GUIDE TO INVENTORY AND MONITORING OF AMPHIBIANS ON DARE COUNTY BOMBING RANGE, CHERRY POINT MARINE CORPS AIR STATION, AND MARINE CORPS BASE CAMP LEJEUNE, NORTH CAROLINA

Supplement to

Monitoring and Management of a Sensitive Resource:
A Landscape-level Approach with Amphibians

Report to the
Legacy Resource Management Program
US Department of Defense
Contract DACA87-99-H-0001
FY 99-01

Joseph C. Mitchell
Department of Biology
University of Richmond
Richmond, Virginia 23173

August 2002

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
AUG 2002		**00-00-2002 to 00-00-2002**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Guide to Inventory and Monitoring of Amphibians on Dare County Bombing Range, Cherry point Marine Corps Air Station, and Marine Corps Base Camp Lejeune, North Carolina	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **University of Richmond,Department of Biology,Richmond,VA,23173**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**Same as Report (SAR)**	**91**	

GUIDE TO INVENTORY AND MONITORING OF AMPHIBIANS ON DARE COUNTY BOMBING RANGE, CHERRY POINT MARINE CORPS AIR STATION, AND MARINE CORPS BASE CAMP LEJEUNE, NORTH CAROLINA

Supplement to

Monitoring and Management of a Sensitive Resource:

A Landscape-level Approach with Amphibians

Report to the
Legacy Resource Management Program
US Department of Defense
Contract DACA87-99-H-0001

FY 99-01

Joseph C. Mitchell
Department of Biology
University of Richmond
Richmond, Virginia 23173

August 2002

Table of Contents

Cover: Squirrel treefrog inside pitcher plant on Camp Lejeune, NC. (Joe Mitchell photo)

Introduction

Until recently most amphibians in the Carolinas have not experienced the dramatic declines documented for other parts of the world and United States (e.g., Phillips, 1990, 1994; Livermore, 1992; Drost and Fellers, 1996; Laurance et al., 1996; Dodd, 1997; Lips, 1998). Severe population crashes in wood frogs and spotted salamanders occurred in 1997-2000 in western North Carolina due to viral and fungal diseases (D.E. Green, National Wildlife Health Center, pers. comm.). Otherwise, amphibians in this region have suffered population declines from habitat loss and alteration and perhaps over-collection for the pet trade and supply houses. In North Carolina, habitat loss and modification from urbanization (roads, home construction, shopping malls, office complexes, etc.) has caused the complete demise of many local amphibian populations, leaving what remains in smaller and smaller fragments that are increasingly isolated from one another. Declines and losses are often local and the causes are usually obvious. Collection of thousands of frogs and salamanders for Carolina Biological Supply Company, a supplier of specimens for schools in the East, has undoubtedly caused population declines in some areas. Military bases usually maintain natural habitats used by amphibians and, despite alterations from training and timber harvesting, can be viewed as regional habitat islands. Such landscapes are becoming increasingly important places for amphibian and other wildlife populations.

Assessments of amphibian populations on military base landscapes provide windows into the quality of the habitats in these areas. Inventories (initial surveys to determine which species are present and where they are located) are usually done before monitoring programs (use of standardized techniques to obtain quantitative data on relative or actual abundance that are repeated over time) are performed. Monitoring can be done in lieu of initial inventory if all of the species encountered by standardized techniques or other means (e.g., haphazard encounters) are recorded. This approach allows one to obtain the list of species in the areas, while at the same time obtaining information on abundance.

The problem for wildlife and land managers and people concerned about these animals is that we lack the long-term data sets necessary for realistic evaluation of population trends. Are populations in a given area declining, stable, or increasing? Are populations declining in some areas and not others? Answers to such questions cannot be obtained without information from numerous places over many years using standardized methodologies. Standardization of methods used to obtain population information is critical to future evaluations of amphibian populations.

This guide is designed to assist resource managers on the Dare County Bombing Range, Marine Corps Air Station Cherry Point, and Marine Corps Base Camp Lejeune with their inventory and monitoring programs on amphibians on their installations. It provides information on identification of larval and adult life history stages of the species most likely encountered during such programs, and it describes several methodologies that allow the accumulation of data that can be used in the future to examine trends. These methods were used for three years to obtain a baseline dataset against which future evaluations can be compared. The techniques used here will be useful on other military bases in the eastern United States. The identification guide is pertinent to eastern North Carolina, but may also be useful to resource managers in adjacent states. This guide supplements the final report to the Legacy Resource Management Program by Mitchell (2002).

Inventory and Monitoring Protocols

Wetland types included in Mitchell (2000, 2001, 2002) are man-made ponds and lakes, beaver ponds, ephemeral (vernal) pools, freshwater marshes, intermittent streams, and pocosins. All sites included are located on a map of each installation and have been assigned a numerical or place name (see Mitchell, 2002). In this supplement I review the five basic methodologies used to monitor amphibians in the 64 different sites on Dare County Bombing Range, Marine Corps Air Station Cherry Point, and Marine Corps Base Camp Lejeune. Most of these techniques are illustrated at the end of this section.

1. Direct Observations

One relatively easy way to study amphibians is to simply observe them in their natural habitat by walking around the edge of a wetland or watching from a vantage point. Unfortunately, amphibians are not as easily observed as birds because they are often hiding beneath vegetation in and out of water, are camouflaged, and often remain still for long periods of time. Many species are active only at night. Daytime observations are useful, however, and should be used to supplement other methods, especially when the goal is to inventory the area for all amphibians present. A primary and critical requirement is for the observer to be trained in accurate identification of all species, and preferably all life history stages, in the area.

I recommend the use of binoculars to scan the shoreline of the wetland one is studying. Bullfrogs, green frogs, and other ranids sitting on the bank or vegetation out in the water may be observed and their microhabitats and behavior studied without disturbing them. Frogs may be encountered as one walks up to a wetland or even while hiking through the woods. This is especially true of toads. Records of these individuals provide insights into how the terrestrial habitat is used. GPS locations of amphibians found in terrestrial habitats will provide information on how far these animals have moved away from wetlands. This is a critical body of data for resource managers, as it allows them to visualize why management of wetland AND upland habitats should be done in a landscape context.

Some species of frogs call periodically during the daytime, especially during the height of the breeding season and sometimes for weeks afterwards. Recognition of a species by its calls is another form of direct observation. Records of frog species based on calls may be the only way one can determine their presence during daytime searches.

On initial approach to a vernal pool or pond, field personnel should first record the species of calling frogs on their data forms. Your presence

may cause them to stop vocalizing. Scan the shoreline, low vegetation, and nearby riparian areas for frogs sitting on the ground or perched on low vegetation. Air and water temperatures and other environmental variables should be taken before disturbing the water by wading or dip-netting. Count each adult frog or salamander if possible, or catch as many as possible for measurement and marking. Water depth and the amount of vegetation along the edge may limit one's movement around the pond.

Weather variables, especially rainfall, directly affect the number of frogs calling, and in some cases, their chorus intensity. Surveying frogs by direct observation is best done when the weather is most favorable. Thus, light to moderate warm rainfall at night is the best time to observe and catch frogs. Surveys in dry weather and under drought conditions will result in lower numbers and fewer species observed.

Egg Mass Surveys

Several species of amphibians in the mid-Atlantic region breed routinely in small ponds and vernal (ephemeral) pools. These include all species of ambystomatid salamanders, newts, and several frogs. Gopher frogs (*Rana capito*) breed exclusively in vernal pools and ponds devoid of fish predators. Some of these amphibians breed early in the year and leave conspicuous egg masses. This life history stage can be identified for some species once the characteristics have been assimilated by the observer. Use of the information in this guide and from other literature sources can be useful. However, several photos of the egg mass (close up and in context) can be sent to experts for final confirmation. Egg masses can be counted to obtain quantitative measures of relative abundance or they can provide indices that are indicative of population size. Shallow pools and ponds are often easily accessed and in many cases easily studied.

Egg masses can often be identified to species. If a positive identification is not possible in the field, then a full description may allow one to determine its identification later (photos are very useful here). Use terms like globular, firm jelly, loose jelly, surface film, attached to branch or grass, approximate depth, clumped, separated, etc. when describing the egg masses. Approximate counts of eggs in the egg masses and measurements of jelly mass length and width could help with identification. Unfortunately, there is no recent reference or guide to field identification of amphibian egg masses for North Carolina or the Southeast. Other sources are Bishop (1941), Wright and Wright (1949), Pfingsten and Downs (1989), and Petranka (1998). This technique may work best with bullfrogs, southern leopard frogs, and green

frogs in pools and ponds that hold water for more than several weeks, and for gray treefrogs and southern toads in shallow, highly ephemeral pools.

Each egg mass should be identified and counted throughout each wetland being surveyed. If this is not possible, say due to deep water, then either find an innovative way to access the entire pond or pool or use a standard distance and count all the egg masses within this band around the margin. If the pool is shallow enough to allow wading, then a grid or transect marked off in meters could be laid out and the eggs counted within each grid cell. If transects are used, then they should cover the entire pool to allow complete coverage. Counts for each species should be kept separate. Distance from the pool margin and depth are valuable data to take. If possible, count the number of eggs in a selected number (or all) of the egg masses themselves. Determination of the number of eggs per egg mass and how many are dead and alive many provide viable information on egg survivorship.

Record all data on the data forms, and repeat this procedure at each pond or pool. The egg mass count method can be conducted during day or night. Night is best because of glare and other visual problems encountered during the day.

2. Frog Call Surveys

Frog vocalizations are an integral part of the reproductive and social biology of these animals. Only males advertise their presence to females and other males in the area by vocalizing. Females do not call. Each species has its own kind of call or types of vocalizations. Frogs can be readily identified to species by their calls. This important characteristic of frog biology allows us to study their activities. The frog call monitoring technique addresses the objective to document the dynamics of frog populations inhabiting wetlands in a specified area.

In the mid-Atlantic region, frog species are reproductively active at different times of the year. Generally, one group breeds in late-winter and early spring and the other group in late-spring and summer (Lee, 1973; Mitchell, 1986). For some of these species, there is little to no overlap in calling times. Frogs also respond to variations in weather. Dates of initiation of calling change annually, the length of the male calling period varies within seasons, and the actual dates on which females breed are all weather-dependent. Rainfall events strongly influence when frog activities occur. Frogs in permanent wetlands exhibit different phonologies (seasonal timing of biological events, e.g., date of first calls, timing of metamorphosis) than frogs in vernal pools and puddles. Wetland hydrology is a major player in frog biology. Thus, spot-checking frogs by recording their

vocalizations only once or twice a season will not provide information about variation in frog reproductive phenology. Knowledge of such variation is important if one wishes to understand the dynamics of frog populations and how to interpret how they are affected by changes in their habitats and changes in weather patterns.

The frog call methodology requires that it be repeated frequently throughout the season. It also allows researchers to accumulate other observations on reproductive biology and habitat utilization. Several different methods can be employed to obtain information on the dynamics of local frog populations. These include direct day and night observations of frogs and other life history stages and the use of automated animal vocalization recorders (FrogLoggers see below).

There are several ways to conduct inventory and monitoring surveys of frog vocalizations. The following describes some of the methods I believe will work for resource managers on military bases in eastern North Carolina and elsewhere. It also notes some of the pitfalls one may encounter when seeking accurate identifications. I urge resource managers and others reading this document who will use these techniques to spend whatever time is necessary to learn local frog calls accurately (see the list of Frog Call Identification Tapes in the appendices).

Recording frog calls on cassette tape - An inexpensive but durable cassette tape recorder will allow one to tape the calls of male frogs at any time. I used a Sony TCM-929 portable, battery-powered, cassette recorder with a separate Sony F-V220 Dynamic hand-held microphone. Both are readily available in most electronic stores. Other recording equipment may be used but good basic recordings can be obtained with such inexpensive equipment. I recommend that a hand-held, directional microphone be used instead of the built-in microphone on the recorder. That allows flexibility in recording and results in much higher quality recordings. Note, however, the calls on a cassette tape will not sound exactly like what one hears in the field. This is due to natural acoustics, one's hearing in the open arena, the quality of the recording, and the quality of the speaker systems. Comparing calls with one's ear in the field with a segment of calls on the cassette recorder is a valuable experience when learning frog calls.

Because of observer effects (some frogs will cease to call when the observer approaches), taping should be done before most other activities take place. Taping should be conducted by one person who directs the hand-held directional microphone toward calling males or the portion of the pond from which the calls are produced. Avoid making any sounds during the taping

session. Recording time should be 5 minutes (minimum) to 10 minutes to help increase the chances of recording all species present. The following information should be recorded on the tape by the biologist BEFORE the recording session: **date, location, time, pond name and/or number, and observer(s) names**. See Heyer et al. (1994) for discussions on recording good frog calls.

Field notes on frog calls - In addition to recording calls on the cassette tape, all species identified by the observer from frog vocalizations must be written on the field data sheet. The cassette is primarily a back-up system. It should not be viewed as the primary source of identification and data records. The backup tapes can be used to query experts about problematic calls.

Learning frog calls - It is possible to become familiar with frog calls by listening repeatedly to commercial tapes that include all the species in your area. However, calls may also be learned by combining training sessions based on tapes with field trips to locations to hear them in context. Calls will sound differently when coming out of a speaker or headset than they will when you hear them in the pond or other wetland. Practice, practice, practice.

Frequency of site visits - How many times during a season this methodology should be carried out depends on the goals of the study. If information on the phenology of the species in the study area is a primary goal, then this methodology should be carried out at least once per week from early March (or when frogs first become active in late winter and this may be January or February) through June. Because several species call into September in some areas (green frogs, cricket frogs), then the weekly methodology could extend from February through September, if personnel are available to continue the project into summer. Twice a month will provide less information on phenology but will allow assessments of habitat utilization and presence/absence and relative abundance of most frog species. Monthly observations will cause you to miss some important events and perhaps even miss some species.

