatwoods site. On BIR, it was widespread in every type of soft-bottomed ditch, canal, and pond, often with emergent vegetation, and was more abundant in deeper water systems than the Two-toed Amphiuma. In two temporary ditches of differing hydroperiod on BIR, the Greater Siren was the dominant salamander (Table 1). In Hernando County, the only two individuals captured came from dome swamp (Enge and Wood, 2000). It was an abundant salamander, second only to the Two-toed Amphiuma, in Lake Conway, where it was found in both the littoral zone as well as in deeper, open water (Bancroft et al., 1983). A possible unusual habitat record was that of a large specimen reportedly captured in brackish water near the mouth of the Pithlachascotee River in Pasco County, although the individual may have come from a nearby freshwater drainage ditch (Neill, 1958). In Florida generally, the species occurred in marshes, ditches and in shallow ponds and lakes (Carr, 1940a), and although it was found in shallow ponds and Water Hyacinth mats, it was especially common in slow moving rivers and canals (Ashton and Ashton, 1988a). In Alabama, it was likewise found in lentic or slow moving freshwater systems and often in open water (Mount, 1975). The species was found to become scarce towards the edges of its geographic range (Petranka, 1998).

Diet.—In southern Florida, stomachs contained both terrestrial and aquatic insects, crayfish, and a fish (Duellman and Schwartz, 1958). In Lake Conway, snails were the dominant food item, but plant material (mostly filamentous algae) usually occurred in stomachs along with snails, and some contained only plant material (Bancroft et al., 1983). In other Florida localities, snails (Hamilton, 1950; Moler, 1994), crayfish (Carr, 1940a), and clams (Moler, 1994) were recorded in stomachs. Generally similar food habits were reported for the species in Alabama (Hanlin, 1978) and Virginia (Burch and Wood, 1955).

Activity.—In southern Florida, we have seen individuals active throughout the year. We have also seen individuals moving about in open water at night, but we do not know if individuals rested, fed, or both during the day. Activity was nocturnal in Alabama, with peaks during the two hours after dark and before dawn (Hanlin and Mount, 1978). The species was found to have remarkably low resting metabolic rates, thereby having enabled individuals to survive two to three years on stored energy, an adaptation for drought-prone habitats (Etheridge, 1990).

Predators.—In southern Florida, a Siren or Two-toed Amphiuma was seen struggling with an Eastern Mud Snake (Duellman And Schwartz, 1958). The Greater Siren was reported as prey of the American Alligator in ENP (Barr, 1997)

Threats.—The Greater Siren represents a potentially abundant secondary consumer and prey item in the innumerable ditches and canals of southern Florida, yet so very little is knows about its population dynamics, ability to colonize canals, and its general life history.

Summary of the Southern Florida Salamanders and Newts

The six salamander and newt species accounted for 7.4 % of the total non-marine native herpetofauna in southern Florida. Endemism in southern Florida was found in one species, and a cline in morphology was apparent in another species. Southern Florida was the southern terminus of the geographic range for all of the species. None of these species have been reported in the West Indies. Breeding seasons of males were longer in two species and shorter, even if beginning earlier in northern populations, in one species. Breeding seasons of females were longer in one species and shorter, having begun earlier, in another species. Notwithstanding the low species diversity of salamanders and newts in southern Florida, the paucity of life history studies on these species was evident in the number of comparisons we could make in this segment of the herpetofauna.

Anura

Family Bufonidae

Anaxyrus quercicus Holbrook, 1840
Oak Toad

Description.—Specimens in the Florida Keys are darker in color, with a narrower and more dull-colored mid-dorsal stripe than those of the mainland (Figure 8) (Duellman and Schwartz, 1958).

Distribution.—Southern Florida populations of the Oak Toad represent the southern terminus of the species' geographic range (Conant and Collins, 1998; Punzo, 2005). The Oak Toad occurs throughout mainland Florida, including the upper but not the lower Florida Keys (Duellman and Schwartz, 1958; Ashton and Ashton, 1988a; Conant and Collins, 1998; Meshaka and Ashton, 2005). Its absence from the upper Florida Keys presumably is the result of its having become isolated by a rise in sea level on the lower Florida Keys after dispersal during pre-Pamlico time (Duellman and Schwartz, 1958). Its present-day persistence on the Florida Keys has been called into question (Lazell, 1989).

Body Size.—Mean adult body size of 20 males

Figure 8. An Oak Toad, *Anaxyrus quercicus*, from Lee County, Florida. Photographed by R.D. Bartlett.

and six females from Miami were 26.5 and 27.9 mm SVL, respectively; and on Big Pine Key both sexes averaged 24.2 mm SVL (Duellman and Schwartz, 1958). Adults of both sexes were larger in northern Florida where the mean body size of adult males (28.7 mm SVL) was significantly smaller than that of females (31.5 mm SVL) (Greenberg and Tanner, 2005).

Habitat and Abundance.—In southern Florida, the Oak Toad has been reported from rocky and sandy pineland and in sandy scrub (Duellman and Schwartz, 1958). In ENP, it was known from saw grass marsh, pineland, and hammock habitats (Meshaka et al., 2000). In this regard, the Oak Toad was most abundant in prairies where it also bred, but also occurred in disturbed, pineland, and hammock habitat of ENP (Dalrymple, 1988). In ENP, the Oak Toad was the third most abundant amphibian and the fifth most abundant species of the reported herpetofauna (Dalrymple, 1988). On BIR, it was reported from pasture and ditches (Meshaka, 1997). The Oak Toad was common on the ABS and in the general region. We found it in sandhill, sand pine scrub, scrubby flatwoods, and low flatwoods habitats and in the vicinity of seasonal ponds during the breeding season. From small mammal trapping grids, number of days this species was observed/trap/month was estimated in the following habitats: Bayhead (0.001), low flatwoods-palmetto (0), low flatwood- grass (0), mature sand pine scrub- oak phase- (0.005), scrubby flatwoods- inopina oak phase (0.008).An adult was collected in October in a short burrow, which it presumably constructed, in a wide, bare sand firelane, suggesting that individuals moving to or from breeding sitess may have taken temporary refuge in atypical sites.

Elsewhere in its geographic range, this species was also associated with generally open habitat but more importantly with well-drained soil. For example, in Hernando County, the species was much more abundant in a sandhill than in a nearby xeric hammock (Enge and Wood, 2001). Elsewhere in Hernando County, most of the few individuals were captured in a sandhill, with the highest numbers found in wet prairie (Enge and Wood, 2000). In Florida, an association was noted between this species and well-drained soils and open habitat (Carr, 1940a). In Florida, the habitat association of the Oak Toad was with upland habitats, such as longleaf pine-turkey oak, xeric hammock, and sand pine scrub (Ashton and Ashton, 1988a). Similarly, in Alabama, it was distributed in regions having sandy soil (Mount, 1975). This toad has also been found in Pine Barrens (Wright and Wright, 1949).

Diet.—In southern Florida, ants comprised the bulk of the Oak Toad's diet (Duellman and Schwartz, 1958). The stomachs of specimens from central Florida contained a wide variety of invertebrates, including, in order of frequency of occurrence, ants, spiders, termites, and carabid beetles in the case of adults and collembolans, ants, spiders, and mites in juveniles (Punzo, 1995). Ants and beetles dominated stomach contents from Florida and Georgia individuals (Hamilton, 1955).

Reproduction.—In southern Florida, calling was reported during April−August (Deckert, 1921) and April−October (Duellman and Schwartz, 1958). The calling season recorded at different localities in this study occured during May−October, with a peak in June, in ENP (Figure 9); April-October with a July peak on the ABS and vicinity (Figure 10). Additional calling records from the Lake Placid area were March (N = 1), April (N = 1), May (N = 2), September (N = 1); and June−October, with July and October peaks, on BIR (Figure 11). In northern Florida, adult movements occurred during May−September and peaked during June−August (Greenberg and Tanner, 2005). For Florida, breeding was noted during

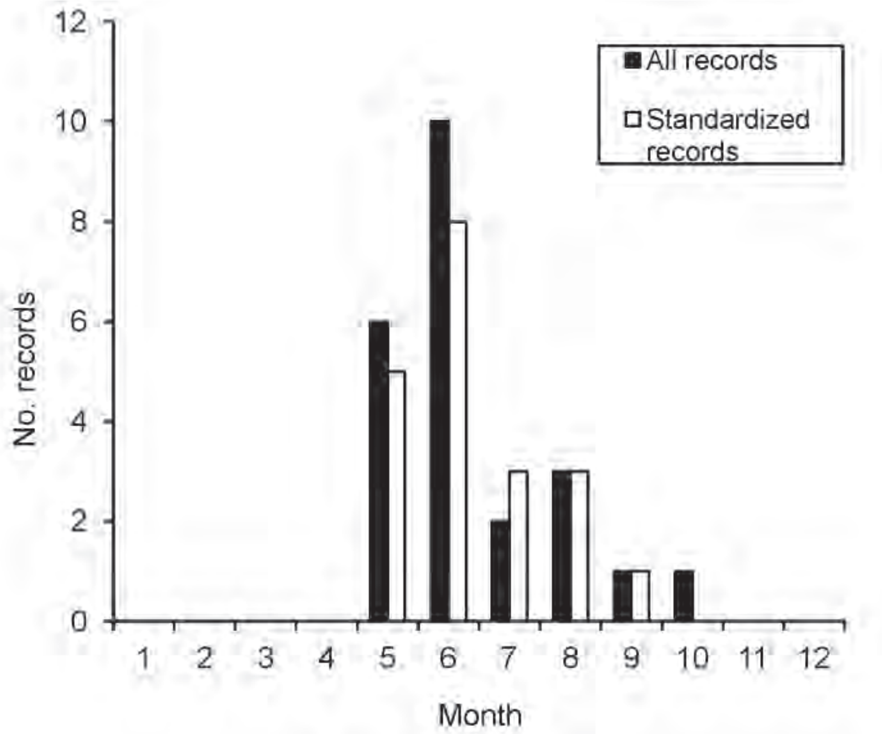

Figure 9. Calling season of the Oak Toad, *Anaxyrus quercicus*, from Everglades National Park as measured by monthly number of records during standardized visits (N = 21) (1991–1996) and from all visits (N = 24)(1991–1998).

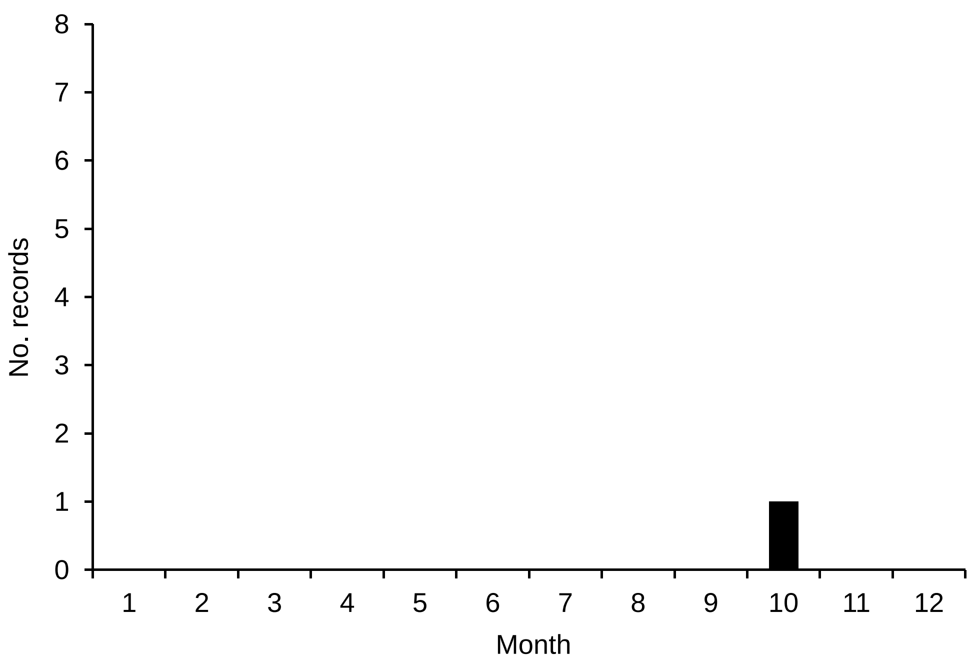

Figure 10. Calling season of the Oak Toad, *Anaxyrus quercicus*, from the Archbold Biological Station (N = 18).

April−September (Carr, 1940a), and a chorus in February (Carr, 1940b). Elsewhere, calling seasons were also shorter than those of southern Florida: April−August for southern Louisiana (Dundee and Rossman, 1989), April−July in Alabama (Mount, 1975), although most of the calling records were during May−July (R. Mount, unpubl. data), spring and summer in the Carolinas and Virginia (Martof et al., 1980).

The seasonal trend of choruses was closely associated with monthly rainfall on BIR ($r = 0.60$, $p = 0.04$) and ENP ($r = 0.77$, $p = 0.003$). In southern Florida, males called when monthly volume of rainfall was at least 7.4 cm, the mean monthly minimum air temperature was at least 16.1 ^{0}C, and the mean monthly maximum air temperature was at least 28.5 ^{0}C. When we applied these thresholds to longterm climate data, predicted calling seasons varied negatively with latitude (Figure 12). Longest predicted calling seasons were for much of southern Florida, (May−October), shorter in northern Florida, Mobile and Eufala, Alabama, Savannah and Tifton, Georgia, and Charleston, South Carolina (May−September), shorter still in Gulfport, Mississippi and Maysville, North Carolina (June−September), and shortest near the northern edge of its geographic range in Marshall, North Carolina (July).

Its breeding pattern with its close association with high air temperatures and rainfall was more similar to that of such tropical frogs as the Great Plains Narrowmouth Toad, *G. olivacea* (Hallowell, 1856) (Wiest, 1982), Coastal Plain Toad, *Ollotis nebulifer* (Girard, 1854) (Blair, 1960; Thornton, 1960; Wiest, 1982), and western bufonids such as the Texas Toad, *A. speciosus* (Girard, 1854) (Blair, 1964), than to the Southern Toad of the southeastern United States.

The high rainfall (3.3± 2.5 cm; range = 0.0−8.4; n = 20) associated with nightly calling in ENP was associated with the short four to five week larval period (Figure 13) and with the shallow water, short hydroperiod systems of natural and altered breeding habitats, such as pastures, edges of saw grass marsh, muhly grass prairies, finger glades, and pineland depressions. Calling habitats on the ABS and vicinity included ditches, seasonal ponds, and temporarily flooded pastures. Its use of shallow, open short hydroperiod sites for breeding in southern Florida was in keeping with other

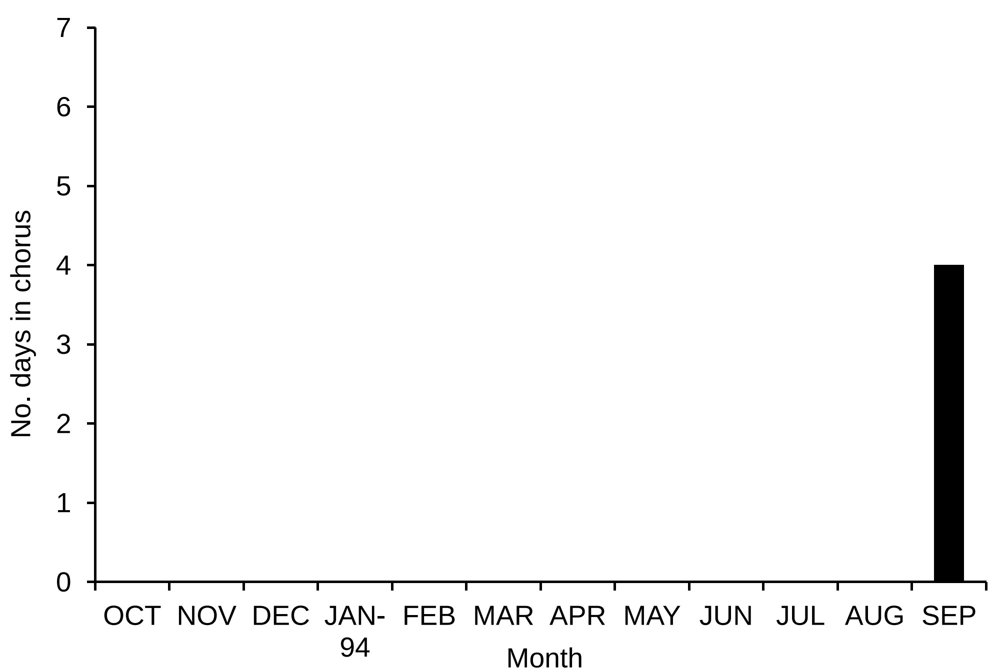

FIGURE 11. Calling season of the Oak Toad, *Anaxyrus quercicus*, from Buck Island Ranch during October 1993–September 1994 (N = 20).

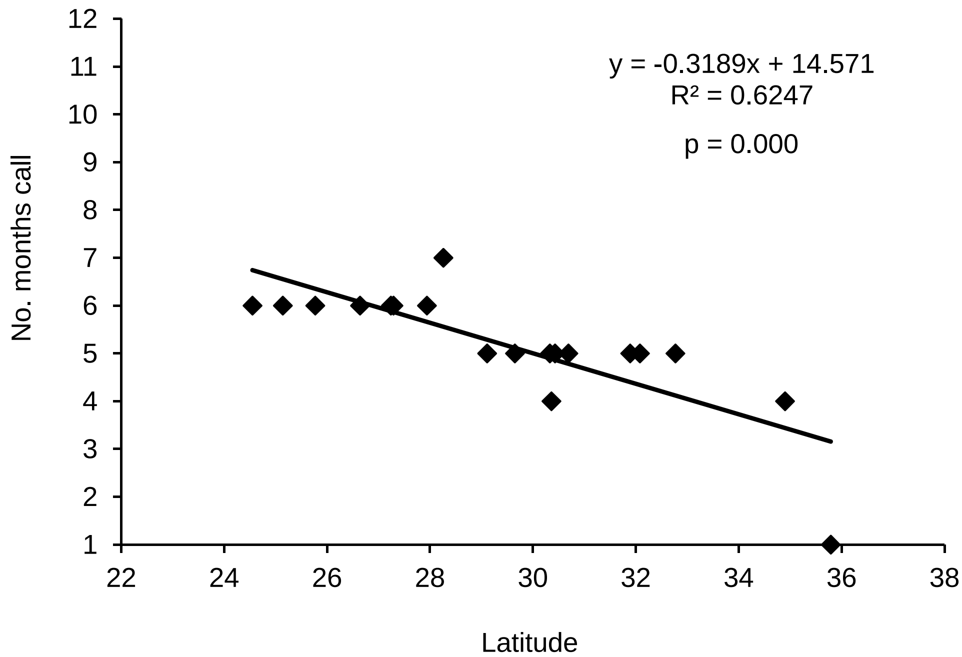

FIGURE 12. Relationship between predicted number of calling months and latitude (n = 19) in the Oak Toad, *Anaxyrus quercicus*.

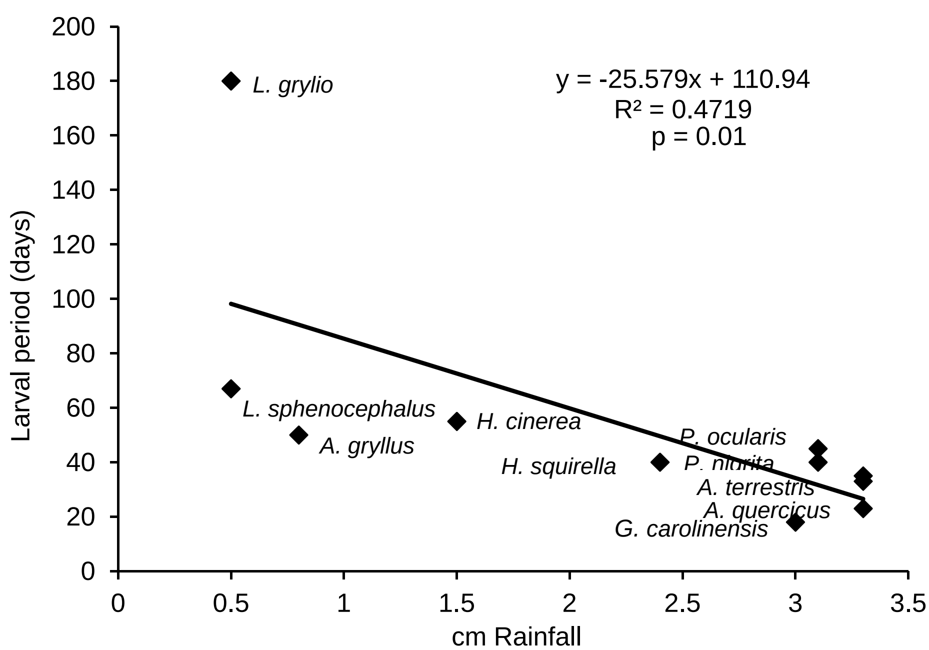

FIGURE 13. Relationship between larval period in days and volume of rainfall (cm) associated with calling in 10 species of anurans from southern Florida.

findings in southern Florida (Duellman and Schwartz, 1958), Florida generally (Carr, 1940a) and in the Southeast (Wright, 1931; Mount, 1975; Dundee and Rossman, 1989). The amount of rainfall the night before diurnal choruses near the Daniel Beard Center (2.8± 1.8 cm; range = 0.4−5.6; n = 10) was similar (t test, P > 0.05) to that associated with nocturnal choruses. The summer peak in calling was associated with warm temperatures (24.0± 0.8 ^{0}C; range = 23−25; n = 10) and high humidity (99.2± 1.4 %; range = 95−100; n = 13), weather conditions associated with nightly calling in southern Florida and across the geographic range. For example, calling in Louisiana was not heard until ambient temperatures reached 21.0 ^{0}C (Dundee and Rossman, 1989). In the Okefinokee Swamp, calling occurred with nightly air temperature minimum of 15.7 ^{0}C, but most often associated with nightly minima of 19.0−23.5 ^{0}C (Wright, 1931). Heavy rainfall was also associated with breeding throughout its range (Carr, 1940a; Mount, 1975; Martof et al., 1980; Dundee and Rossman, 1989; Greenberg and Tanner, 2005). The importance of rainfall in its breeding activities was also reflected in June and September pulses of tadpoles on BIR (Babbitt and Tanner, 2000). In northern Florida, adult movements to and from breeding ponds were associated with both cumulative rainfall and maximum air temperature (Greenberg and Tanner, 2005). Interestingly, however, neither of those two variables explained most of the variation in pond use and across years (Greenberg and Tanner, 2005). Calling during the day and night was also noted in the Okefinokee (Wright, 1931), Louisiana (Dundee and Rossman, 1989), and Alabama (Mount, 1975).

Growth and Survivorship.—On BIR, the larval period of the Oak Toad lasted approximately one month (Babbitt and Tanner, 2000; K.J. Babbitt, unpubl. data), compared with 33−44 days in the Okefinokee Swamp (Wright, 1931). We have assumed that sexual maturity in southern Florida occurred within a few months of larval transformation. We suspect this because juveniles were uncommonly encountered in our study and because of the small minimum adult body size of males (19 mm SVL) and females (20 mm SVL) (Wright and Wright, 1949). Furthermore, the post-metamorphic growth in southern Florida of individuals 17−22 mm SVL was up to 4 mm per month during February−March (Hamilton, 1955). In contrast, growth to maturity in an Okefinokee population was reached near the end of the first year of life (Wright, 1931).

Activity.—In southern Florida, we encountered active individuals throughout the year, but less frequently outside of the warm wet months of its breeding season. In north-central Florida more individuals were encountered during the summer breeding season when temperatures were warm and humidity was high than in the winter/dry season (Dodd, 1994). However, no captures by trapping occurred during December−February in northern Florida, and most activity occurred during June−September (Franz et al., 1995). Also in northern Florida, adults moved during May−September, and juveniles moved during June−October (Greenberg and Tanner, 2005). This toad was also seasonal in activity in the Okefinokee (Wright, 1931) and it was seldom seen in Alabama outside of the April−July breeding season (Mount, 1975). Movements of individuals recaptured within a month of original capture were generally within a few meters (Hamilton, 1955). We encountered active individuals both at night and during the day. In southern Florida, it was often encountered during the day (Duellman and Schwartz, 1958). On the ABS, we observed adults and juveniles moving during the day in October and December. In Florida, it was known to be active day and night (Loennberg, 1895; Carr, 1940a), although it was thought to be a diurnal toad that moved about at night to breed (Carr, 1940a).

Predators.—In southern Florida, the Eastern Spadefoot, Southern Leopard Frog, Eastern Hognose Snake, and Eastern Ribbon Snake were predators of the Oak Toad (Duellman and Schwartz, 1958), and in ENP, WEM observed American Crows (*Corvus brachyrhynchus*) feeding on live and dead Oak Toads on roads. The Gopher Frog was also reported as a predator of the Oak Toad (Barbour, 1920).

Parasites−Parasites were detected in Oak Toads from Lee County (Hamilton, 1955).

Threats−As a result of urban development, the eastern rock rim and much of the sandy uplands of the lower west coast of southern Florida no longer provide habitat for the species. Likewise, extensive conversion of sandhill and scrub habitats to citrus and commercial and housing development have resulted in extensive habitat loss in the southern Lake Wales ridge region. The status of the species on the Keys is unclear (Lazell, 1989). Widespread drainage of seasonal ponds has also negatively affected the species.

Anaxyrus terrestris (Bonnaterre, 1789)
Southern Toad

Description−In southern Florida, the dorsum ranges in color from red to brown, and the venter is dirty white in color and variably marked with dark flecks (Figure 14) (Duellman and Schwartz, 1958). Specimens from the Florida Keys tend to be greenish in color as compared to those of the south Florida mainland that tend to be brown in color (Duellman and Schwartz, 1958).

Distribution.—Southern Florida populations of the Southern Toad represent the southern terminus of the species' geographic range (Conant and Collins, 1998; Jensen, 2005a). The Southern Toad is a monotypic species of the southeastern coastal plain (Blem, 1979; Conant and Collins, 1998). Its geographic distribution in Florida is statewide on the mainland, including the lower but not upper Florida Keys (Duellman and Schwartz, 1958; Ashton and Ashton, 1988a; Conant and Collins, 1998; Meshaka and Ashton, 2005). Its distribution on the Florida Keys reflects its having become isolated on the Lower Keys after dispersal during pre-Pamlico time (Duellman and Schwartz, 1958).

Body Size.—Males were smaller than females in all southern Florida populations, with the relative size difference having been most pronounced in ENP and in the Lake Conway population of central Florida (Table 3). Both males and females from ENP were larger in mean body size than any of the other populations. These data and the individual body size record from ENP (Meshaka, 2000) supported the conclusion by Duellman and Schwartz (1958) that large individuals from southern mainland Florida were not rare. In contrast, both sexes on Big Pine Key were smaller in mean body size than any of the southern peninsula populations. Occasionally, enormous females have appeared elsewhere in Florida, such as the 150 mm SVL individual from Wacissa, Jefferson County (Means and Richter, 2007).

Habitat and Abundance.—In southern Florida, the species was most often associated with habitats characterized by well-drained soils, including sandy and rocky pinelands, sandy scrub, and hammock, as well as edificarian and ruderal areas (Duellman and Schwartz, 1958). It was also present throughout the year in gardens and cultivated land (Deckert, 1921). In ENP, this toad occurred in marsh, pineland, hammock, and Brazilian Pepper (*Schinus terebinthifolius*) stands (Meshaka et al., 2000) and was found to be evenly distributed among pineland, hammock, prairie, and disturbed habitat (Dalrymple, 1988). It was very abundant on Long Pine Key and in scattered tree islands. It has also been heard calling in Flamingo, perhaps

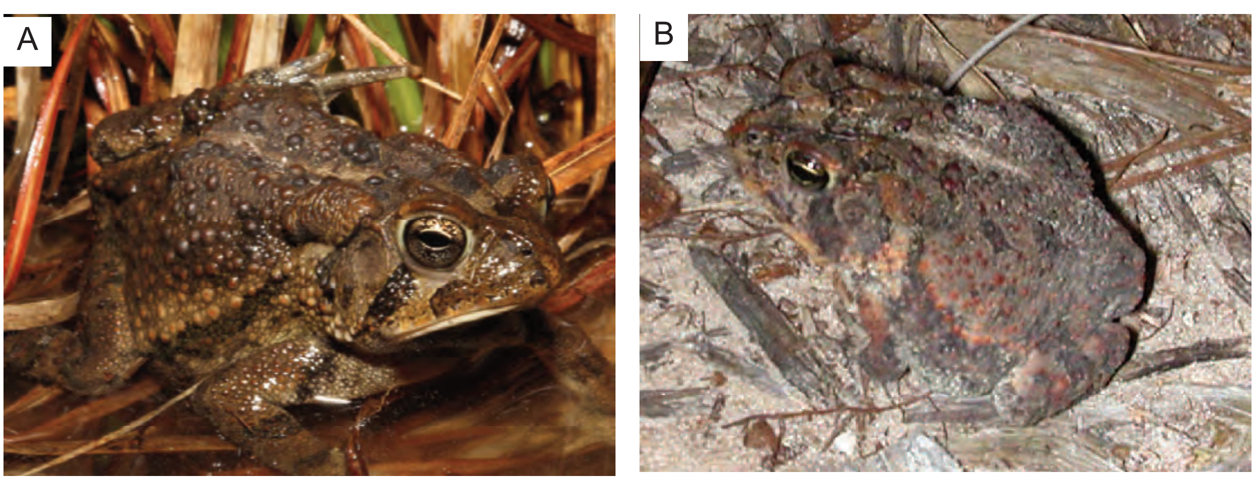

Figure 14. Southern Toads, *Anaxyrus terrestris*, from Lee (A) and Highlands (B) counties, Florida. Note the distinct cranial knobs. Photographed by R.D. Bartlett (A) and P.R. Delis (B).