FrogLoggers - Automated animal vocalization recorders (FrogLoggers; Peterson and Dorcas, 1994) do most of the work for you. They record animal vocalizations during the period established by the researcher on the timers (e.g., 12 seconds per hour for about 7 days on one side of a 90 minute cassette tape). FrogLoggers are set outside in secure areas, locked, and chained to an immovable object. Microphones are placed within a cutoff plastic

soda bottle and attached to a branch of a tree or shrub so that they point to the area to be recorded. Once operative, the field researcher or technician turns over or changes the cassette tape on a regular (RIGID) basis, the timing of which is determined by the recording time set on the timers and how long it takes to use up most of one side of a tape. Battery life may be affected by local conditions and the field person will need to replace them as needed. If FrogLoggers are to be used for extended periods of time, solar panels may be established to bypass the use of batteries (M. Dorcas, personal communication). A primary advantage of this methodology is the regular recording of animal vocalizations (it records birds, too) on a regular schedule over a 24 hour period. FrogLoggers also provide information on size of the frog chorus and on sensitive, secretive species. One quickly obtains information on the day/night patterns of animal behavior, especially frogs and birds.

An important aspect to keep in mind is that tapes from FrogLoggers accumulate rapidly. The project director should have someone available to record the data from the cassette tapes as soon as possible. In my experience, it takes a minimum of about 2 hours for a person well versed in frog call identification to record the data from one 90 minute tape.

FrogLoggers are not available commercially. You can make them following instructions in Peterson and Dorcas (1994). As this is only one possible type of assembly, creative persons may devise their own automated animal vocalization recorders.

3. Larval Surveys

Assessing amphibian larval (tadpoles and aquatic salamander larvae) presence and relative abundance can be an effective way to study and monitor amphibian populations. Such a program provides useful information on an often-neglected aspect of frog population and community biology. This is especially important because studying tadpoles through metamorphosis provides information on reproductive success and phenology of local populations. Several techniques may be used to obtain information on tadpole populations, and each is effective in different habitats.

The major advantages of these techniques are that they can be used day or night in a wide variety of wetland types and require relatively inexpensive equipment. They also allow us to obtain quantitative estimates of relative abundance. The primary disadvantage is that some tadpoles and salamander larvae are difficult to identify. The same references listed for egg masses may illustrate and describe larvae.

Tadpole and larval salamander color, shape, and sometimes pattern are influenced by local environmental conditions. Larvae of the same species in muddy road rut pools will be the color of the mud, whereas those in woodland pools with dark organic substrate will be dark in color. Thus, this technique is best used by well-trained personnel who become experienced in recognizing the ranges of variation of both tadpoles and salamander larvae in each local species.

Another way to ensure accurate identifications is to make a collection of preserved larvae that are confirmed to species by an expert. Collections of larvae can be made as one would preserve fish for museums. Obtain a quantity (e.g., 1 quart or liter) of formaldehyde (stock solution is 37%), treat this as 100% and dilute to 8-10% formalin (1 part formaldehyde to 9 parts water). Use Nalgene® jars or glass jars that are well protected against breakage. Drop the larva or larvae directly into the 10% formalin in the container where it will be quickly killed and be preserved. Anesthesia can be accomplished beforehand by immersing the larvae into water containing a few drops of Benzocaine. Insert a label (100% rag paper) into the jar with date and site of collection. Make sure you use a #2 pencil for the label, as inks may dissolve. The small collection of jars with properly identified larvae will an invaluable reference.

Dip nets - Sturdy dip nets can be used in a wide variety of wetlands, especially in small ones and those with vegetation. I recommend the D-shaped ring over the round-shaped ring because the flat portion of the dipnet can be dragged across the substrate much like a small-scale seine. Sweep lengths should be standardized to the extent possible (e.g., 1 meter). Sweeps in all but the smallest wetlands (small pools, road ruts) should be at least 5 meters apart to approximate independent sampling for statistical treatment (Shaffer et al., 1994). The numbers of individuals of each species in each sweep are recorded on the data form, along with all pertinent environmental data. This allows an assessment of relative abundance (based on the total sample) and, at least for some sites, statistical treatment of the data (using numbers of each species per sweep sample). If time allows, salamander larvae and tadpoles can be measured or staged using developmental staging schemes (e.g., Gosner, 1960) to provide important information on population structure.

The technique I have found useful with this method is to quickly extend the dipnet approximately 1 meter or more away from the shoreline, dig all the way to the bottom, and then in a vigorous and rapid motion drag the dipnet toward the shore with all the debris and leaves. The rapid movement of the sweep reduces the chances that the larvae will escape and it helps the net

pass through vegetation. Pull all this material up onto shore. Before dumping the contents on the ground or plastic sheet or pan, check the bag for any adult or juvenile amphibians that may escape once you have emptied it. Catch, identify, and count them before checking the contents of the bag. Place them in a separate plastic bag for later measurement.

Once you have emptied the contents on the ground, on a plastic sheet, or in a shallow pan, poke carefully through the debris and leaves for salamander larvae and tadpoles (see below for notes on handling amphibians). A spoon is a very useful tool for this part and it also helps to scoop up larvae. These animals may be small, so it is advisable to take your time. Look at every leaf. All animals caught for observation can be placed into one or two plastic bags or a shallow pan containing a quantity of water. Do not combine small larvae with large larvae because the larger ones may eat the smaller ones.

The required number of sweeps of the dipnet depends on the size of the pond. Small ponds and wetlands (<15 m in diameter) may be sampled with as few as 10 sweeps. Larger ponds and wetlands should be sampled with 20 to 50 sweeps. Small ephemeral pools may take only 3-5 dipnet sweeps to fully access the tadpoles in this small volume of water. Once the number of sweeps has been determined for each pond, the same number of sweeps should be taken each sampling session to facilitate season-to-season and year-to-year comparisons. All of the parts of the pond system should be sampled to increase the chances of encountering larvae. Remember that the species of larvae and the numbers of individuals of each species should be recorded for each sweep of the dipnet.

Minnow Traps – Standard Gee minnow traps are well-suited for sampling aquatic amphibians in shallow water habitats. They are relatively inexpensive (about $10 each) and can be used in large numbers. Results provide a quantitative assessment of relative abundance of target species.

The number of minnow traps set in a shallow pool, road rut, ditch, vernal pool, or limesink varies according to the size of the aquatic site. Very small sites should have three and the largest sites should have 30-50. Traps are set during the day on Day 1 and pulled out for inspection about 24 hours later. They may be reset if you sampling for more than one 24 hour cycle.

All traps are set directly on the bottom and either parallel to the shoreline or alongside objects in the water (e.g., logs). Traps are set so that the top edge (about 1-1.5 inches) is above the water’s surface to avoid drowning air-breathing vertebrates and invertebrates. Traps are set unbaited. The funnel opening diameter of the minnow traps from the factory is too small for many amphibians. A broom handle should be used to widen the openings on

both funnels of each trap before setting (about 1 1/4 inches in diameter). This will flare back the wire edges and minimize the number of escapees, and it reduces the chance of injury to larger animals that squeeze through the funnel openings.

Captured animals are identified, counted, and measured as in other protocols. All data recorded pertain to the individual trap and sampling date. Results are provided as a species list for this technique at the study site and as number of individuals per trap by species for the trap session. When number of traps differ among study sites, the data are standardized for consistency and comparability. Results are expressed as number of individuals per 100 trap nights (or other standard number, e.g., 50).

4. Coverboards Transects

The use of coverboards for inventorying and monitoring amphibians in terrestrial habitats has received considerable attention (e.g., Grant et al., 1992) and is recommended by the US Fish and Wildlife Service for monitoring terrestrial salamanders. Coverboards can also be used to inventory frogs and snakes, and I have found that several lizard species are encountered under them as well. Coverboards, when laid out in transect fashion may aid the inventory of amphibians and reptiles of a target area. This technique should not, however, be used solely for such purposes because it has inherent biases and will not provide a full inventory.

Coverboards can be of most any material and size, depending on the target species, the environmental conditions in the habitat sampled, and the goals of the project. Wood is usually the material of choice but metal sheets are also used if reptiles are targeted. Size and configuration vary according to the questions established initially. In order to achieve consistency on the military bases in eastern North Carolina, I selected a transect approach for this methodology.

Transects on Dare Bombing Range, Cherry Point MCAS, and Camp Lejeune consisted of 30 coverboards set 10 meters apart. Twenty of the coverboards were 2x4 ft ½ inch plywood and 10 were sheets of roofing tin. The first three sites of a linear transect (the set of 3 repeated subsequently 10 times for a total of 30 sampling points) consisted of two plywood coverboard sites and then a sheet of roofing tin. Coverboards were placed directly on the ground. Branches, logs, and excessive vegetation were cleared away so that coverboards was flush with the ground surface.

Coverboards were checked on a monthly basis during all seasons in order to obtain information on the seasonal activity patterns of the targeted

species. Boards were checked by two people, one turning over the coverboard and the other poised to capture the animal that may be uncovered. All individuals observed were identified and noted on a standardized data sheet for each individually-numbered coverboard, whether or not it was captured. Individuals captured were measured (see below) and released. Individuals of some species (e.g., frogs, lizards) were marked by toe-clipping (see below) before release. The same methodology should be used when coverboard transects are used in future monitoring years.

5. PVC Pipe Transects

PVC pipes are being used for monitoring selected species of amphibians and reptiles in the Southeast. Pipes have been used in a variety of ways, including attaching pipes to trees (Broughton et al., 2000) and standing them upright at selected distances from aquatic breeding sites (Dodd, 1996). Like most other monitoring protocols, the results one obtains are protocol specific. The majority of captures include treefrogs and arboreal lizards.

I chose to use the upright method for PVC pipes on the military bases in eastern North Carolina and included the transect approach for this protocol. PVC pipes used in this project were white, about 1.5 meters long, and 2.5 inches in diameter. Each was sunk in the ground next to each of the roofing tin sites along the coverboard transects (see above). Thus, each transect had 10 PVC pipes. Each was checked when the coverboard transects were checked (monthly).

Animals were captured by picking up the pipe, inverting it, and dumping the contents into a plastic bag. All captured individuals were identified, measured, marked by toe-clipping, and released adjacent to the site. Data were recorded for all animals captured at each PVC pipe location. The same methods should be used if PVC pipes are used in the future for monitoring.

Handling Amphibians

Amphibians have sensitive skin and whatever is on your hand may easily transfer to the animal in your hand. Frogs and salamanders are also sensitive to drying conditions and the heat of the sun. The following is a list of precautions that will minimize the stress and potential death of an individual you have captured:

(1) Never use bug spray or other chemicals on your hand while working with amphibians.

(2) Keep the frog or salamander out of the hot sun and do not let it overheat.

(3) Keep the animal moist.

(4) Do not keep tadpoles or salamander larvae out of water for more than a minute or so; return them to the water as soon as possible.

(5) Do not squeeze frogs any tighter than is necessary to restrain them; holding them firmly around the waist is the best method.

(6) Do not squeeze tadpoles; they are turgid with water and may pop open.

Measuring and Marking Amphibians

The following measurements should be taken whenever amphibians are captured so that information on life histories, size variation among sites and installations, and sexual dimorphism can be assessed. All measurements are in millimeters (mm) and weights in grams (g).

Note - these measurements are far more valuable if associated with the gender of the animal being measured. So, make sure you know how to tell males and females apart. The species descriptions in this guide will help.

1. Snout-vent length (SVL) - straight-line distance from the tip of the snout to the cloacal opening. For frogs, take the measurement along the dorsal midline. Make sure that frogs is not "humped up," as the upward extension of the sacral hump may cause the frog's body to shorten unnaturally. The body should be flat. For salamanders, the SVL should be taken along the ventral midline and the animal should be as straight as possible. Take the measurement from the tip of the snout to the posterior margin of the vent. Use a metric plastic ruler or calipers for all measurements. Salamanders should be restrained in plastic bags to keep them straight while measuring.

2. Tail length - Not applicable to frogs. For salamanders the tail should be straight and the measurements taken from the posterior margin of the vent to the tip of the tail. Use a metric plastic ruler.

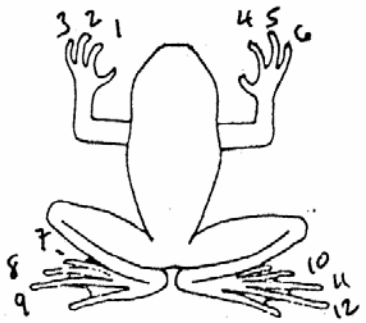
3. Tympanum diameter - Because the tympanum in some frogs, especially ranids, is sexually dimorphic, a useful measurement is the diameter of this organ. Also, some descriptions of males and females compare tympanum diameter to the diameter of the eye. Both measurements should be taken. These measurements may allow an accurate determination of the sex of some adult frogs.

4. Weight - Body mass (weight) is a useful measurement for many amphibians. I prefer highly portable Pesola® scales for most frogs and salamanders. Small amphibians (e.g., metamorphs and larvae) are best weighed on a portable Ohaus Scout electronic balance.

Marking animals for identification upon later capture is essential for several reasons. If the project uses some types of standardized protocols to determine relative abundance, then repeated counts of the same unmarked individuals may skew results. Marked individuals also allow determinations of movement distances among aquatic and upland habitats. Frogs and salamanders can be marked individually with unique combinations of numbers, or they can be marked with a site number. The former consumes lots of time but often yields information one cannot obtain in any other way. Frog and some salamander populations fluctuate dramatically and recapture rates can be low. Sinking lots of time into such populations may not be cost effective. Assigning site numbers to individuals as a second choice can yield important information on minimal movement distances in the landscape. Several species of frogs on the military bases in eastern North Carolina move from site to site and often traverse several hundred meters (see data in Mitchell, 2002). Such movements demonstrate why habitat management must be done in a landscape context.