Table 3. Body size (mm SVL) and body size dimorphism of adult Southern Toads, *Anaxyrus terrestris*, from selected sites. For our study, means are followed by standard deviation, range, and sample size. For literature values, means are followed by range.

Location	Male	Female	M:F ratio
Florida			
Big Pine Key (Duellman and Schwartz 1958)	48.8; N.A.	51.3; N.A.	0.95
ENP (Long Pine Key) (This study)	64.5 ± 7.5; 51.0 - 85; 141	81.1 ± 17.1; 55.0 - 123.8; 137	0.80
Everglades (Duellman and Schwartz 1958)	58.7; N.A.	65.1; N.A.	0.90
Coral Gables (Duellman and Schwartz 1958)	58.8; N.A.	67.0; N.A.	0.88
Lake Placid (this study)	59.5 ± 5.4; 50.0 - 70.0; 58	69.6 ± 8.5; 54.6 - 90.0; 81	0.86
Lake Conway (Bancroft et al. 1983)	58.5; 48 - 65	73.8; N.A.	0.79

associated with the hardwood hammocks in the mangrove fringe. In ENP, the Southern Toad was the second most abundant amphibian and the fourth most abundant species of the reported herpetofauna (Dalrymple, 1988). In ENP, the species was remarkably resilient to fire. WEM noticed that on wet nights immediately following widespread prescribed burns on Long Pine Key, live individuals appeared to be as abundant on the road as before the fire. In contrast, dead Southern Leopard Frogs, presumably killed by the fire, were encountered in the same areas.

On the ABS, the Southern Toad occurred in mature sand pine scrub, long-unburned scrubby flatwoods and sandhill, bayhead, and low flatwoods associations, as well as the park-like environment of the main grounds. For reasons unknown, numbers of post-metamorphic individuals observed around the buildings in the latter area exhibited a longterm decline. The species was not recorded from a sandhill site unburned for 67 years (Meshaka and Layne, 2002) but was present after 74 years (Ashton et al. unpubl. data). From small mammal trapping grids, number of days this species was observed/trap/month was estimated in the following habitats: Bayhead (0.001), low flatwoods-palmetto (0), low flatwood- grass (0), mature sand pine scrub- oak phase- (0.005), scrubby flatwoods- inopina oak phase (0.008).In two long-unburned scrub sites with relatively humid microclimates frequencies of captures in two pitfall-funnel trap-drift fence arrays were low (0.003 and 0.001) but increased at two other arrays in the same habitat following a prescribed fire (Figure 15, 16), attesting to its preference of open sandy habitat. The species was rarely encountered in Gopher Tortoise burrows in the xeric vegetation associations (Lips, 1991). An individual was found in the burrow of an Oldfield Mouse *(Peromyscus polionotus)* in October. The species was common in the general area of Lake Placid, occurring in citrus groves, remnant patches of scrub, and around buildings in developed areas where it was commonly observed at night feeding on insects attracted to lighted windows or street lights. In contrast, this species was rare on BIR (Table 1), where artificial hydrological alteration through ditching may have created conditions too wet for adults (Meshaka, 1997).

This species was reported to have a wide habitat distribution elsewhere in Florida. For example, it was generally abundant in sandhill habitat, especially in infrequently burned sites in Hillsborough County (Mushinsky, 1985). In Hernando County individuals were more abundant in xeric hammock than in sandhill, where it was also relatively numerous and captured in second highest numbers in basin swamp and wet prairie (Enge and Wood, 2001). Elsewhere in Hernando County, individuals were most common in xeric hammock (Enge and Wood, 2000). In forested habitat of Gadsden County, the Southern Toad was the dominant species of the herpetofaunal community (Enge,

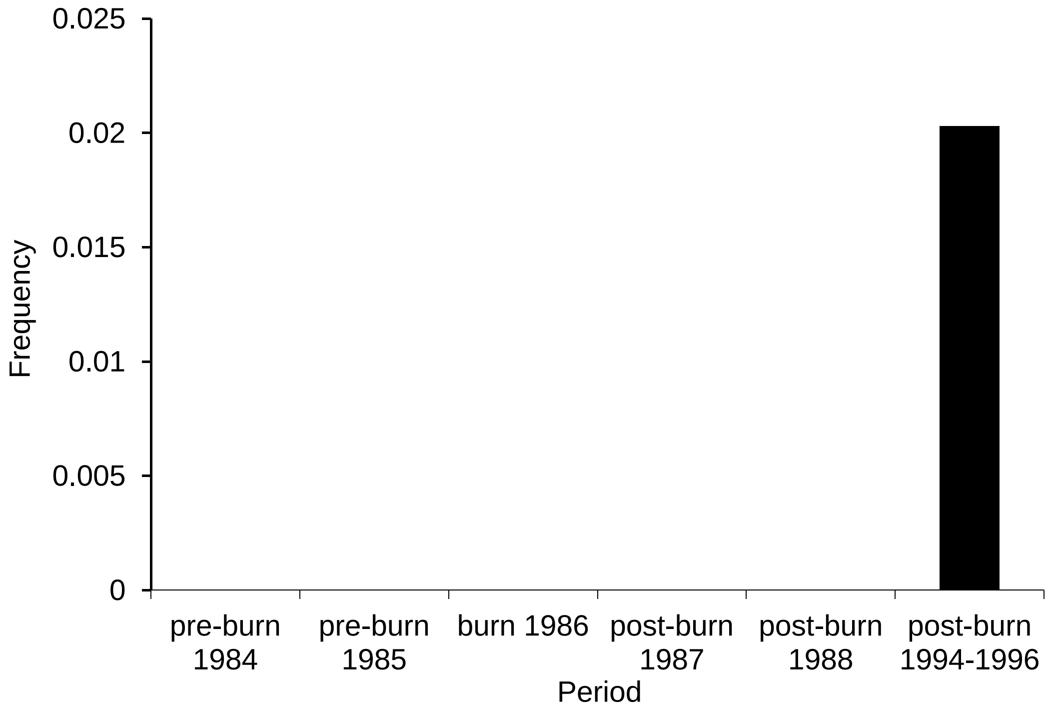

Figure 15. Relative abundance of Southern Toads, *Anaxyrus terrestis*, from scrub habitat at the Archbold Biological Station, Florida (N = 5). .

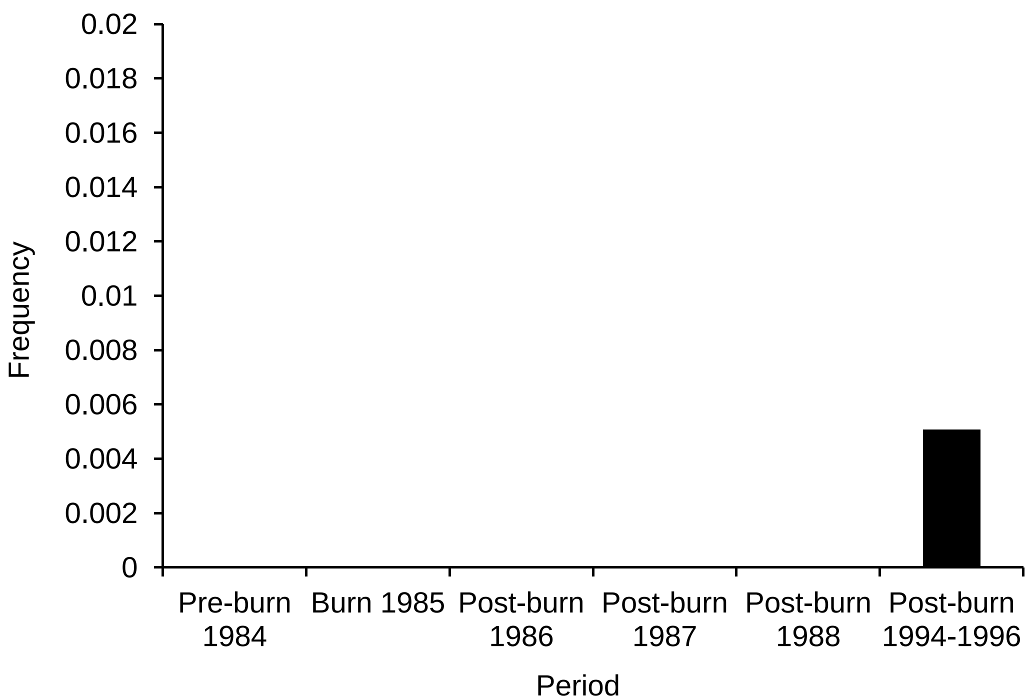

Figure 16. Relative abundance of Southern Toads, *Anaxyrus terrestis*, from scrub habitat on the Archbold Biological Station, Florida.

1998). For Florida generally, the Southern Toad was considered to be widely distributed but seemingly most abundant in open, high, and mixed hammock (Carr, 1940a). However, no distinct habitat preference has also been noted for this species in Florida (Ashton and Ashton, 1988a). In Alabama, the Southern Toad was associated with friable soil (Mount, 1975), and range-wide it was reported to have a generalized habitat selection (Wright and Wright, 1949).

Diet.—Its diet in southern Florida included a wide range of invertebrates, including crayfish, millipedes, and velvet ants, although ants and beetles predominated (Duellman and Schwartz, 1958; Krakauer, 1968; Meshaka and Mayer, 2005; Meshaka and Powell, 2010). In the southern Everglades, the Southern Toad represented one of a few ant and beetle specialists, and its near extirpation from much of south Florida may have provided 13 beetle-eating exotic herpetofaunal species with a competitive advantage (Meshaka and Mayer, 2005). Its high trophic overlap with syntopic Cane Toads (*Rhinella marina*) in Lake Placid was thought to place these two species in potential for competition (Meshaka and Powell, 2010). Ants and beetles likewise dominated the prey of the species in loblolly pine stands in the coastal plain region of South Carolina (Mosley et al., 2005). Cane Toad eggs were lethal to 20% of the larval Southern Toads that eat them (Punzo and Lindstrom, 2001).

Reproduction.—Breeding could potentially occur at any time of the year on the lower Florida Keys (Lazell, 1989). In Miami-Dade County, calling was recorded during May−September (Deckert, 1921), and in southern Florida breeding occurred during April−August and calling was heard as late as 27 October (Duellman and Schwartz, 1958). In south Florida, a chorus was heard in February (Krakauer, 1968). In ENP, we recorded calling during February−October, with a peak in June (Figure 17). On the ABS, the calling season extended from March to November, with a May-June peak (Figure 18), while in the general Lake Placid area calling had been recorded in March, April, May, August, September, and November,

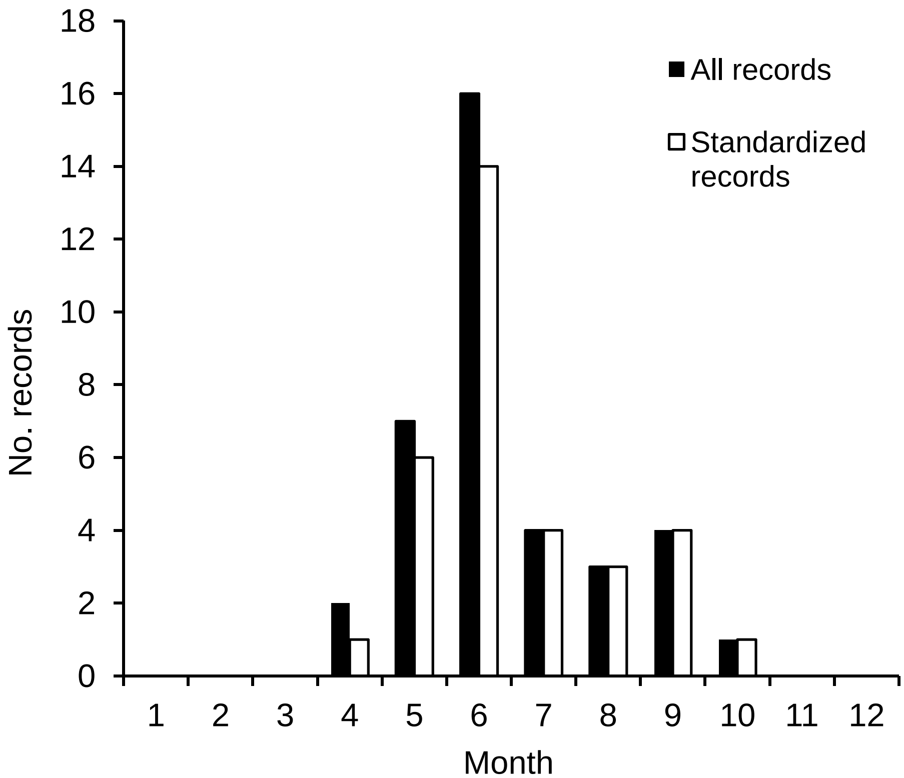

Figure 17. Calling season of the Southern Toad, *Anaxyrus terrestris,* from Everglades National Park as measured by monthly number of records during standardized visits (N = 33) (1991–1996) and from all visits (N = 39) (1991–1998).

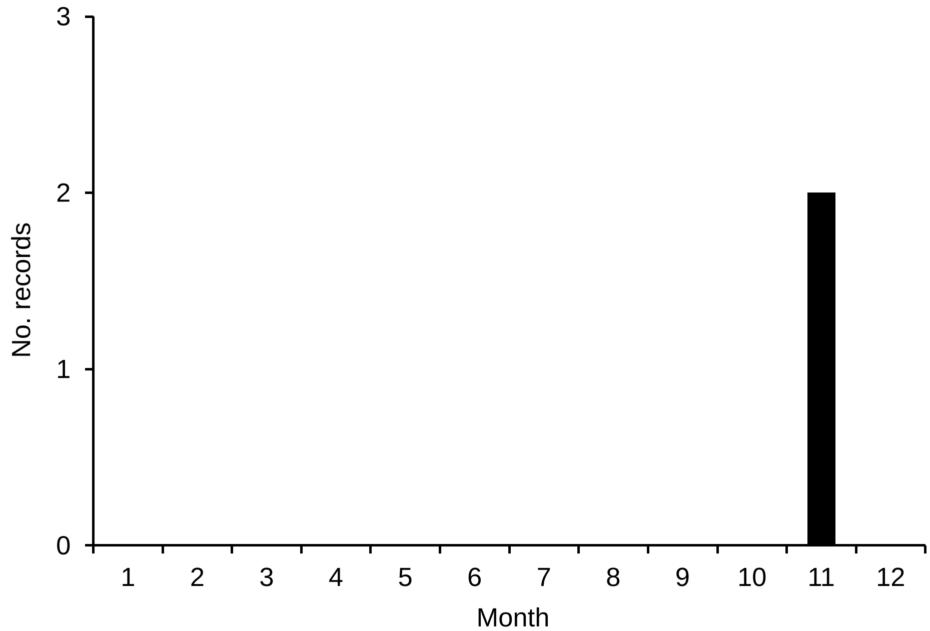

FIGURE 18. Calling season of the Southern Toads, *Anaxyrus terrestris*, at the Archbold Biological Station (N = 16).

with a peak in March (seven of 19 recorded dates). Individuals in amplexus were observed in a swimming pool in May, and other individuals appeared in the pool in June. Recently-transformed individuals were observed in August. Although a few individuals of this species were observed on BIR (Meshaka, 1997), no calling was recorded, and no tadpoles were found in ditches and other potential habitats sampled (K.J. Babbitt, pers. comm). At Lake Conway, calling was recorded during February−September, with annual seasonal peaks having varied between spring and summer (Bancroft et al., 1983). Breeding of the Southern Toad occurred during March−September for Florida generally (Carr, 1940a), and a chorus was heard in February (Carr, 1940b). Elsewhere, calling seasons were also shorter than that of southern Florida: March−May in Alabama (Mount, 1975), and March−May for most breeding for the Carolinas and Virginia (Martof et al., 1980).

Frequency of Southern Toad choruses was closely associated with monthly rainfall ($r = 0.87$, $p = 0.0002$). In southern Florida, males called when monthly volume of rainfall was at least 7.4 cm, the mean monthly minimum air temperature was at least 14.3 ^{0}C, and the mean monthly maximum air temperature was at least 20.1 ^{0}C. When we applied these thresholds to longterm climate data, predicted calling seasons varied negatively with latitude (Figure 19). The longest predicted calling season (March−November) was in the Miami area and was predicted to occur during April−October for much of the rest of Florida. The predicted calling season at Eufala and Greensboro (May−September) and Mobile (May−October), Alabama, differed from that reported for Alabama (Mount, 1975). The May−September calling season predicted for Charleston, South Carolina, was also substantially shorter than that for the Carolinas and Virginia (Martof et al., 1980). In these cases, it was not clear to us whether the climate-based estimates were inaccurate or if the literature records were based on insufficient sampling, or even if the literature records accidentally included other early-breeding *Anaxyrus* species.

The close association of high rainfall (3.3 ± 2.8 cm; range = 0.0−8.4; n = 30) and nightly calling in ENP was associated with the short four to six week larval period (Figure 13) correlated with the shallow water and short hydroperiod conditions of natural and altered breeding habitats, as in the case of the Oak Toad.

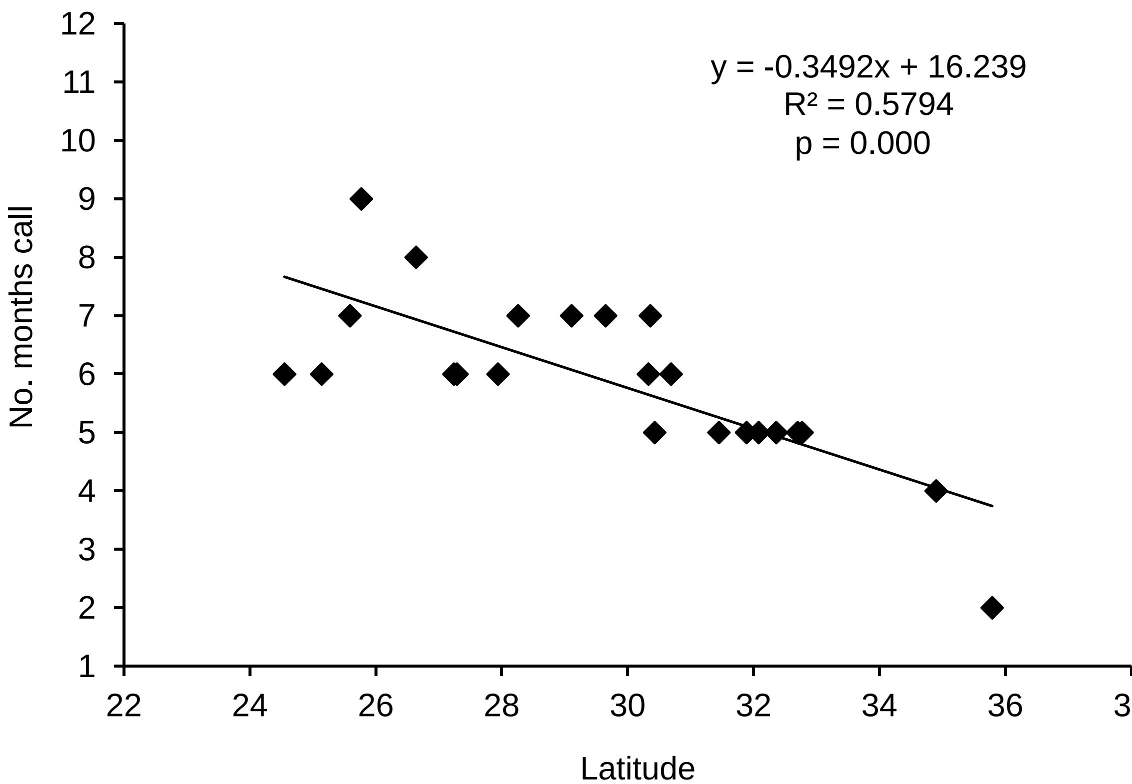

FIGURE 19. Relationship between predicted number of calling months and latitude (n = 23) in the Southern Toad, *Anaxyrus terrestris*.

However, the Southern Toad was more apt to use shallow margins of permanent systems and to use deeper water than was the Oak Toad. Its use of short hydroperiod sites and inclusion of longer hydroperiod sites was in keeping with other findings in southern Florida (Duellman and Schwartz, 1958), as well as in Miami-Dade County where males were heard calling from ditches bordering roads, in hammocks, and pineland (Deckert, 1921). The same was true for Florida generally (Carr, 1940a), and the Southeast (Wright, 1931; Mount, 1975; Dundee and Rossman, 1989).

Near the Daniel Beard Center, the amount of rainfall (5.6± 1.5 cm; range = 3.8−7.4; n = 3) the night before diurnal choruses was within the range of the nightly rainfall associated with nocturnal choruses. The summer peak in calling was associated with warm (25.0 ± 1.4 ^{0}C; range = 23−28; n = 25) and very humid (99.0± 1.4 %; range = 95−100; n = 28) conditions. On the ABS and vicinity, choruses in spring before the rainy season and in fall, following the rainy season, were typically formed after heavy rain. The lowest ambient temperature associated with calling in Louisiana was 18.3 ^{0}C (Dundee and Rossman, 1989). Although the species could call at ambient temperatures as low as 14.6 ^{0}C, most vocalization occurred at the temperature range of 18.5−24.1 ^{0}C (Wright and Wright, 1949). Diurnal calling by the Southern Toad has been heard across southern Florida as well (Duellman and Schwartz, 1958).

The pattern of calling by the Southern Toad during warm and wet conditions in southern Florida more closely resembled that of the Oak Toad than other bufonids in the eastern United States, such as Woodhouse's Toad, *A. woodhousii* (Girard, 1854), that bred with or without rain (Mount, 1975) or the American Toad, *A. americanus* (Holbrook, 1836), whose breeding activity ended before conditions were warm enough for the Southern Toad to begin in southern Florida. Furthermore, geographic variation in the seasonal distribution of calling in the Southern Toad was such that populations from southern Florida called during a longer period than any other population of conspecifics or any other North American bufonid, including syntopic populations of the Oak Toad.

Males from ENP were fertile throughout the year, and a testicular size cycle was less evident in testis length than in width (Figure 20, 21). A late summer peak in fat mass was evident in males from ENP (Figure 22).

At ENP, although nearly gravid females were collected on roads throughout much of the year, only one fully gravid female was captured, leading to the conclusion that clutches did not fully ripen until females were in close proximity to the breeding site. On and around the ABS, gravid females were present throughout the year but were most frequent during spring and summer (Figure 23). Mean clutch size of 29 females with mean SVL length of 72.5 mm (range = 62.0−89.0 mm) from the Lake Placid area was 8,334± 4,141.0 (range = 3,598−20,562). Mean egg size was 1.31 ± 0.8 mm (range =1.12−1.43 mm), and both clutch size (Figure 24) and egg size (Figure 25) increased with an increase in body size. Both egg size (Figure 26) and clutch mass (Figure 27) relative to body mass (mean = 21.5 ± 4.1%; range = 15.6−31.0), known as relative clutch mass (RCM), also increased with clutch size. A fall winter peak in fat-mass was evident in females from ENP (Figure 28).

Growth and Survivorship.—In southern Florida, the larval stage of the Southern Toad lasted approximately one to two months (K.J. Babbitt, unpubl. data). Similarly, its larval period was 35−55 days in the Okefinokee (Wright, 1931) and one to two months in Louisiana (Dundee and Rossman, 1989). In southern Florida, the smallest individuals appeared during June−January (Figure 29, 30). In the Okefinokee, recently transformed individuals were found during April−October (Wright, 1931). Body size of metamorphoslings ranged 11.0−14.8 mm SVL in southern Florida (Figure 29, 30), and 6.5−10.5 mm SVL in the Okefinokee (Wright, 1931). In both ENP (Figure 29) and Lake Placid (Figure 30), post-metamorphic growth of both sexes was rapid, and sexual maturity was achieved within seven or eight months of transformation. In contrast, minimum body size at reproduction in the Okefinokee was reached in the third year (Wright, 1931). In ENP, average body size of males was reached in four to five months of post-

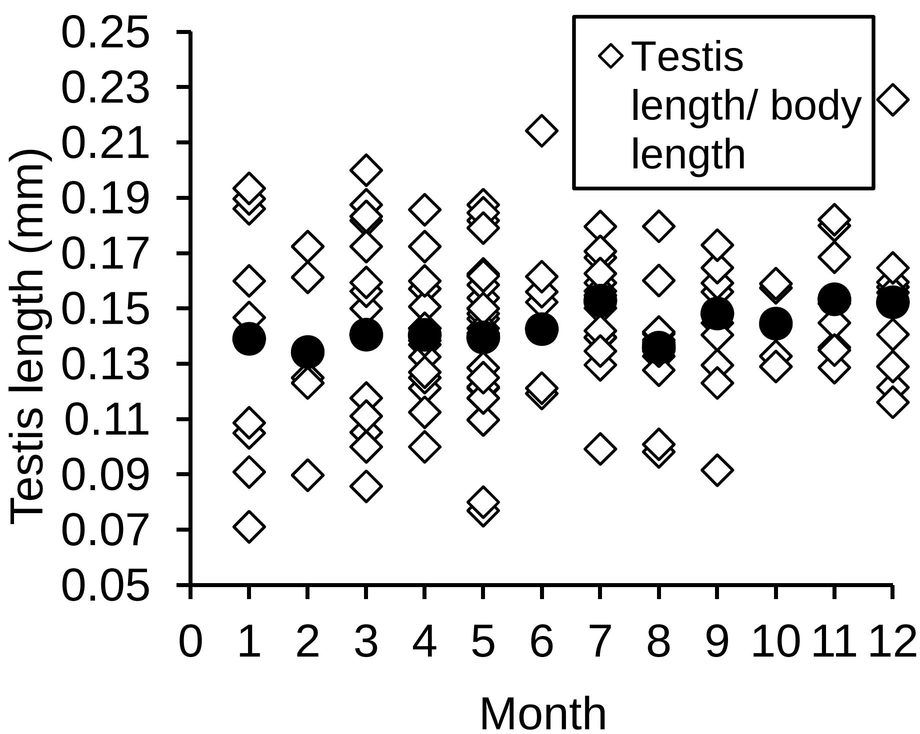

Figure 20. Monthly distribution of testis size of the Southern Toad, *Anaxyrus terrestris*, from Everglades National Park.

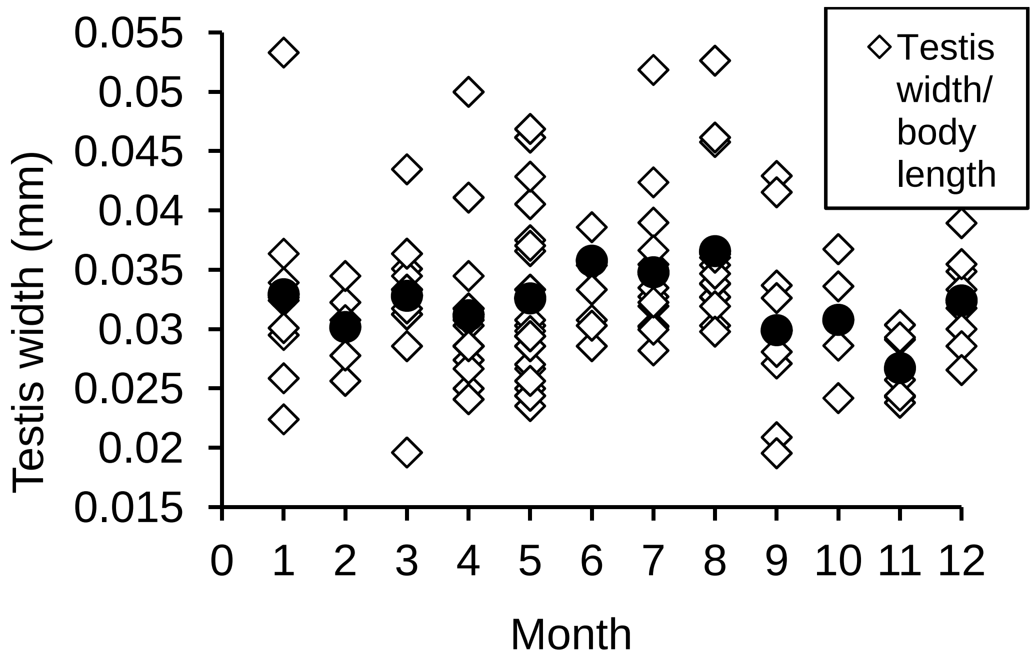

FIGURE 21. Monthly distribution of testis size of Southern Toad, *Anaxyrus terrestris*, from Everglades National Park (N = 136).