In this study I have used the standard method of toe-clipping for marking frogs. My field crew and I have marked only those frogs that are easily toe-clipped, as we usually process large numbers at a time. This includes all toads, treefrogs, and ranid frogs. The site at which the frog was captured determined the number to be assigned to the frog. We used single numbers for each of the wetlands, but two numbers for the terrestrial transects (one for each half). Toes were removed surgically with cuticle scissors, making sure that the scissors were sterilized between individuals and that the entire toe was removed at the base. No more than two toes were removed from each individual and only one toe was removed from each limb. The thumbs were not included because they are used by males to amplex females during mating. The toes were saved in small plastic tubes with ethanol for potential later studies of skeletochronology (to determine age of breeding

populations) and genetics. The following scheme was used for assigning site numbers to the toes:



Health Issues

An important recent development in the scientific evaluation of the worldwide amphibian decline crisis is the realization that things we may do may harm the animals we are studying. The Declining Amphibian Populations Task Force (DAPTF), a network of concerned scientists based in the United Kingdom, released a Fieldwork Code of Practice 1998. The seven points to the code are included here to make teachers and students aware of the issues involved.

1. Remove mud, snails, algae, and other debris from nets, traps, boots, vehicle tires and all other surfaces. Rinse cleaned items with sterilized (e.g., boiled or treated) water before leaving each study site.
2. Boots, nets, traps, etc. should then be scrubbed with 70% ethanol solution and rinsed clean with sterilized water between study sites. Avoid cleaning equipment in the immediate vicinity of a pond or wetland.
3. In remote locations, clean all equipment as described above (or with a bleach solution) upon return to the lab or “base camp”. Elsewhere, when washing machine facilities are available, remove nets from poles and wash with bleach on a “delicate” cycle, contained in a protective mesh laundry bag.
4. When working at sites with known or suspected disease problems, or when sampling populations of rare or isolated species, wear disposable gloves and change them between handling each animal. Dedicate sets of nets, boots, traps, and other equipment to each site being visited. Clean and store them separately at the end of each field day.
5. When amphibians are collected, ensure the separation of animals from different sites and take great care to avoid indirect contact between them

(e.g., via handling, reuse of containers) or with other captive animals. Isolation from unsterilized plants or soils which have been taken from other sites is also essential. Always use disinfected/disposable husbandry equipment.
6. Examine collected amphibians for the presence of diseases or parasites soon after capture. Prior to their release or the release of any progeny, amphibians should be quarantined for a period and thoroughly screened for the presence of any potential disease agents.
7. Used cleaning materials (liquids, etc.) should be disposed of safely and if necessary taken back to the lab for proper disposal. Used disposable gloves should be retained for safe disposal in sealed bags.

Note that the discovery of diseases on Camp Lejeune that cause amphibian mortality and population die-offs (Mitchell, 2002) indicates that many of these precautions should be taken seriously.

Environmental Data

Taking accurate measurements of environmental variables may be difficult. The most important criterion is to take each measurement the same way each time with the same instrument. Water temperature varies in a wetland due to shading, depth, presence of vegetation, etc. The edges of wetlands may not be discrete, but may vary considerably due to the nature of the slope and vegetation along the margin. Such naturally-induced variation makes it difficult to obtain accurate measurements. Thus, one must decide, for instance, whether to take several water temperature measurements and average them, or take a single measurement in exactly the same place each time. Decisions on standardization of such measurements must be made in the planning stage of the project.

Temperature and water measurements - Physical parameters that need sampling at each wetland studied are (1) temperature (in Celsius) of the air and water, (2) an estimate of turbidity, (3) pH, and (4) dissolved oxygen (if you have a DO meter calibrated appropriately for elevation). Recording temperature is essential. Air temperature should be taken about 1 meter above the ground in shade while you are standing near the edge of the pond. Make sure that the thermometer is held away from you to avoid body temperature influence. Water temperature should be taken in about the same place in the pond where the

water sample was obtained. Take several readings from several locations. Both of these samples should be taken before entering the pond to sample larvae.

Water samples for chemical analysis. - A number of chemical factors influence the presence and survival of amphibians. These include pH, alkalinity (or acid neutralizing capacity), dissolved oxygen, salts, and heavy metals. Most of these are obtained easily, either with field meters or by having them analyzed in a chemistry lab. Other chemicals, like pesticides and herbicides, can provide additional insights into the possible chemical perturbations on amphibians.

Water sample bottles require special preparation because the acid-base chemistry required for many chemical analyses can be altered by contaminated bottles. The usual procedure is to use bottles that have been rinsed thoroughly in hydrochloric acid and stored with de-ionized water. Enough bottles should be made available to cover most of the sampling periods for all ponds BEFORE the field season starts. This will avoid having to obtain these specially-prepared bottles on short notice.

Take the water sample before entering the wetland to sample or monitor amphibians but after recording observations on species present (e.g., direct observation, frog calls) and other environmental data (e.g., temperatures). Be careful to minimize disturbance of the sediment on the bottom when collecting the water so that chances of getting undesirable material in the bottle is minimized.

The de-ionized water in the bottle should be dumped out immediately before obtaining a water sample from the pond. Plastic gloves are preferred protection against contamination by chemicals on one’s hands but in practice this is not always done. One’s hand should, however, never come in contact with the column of water being sampled or the uncovered mouth of the bottle. The bottle must be rinsed three (3) times with wetland water before taking the final sample. The final sample should be taken from an untouched portion of the wetland, avoiding plant material and bottom debris. Take the sample in a portion of the wetland that has at least 20 cm of water. Immerse the bottle to 10-20 cm below the surface and fill it completely.

Once the sample has been taken and the bottle capped, the bottle should be wiped dry and placed into a separate plastic bag and labeled. The date, pond name or number (or both), and location must be provided on either a label inside the bag or written clearly on the outside of the plastic bag with a magic marker. Store the water bottles with their samples in the field in a cooler with frozen blue ice packs.

Work closely with the laboratory conducting the chemical analyses, as they may have their own set of rules for sample collection.

Checklist of Things to do Before and After Each Field Trip

This list includes points for a full species inventory. Parts not applicable to the specific methodology you have selected may be omitted.

1. Review procedures, species ID, and prep equipment in the lab before each method is to be used.
2. Review briefly and prep equipment at the field vehicle at start of the actual protocol execution.
3. Assign specific tasks to each field technician and review them.
4. Identify frog calls heard and adults observed upon approaching wetland.
5. Tape record frogs if night field trip.
6. Take water samples, and air and water temperatures.
7. Record habitat information as noted on data sheet.
8. Photograph sites and procedures as needed.
9. Record all observations (e.g., frogs calling, adults, egg masses) on data sheets.
10. Obtain dipnet samples & record results for <u>each</u> sweep or each minnow trap; preserve examples of larvae if necessary.
11. Review data sheets for completeness.
12. Pack up all supplies in bucket or other waterproof container, and assemble all equipment and supplies.
13. Review tapes (make sure it worked), data sheets, and equipment at vehicle (to ensure against loss).
14. Repeat 2-11 for each site in the field.
15. Back in the lab:
    a. check labels of all samples
    b. water samples in refrigerator (if applicable)
    c. specimen jars in safe storage
    d. copy data sheets; make backup copies
    e. clean equipment and supplies, repack
    f. all data sheets and tapes in files, or put the data into a computerized file (spreadsheet).

Other Points to Remember during Amphibian Surveys on Military Bases

1. If monthly sampling is the objective of the monitoring plan, then make sure that monthly sampling intervals are spaced about 4 weeks apart and in the center two weeks or so within the month.

2. Note water levels of each pool and pond each time frog calls are taken and each time aquatic sampling is done.

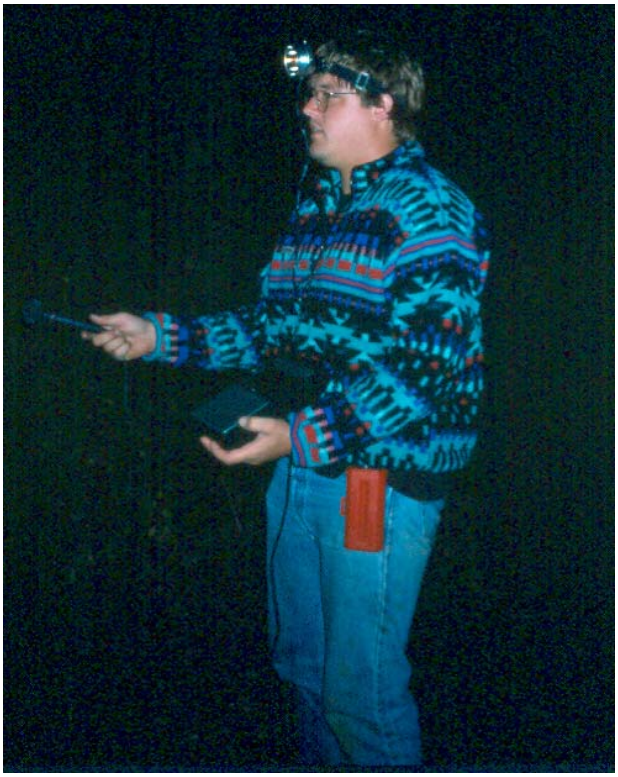
3. You can take the collection of preserved and identified tadpoles and salamander larvae with you in the field to aid in field identification.

5. Do not release individuals that are malformed or otherwise have colors and patterns different from "normal." These should be measured and photographed. If malformed individuals are found, then they should preserved properly. This also pertains to individuals with nodules or lumps in their skin, as these may be parasites or tumors.

6. Take photographs of techniques, people doing things, habitats, water levels, and animals.

Bullfrog (*Rana catesbeiana*) egg mass; note large numbers and air bubbles.

Southern leopard frog (*Rana sphenocephala*) egg mass; note globular egg mass attached to vegetation.



Recording frog calls at night with portable cassette tape recorder with hand-held directional microphone.

Portable FrogLogger; the microphone that extends from the upper end of the box is placed inside a cut-off 2-liter bottle for protection from weather, tied to a limb, and directed toward the pond.

Use of D-ring dipnet for sampling aquatic habitats for amphibian larvae

Minnow trap set in shallow wetland at Camp Lejeune. Note that the trap is set with the top above the water line and is tethered and marked with flagging.

One of 20 2x4 foot plywood boards in place in a coverboard transect in pine flatwoods at Cherry Point Marine Corps Air Station

One of 10 sheets of roofing tin and PVC pipe in a coverboard transect at Dare County Bombing Range

IDENTIFICATION GUIDE TO AMPHIBIANS IN EASTERN NORTH CAROLINA

Identification of frogs, toads, and salamanders requires some basic knowledge of amphibian anatomy and understanding of key terms. This guide lacks dichotomous keys and assumes that a species in hand or one observed will be identified by comparing it with illustrations and descriptions from standard field guides and other sources (see below). Adult frogs and salamanders of different species differ in body form, certain key anatomical features, color, and pattern. Juveniles of the species included in this guide should not be difficult to identify but some individuals may exhibit variations that may be problematic. The most difficult amphibians to identify are the larval forms: tadpoles and salamander larvae. The descriptions included in this Supplement should allow most individuals to be identified correctly. However, the youngest larvae may be difficult because some features used in descriptions may not be fully developed.

The following species accounts provide a means to identify the 20 frogs and toads and 10 salamanders one may encounter during inventory and monitoring projects on the Dare County Bombing Range, Marine Corps Air Station Cherry Point, and Marine Corps Base Camp Lejeune. It may also be useful to other military bases in the Mid-Atlantic and southeastern regions. Body sizes, call descriptions, and description notes were derived from Conant and Collins (1998), Petranka (1998), and my own observations and notes. These descriptions may not work on every individual encountered because of the wide range of variation exhibited by some species. Sources that should be consulted for illustrations and when you are unsure of your identification include Martof et al. (1980), Pfingston and Downs (1989), Conant and Collins (1998), Altig and McDiarmid (1998), and Petranka (1998). Information in the following accounts was derived from Bishop (1943), Wright and Wright (1949), Pfingston and Downs (1989), Conant and Collins (1991), Petranka (1998) and my own experience on these installations. Color photographs of each species are at the end of the frog and salamander sections. Illustrations of tadpoles and salamander larvae are also included. Refer to the descriptions, color photographs, and larval illustrations to aid in the identification of an individual amphibian.

Guide to Species

Frogs

Coastal Plain Cricket Frog (*Acris gryllus gryllus*)

Adults: These small frogs (to 1 3/8 inches [35 mm] body length) have a blunt snout, a dark, ragged-edged stripe along the inside of the thigh, and legs that are not much longer than the body; the heel usually extends beyond the snout when the leg is extended (carefully) along the side of the body. A dark stripe usually occurs along the side of the body and a dark, triangular patch occurs between the eyes on the dorsum of the head. Several raised slightly elongated, bumps resembling warts occur on the body. Body color is highly variable within populations: gray, green, and brown. Various combinations of red, yellow, orange, brown, green, and gray occur on the dorsum as a distinct stripe or sometimes as patches. The venter is white.

Sexual dimorphism: Males have orange-brown skin under the chin (the vocal pouch) during the breeding season, whereas females have white chins.

Juveniles: Colored and patterned as adults.