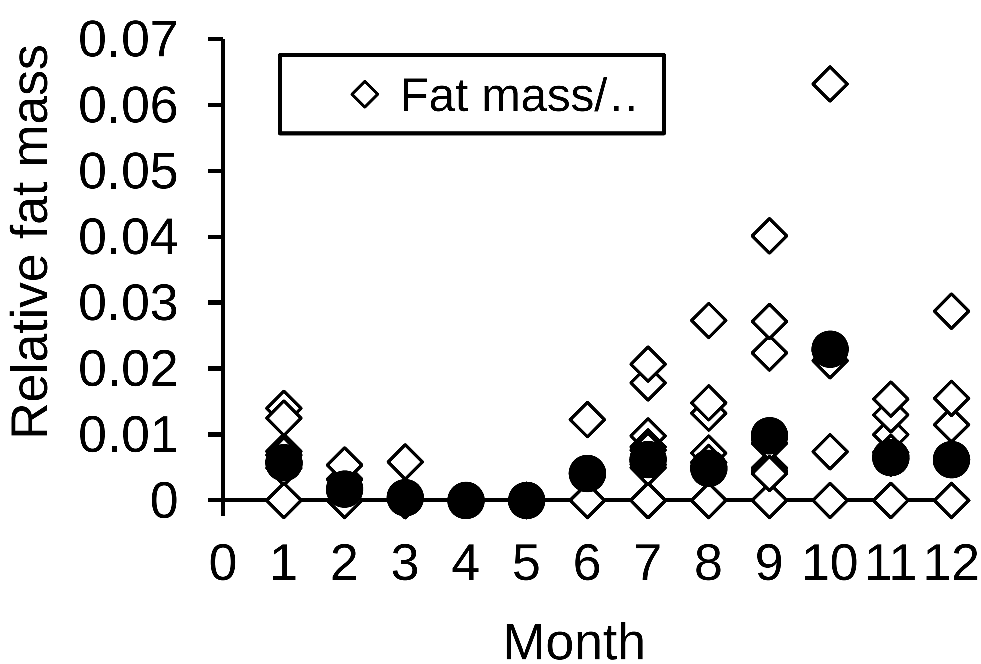

FIGURE 22. Fat cycle of male Southern Toads, *Anaxyrus terrestris*, from Everglades National Park (N = 136).

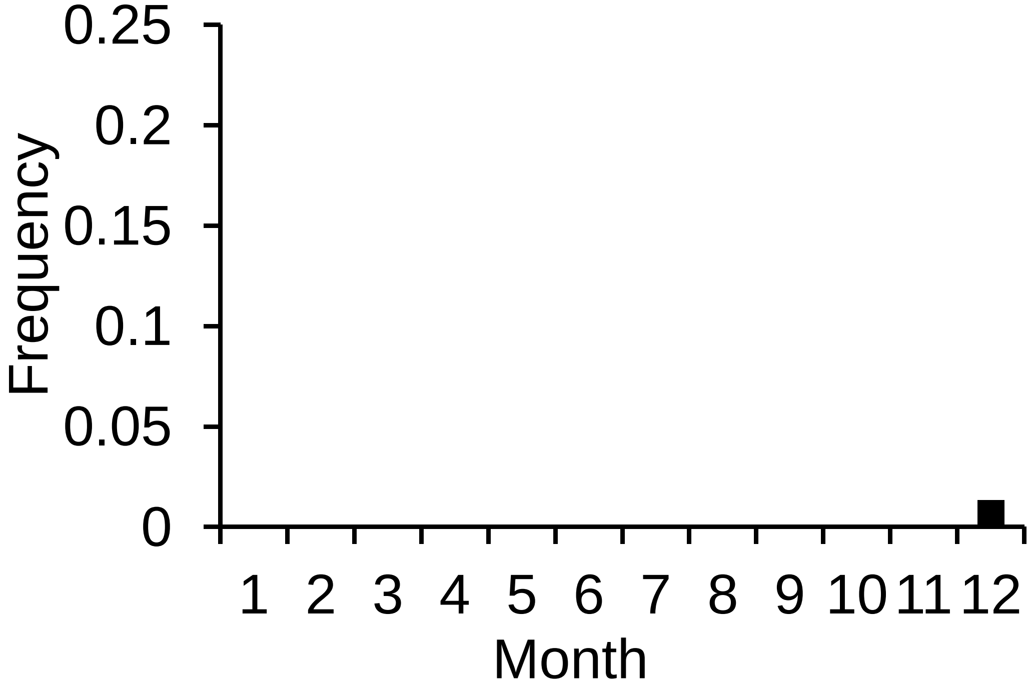

FIGURE 23. Frequency of gravid Southern Toads, *Anaxyrus terrestris*, collected from Lake Placid, Florida (N = 78).

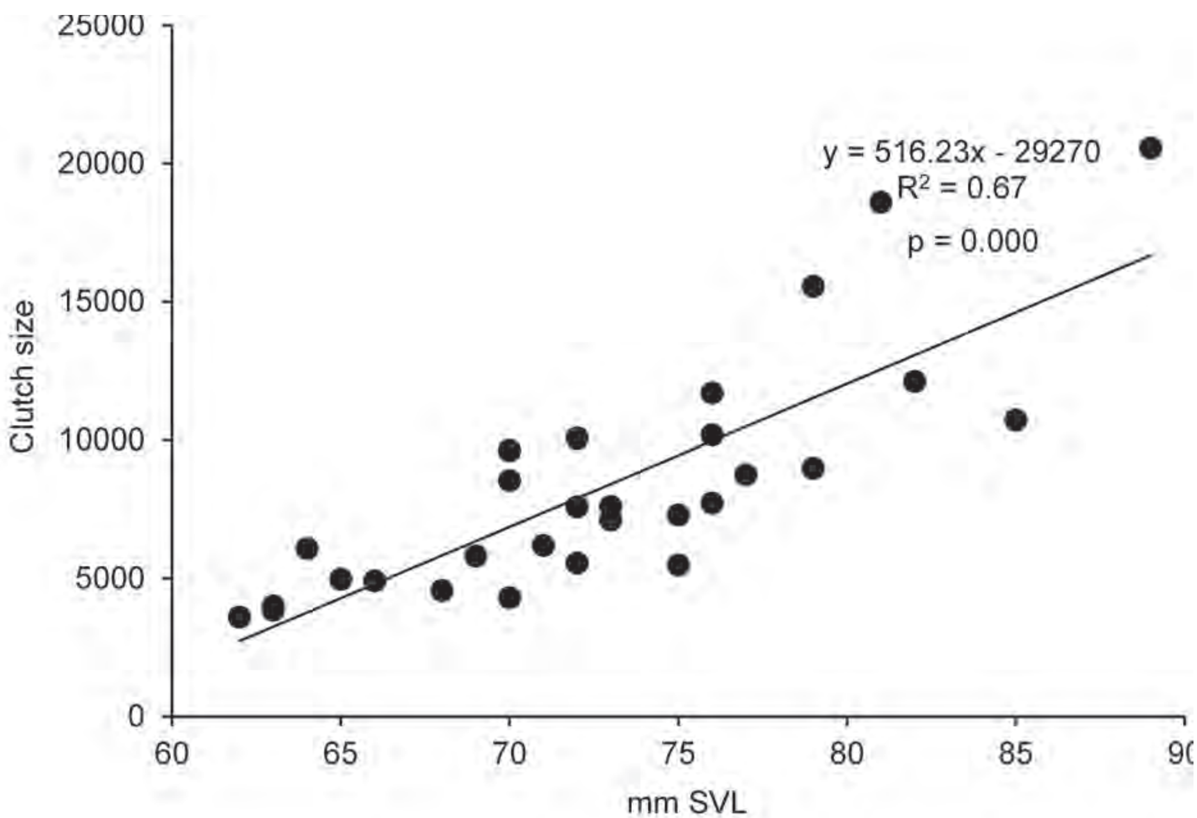

FIGURE 24. Relationship between clutch size and body size in Southern Toads, *Anaxyrus terrestris*, from Lake Placid, Florida (n = 29).

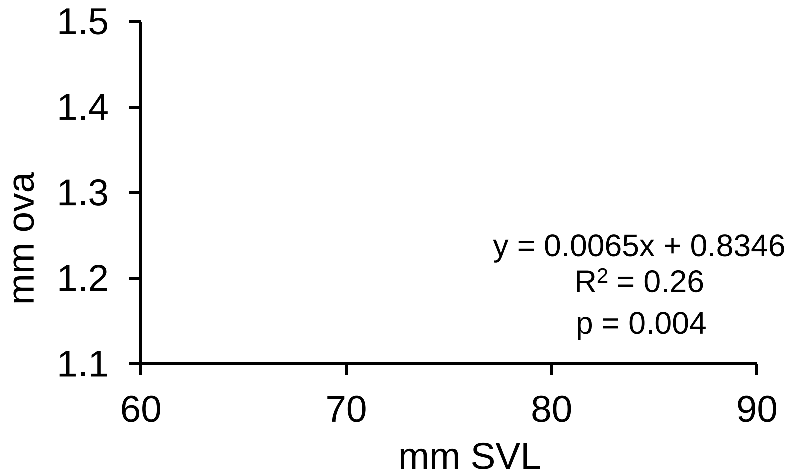

FIGURE 25. Relationship between mean oval diameter and body size in Southern Toads, *Anaxyrus terrestris*, from Lake Placid, Florida (n = 29).

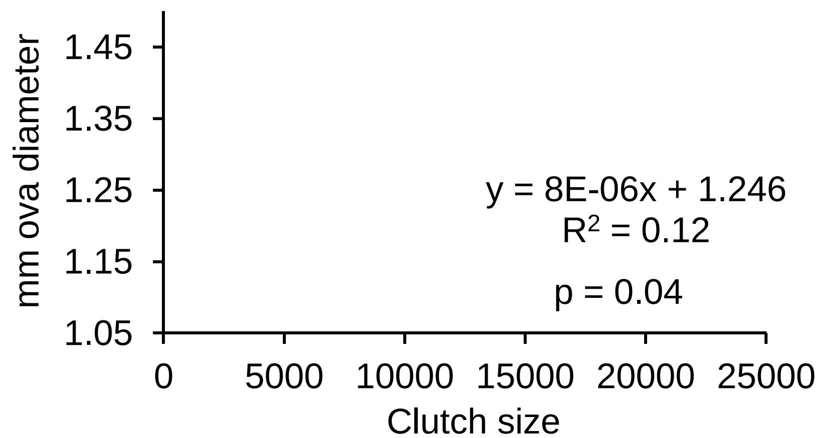

FIGURE 26. Relationship between mean oval diameter and clutch size in the Southern Toad, *Anaxyrus terrestris*, from Lake Placid, Florida (n = 29).

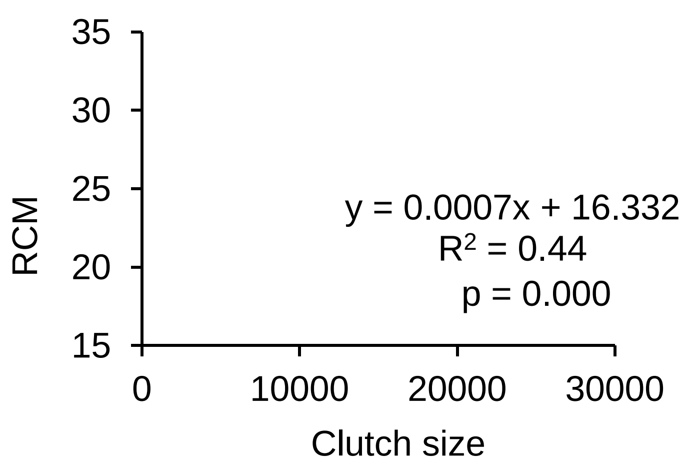

FIGURE 27. Relationship between relative clutch mass (RCM) and clutch size in, *Anaxyrus terrestris*, from Lake Placid Florida (n = 29).

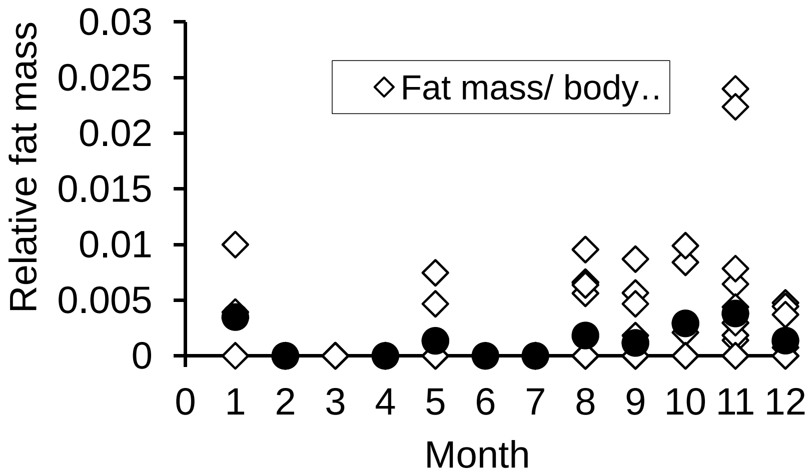

Figure 28. Fat cycle of female Southern Toads, *Anaxyrus terrestris*, from Everglades National Park (N = 126).

metamorphic and in seven to eight months of post-metamorphic life in females. Monthly distribution of body sizes suggested that in Lake Placid, average body size of both sexes was reached in five to six months. In ENP and on the ABS, males probably died at about one year of post-metamorphic age based on a single size-class in samples, whereas two or three size-classes of females were suggestive of greater longevity for that sex (Figure 29, 30). Minimum body size of sexually mature individuals from southern Florida (Table 3) was larger than that reported for males (42 mm SVL) and females (44 mm SVL) of the species (Wright and Wright, 1949) and the smallest recorded reproductive individual (42 mm SVL) in the Okefinokee (Wright, 1931).

Activity.—In southern Florida, individuals were active throughout the year, with a peak during the wet season (Figure 29, 30). These findings contrasted with depressed if any activity during a few winter months in the Okefinokee (Wright, 1931). Individuals were active at temperatures as low as 10 ^{0}C as long as relative humidity was high, but during the winter toads tended to be most active on warm nights. Unlike the Oak Toad, which was often encountered moving about during the day, southern Florida Southern Toads were much more nocturnal in habits, but often emerging after daytime showers (Duellman and Schwartz, 1958; this study). For Florida generally, the Southern toad was considered a nocturnal species (Carr, 1940a).