Advertisement calls: Male vocalizations sound like pebbles being clicked together - *gick-gick-gick-gick,* etc. - that starts slowly and picks up speed during the 15-30 second call period. Males will call day and night.

Eggs: About 150-300 small, cream-colored eggs are laid singly in vegetation in shallow water.

Tadpoles: The most distinguishing feature of Coastal Plain Cricket Frog tadpoles is usually black tail tip. On some tadpoles it looks as if the tip of the tail had been dipped in India ink. Body color is olive to yellowish brown with varying intensities of darker pigment. The venter is pinkish. The dorsal fin on the tail is higher than the ventral fin and its most anterior point is about mid-body. Both upper and lower fins have black pigment.

Distribution: Dare County Bombing Range, Marine Corps Air Station Cherry Point, and Marine Corps Base Camp Lejeune.

Seasonality: Males start calling in mid- to late-April, depending on the weather, and can be heard well into September. Tadpoles may be found in wetlands throughout the summer. Metamorphosis occurs in July and September.

Habitat: These frogs occur most often in grassy areas along the margins of limesinks, ephemeral pools and ponds and manmade ponds and lakes where they breed in shallow water. They also occur in shallow pools in dirt roads, depressions in fields, and riparian corridors along creeks and streams. Cricket frogs are seldom encountered far away from water. Terrestrial habitats, usually adjacent to pools or ponds, include hardwoods, mixed hardwood and pine, pine flatwoods, long leaf pine stands, and pocosins.

Identification notes: The triangular head patch, dark stripe on the thigh, and the various colors will distinguish Coastal Plain Cricket Frogs from others of its size.

Fowler's Toad (*Bufo fowleri*)

Adults: Fowler's Toads (to 76 mm body length) are brown to light tan to grayish in color with several irregularly shaped black patches on the dorsum. Most of the black patches usually contain 2-4 yellowish warts. There may be a cream-colored thin stripe down the middle of the back. The venter of the body and chin is white. The legs lack raised warts with black spines on the tip, especially on the lower legs. The rear of each foot bears a small black keratinized structure used for digging.

Sexual dimorphism: Males during the breeding season have black throats, whereas females have white to cream throats.

Juveniles: Similar to adults in color and pattern. A hand lens may be needed to examine the rear legs for low spineless warts.

Advertisement calls: The trill of Fowler's Toads is fast and high usually lasting 3-10 seconds; the warmer the frog the shorter the trill. It is a nasal call, something like the bleating of a sheep.

Eggs: Females lay long, gelatinous strings of paired black eggs. Clutch size is 2000-8000.

Tadpoles: Tadpoles are black at all stages with only the lower fin light in color. The musculature is not bi-colored. The anal opening lies along the ventral midline. Dorsal fin height is greater than the height of the tail musculature.

Distribution: Dare County Bombing Range, Marine Corps Air Station Cherry Point, and Marine Corps Base Camp Lejeune. This species was not encountered during the FY 99-01 survey.

Seasonality: This is a warm season breeder. Males call late April through August, depending on rain. Most breeding activity occurs in spring and early summer usually associated with rain events. They are inactive in cold months, but may be found on the surface April through October.

Habitat: Fowler's Toads require sandy soils burrowing. They occur throughout the Coastal Plain but its actual distribution is spotty in eastern North Carolina. They occupy most types of forest habitats, except for mature hardwoods with loamy soils. Terrestrial habitats include hardwoods, mixed hardwood and pine, pine flatwoods, long leaf pine stands, and pocosins. They also occur along canals, in fields, in developed and bivouac areas.

Identification notes: Fowler's Toads can be distinguished from Southern Toads by its low cranial crest, several warts to each black blotch on the back, and the lack of raised, spine-tipped warts on the thighs and lower legs. Southern Toads have distinctly high cranial crests, a variable number of warts in dark areas, and raised, spine-tipped warts on the rear legs. The tail musculature is all black in Fowler's Toads but bi-colored in Oak Toads. The upper tail fin is wider than the musculature but about equal in Southern Toads.

Oak Toad (*Bufo quercicus*)

Adults: Oak Toads (to 1 5/16 inches [33 mm] body length) have numerous small warts (glands) on the back, including a large one (the parotoid) behind the eye, and a broad, squat body. Oak toads usually have four or five pairs of dark spot or blotches on the back and a conspicuous light middorsal stripe down the back that may be white, cream, yellowish, or orange. The warts are reddish-brown to red or orange in color. The ground color ranges from charcoal-gray to virtually black. The venter normally is grayish-white.

Sexual dimorphism: Males are usually smaller than females and the skin on the chin is dark brown to almost black in color during the breeding season.

Juveniles: Similar to adults.

Advertisement calls: A high-pitched *peep,* like the peeping of newly hatched chicks. The calls can be heard day and night.

Eggs: The 2,500-8,000 black eggs are laid in two long, gelatinous strings in shallow water usually unattached to vegetation.

Tadpoles: Tadpoles of Oak Toads are dark brown to black at all developmental stages. The body is ovoid in shape, broader posteriorly than anteriorly. The eyes, as in the two other toads, are located more on top of the head than in tadpoles of other frogs. The anal opening lies along the midline, not curved to the right as in frogs. The upper half or more of the muscular portion of the tail is dark and lower half is light. Often the tail musculature exhibits a series of dorsal light saddles. The fins are about the same size above and below the muscular portion and somewhat opaque. Toad tadpoles often aggregate and occur in large numbers.

Distribution: Dare County Bombing Range, Marine Corps Air Station Cherry Point, and Marine Corps Base Camp Lejeune.

Seasonality: Oak Toads call during spring and summer. They are usually heard during rainy periods from April to September depending on the weather. Eggs are laid during this period. The larvae are present for up to 2 months but may metamorphose earlier if the pool dries.

Habitat: Adults are terrestrial and usually underground outside of the breeding season. They breed in shallow water (road ruts, shallow depressions in fields, marshes, pond margins) in the open. Upland habitats include developed and bivouac areas, fields, hardwood forests, mixed hardwood/pine forests, pine flatwoods, and long leaf pine stands.

Identification notes: The small size of adults, combined with the conspicuous middorsal stripe, will help to distinguish this toad from Fowler's Toads and the Southern toad.

Southern Toad (*Bufo terrestris*)

Adults: Southern Toads (to 3 inches [76 mm] body length) usually have pronounced knobs and high cranial crests on top of the head. Usually one to two warts occur on the brown to nearly black spots. Warts on the thighs are capped with a spine. A light line usually occurs down the center of the back. Body color is brown to grayish. A large parotid gland occurs behind each eye. The venter usually lacks spots or other distinct dark markings.

Sexual dimorphism: Males are usually smaller than females and the skin under the chin is dark in color during the breeding season.

Juveniles: Recently metamorphosed Southern Toads resemble adults with the 1-2 warts per blotch on the back and the raised warts with spines on the thighs. The cranial knobs are not usually well-developed but their position can often be determined by the presence of backward extensions of the cranial crests. A hand lens may be necessary to examine these features.

Advertisement calls: A shrill, musical trill lasting from 2-8 seconds (as described in Conant and Collins, 1998).

Eggs: The round eggs are black, numbering 2,000-8,000, and are laid in long, gelatinous strings in shallow water usually unattached to vegetation.

Tadpoles: Southern Toad tadpoles are black at all developmental stages and are similar in shape and eye position to Oak Toads, although larger. The anal opening lies along the ventral midline. Most of the muscular portion of the tail is dark and only the extreme lower side is light in color, not distinctly bi-colored as in Oak Toads. The dorsal fin is similar in height to that of the tail musculature.

Distribution: Dare County Bombing Range, Marine Corps Air Station Cherry Point and Marine Corps Base Camp Lejeune.

Seasonality: Males call from March through August and egg strings may be found at any time during this period. Length of larval period is about one month.

Habitat: Southern toads can be found in many different terrestrial habitat types when they are not at shallow breeding pools. Such places include

hardwoods, mixed hardwood and pine, pine flatwoods, long leaf pine stands, pocosins, fields. Breeding locations are usually shallow pools in dirt roads and wet depressions in grassy fields, ditches along roadsides, and the margins of ephemeral pools and ponds.

Identification notes: Adult Oak and Southern toads are usually not difficult to distinguish in the mid-Atlantic region because of the significant difference in size, as well as the presence of prominent cranial knobs and crests in *terrestris.* Recently metamorphosed juveniles and tadpoles may be more difficult, but paying attention to the type of warts on the thighs of juveniles and when early stage tadpoles are present will help. The relative difference in upper tail fin height will distinguish Southern Toad tadpoles (about equal) to those of Fowler's Toads (upper tail > tail musculature).

Cope’s Gray Treefrog (*Hyla chrysoscelis*)

Adults: These are moderate-sized treefrogs (to 2 inches [61 mm] body length) with expanded toe tips used for climbing. The skin is not smooth but evenly covered in small, smooth bumps. Body color is usually moderately light gray but may be greenish during the breeding season. Temperature plays an important role in the biology of this frog, thus individuals may be dark gray when they are cold. Irregular dark brown to nearly black blotches, sometimes outlined in black, occur on the dorsum. A small, white patch occurs beneath each eye. The inside of the thighs and groin are orange with black mottling.

Sexual dimorphism: Males have dark-colored (nearly black in some) throats, whereas females have white throats.

Juveniles: Colored and patterned as adults.

Advertisement calls: A fast, rasping trill that lasts about 3 to 10 seconds, depending on temperature.

Eggs: The dark-colored eggs are laid in multiple, small gelatinous egg masses on top of shallow water in ephemeral pools. Number per mass is about 20-200. Total number of eggs produced by individual females range from 1,000 to 2,500.

Tadpoles: Cope’s Gray Treefrog tadpoles are dark gray to yellowish-brown to olive in color with high tail fins. The venter is white to light cream and may

be iridescent. The dorsal fin is slightly larger (wider) than the ventral fin and its anterior point on the dorsum of the body is at the midpoint. Both fins are variously mottled with patches of gray pigment. The fins of many gray treefrog tadpoles are red along the margins with black pigment along the edge. This results when these tadpoles are in the presence of an abundance of invertebrate predators, especially dragonfly naiads.

Distribution: Dare County Bombing Range, Marine Corps Air Station Cherry Point, and Marine Corps Base Camp Lejeune.

Seasonality: Cope’s gray treefrogs begin calling in mid- to late-April, depending on the weather, and continue well into August when conditions are moist or wet. Most egg-laying occurs in May and June but also occasionally in July-August. Males may call from trees in spring and summer, especially when it rains or is about to rain. Tadpoles can be found in pools throughout the summer but are most prominent May-July. Metamorphosis occurs June through August.

Habitat: Adults and juveniles use a wide variety of terrestrial habitats that contain shrub vegetation to hardwood trees. They include hardwoods, mixed hardwood and pine, pine flatwoods, long leaf pine stands, and pocosins. Many wetland breeding sites occur in or adjacent to these habitats. Riparian areas along streams are used extensively by juveniles. Adults may be found on various human constructions, developed and bivouac areas and in forested habitats outside of the breeding season. The primary breeding habitat is shallow, ephemeral pools and in small bodies of water in open places near woody vegetation. Such pools usually lack fish.

Identification notes: This species is best differentiated from other treefrogs by the presence of the bright orange to yellow and black mottling on the concealed portion of the thighs.

Green Treefrog (*Hyla cinerea*)

Adults: This is a slender bright green treefrog. Body size is up to 2¼ inches (57 mm). A prominent, narrow white stripe may or may not be present along each side of the body. If present, the stripe may extend completely from the snout to the rear legs or may terminate on the body. The venter is white. Body color

will vary with temperature, from bright green to nearly yellowish to grayish brown. Small golden flecks may occur on the back.

Sexual dimorphism: During the breeding season males possess a wrinkled pink-colored skin under the chin (location of the vocal sac).

Juveniles: Similar to adults in color and pattern.

Advertisement calls: A loud, nasal *queenk-queenk-queenk* repeated rapidly for several seconds.

Eggs: Females lay about 400-1,500 eggs in small egg masses on or near the surface attached to vegetation.

Tadpoles: The body of the tadpole is yellowish green above and pale cream to yellowish below. The tail musculature is similar in color but may have irregular dark patches. The heights of both fins are approximately equal and are clear with patches of dark pigment. The dorsal fin inserts about midway on the body of the tadpole.

Distribution: Dare County Bombing Range, Marine Corps Air Station Cherry Point, and Marine Corps Base Camp Lejeune.

Seasonality: This is the late-spring and summer frog of the coastal mid-Atlantic region. Males call from May to August. Larvae occur from about June to August.

Habitat: Green Treefrogs are most often found in vegetation along the margins of lakes, ponds, and marshes in coastal areas and wetlands associated with streams and rivers. Adults often use human shelters, such as bath houses, bivouacs, and other structures when they are not breeding and can be seen in water-saving postures (legs tucked under the body) in corners, above doors, and in shower stalls. Terrestrial habitats include hardwoods, mixed hardwood and pine, pine flatwoods, long leaf pine stands, and pocosins. This frog is tolerant of brackish water and is often abundant in coastal marshes.

Identification notes: This treefrog is more slender and has smooth skin compared to Cope's Gray Treefrogs that may occur in the same area. The lack of a dark bar between the eyes distinguishes it from the Squirrel treefrog.

Pine Woods Treefrog (*Hyla femoralis*)

Adults: Coloration and pattern are highly variable in this species. Body size is up to 1 ½ inches (38 mm). Dorsal coloration ranges from gray or greenish gray to deep reddish brown with an irregular black patter. There is a row of small whitish, yellow, or orange spots inside the concealed portion of the thighs. There is no light spot below the eye.

Sexual dimorphism: Males have a dark throat during the breeding season. The fold of tissue on the upper chest is dark gray-brown in males and white in females.

Juveniles: Similar to adults in color and pattern, although the row of light spots on the rear of the thigh may be absent, or only faintly visible.

Advertisement calls: A rapid “dot and dash” call (like Morse Code) lasting from 5-20 seconds and repeated quickly. A large chorus sounds like a group of riveting machines all operating at once.

Eggs: Females lay about 30-50 eggs on the surface, unattached to vegetation.

Tadpoles: The body of the tadpole is light brown to gray or olive in color. Tail fins are high and may be edged in red, especially toward the tip. The tail musculature is distinctly striped and usually reddish in color. There is a distinct flagellum on the tip of the tail.

Distribution: Dare County Bombing Range, Marine Corps Air Station Cherry Point, and Marine Corps Base Camp Lejeune.

Seasonality: Males call from April to early September. Larvae may be seen from May to early September.

Habitat: Pine Woods treefrogs are most often found in vegetation along the margins of ponds and marshes, cypress swamps, especially those near pine flatwoods and other pine-dominated habitats. They occur frequently in ditches, road ruts and other similar man-made habitats. This is a pine-adapted species (especially long leaf pine habitats in the Southeast) but may also occur in the following terrestrial habitats: hardwoods, mixed hardwood and pine, and pocosins.

Identification notes: The row of light spots on the rear of the thigh will easily distinguish adult Pine Woods Treefrogs from Cope's Gray Treefrogs and Squirrel Treefrogs. In addition, Cope's Gray Treefrogs have orange and black mottling on the inside of the thigh, as opposed to the light spots on Pine Woods Treefrogs.

Barking Treefrog (*Hyla gratiosa*)

Adults: This species is the largest treefrog in the mid-Atlantic region, reaching a length of 2 5/8 inches (70 mm). The dorsal pattern consists of a number of small round, dark spots on a background that can be light or dark green, brown or gray to pale yellow. At least some green pigment is usually in evidence. Some individuals are green with small yellow flecks. There are no white stripes on the sides. The venter is cream.

Sexual dimorphism: Males have dark throats during the breeding season. They also have more yellow on the inside of the legs and lower venter. Females are largely white ventrally.

Juveniles: Colored and patterned as adults.

Advertisement calls: The breeding call is a single, explosive *doonk* or *toonk,* repeated every one to two seconds. It is given in or close to the water. A loud, barking *quonk* is often given from higher up in vegetation.

Eggs: Females lay 2000-3000 eggs singly or in small groups, usually attached to vegetation in shallow water.

Tadpoles: Barking Treefrog tadpoles are plump and golden brown in color, with a conspicuous sheen. The upper tail fin is noticeably high and the tail musculature normally has one black saddle slightly anterior to mid-length. The tip of the tail usually bears a flagellum, although this breaks off easily.

Distribution: Marine Corps Air Station Cherry Point and Marine Corps Base Camp Lejeune.

Seasonality: Adults breed from late April to July. Larvae occur from early May to early August.

Habitat: Adults and juveniles occur in cypress swamps, various temporary ponds, limesinks, and Carolina Bays, and along the margins of creeks. Barking Treefrogs are adept at both climbing and burrowing, often taking refuge in soil beneath roots or clumps of vegetation. They often share the same habitat with several other species of treefrogs and have been known to hybridize with the Green Treefrog in Alabama (Lamb and Avise, 1986).

Identification notes: The numerous dark spots on juveniles and adults and its large plump body size are usually sufficient to distinguish the Barking Treefrog from the other treefrogs within its range.

Squirrel Treefrog (*Hyla squirella*)

Adults: This highly variable species may reach 1 5/8 inches (41 mm). Body color can vary within the same individual from brown to green and from plain to spotted. There is often a spot or dark bar between the eyes. A light cream to white-colored stripe is often present along the side of the body. The venter is white.

Sexual dimorphism: Throats of males are dark orange-yellow and the tissue is loose, indicating the vocal sac. Throats of females are white.

Juveniles: Similar to adults in color and pattern.

Advertisement calls: A harsh, duck-like rasp or trill repeated 15-20 times in about 10 seconds. They also emit a rain call consisting of a scolding rasp, much like a squirrel.

Eggs: Females lay small masses of 100-200 eggs near the surface, usually attached to vegetation.

Tadpoles: Tadpoles are brown to bluish in color. The tail musculature is not striped and the dorsal fin height is less than the tail musculature height. The dorsal fin extends to the posterior border of the eye. There is no pigmentation on the throat.

Distribution: Dare County Bombing Range, Marine Corps Air Station Cherry Point, and Marine Corps Base Camp Lejeune.

Seasonality: Adults breed from late April and early May to August. Breeding calls can be heard during this period. Rain calls may be heard during the same period and also past the breeding season into September. Larvae occur from May to September.

Habitat: Squirrel treefrogs are found most often in vegetation along the margins of ponds, streams, and marshes, but also in hedges, woods, brush piles and other, similar places. They are often the most common treefrogs found in and around houses, outdoor bath houses, bivouacs, and other human structures. They occur in a variety of terrestrial habitats, including hardwoods, mixed hardwood and pine, pine flatwoods, long leaf pine stands, and pocosins.

Identification notes: This treefrog is best differentiated from the Green and Pine Woods treefrogs by a process of elimination. It lacks the line of light spots on the rear of the thigh seen in the Pine Woods Treefrog. The dark bar between the eyes will distinguish it from Green Treefrogs, and the lack of a white patch beneath the eye will distinguish it from Cope's Gray Treefrogs.

Eastern Narrow-mouthed Toad (*Gastrophryne carolinensis*)

Adults: These small, stocky frogs have a pointed snout with a tiny mouth, smooth skin, and a unique fold across the back of the head. Body color is gray, brown, or reddish. A broad dark patch that extends from the eyes to the groin is present in some individuals but is obscured by irregular light and dark pigmentation in others. The venter is heavily mottled or speckled with light and dark brown pigment.

Sexual dimorphism: The throats of adults males are black. Throats of females are gray to cream.

Juveniles: Colored and patterned as adults.

Advertisement calls: Males produce an explosive, nasal *baaa* that lasts for 1 to 4 seconds and sounds like the bleating of a sheep. There is no buildup to the call; it explodes from its initiation (compare with the Fowler's Toad).

Eggs: Packets of about 10 to 150 eggs are laid in small gelatinous masses on the water’s surface in small, shallow, highly ephemeral pools.

Tadpoles: The tadpole of this species is unique because it lacks the normal grazing mouthparts typical of tadpoles of other frogs. The body is somewhat flattened and wide. Color of the body and tail musculature is black sometimes with fine light gray dots. A light line may be present from below the eye to the rear leg, and a light line occurs along the midline of the tail musculature. The venter is finely dotted with gray. The tail fins are about equal in height and bear a variable number of irregular black patches. The dorsal and ventral tail fins insert on the rear of the body. The spiracle is located along the midline of the venter.

Distribution: Dare County Bombing Range, Marine Corps Air Station Cherry Point, and Marine Corps Base Camp Lejeune.

Seasonality: Males call in late spring and summer usually following thunderstorms and heavy rain. Females lay eggs during that time and tadpoles metamorphose in 3-5 weeks. Adults and juveniles are active in all warm months of the year in terrestrial habitats.

Habitat: Adults are active during the breeding season in open fields and areas without canopy that have shallow depressions that fill with summer rains. Outside of the breeding season adults and juveniles occur in hardwoods, mixed hardwood and pine, pine flatwoods, long leaf pine stands, and pocosins.

Identification notes: These microhylids, commonly called toads, lack the large parotid glands, warty skin, and webbing between the toes present in true toads of the genus *Bufo*. Their pointed snouts should also distinguish them from other frogs.

Brimley's Chorus Frog (*Pseudacris brimleyi*)

Adults: This small frog reaches a length of 1 ¼ inches (32 mm).
The dorsum is usually yellowish-brown with a bold black stripe that runs through the eye and down the side of the body. The underside is yellow with dark spots on the chest. There are often three dark stripes on the back but these may be indistinct or absent altogether.

Sexual dimorphism: The throat in breeding males is dark and the tissue is flaccid. Throats of females are cream-colored.

Juveniles: Patterned and colored like adults.

Advertisement calls: Males emit a short, rasping trill that is strongly accentuated at the end. It lasts less about a second and is repeated up to a dozen or more times. Males call day and night.

Eggs: Females lay several hundred eggs singly among vegetation in shallow water wetlands.

Tadpoles: Tadpoles are very similar to those of Spring Peeper tadpoles except that the tail musculature is distinctly striped. The anus is curved to the right.

Distribution: Dare County Bombing Range, Marine Corps Air Station Cherry Point, and Marine Corps Base Camp Lejeune. No Brimley's Chorus Frogs were captured during the FY 99-01 study.

Seasonality: Males are often the earliest frogs to call during the season, beginning with the first warm days of late winter and lasting until early April. The most intense choruses are usually from late February to late March, depending on weather conditions. Females lay eggs during this time. Larvae can be found from March to early May.

Habitat: Brimley’s Chorus frogs occur in most forested habitats, including hardwoods, mixed hardwood and pine, pine flatwoods, long leaf pine stands, and pocosins. Outside of the breeding season they hide beneath leaf litter and other forms of cover. During the breeding season they occur in shallow, seasonally flooded pools in forested areas, as well as the margins of swamps, ditches, other shallow, ephemeral wetlands, and in fields.

Identification notes: The distinctive dark stripe along each side of the adults will distinguish Brimley’s chorus frog from the other species of chorus frogs.

Northern Spring Peeper (*Pseudacris crucifer crucifer*)

Adults: This small frog (to 1 ½ inches [37 mm] body length) has a light brown to tan to grayish body with a distinct dark cross on its back in the form of

an imperfect “X”. A dark bar occurs between the eyes on the top of the head, but it be may obscured in dark frogs. The venter is white to cream and may have small dark spots.

Sexual dimorphism: The dark color and loose tissue in throats of males distinguish them from females during the breeding season.

Juveniles: Colored and patterned as adults.

Advertisement calls: This is the well-known harbinger of spring with its clear, high-pitched “*peep-peep-peep-peep*” repeated several times at an interval of a second or less. The call features a distinct, terminal upward slur. Males call during the day and especially at night, when choruses are most intense.

Eggs: Up to about 1,600 cream-colored eggs are laid singly by females among vegetation and on dead leaves on the bottom of shallow water wetlands.

Tadpoles: Spring peeper tadpoles are gray, brown, or nearly black depending on the type of substrate with patches of black pigment on the tail musculature and in the tail fins. Older tadpoles have more pigment than younger tadpoles. The venter is iridescent gold. Dorsal and ventral fins are nearly equal in size and the dorsal fin inserts on the posterior portion of the body.

Distribution: Dare County Bombing Range, Marine Corps Air Station Cherry Point, and Marine Corps Base Camp Lejeune.

Seasonality: Males begin calling with the first warm days of late winter and continue, depending on the weather, well into April. Air temperatures in the 50s and 60s F (10-15^{o} C) in January and February will stimulate these frogs to call. Choruses are most intense in this area in March and April. Females lay eggs during this time. Males can be heard calling from trees periodically in autumn (September-December) on cool days. Tadpoles can be found in shallow water breeding sites March through June.

Habitat: Spring peepers occur in forested habitats outside of the breeding season where they seek shelter in trees, shrubs, and beneath leaf litter. Habitats include hardwoods, mixed hardwood and pine, pine flatwoods, long leaf pine stands, and pocosins. During the breeding season they occur in vegetation surrounding, and sometimes well away from, a wide variety of wetland types,

including vernal pools in woodlands, road ruts, and grassland depressions, roadside ditches, freshwater marshes, and alongside small ponds that lack fish. Tadpoles can be abundant in these wetlands.

Identification notes: The call of this species is easily learned. It distinguishes this species from all others with the possible exception of the Ornate Chorus Frog. However, the call of the Ornate Chorus Frog does not have the terminal upward slur that is heard in the Spring Peeper; its call is more metallic. Other frogs in this size range lack the “X” on the back.

Southern Chorus Frog (*Pseudacris nigrita*)

Adults: This small frog (to 1 1/4 inches [32 mm] body length) has small toe pads and little to no webbing between the toes. Body color is silvery to tan to slate gray usually with 3 narrow, dark stripes on its back. The stripes are usually not complete and in some individuals may be broken into a series of elongated spots or lacking altogether. The upper lip is white. A dark line runs from the snout passing through the eye to the groin. The snout tends to be more pointed than in other chorus frogs. The venter is white often with a variable amount of dark stippling in the upper abdomen.

Sexual dimorphism: Males have dark throats during the breeding season.

Juveniles: Colored and patterned as adults.

Advertisement calls: Calls of males sound much like a fingernail running over the teeth of a stiff comb, like a loud *crreek* or *prreep* repeated regularly to intermittently depending on the temperature.

Eggs: About 30-150 eggs are laid in each of several clear egg masses attached to grass stems near the surface in shallow water. Total clutch size is up to about 700 eggs.

Tadpoles: Chorus frog tadpoles are dark brown to nearly black dorsally and bronze ventrally. Fine dots of greenish yellow occur on the upper body and tail musculature. The dorsal and ventral fins are about equal in height and the anterior insertion of the dorsal fin is on the posterior portion of the body. The dorsal fin has elongated dark markings.

Distribution: Marine Corps Air Station Cherry Point and Marine Corps Base Camp Lejeune.

Seasonality: Males call early in the year, usually beginning when air temperatures are above freezing (40-50 F) for three or more days. Breeding occurs over a short, several-day span in February or March but males will call from then into early-April. Tadpoles are seldom found after April to mid-May.