Predators.—In southern Florida, individuals were eaten by Peninsula Ribbon Snakes (Duellman and Schwartz, 1958) and Eastern Indigo Snakes (Steiner et al., 1983). Southern Toads were recovered from stomachs of the Eastern Indigo Snake on and in the vicinity of the ABS (Layne and Steiner, 1996), and JNL observed an Eastern Indigo Snake extract several toads from a crevice at ground level in the concrete foundation of a building. In ENP, this species was eaten by the Cuban Treefrog (Meshaka, 2001), and American Crows captured metamorphoslings in flooded fields the morning after calling and spawning (WEM, pers. obs.). In Gainesville, adults were killed by Giant Water Bugs (*Lethocerus* sp.) (McCoy, 2003). In Florida, this species was reported to be prey of the Eastern Hognose Snake (Carr, 1940a).

Threats.—Because the Southern Toad is not a habitat specialist, conservation of the species can be approached within the context of uplands in general with wetland connections. On the Florida Keys, this species was subject to the deleterious effects of mosquito spraying, even on refuge

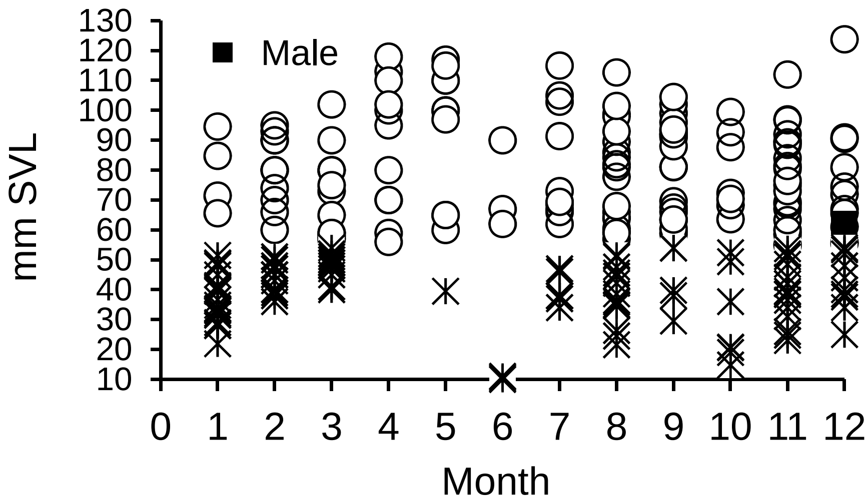

Figure 29. Monthly distribution of body sizes of the Southern Toad, *Anaxyrus terrestris*, from Everglades National Park (N: males = 141, females = 137, juveniles = 111). .

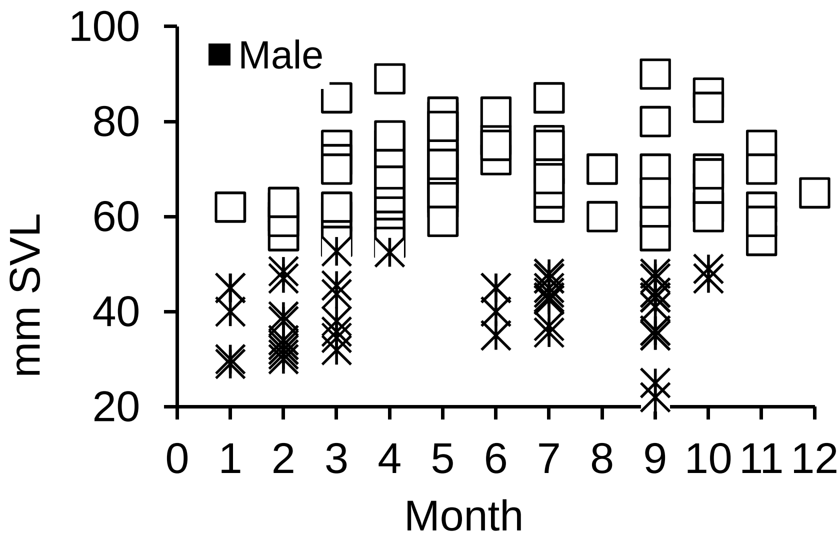

Figure 30. Monthly distribution of body sizes of the Southern Toad, *Anaxyrus terrestris*, from Lake Placid, Florida (N: males = 58, females = 81, juveniles = 56).

lands (Lazell, 1989). Although adults can thrive in developed areas, scarcity of suitable breeding sites may be a limiting factor in these environments. Larval times of the Southern toad are longer, and body size at transformation is smaller, when in the presence of larval Cuban Treefrogs (Smith, 2005).

Family: Hylidae

Acris gryllus (Le Conte, 1825
Southern Cricket Frog

Description.—One form of the Southern Cricket Frog has been described that occurs in southern Florida: The Florida Cricket Frog, *A. g. dorsalis* (Harlan, 1827). In southern Florida, the dorsum is highly variable in color (Figure 31) (Duellman and Schwartz, 1958). The middorsal stripe is light and well-defined or may be absent altogether. The dorsum may be green or very dark, in which case the olive-green to brown dorsolateral stripes may be obscured (Duellman and Schwartz, 1958).

Distribution.—Southern Florida populations of the Florida Cricket Frog represent the southern terminus of the species' geographic range (Conant and Collins, 1998; Jensen, 2005b). The Florida Cricket Frog occurs throughout nearly all of northern Florida southward to the end of the southern peninsula (Ashton and Ashton, 1988a; Conant and Collins, 1998; Meshaka and Ashton, 2005).

Body Size.—In southern Florida, mean adult body size of 10 males was slightly smaller than that of 21 females (18.2 mm vs. 20.2 mm) (Duellman and Schwartz, 1958), whereas at Lake Conway the body size of 15 males (mean = 20.7 mm SVL) averaged smaller than that of a single female (23 mm SVL) (Bancroft et al., 1983). The southern Florida form was thought to be larger than those in northern Florida (Duellman and Schwartz, 1958).

Habitat and Abundance.—In southern Florida, the Florida Cricket Frog was almost exclusively aquatic and was not encountered inland of the shoreline of such habitats as sloughs; muhly grass-dominated prairies and saw grass-dominated marshes; and canals, ponds, ditches, and lakes with emergent vegetation (Meshaka, 1997; Meshaka et al., 2000). In ENP, the only record of the species was from prairie (Dalrymple, 1988). On the ABS, it occurred in emergent vegetation in shallow water of Lake Annie; permanent and seasonal ponds in flatwoods, bayheads, sand pine scrub, and fallow fields; artificial water holes; and ditches. In the

Figure 31. A Florida Cricket Frog, *Acris gryllus dorsalis*, from Charlotte County, Florida. Photographed by R.D. Bartlett.

Price Tract of the ABS, the species occurred in the emergent vegetation along the lake's shoreline, flooded marsh and black gum swamp, and heavily-vegetated borrow pit. From small mammal trapping grids, number of days this species was observed/trap/month was estimated in the following habitats: Bayhead (0.0007).

Habitats of the Florida Cricket Frog in southern Florida were generally similar to those reported elsewhere in Florida. For example, in Lake Conway, it was the second most abundant anuran, found in high numbers generally within 1 m of shore in low grass (Bancroft et al., 1983). In Hernando County, this species was more abundant in xeric hammock than sandhill (Enge and Wood, 2001). Elsewhere in Hernando County, the Florida Cricket Frog was found in extremely high numbers in xeric hammock (Enge and Wood, 2000). For Florida generally, this little frog was found in nearly any freshwater system, especially with emergent vegetation (Carr, 1940a; Ashton and Ashton, 1988a). In contrast, it was considered this to be a terrestrial and shade-loving frog found in meadows and about creeks and ponds (Wright and Wright, 1949).

Diet.—In southern Florida, its diet of included a wide range of invertebrates but was dominated by beetles, followed by ants (Duellman and Schwartz, 1958).

Reproduction.—In southern Florida, calling was first heard in mid-March, followed by choruses during April−October with a peak during May−June (Duellman and Schwartz, 1958). In ENP and the ABS calling occurred throughout the year, with a June peak in ENP (Figure 32) and an April peak on the ABS (Figure 33). Calling occured during January−October, with April and September peaks, on BIR (Figure 34). In contrast to nocturnal calling, at both ENP and BIR diurnal calling occurred throughout the year. In central Florida, calling occurred during February−September, with a usual peak in mid-summer but in the fall in some sites (Bancroft et al., 1983). For the state as a whole, breeding was noted throughout the year (Carr, 1940a). Elsewhere, calling season of its nearest relative, the Southern Cricket Frog, A. g. gryllus (LeConte 1825), was shorter than that of southern Florida: March−August in Alabama

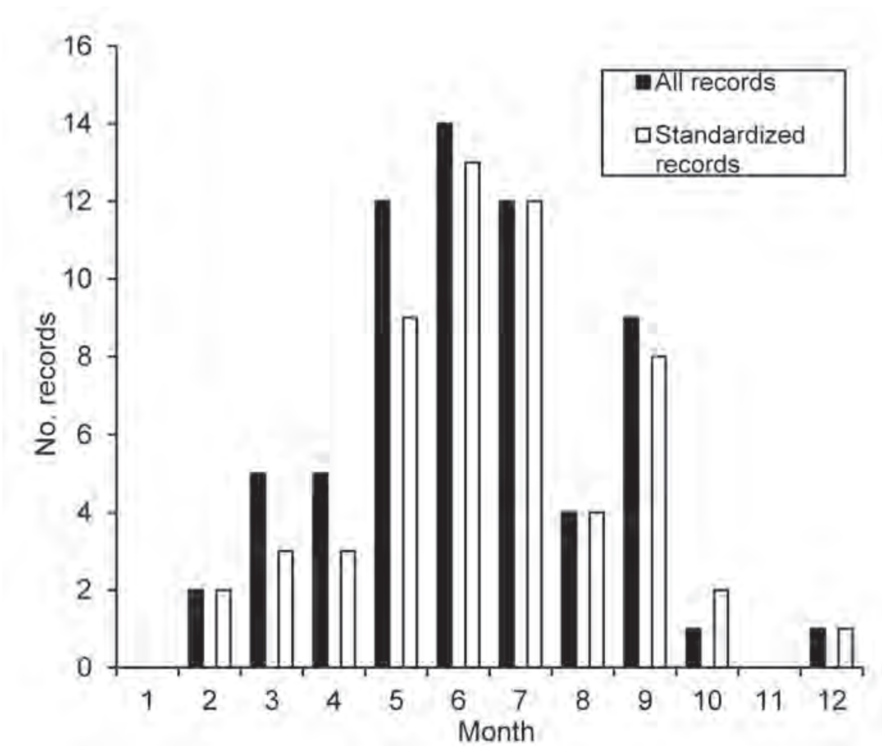

FIGURE 32. Calling season of the Florida Cricket Frog, *Acris gryllus dorsalis*, from Everglades National Park as measured by monthly number of records during standardized visits (N = 57) (1991–1996) and from all visits (N = 64).

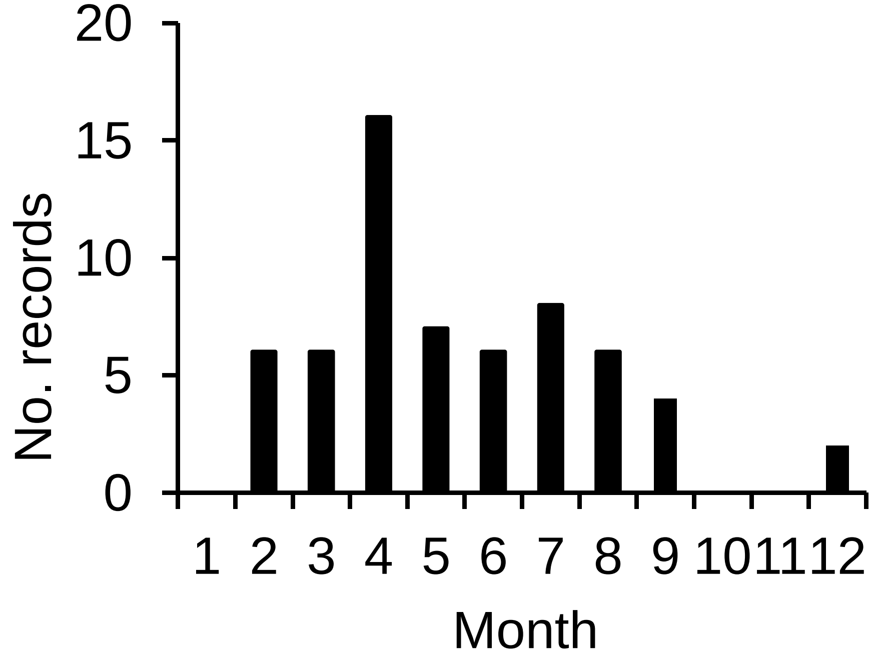

FIGURE 33. Calling season of the Florida Cricket Frog, *Acris gryllus dorsalis*, from the Archbold Biological Station (N = 64).

(Mount, 1975) and during late spring−summer in the Carolinas and Virginia (Martof et al., 1980).

Calling was not associated with monthly volumes of rainfall on BIR but was correlated with amount of precipitation in ENP ($r = 0.75$, $p < 0.005$), perhaps because of the need for rain to fill many of the long hydroperiod calling sites of ENP, whereas on BIR water was partially-drained during the wet season and artificially raised during the dry season. Similarly, calling during 1991-1992 at Pahayokee extended from June 1991 through August 1991 and from July to September 1992. Following high water in 1995, calling at Pahayokee was heard in October 1995 and again from February through July 1996 when observations were terminated.

In southern Florida, males called when monthly volume of rainfall was at least 4.3 cm, the mean monthly minimum air temperature was at least 10.8 ^{0}C, and the mean monthly maximum air temperature was at least 26.7 ^{0}C. When we applied these thresholds to longterm climate data, predicted calling seasons varied negatively with latitude such that predicted calling seasons were either seven or nine months in duration (Figure 35).

The low mean volume of rainfall (0.8 ± 1.0 cm; range = 0.0−3.8; n = 49) associated with nightly calling in ENP was correlated with an intermediate seven to eight week larval period (Figure 13) and exclusive association with long hydroperiod and permanent systems of natural and altered habitats, such as ponds, canals, sloughs, and marshes. This reflected its highly aquatic habits apparently independent of an upland connection. Its use of such long hydroperiod sites was in keeping with other findings in southern Florida (Duellman and Schwartz, 1958) and in Florida generally for what would presumably have been mostly Southern Cricket Frogs (Carr, 1940a). Summer peak in calling was reflected in the mean warm (25.2 ± 2.7 ^{0}C; range = 14−30; n = 48), mean humid (97.2 ± 3.2%; range = 90−100; n = 49) conditions associated with nightly calling. This species called day and night throughout its Florida range.

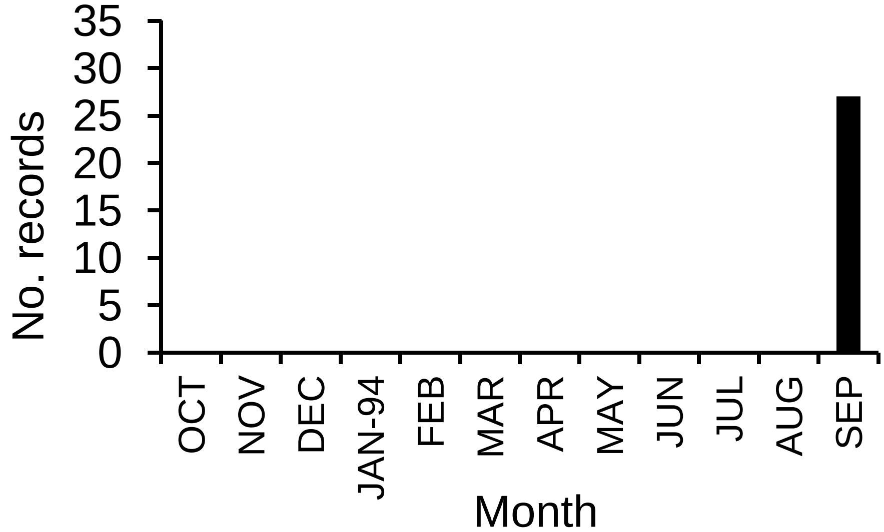

FIGURE 34. Calling season of the Florida Cricket Frog, *Acris gryllus dorsalis*, from Buck Island Ranch during October 1993–September 1994 (N =162).

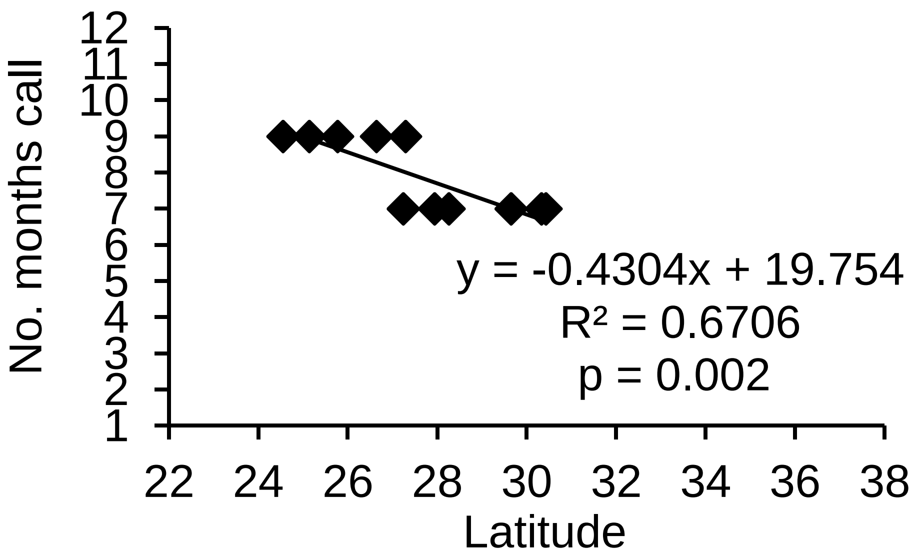

FIGURE 35. Relationship between predicted number of calling months and latitude (n = 12) in the Florida Cricket Frog, *Acris gryllus dorsalis*.

Growth and Survivorship.—In south-central Florida, the larval period of the Florida Cricket Frog lasted approximately two to three months (Babbitt and Tanner, 2000; K.J. Babbitt, unpubl. data), similar to the probable range of 50-90 days for the Southern Cricket Frog (Wright, 1931). Metamorphoslings were found during July−August in southern Florida (Duellman and Schwartz, 1958) and were observed during April−October in the Okefinokee Swamp (Wright, 1931). Growth to sexual maturity in southern Florida probably took less than one year if its minimum size at sexual maturity was similar to that of the Southern Cricket Frog (15.9 mm in males and18.7 mm in females) (Wright and Wright, 1949).

Activity.—In southern Florida, we found individuals active throughout the year as found in Florida generally (Carr, 1940a), and we found it to be active day and night. Although we found this form to be highly aquatic in its habits, it has been found a few hundred meters from water (Carr, 1940a).

Predators.—In southern Florida, predators of this frog were the Eastern Spadefoot, the Florida Water Snake, and the Peninsula Ribbon Snake (Duellman and Schwartz, 1958). Elsewhere in Florida, this species was eaten by the Southern Leopard Frog (Kilby, 1945).

Threats.—The Florida Cricket Frog appears to do well even in artificial water bodies such as borrow pits and roadside ditches as long as littoral zones are well-vegetated. In the Lake Placid area and elsewhere, extensive removal of emergent aquatics along lake shores to establish swimming areas is presumed to have had a negative effect on populations of this species.

Hyla cinerea (Schneider, 1799)
Green Treefrog

Description.—In southern Florida, the dorsum of this species is smooth in texture and ranges in color from grassy green to olive, occasionally with small gold spots. A white lateral line on either side of the body varies in its development and length (Figure 36) (Duellman and Schwartz, 1958).

Distribution.—Southern Florida populations of the Green Treefrog represent the southern terminus of the species' geographic range (Conant and Collins, 1998; Redmer and Brandon, 2005). The Green Treefrog occurs throughout Florida, including some of the Florida Keys (Ashton and Ashton, 1988a;

FIGURE 36. A Green Treefrog, *Hyla cinerea*, from Lee County, Florida. Photographed by R.D. Bartlett.

Conant and Collins, 1998; Meshaka and Ashton, 2005). The Green Treefrog has been introduced to the West Indies (Lever, 2003).

Body Size.—In southern Florida, females exceeded males in mean adult body size (Table 4). Populations from the eastern rim of the Everglades were larger in adult body size than than those from the Everglades (Duellman and Schwartz, 1958). Mean adult body size of both sexes in the southern Everglades increased with distance from the eastern rim, was generally smaller in southern Florida, and sexual dimorphism in body size was greatest in southern Florida populations (Table 4).

Habitat and Abundance.—Throughout southern Florida, the Green Treefrog was semi-aquatic and found most often in wetlands, well-vegetated lakes, and canals, and in adjoining mesic uplands. In southern Florida, it was especially abundant in willow clumps along canals and sloughs and in hammocks and cypress swamps, less frequent in sandy pineland, and absent in mangrove and salt marsh associations (Duellman and Schwartz, 1958). This treefrog was also recorded from brackish water on the Florida Keys (Peterson et al., 1952). It was found around freshwater lakes in the saline glades of ENP as well as in mangrove forest (Meshaka, 2001), although freshwater systems of prairie and marsh were the preferred habitats (Dalrymple, 1988; Meshaka et al., 2000; Meshaka, 2001). On BIR, it occurred in ponds, canals, and on buildings (Meshaka, 1997).

On the ABS, individuals were usually found in close vicinity of aquatic habitats. Although it absent or rare in sandy xeric uplands, it was often present in permanent ponds with well-developed emergent shoreline vegetation occurring in xeric habitats. From small mammal trapping grids on the ABS, number of days this species was observed/trap/month was estimated in the following habitats: Bayhead (0.004).During the non-breeding season this frog could be found around buildings remote from water, appearing on lighted windows at night to feed on insects. We also found this species in the cypress zone bordering Lake Istokpoga, Highlands County, and the mangrove zone on Sanibel Island, Lee County. In October 1962, JNL observed numerous individuals in cracks in the concrete and at the entrance and around Mud Dauber (Hymenoptera) nests under highway bridges on SR-70 in eastern Highlands County and western Okeechobee County. In Brevard County, the species was found in salt marsh habitat (Neill, 1958). However, Florida populations in general were primarily associated with freshwater systems, especially permanent ones (Carr, 1940a; Ashton and Ashton, 1988a), as was the case for Alabama (Mount, 1975), Louisiana (Dundee and Rossman, 1989), and elsewhere, including northeastern populations (Wright and Wright, 1949). In southern Florida, individuals minimized water loss by hiding in the wet petioles of palms (Carr, 1940a), and these individuals used axils of palm fronds for retreats as well as shaded branches in hammocks (Duellman and Schwartz, 1958). Although use of palm tree boots for refuge by the Green Treefrog could also facilitate human-mediated dispersal (Meshaka, 1996), its use of similar refuges as the Cuban Treefrog placed it in direct danger of predation (Meshaka, 2001). To that end, the Green Treefrog fared poorly in habitats colonized by the Cuban Treefrog (Meshaka, 2001).

Diet.—Flies and beetles dominated the diet of the Green Treefrog in ENP, although a wide range of invertebrates was also eaten (Meshaka, 2001; Meshaka and Mayer, 2005). Dietary overlap was intermediate between the Green Treefrog and the Cuban Treefrog, high with juvenile Cuban Treefrogs, and highest with Squirrel Treefrogs (Meshaka, 2001; Meshaka and Mayer, 2005). Stomachs of five adults from the vicinity of Lake Istokpoga, Highlands County, contained mostly caterpillars and spiders, while in northern Florida flies, spiders, and beetles were the dominant prey (Kilby, 1945). In Louisiana, it consumed snails, beetles, and spiders (Dundee and Rossman, 1989), and in Arkansas arthropods associated with the leafy parts of plants, such as leafhoppers, grasshoppers, caterpillars, chrysomelid beetles, and spiders predominated in the diet (Brown, 1974). Cane Toad eggs were lethal to 100% of the larval Green Treefrogs that ate them (Punzo and Lindstrom, 2001).

Reproduction.—On the lower Florida Keys, the Green Treefrog called during May−June (Lazell, 1989) and during May−October in southern Florida (Duellman and Schwartz, 1958). In ENP, calling occurred during February−October with a June peak (Figure 37).

Calling occurred during April−September with a June−August peak on the ABS (Figure 38) and during March−September with a July or June – July peak on BIR (Figure 39). Calling was recorded during April−September, with a July−August peak at lake Conway (Bancroft et al., 1983), in the Gainesville area breeding was reported during April−August (Kilby, 1945), and calling was heard during March−September in northwestern Florida (Gunzburger, 2006). For Florida generally, breeding took place during March−August (Carr, 1940a) although a chorus was heard in February in Gainesville (Carr, 1940b). Elsewhere, calling seasons were also shorter than that of southern Florida: April−August in Alabama (Mount, 1975), April−September in Louisiana (Dundee and Rossman, 1989) and the Carolinas and Virginia (Martof et al., 1980), May−August in southern Illinois (Garton and Brandon, 1975), and May−July in Maryland (Harris, 1975).

Seasonal calling was significantly correlated with rainfall in ENP ($r = 0.83$, $p = 0.001$), perhaps because of the reliance on rain to fill many of the long hydroperiod calling sites of ENP. For example, calling at Pahayokee was heard from June 1991 (at the beginning of the monitoring period) through September 1991 and again from June 1992−September 1992, whereas at Eco Pond and Anhinga Trail, calling ended in September 1991 and occurred again from March 1992 to September 1992, three months earlier than at the marsh sites. At a pond on BIR, no association was found between calling and rainfall. As noted in Alabama (Mount, 1975), this species in southern Florida did not need rain in order to call. In southern Florida, males called when monthly volume of rainfall was at least 0.5 cm, the mean monthly minimum air temperature was at least 10.8 ^{0}C, and the mean monthly maximum air temperature was at least 24.5 ^{0}C. When we applied these thresholds to longterm climate data, predicted calling seasons varied negatively with latitude (Figure 40). Longest predicted calling seasons were in south Florida sites: Throughout the year on Key West, Flamingo, and Miami, March−November in Okeechobee, Orlando, and Tampa, April−November in Lake Placid and Daytona Beach, March−October in Gainesville, and April−October in Tallahassee and Jacksonville. The April−October predicted calling season for New Orleans approximates the records for Louisiana (Dundee and Rossman, 1989).

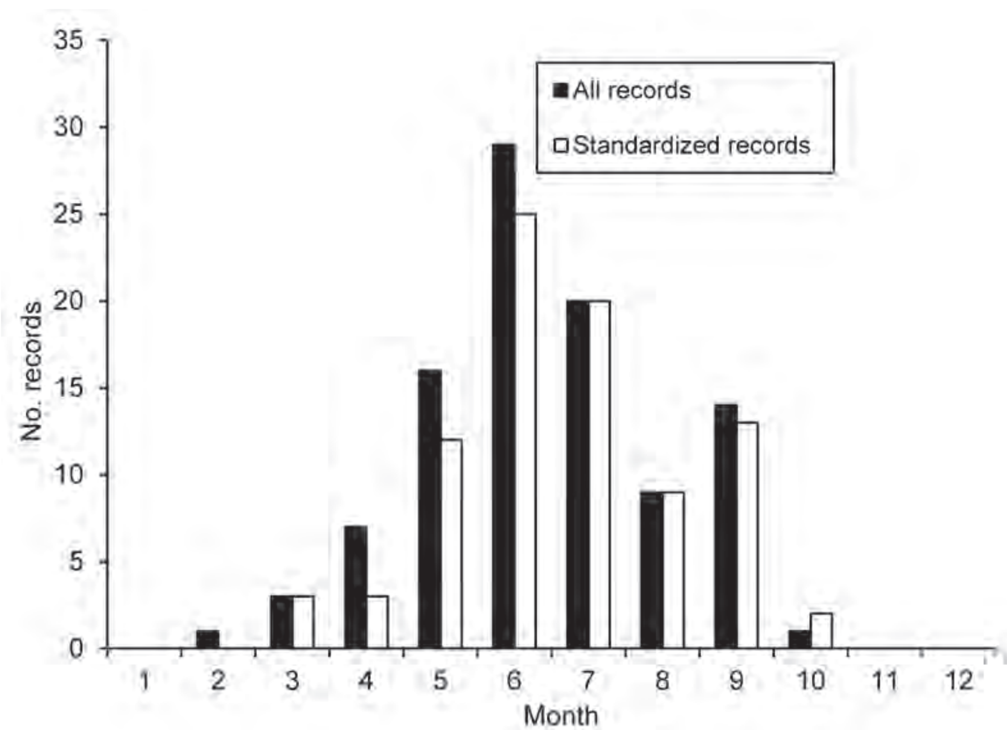

Figure 37. Calling season of Green Treefrog, *Hyla cinerea*, from Everglades National Park as measured by monthly number of records during standardized visits (N = 87) (1991–1996) and from all visits (N = 98).