Habitat: Males call from grassy areas associated with very shallow water in wetlands without fish. These include tire ruts, pools in dirt roads, roadside ditches, and pools in fields in the open. Outside of the breeding season adults and juveniles remain hidden in the leaf litter of hardwood forests and among shrubby and grassy vegetation not far from the vicinity of breeding sites. Riparian areas and saturated forested wetlands are used extensively for shelter. Habitats include hardwoods, mixed hardwood and pine, pine flatwoods, and long leaf pine stands.

Identification notes: This species is distinguished from the Spring Peeper by the presence of stripes or spots on the back rather than an “X” shaped marking, from Brimley’s Chorus Frog by its more pointed snout, lack of a black lateral stripe, and white upper lip, and from the Ornate Chorus Frog by the lack of dark spots on the sides and near the groin. The distinctive call will allow one to identify calling males.

Little Grass Frog (*Pseudacris ocularis*)

Adults: This is the smallest frog in North America. It reaches a maximum length of 11/16 inches (17 mm). The toes are slightly webbed. Dorsal coloration is variable, ranging from tan or brown to greenish, pink, or reddish. The chest is white or yellow. A dark line passes through the eye and along the sides. In most individuals a thin dark line begins as a triangle between the eyes and runs mid-dorsally to the anal region.

Sexual dimorphism: The throats of males in this species are dark and the tissue in the lower half is wrinkled. The throats of females are cream to yellowish.

Juveniles: colored and patterned like adults, although some details are often not well-developed.

Advertisement calls: A high-frequency insect-like tinkling sound. Males call day and night.

Eggs: Females deposit about 50-100 eggs singly, attached to vegetation in shallow water.

Tadpoles: Tadpoles are dark brown dorsally, with a light dorsal stripe extending from the tail to the eye. The dorsum of the tail musculature is banded or marked with saddles. The tail fins are clear or with a few scattered dark spots.

Distribution: Dare County Bombing Range, Marine Corps Air Station Cherry Point, and Marine Corps Base Camp Lejeune.

Seasonality: Males will call from February through September. Tadpoles can usually be found from March through July.

Habitat: Adults and juveniles frequent moist, grassy areas along the margins of ponds, cypress swamps, bays, ditches, road ruts and similar places. Little Grass Frogs do not climb extensively and are normally found in low vegetation. Outside of the breeding season they take shelter in leaf litter and among shrubby vegetation close to their breeding sites. Habitats include hardwoods, mixed hardwood and pine, pine flatwoods, long leaf pine stands, and pocosins.

Identification notes: The small size of adult Little Grass frogs causes them to often be mistaken for the young of one of the other species of chorus frogs. The lack of spots on the chest of Little Grass frogs will help to distinguish them from juvenile Brimley’s chorus frogs. The prominent lateral line will distinguish it from the Ornate Chorus frog and the Southern chorus frog.

Ornate Chorus Frog (*Pseudacris ornata*)

Adults: Ornate chorus frogs reach a maximum length of 1 7/16 inches (37 mm). They have a black, mask-like stripe running through the eye and dark spots on the sides and near the groin. There are numerous yellow spots on the concealed portions of the hind legs and yellow coloration on the groin itself. Dorsal

coloration is highly variable, ranging from green to brown. There are usually several dark, irregular markings on the back.

Sexual dimorphism: Males have dark throats and females have white throats.

Juveniles: Colored and patterned like adults but paler, with color and pattern much less developed.

Advertisement calls: A series of high-pitched, bird-like peeps, similar to the call of the Spring Peeper, but shorter, and without the terminal, upward slur. It sometimes sounds metallic. Males call day and night.

Eggs: Females lay about 60-100 eggs in a gelatinous mass attached to vegetation under water in shallow wetlands.

Tadpoles: Ornate chorus frog tadpoles are light to dark brown with a bicolored tail musculature. The tail musculature has no black saddle. The jaws appear narrow and angled compared with other chorus frog tadpoles.

Distribution: Marine Corps Air Station Cherry Point (likely) and Marine Corps Base Camp Lejeune.

Seasonality: Males call from vegetation in shallow water and can be heard in the Fall, Winter, and early Spring. Breeding occurs in February and March. Larvae can be found March through May.

Habitat: Ornate Chorus Frogs breed in shallow wetlands that lack fish. These habitats include shallow, ephemeral ponds both in wooded areas and in open fields, Carolina Bays, ditches, road ruts, and similar places. Outside the breeding season adults and juveniles seek shelter in leaf litter and dense vegetation close to breeding ponds. Terrestrial habitats include hardwoods, mixed hardwood and pine, pine flatwoods, and long leaf pine stands.

Identification notes: Ornate Chorus Frogs can be distinguished from other chorus frogs by the presence of light-bordered dark spots on the sides and near the groin.

Eastern Spadefoot (*Scaphiopus holbrookii*)

Adults: Spadefoot toads (to 2 ¼ inches [57 mm] body size) are brown to blackish brown with two, wide, irregular yellowish lines extending down the back to form a lyre-like pattern. Each line originates at the eye. An additional light yellowish line occurs on each side of the body. Body color depends on temperature; cooler spadefoots are darker. The pupil of the eye is vertical, not round, and the eyes protrude well above the head. There are no parotoid large glands on the back. The venter is white. A characteristic feature is the single black spade located on the heel of each foot.

Sexual dimorphism: Both sexes have white throats. The webbing between the toes on the rear feet in males is dark gray but light gray in females. Males have longer and wider feet than females. Dorsal stripes in males are greenish yellow. They are sulfur yellow in females.

Juveniles: Colored and patterned as adults.

Advertisement calls: Male vocalizations are moderately short, explosive grunts described as a low-pitched *wank* repeated about every 2 or more seconds, depending on the temperature.

Eggs: Several thousand eggs are laid in irregular bands along grass stems or in the open in shallow water.

Tadpoles: The body color of this tadpole is very dark brown to black with a yellowish stripe along the body and the tail musculature. The body is somewhat flattened. The dorsal and ventral fins are not wider than the width of the tail musculature, and the dorsal fin barely extends onto the body. The fins are usually clear but may have some scattered dark pigment.

Distribution: Marine Corps Air Station Cherry Point and Marine Corps Base Camp Lejeune.

Seasonality: These frogs appear sporadically on the surface and are seldom seen except during or immediately after heavy rain storms. Most of their time is spent underground. The activity period is April - September. Tadpoles have a very short developmental time; they reach metamorphosis in about three weeks following hatching.

Habitat: Most places known to harbor this species are sandy or of a soil type that allows spadefoots to burrow underground. Fields, grasslands, mixed hardwood and pine forest patches, and abandoned open areas may have these frogs. Breeding locations are shallow, ephemeral pools that form during rain storms or are depressions that hold water for varying lengths of time. Most of these places are in the open or in sparse vegetation, and they all lack fish. Terrestrial habitat types include hardwoods, mixed hardwood and pine, pine flatwoods, long leaf pine stands, and pocosins.

Identification notes: The pop eyes, vertical pupil, single spade, and yellowish lyre pattern will distinguish this frog from all others in the area. Toads have raised warts on the skin, black blotches on the back, a large gland behind each eye, and two smaller spades on each foot.

Carolina Gopher Frog (*Rana capito capito*)

Adults: Carolina Gopher frogs are short and rounded in appearance. They reach a maximum length of 3 ½ inches (90 mm). The head is large, even compared to other *Rana*, and the eyes are prominent and bulging. Dorsal coloration is variable (olive to olive-brown) but nearly always dark. Skin texture is rough, like a pattern of small bumps. The dorsum is usually spotted but the spots may be fairly inconspicuous due to the often dark overall coloration. The venter is heavily marked with dark flecks giving a characteristic marbled appearance.

Sexual dimorphism: The tympanum in males is larger than the diameter of the eye, but it is smaller than the eye in females. Males also have enlarged thumbs, although the thumb pad (pollex) is less pronounced than in other ranids. The vocal sacs in males are dark. Males also have yellow axillary and groin areas during the breeding season. They are white in females.

Juveniles: Similar in color and pattern to adults but with much less coloration on the venter.

Advertisement calls: Males emit a deep snore that can be heard a considerable distance away.

Eggs: Female Carolina Gopher Frogs lay several hundred eggs in a dense, globular mass, usually attached to stems or other vegetation under water. They tend to lay eggs in deeper water than Southern Leopard Frogs.

Tadpoles: Gopher Frog tadpoles are large, with very high tail fins. Color is usually brownish with scattered dark pigment on the tail musculature and fins. There are no blotches in either tail fin, instead pigmentation consists of an even distribution of very fine black points throughout both tail fins.

Distribution: The only confirmed site is Marine Corps Base Camp Lejeune.

Seasonality: Carolina Gopher Frogs begin calling in late February and early March, with the onset of the first warm rains. Adults are difficult to find outside of the breeding season because they are in underground burrows. Larvae are present from March to late June or early July.

Habitat: Gopher frogs, as the name implies, are largely burrowers, seeking refuge in crayfish holes, small mammal burrows, and in holes beneath stumps well away from breeding sites. During the breeding season they can be found in temporary ponds, Carolina bays, lime sinks, borrow pits and other wetlands that lack fish. Forest habitats include hardwoods, mixed hardwood and pine, pine flatwoods, long leaf pine stands, and pocosins.

Identification notes: The other frogs occurring with *R. capito* have narrower waists and a more slender appearance. Also, the presence of numerous small warts on the dorsum will help to differentiate this species.

American Bullfrog (*Rana catesbeiana*)

Adults: This large, stout frog (to about 6 inches [152 mm] body length) has large eyes, long limbs with extensive webbing between the toes, and no dorsolateral ridge (raised line) along each side of the back. Body color varies from green to brown and may or may not have a netlike pattern of gray to dark brown, or a series of large obscure blotches. The venter is white with a highly variable mottling of gray. The snout and sides of the head are green.

Sexual dimorphism: The diameter of the tympanum in males is distinctly larger than the diameter of the eye; they are about the same size in females. During

the breeding season males have a yellow chin and throat, and a dark, swollen patch on their thumbs (the pollex).

Juveniles: Similar to adults in color but there may be numerous small black dots on the back.

Advertisement calls: Males are well known for their deep, bass *jug-o'-rum* calls.

Eggs: Females lay 10,000 to nearly 30,000 eggs in a large surface film in vegetation in ponds and lakes.

Tadpoles: Tadpoles of this species are the typical pollywog type of tadpole and can be large (up to 150 mm total length). Dorsal body color is uniformly greenish brown to olive with a clear yellowish venter. Distinct, small, black dots occur on the body, musculature of the tail, and at least the dorsal fin. The dorsal fin is not as wide as the width of the tail musculature.

Distribution: Dare County Bombing Range, Marine Corps Air Station Cherry Point, and Marine Corps Base Camp Lejeune.

Seasonality: Bullfrogs begin calling and establishing territories in late-April to early May in the mid-Atlantic region. Males call from that time throughout the summer. Egg laying occurs late-May to July. Tadpoles can be found in every month of the year, even under the ice, because they usually take up to two years or more to reach metamorphosis.

Habitat: Adults inhabit permanent water, such as beaver ponds and manmade lakes that may or may not have fish. Streams are also used by bullfrogs for shelter and breeding. Juveniles disperse widely from breeding sites and may found in ephemeral pools in roads and woods, roadside ditches, and other shallow wetlands long distances from permanent water. Juveniles occur in hardwoods, mixed hardwood and pine, pine flatwoods, long leaf pine stands, and pocosins. Tadpoles can be found in ponds, lakes, and streams.

Identification notes: This frog is distinguished from green frogs (*Rana clamitans*) by the lack of the raised dorsolateral ridge on each side of the back. Green frogs have similar coloration but are smaller and possess dorsolateral ridges.

Northern Green Frog (*Rana clamitans melanota*)

Adults: Green frogs (to 3 ½ inches [89 mm] body length) are similar in shape to bullfrogs but are proportionally smaller. A distinct dorsolateral ridge is present on each side of the back. Body color varies from greenish brown to nearly all brown, sometimes with small dark spots on the back, especially on young frogs. A green patch is present below the eye on the upper lip to the tip of the snout. The venter is white but may have dark markings on the upper chest and legs.

Sexual dimorphism: The tympanum is larger than the diameter of the eye in males but similar in size to the eye in females. During the breeding season males have yellow throats and the dark pollex is enlarged.

Juveniles: Body color is usually brownish with numerous small dark spots on the back. Dorsolateral ridges are present.

Advertisement calls: Males emit several types of vocalizations, the most common of which is the one often described as a plucked and rather explosive loose banjo string. The call may be made once or several times with the notes becoming progressively less audible. This species emits a loud, high-pitched *squeenk* when startled as they jump from their resting sites along the bank of a pond.

Eggs: Between 1,000 and 4,000 dark eggs are laid by a female in a single, clear surface egg mass attached to vegetation in shallow water.

Tadpoles: Tadpoles are similar to bullfrog tadpoles but are olive green with a cream-colored, non iridescent venter. These tadpoles may be nearly all brown in color, resembling the clay of road rut pools or very dark with an abundance of dark blotches in pools filled with blackened leaves. The dark markings on the body, tail musculature, and tail fins are irregular in shape, often in the form of diffuse black spots. The dorsal fin is not as wide as the width of the tail musculature.

Distribution: Dare County Bombing Range, Marine Corps Air Station Cherry Point, and Marine Corps Base Camp Lejeune.

Seasonality: Green frogs begin calling as early as late-April and will call throughout the summer into September. Eggs are laid May through September. Tadpoles may be found in every month of the year because they take a year or more to reach metamorphosis.

Habitat: Green frogs occupy a wide variety of freshwater wetland habitats, including margins of permanent beaver and manmade ponds and lakes, vernal pools in woodlands, road ruts, and grassland depressions, roadside ditches, streams, and rivers. Juveniles disperse long distances from breeding sites through terrestrial habitats to ephemeral pools and other shallow bodies of water. Such habitats include hardwoods, mixed hardwood and pine, pine flatwoods, long leaf pine stands, and pocosins. Tadpoles are found in all of these wetlands.

Identification notes: The dorsolateral ridge and green patch on the upper lip below the eye will distinguish this species from other ranid frogs in the area.

Pickerel Frog (*Rana palustris*)

Adults: The dorsum of this ranid frog is brown to olive green with the dorsolateral ridges bordered by light cream. Two rows of squarish dark spots occur in the field between the ridges. The corners of the square spots are not angular but rounded. The spots may fuse in some individuals forming stripes. Legs colored as the dorsum except there is a series of dark colored stripes dorsally. The chin and venter are yellow to white. The inside of the thighs in adults is yellow.

Sexual dimorphism: During the breeding season, males have enlarged, dark thumb pads (pollex), and paired vocal sacs that may be hard to see.

Juveniles: Similar to adults in color and pattern.

Advertisement calls: This frog has a soft snore that does not carry great distances. They may call underwater, further muffling their calls. Thus, careful listening at wetland breeding sites may be required to hear this frog.

Eggs: Females lay gelatinous egg masses containing up to 3000 eggs. They are usually attached to vegetation or branches under water.

Tadpole: The tadpoles are usually dark olive green with blotches of white to yellowish pigment on the iridescent venter. The dorsum of the body has fine yellow spots. The dark, diffuse markings on the tail increase in density toward the tip. The tail musculature and the dorsal and ventral fins are about equal in size.

Distribution: Dare County Bombing Range, Marine Corps Air Station Cherry Point, and Marine Corps Base Camp Lejeune. Not caught during the Legacy 99-01 amphibian project (Mitchell, 2000, 2001, 2002).

Seasonality: This frog breeds in late winter in the Coastal Plain, although juveniles and adults may be active in most other months.

Habitat: Pickerel frogs occupy freshwater ponds, marshes, vernal pools, and streams in a variety of forest cover types, including hardwoods, mixed hardwood and pine, and pine flatwoods. The combination of wetland in or adjacent to forest cover is apparently preferred by this species.

Identification notes: Southern Leopard Frogs, with which this species is most likely to be confused, have round spots, no yellow on the venter, and a white spot in the middle of the tympanum. Green frogs lack the dorsal spots.

Southern Leopard Frog (*Rana sphenocephala*)

Adults: Body coloration in this species varies from green to brown with a highly variable series of distinctly dark, round spots in the back between the light-colored dorsolateral ridges. There are few spots on the sides. Maximum body size reaches about 2 ½ inches (64 mm). The snout is distinctly pointed, there is a white spot in the center of the tympanum, and the venter is white.

Sexual dimorphism: Males are similar to females but have paired vocal pouches and a dark pollex during the breeding season. Tympanum diameters are similar in size.

Juveniles: Similar to adults in color and pattern.

Advertisement calls: Males emit a series of short, chuckle-like calls that sound similar to that produced by rubbing an inflated balloon.

Eggs: A single, clear, globular egg mass of up to 3,500 eggs is laid in shallow water usually where live or dead grasses are present.

Tadpoles: The body of Southern Leopard Frog tadpoles is dark olive green with large, diffuse black spots on the tail musculature and both fins. The coiled intestines are clearly visible through the body wall. The venter is pinkish and somewhat iridescent. The dorsal tail fin is about equal in height as the tail musculature and inserts on the body at the midpoint. Tadpoles in wetlands with high densities of predators, like dragonfly naiads, develop a black tail tip.

Distribution: Dare County Bombing Range, Marine Corps Air Station Cherry Point, and Marine Corps Base Camp Lejeune

Seasonality: Males may call in virtually any month but most breeding takes place from early Spring (March-April) to July. Adults can be found in suitable habitat throughout the warmer part of the year. Tadpoles can be found in any month of the year because they take more than a year to reach metamorphosis.

Habitat: These frogs may be found in lowland riparian corridors along stream courses, freshwater marshes, beaver ponds, and in shallow pools in grassy fields. Adults may be found along the margins of wetlands during spring and summer. Juveniles disperse widely and may be found well away from water as well as in isolated ephemeral pools, small ponds, and riparian areas. Terrestrial habitats include hardwoods, mixed hardwood and pine, pine flatwoods, long leaf pine stands, and pocosins. Tadpoles occur in pond margins, marshes, and ephemeral pools.

Identification notes: Southern leopard frogs have distinctly round spots and lack the yellow legs seen in Pickerel Frogs.

Carpenter Frog (*Rana virgatipes*)

Adults: Carpenter frogs are brown to olive dorsally with four irregular olive yellow stripes. The venter is cream with distinct black mottling, especially posteriorly. The inside of the rear legs are also heavily mottled. There are no dorsolateral ridges.

Sexual dimorphism: The tympanum is slightly larger in males than females, and males have a swollen pollex during the breeding season. The paired vocal sacs are dark gray to nearly black.

Juveniles: Similar to adults in color and pattern.

Eggs: Egg masses containing up to about 600 eggs are to vegetation attached below the surface of the water.

Tadpoles: The color of the body and tail musculature is dark brown to olive brown to nearly black and may contain black spots. The upper half of the tail musculature is darker than the lower half. The venter is cream in color with some dark mottling. The dorsal and ventral tail fins are variously pigmented but the upper fin always has a series of dark pigment patches that forms a dark line that parallels the musculature.

Distribution: Dare County Bombing Range only.

Seasonality: Carpenter frogs begin activity in early to mid-April, depending on the weather. They call for an extended period of time, March to September. Tadpoles can be found in every month of the year as they overwinter before metamorphosis in late summer.

Habitat: Beaver ponds, marshy expanses of stream corridors, and sphagnum areas, all of which are acidic and heavily choked with vegetation may be occupied by this specialized frog. Pocosin habitat and Atlantic white cedar stands in pocosins support populations. The water in these habitats is stained darkly and with pH values ranging between about 4.0 and 5.0. There is an abundance of dark organic material in the water in the preferred locations.

Identification notes: The four light stripes, the black mottling, and the lack of the dorsolateral ridge should distinguish this frog from all others in the area.

Southern Cricket Frog (Joe Mitchell)

Southern Toad (Joe Mitchell)

Fowler's Toad (Joe Mitchell)

Cope's Gray Treefrog (Joe Mitchell)

Oak Toad (Joe Mitchell)

Green Treefrog (Joe Mitchell)

Pine Woods Treefrog (Joe Mitchell)

Squirrel Treefrog, gray phase (Joe Mitchell)

Barking Treefrog (Joe Mitchell)

Eastern Narrow-mouthed Toad (Joe Mitchell)

Squirrel Treefrog, green phase (Joe Mitchell)

Brimley's Chorus Frog (Joe Mitchell)

Northern Spring Peeper (Joe Mitchell)

Southern Chorus Frog (Tripp Lamb)

Little Grass Frog (Joe Mitchell)

Ornate Chorus Frog (Joe Mitchell)

Spadefoot Toad (Joe Mitchell)

Carolina Gopher Frog (Joe Mitchell)

American Bullfrog (Joe Mitchell)

Northern Green Frog (Joe Mitchell)

Pickerel Frog (Joe Mitchell)

Southern Leopard Frog, normal phase (Joe Mitchell)

Southern Leopard Frog, lime green phase (Joe Mitchell)

Carpenter Frog (Joe Mitchell)

Selected Frog habitats in eastern North Carolina

Canal habitat and adjacent dirt road at Dare Co. Bombing Range (Joe Mitchell)

Shallow pool in open area on Dare Co. Bombing Range (Joe Mitchell)

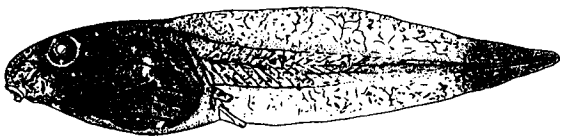
Road rut puddles on Cherry Point MCAS (Joe Mitchell)

Ephemeral pool in old logging road on Cherry Point MCAS (Joe Mitchell)

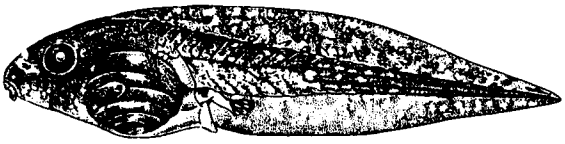
Ephemeral limesink habitat on Camp Lejeune (Joe Mitchell)

Limesink pond at Camp Lejeune (Joe Mitchell)

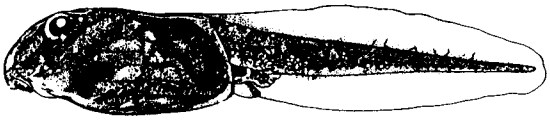
Tadpoles of Frogs and Toads



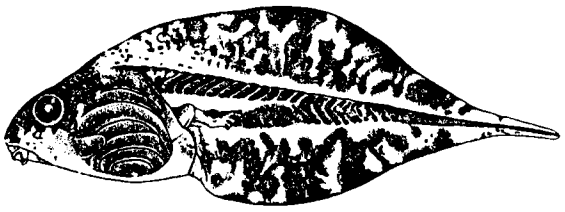
Coastal Plain Cricket Frog



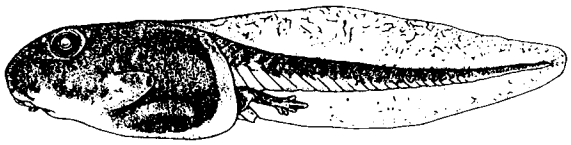
Green Treefrog



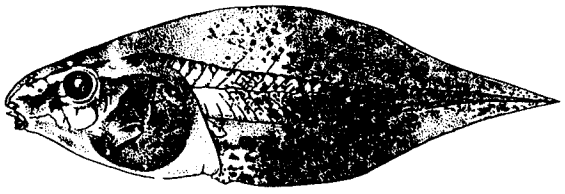
Fowler's Toad



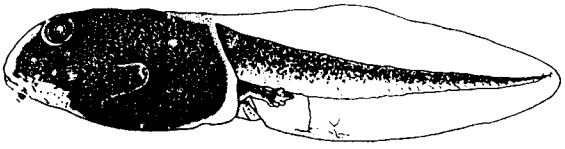
Pine Woods Treefrog



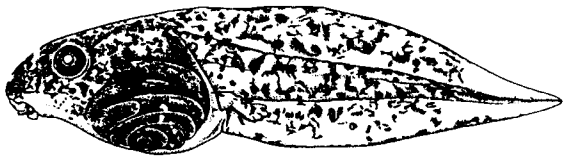
Oak Toad



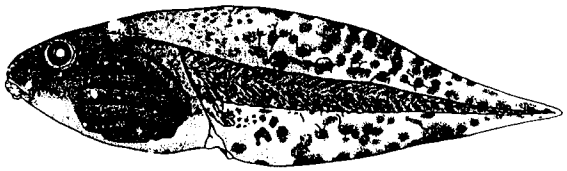
Barking Treefrog



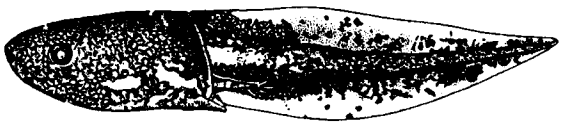
Southern Toad



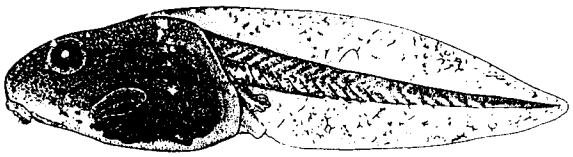
Squirrel Treefrog



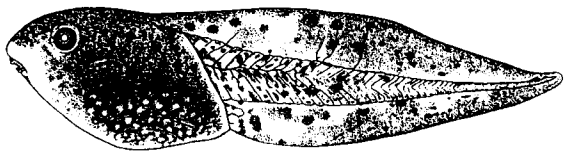
Cope's Gray Treefrog



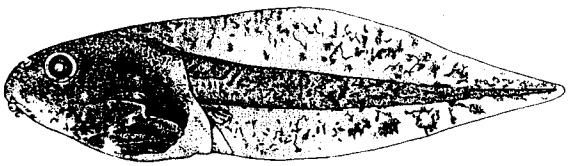
Eastern Narrow-mouthed Toad



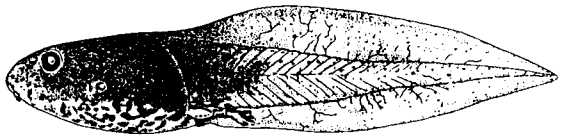
Brimley's Chorus Frog



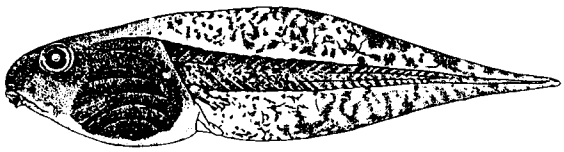
Carolina Gopher Frog



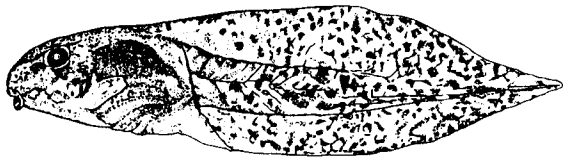
Northern Spring Peeper



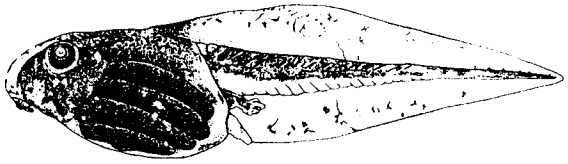
American Bullfrog



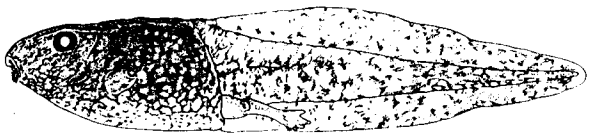
Southern Chorus Frog



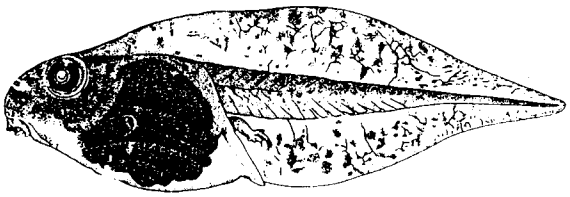
Northern Green Frog



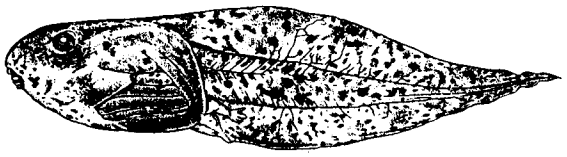
Little Grass Frog



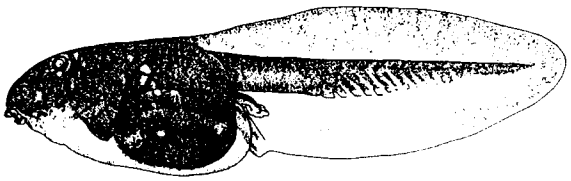
Pickerel Frog



Ornate Chorus Frog



Southern Leopard Frog



Eastern Spadefoot

Carpenter Frog

Salamanders

Mabee's Salamander (*Ambystoma mabeei*)