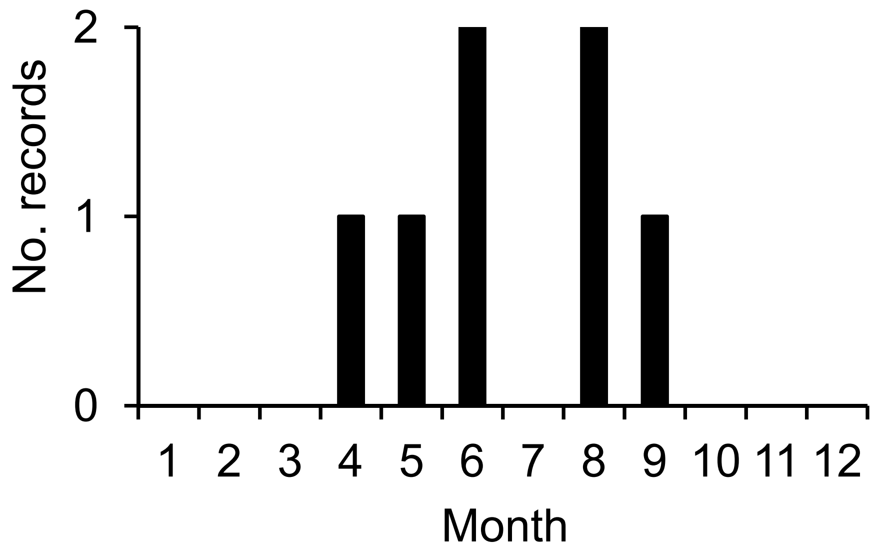

FIGURE 38. Calling season of the Green Treefrog, *Hyla cinerea*, from the Archbold Biological Station (N = 7).

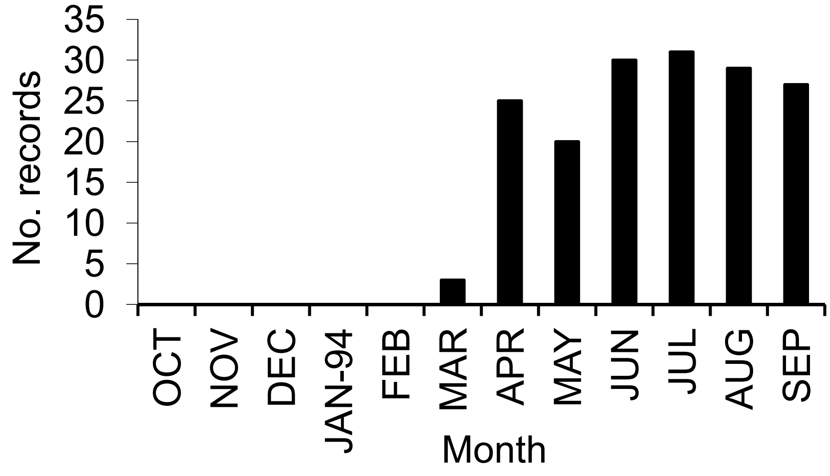

FIGURE 39. Calling season of the Green Treefrog, *Hyla cinerea,* from Buck Island Ranch during October 1993–September 1994 (N = 165).

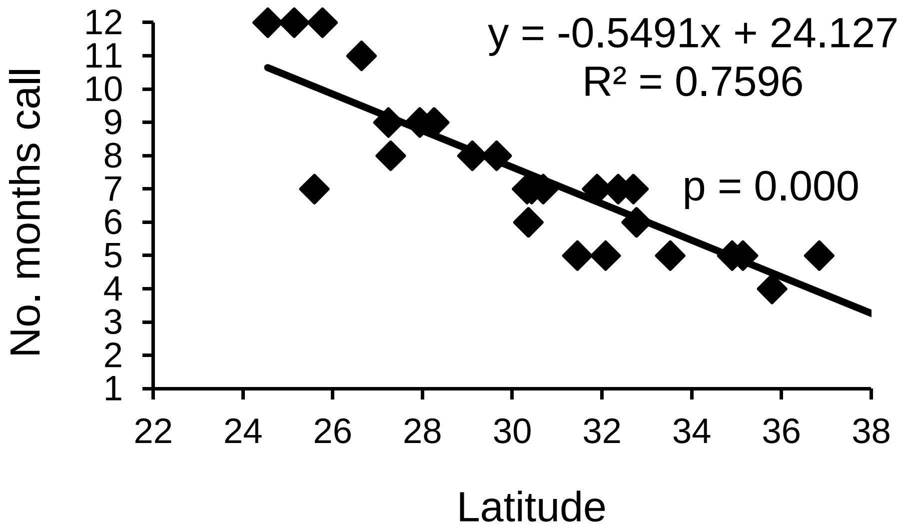

Figure 40. Relationship between predicted number of calling months and latitude in the Green Treefrog, *Hyla cinerea* (n = 27).

Elsewhere in the Southeast, predicted calling seasons for Birmingham (May−September) and April−October for Mobile, Eufala, and Greensboro, Alabama were slightly longer than reported for Alabama (Mount, 1975). The May−October predicted calling season for Charleston, South Carolina was similar to records in the Carolinas and Virginia (Martof et al., 1980). Finally, the May−September predicted calling season for Memphis was similar to findings in southern Illinois (Garton and Brandon, 1975).

The intermediate volume of rainfall (mean = 1.5 cm) associated with nightly calling in ENP (Meshaka, 2001) was in keeping with the intermediate seven to eight week larval period (Figure 13). This relationship also reflects the close association of the species with natural and altered habitats, such as ponds, canals, lakes, sloughs, and marshes, with a long hydroperiod or permanent water, particularly those with lush emergent vegetation. It would also call from seasonally-flooded prairies or fields. The hydroperiod and structure of breeding sites of the Green Treefrog in southern Florida were similar to those in the Okefinokee (Wright, 1931), Louisiana (Dundee and Rossman, 1989), and Illinois (Garton and Brandon, 1975).

The amount of rainfall the night before two diurnal choruses near the Daniel Beard Center (0.0, 0.6 cm) was within the range of the volume of rainfall the night preceding nocturnal choruses. Summer peak in calling reflected the warm (mean = 25.6 ^{0}C), high relative humidity (mean = 95.0%) conditions associated with nightly calling (Meshaka, 2001). Minimum ambient temperatures associated with calling were 19.5 ^{0}C in Louisiana (Dundee and Rossman, 1989) and 20.0 ^{0}C in Illinois (Garton and Brandon, 1975). Although males could call at ambient temperatures of 14.6 ^{0}C and when air temperature minima ranged 6.7−12.3 ^{0}C, vocalization was most prevalent at an ambient air temperature range of 20.2−26.9 ^{0}C (Wright and Wright, 1949).

As in southern Florida, diurnal calling has also been reported in Okefinokee populations (Wright, 1931), but not in Arkansas (Trauth et al., 2004) or Illinois (Garton and Brandon, 1975). In ENP, males appeared to be fertile throughout the year (Meshaka, 2001). Gravid females were collected during April−October in southern Florida and during April−August in northwestern Florida (Gunzburger, 2006), which exceeded the breeding season of the Green Treefrog in Illinois (Garton and Brandon, 1975). These findings corroborated the findings of geographic variation in breeding season of this species (Garton and Brandon, 1975). At Lake Istokpoga, Highlands County, means of clutch size (mean = 2,591.2 ± 1151.9; range = 1224−5066; n = 11), relative clutch mass (mean = 21.2 ± 3.3%; range = 14.4−26.8; n = 11), egg size (mean = 1.22 ± 0.07 mm; range = 1.13−1.31; n = 9), and female body size (mean = 51.7 mm SVL) were large, and both clutch size and relative clutch mass were positively associated with female body size (Meshaka, 2001; Figure 41, 42). The relationship between mean oval diameter and female body size from south-central Florida was positive but not significant (Figure 43). In northwestern Florida, clutch sizes averaged 1,214 eggs and were positively associated with female body size (Gunzburger, 2006). Mean clutch size that we estimated from Lake Istokpoga was larger than that of Arkansas (Trauth et al., 1990).

Growth and Survivorship.—The approximately two month larval period on BIR (Babbitt and Tanner, 2000; K.J. Babbitt, unpubl. data) was not markedly different than 55−63 days in the Okefinokee Swamp of southern Georgia (Wright, 1931) and four to six weeks in southern Illinois (Garton and Brandon, 1975).

In ENP, the smallest individuals (20 mm SVL) were found in August (Meshaka, 2001), while in the Okefinokee transformation (11.5−17.0 mm SVL) occurred during July-October (Wright, 1931). Minimum body size (SVL) at sexual maturity of southern Florida populations (Table 4) was much smaller than that (males = 37 mm; females = 41 mm) reported for the species (Wright and Wright, 1949). Sexual maturity of the Green Treefrog was attained in five or six months after transformation in ENP (Meshaka, 2001) and on and around the ABS (Figure 44), as compared with three years in the Okefinokee (Wright, 1931). Data from ENP indicated that few individuals survived longer than one year following metamorphosis (Meshaka, 2001).

Activity.—In ENP, individuals were active throughout the year, with most activity having occurred in warm humid conditions (Meshaka, 2001). During the dry season in southern Florida, low relative humidity curtailed activity more so than cold air temperature. In contrast, in northern Florida cold air temperatures curtailed activity, with 95% or more of post-metamorphic individuals being active on nights with air temperatures of at least 17.8 ^{0}C (Goin, 1958). There appeared to be a midwinter hiatus in activity in the Okefinokee (Wright, 1931) and in Illinois (Garton and Brandon, 1975). Apart from having heard choruses during the day, we did not see Green Treefrogs about during the day in southern Florida. Likewise, individuals were nocturnally active in Alabama (Mount, 1975), the Carolinas (Martof et al., 1980), Arkansas (Trauth et al., 2004), and Illinois (Garton and Brandon, 1975).

Predators.—In south Florida, the Green Treefrog was eaten by the Cuban Treefrog, which negatively impacted population sizes (Meshaka, 2001), the Pig Frog (Florida Game and Freshwater Fish Commission in Duellman and Schwartz, 1958), the Eastern Racer, Eastern Corn Snake (Allen and Neill, 1950a), Peninsula Ribbon Snake (Duellman and Schwartz, 1958; this study), the Everglades Rat Snake (Neill, 1951b,c), the Okefinokee Fishing Spider (*Dolomedes okefinokensis*) (Jeffery et al., 2004), and the Eastern Garter Snake which was seen eating dead and dying Green Treefrogs from off of blacktop roads (this study). Elsewhere in Florida, this species was eaten by the Southern Leopard Frog (Kilby, 1945). In North Carolina, the Cottonmouth was a predator of this species (Palmer and Braswell, 1995).

Threats.—Although once continuously distributed in southern Florida, the Green Treefrog is now absent from much of the highly urbanized eastern rock rim area, and on the Florida Keys ditching for mosquito control has destroyed many of the freshwater lenses needed for reproduction in this species (Lazell, 1989). In the Lake Placid area in south-central Florida, this species and the Squirrel Treefrog have nearly disappeared from some sites around buildings where they regularly fed at night subsequent to the appearance of the introduced Cuban Treefrog. Drainage for development and agriculture has also reduced available breeding habitat. Larval time of the Green Treefrog is longer and body size at transformation is larger when in the presence of larval Cuban Treefrogs (Smith, 2005).

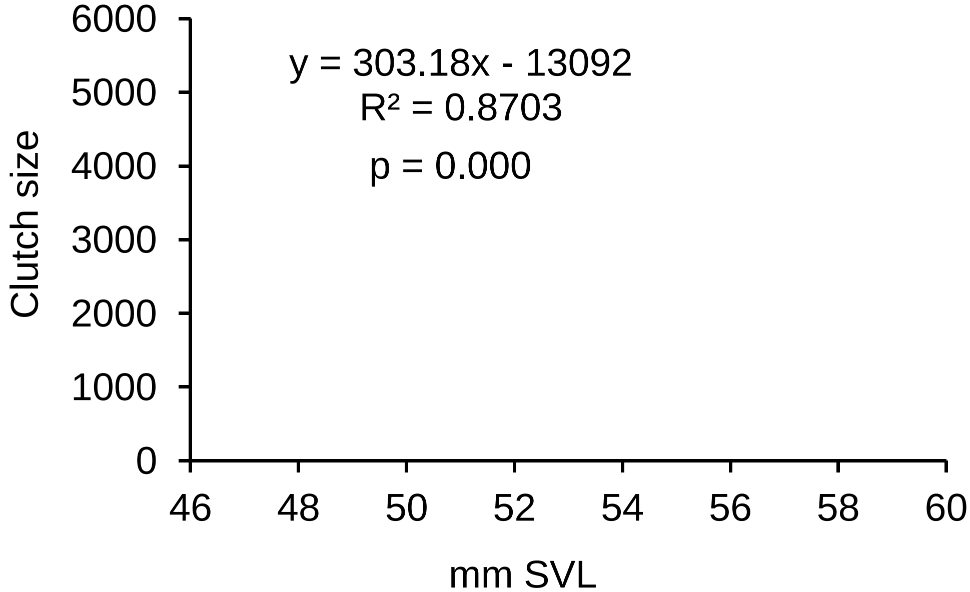

FIGURE 41. Relationship between clutch size and body size in the Green Treefrog, *Hyla cinerea*, from south-central Florida (n = 11).

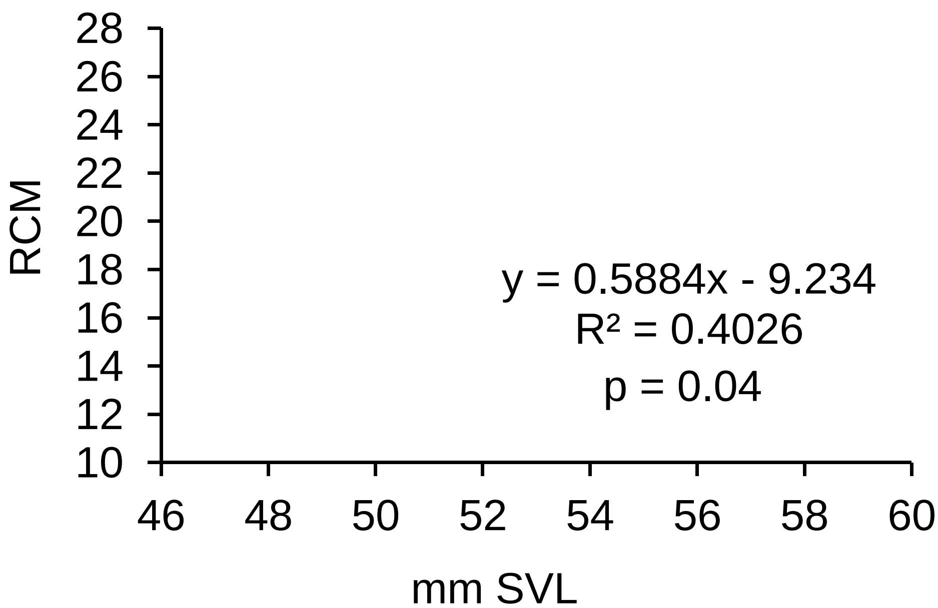

FIGURE 42. Relationship between relative clutch mass (RCM) and body size in the Green Treefrog, *Hyla cinerea*, from south-central Florida (n = 11).