Adults: Mabee's salamanders reach a maximum length of 4 ½ inches (102 mm). Dorsal ground color ranges from black to dark brown. The venter is dark brown to gray. The dorsal pattern consists of numerous light specks. These specks are most abundant along the sides. The toes are conspicuously long and the head is noticeably small, compared with other ambystomatid salamanders.

Sexual dimorphism: During the breeding season, the area surrounding the vent in males is swollen conspicuously. The area is generally flat or slightly mounded in females.

Juveniles: Generally patterned as adults, although the light flecking may not be well-developed.

Eggs: About 250 eggs are laid in a loose, stringy mass in shallow water of ephemeral ponds. Eggs are often laid among vegetation or under logs.

Larvae: Larval Mabee's salamanders are generally light gray to greenish above with a cream-colored venter. The body is often distinctly marked with several thin or broken stripes.

Distribution: Marine Corps Air Station Cherry Point and Marine Corps Base Camp Lejeune.

Seasonality: Mabee's salamanders begin breeding activity in the Fall, emerging from underground retreats and migrating to suitable breeding ponds. They require ponds that lack fish. Eggs are laid from November or December until early March, depending on climatic conditions. Adults can be found during this period under logs, leaves or other debris both within and along the margins of ponds. Larvae can be found in the ponds from December and January until May or June.

Habitat: Outside the breeding season, when adults can be found as described above, Mabee's salamanders seek refuge underground in crayfish holes, rodent burrows, decayed root channels and similar places. Upland habitats include

hardwoods, mixed hardwood and pine, pine flatwoods, long leaf pine stands, and pocosins.

Identification notes: Mabee's salamanders can be distinguished from other ambystomatids by the presence of numerous small flecks, as opposed to the strongly cross-barred pattern in the Marbled salamander.

Marbled Salamander (*Ambystoma opacum*)

Adults: These are short (to 4 ¼ inches [108 mm] total length), stocky salamanders with several gray to white crossbars on a black to bluish black body. The crossbars may be broken in some individuals or run together to form parallel white stripes. Crossbars occur on head, body, and tail. The venter is black.

Sexual dimorphism: Males have white crossbars and distinctly swollen cloacal lips during the breeding season. Females have gray crossbars and a flattened cloacal area.

Juveniles: Recently metamorphosed juveniles may lack the crossbars, instead having scattered light flecks to an irregular light mottling pattern on a brownish to blue black body.

Eggs: Eggs numbering from about 50 to 200 are laid singly by females under logs and rocks in moist shallow depressions where vernal pools will form with winter rains. The eggs are not encased in a gelatinous mass.

Larvae: Larvae are dark brown to grayish to tan in color without distinct markings on the dorsum. Venter is cream with tiny black peppering under the chin and around the fold of skin between the chin and abdomen. The peppering may be indistinct and best observed with a hand lens. A line of distinct white dots is present along each side in older larvae. The broad tail fin may be heavily mottled with dark pigment.

Distribution: Marine Corps Air Station Cherry Point and Marine Corps Base Camp Lejeune.

Seasonality: Males and females mate on the forest floor usually in September and October when surface conditions are wet. Females then deposit eggs under

moist logs in and along the inside margins of woodland pools and other ephemeral pools and remain with them until winter rains fill the depressions. Embryos hatch shortly after contact with water and the female then leaves the pool for her underground retreat in the forest. Eggs may be viable for several months in the nests. Larvae overwinter in the pool and metamorphose about May-June the following year. Adults and juveniles live underground in the forest outside of the breeding period but may be found occasionally under logs when the forest floor is wet.

Habitat: Adults prefer the floor of mature hardwood forests in the mid-Atlantic area where they live in rodent burrows, decayed root channels, and other pockets beneath the surface. They occur in pine flatwoods in the South, and likely in the following habitats in eastern North Carolina: hardwoods, mixed hardwood and pine, pine flatwoods, long leaf pine stands, and pocosins. Fields and some disturbed areas with patches of forest and wetland pools remaining may support this species.

Identification notes: The adults are unique with their stocky bodies and light-colored crossbars. The light stippling under the chin and the chunky body shape should separate the larvae of this species from other salamander larvae.

Southern Dusky Salamander (*Desmognathus auriculatus*)

Adults: This is a brown to black salamander reaching a total length of about 160 mm. There are 1-2 rows of white spots along each side. A light line occurs between the eye and the rear margin of the jaw on each side. The venter is gray brown to black and may have tiny white speckling. The tail is flattened laterally and has a prominent keel, especially posteriorly.

Sexual dimorphism: Males reach larger sizes (to 65 mm snout-vent length) than females (to 55 mm), but are difficult to distinguish except internally. Females may have papillae inside the cloaca; males lack them.

Juveniles: Similar to adults in color and pattern.

Larvae: Gilled larvae are dusky brown to black and have small, pale dorsal spots, and may reach 32 mm snout-vent length. They have unique darkly pigmented gills.

Distribution: Dare County Bombing Range, Marine Corps Air Station Cherry Point, and Marine Corps Base Camp Lejeune. This species was not found during the FY 99-01 survey.

Seasonality: Females lay 9-36 eggs in the fall. Nests have been found from late August to November. Adults may be active in all months in aquatic habitats. Little is known of the seasonal ecology of this species.

Habitat: Southern Dusky Salamanders usually occur in slow-moving bodies of water, such as coastal streams. They have been found in springs, swamps, canals, and pools in riparian zones. Habitats containing such wetlands in the region include hardwoods, mixed hardwood and pine, pine flatwoods, long leaf pine stands, and possibly pocosins.

Identification notes: The light eye-jaw stripe will distinguish this salamander from all others in the region.

Southern Two-lined Salamander (*Eurycea cirrigera*)

Adults: This is a slender yellow to greenish-yellow salamander (maximum total length to 4 5/16 inches [110 mm]) with two dark brown stripes that border a broad yellowish to brownish stripe on the back. The broad light stripe along the back is usually peppered with black dots of varying densities. In some individuals, there may be a thin dark line down the center of the back and in others the back is dark. The venter is plain yellow to cream in color and translucent; internal organs are clearly visible. There are 14 costal grooves.

Sexual dimorphism: Males in some populations possess well-developed projections (cirri) downward from the nostrils. Enlarged ova are usually visible through the ventral wall in fully gravid females.

Juveniles: Similar to adult in color and pattern.

Eggs: Fewer than 100 eggs are deposited by females under rocks, among root masses and vegetation, and under leaves and other objects under water in flowing streams.

Larvae: Two-lined salamander larvae are elongated and streamlined. The anterior martin of the tail fin occurs behind the rear legs. Body color is gray to light brown with a variable mottling pattern, the venter is cream in color, and the tail fin is variously mottled.

Distribution: Marine Corps Base Camp Lejeune and possibly Cherry Point Marine Corps Air Station.

Seasonality: Although this salamander can be found in most months of the year, it is most commonly encountered in spring and fall. Females lay their eggs in April and May. Hatching occurs one to two months later and the larvae metamorphose in 1-2 years.

Habitat: The margins of creeks and swamps are used extensively by this salamander. Adults may venture far into the adjacent forest during wet periods where they can be found under logs and other surface objects.

Identification notes: The yellow coloration distinguishes this species from all other salamanders in this region. The larvae differ from other streamside species by the lack of a definable pattern on the body and tail. The gills on the larvae are longer than those in Southern Dusky larvae.

Dwarf Salamander (*Eurycea quadridigitata*)

Adults: This is a small, slender salamander with four toes on each limb (most salamanders have 5 on the rear feet) and a short snout. Dorsal color is brownish yellow to bronze with a dark dorsolateral stripe on each side. A middorsal row of small dark spots may be present. The venter is yellow to silver gray. The tail is squarish in cross-section, keeled, and long (45-60% of total length).

Sexual dimorphism: Mature males have cirri during the reproductive season; females lack them.

Juveniles: Similar to adults in color and pattern.

Larvae: Gilled larvae are small, dark, with tail fins slightly shorter than the width of the tail musculature. The anterior margin of the dorsal fin is about at midbody.

Distribution: Dare County Bombing Range, Marine Corps Air Station Cherry Point, and Marine Corps Base Camp Lejeune. This species was not encountered during the FY 99-01 survey.

Seasonality: Females lay up to 42 eggs in fall and winter in seepage areas or edges of shallow ponds. Eggs are attached singly to vegetation. They may be active all year in this microhabitat. Larvae transform into 2-6 months after hatching during April-July.

Habitat: Low swampy areas in a variety of habitats, including hardwoods, mixed hardwood and pine, pine flatwoods, and long leaf pine stands. They may be found beneath objects along the margins of swamps, ponds, lime sinks, and springs.

Identification notes: The presence of only 4 toes on the hind feet will distinguish this species from the Southern Two-lined Salamander.

Atlantic Coast Slimy Salamander (*Plethodon chlorobryonis*)

Adults: Adult slimy salamanders reach a maximum length of 6 ¾ inches (172 mm). They are chiefly black with numerous silvery white spots or brassy flecks that are mostly confined to the sides. The venter is usually lighter in color than the dorsum. There are normally 16 costal grooves. In some individuals there may be few or no spots or flecking, resulting in a largely plain black or dark gray salamander.

Sexual dimorphism: Adult males possess a mental (hedonic) gland on the anterior portion of their chins during the breeding season. Females lack them.

Juveniles: Colored and patterned like adults.

Eggs: Females deposit small clutches of about 10-20 eggs inside rotten logs, damp leaf litter or similar places. Metamorphosis takes place completely within the egg, there is no free-living larval stage.

Seasonality: Slimy salamanders breed in the fall and also perhaps in late winter and early spring. Adults can be found most commonly during these

periods, but they may be encountered during any month of the year during suitable weather conditions.

Habitat: Adults can be found in hardwood and mixed forest under logs, trash, piles of leaf litter and other debris, provided that they provide suitable moisture. Habitats include hardwoods, mixed hardwood and pine, pine flatwoods, long leaf pine stands, and pocosins. Salamanders frequently move about during rainy nights to forage. Juveniles are found in the same microhabitats. During summer, these salamanders go deeper underground.

Identification notes: The combination of white or brassy markings on a black or dark gray background will serve to distinguish this salamander from all others in the region.

Dwarf Waterdog (*Necturus punctatus*)

Adults: These are completely aquatic salamanders with external gills, elongated bodies, and a paddle-like tail, reaching about 190 mm total length. The dorsum is dark brown to dark olive in color with numerous black spots with irregular edges. The spotting fades in adult specimens as increasing melanism obscures them, although spotting remains visible on the tail. The snout is blunt and somewhat squared off. The venter is white. The rear feet have four toes.

Sexual dimorphism: The cloacal lips of males swell during the reproductive season, and there are two papillae that point posteriorly. Females lack the swelling and papillae.

Juveniles: Colored and patterned as adults.

Larvae: Hatchlings and small larvae are uniformly brown, with mottled fins, and bluish white venters. Those larger than 50 mm snout-vent length are similar to adults in color and pattern.

Distribution: Dare County Bombing Range, Marine Corps Air Station Cherry Point, and Marine Corps Base Camp Lejeune. This species was not encountered in the FY 99-01 survey. There are several records near the North Carolina coast (Dundee, 1998), suggesting that this species may occur on one of these bases.

Seasonality: Little is known about the ecology of this species. Mating apparently occurs in winter and females lay 20-40 eggs in spring. They are likely active year-round in the water.

Habitat: These salamanders live in streams and rivers of the southeastern Coastal Plain. They are sometimes found in leaf packs in the slow backwaters of these streams.

Identification notes: The large feathery gills, gray body, and paddle-like tail will distinguish this aquatic salamander from others in this area.

Broken-striped Newt (*Notophthalmus viridescens dorsalis*)

Adults: Mature adult newts are yellowish brown, olive green, or dark olive brown above with a black-bordered red dorsal stripe that is broken in at least one or two places on the head and trunk. The venter is yellow with black flecks. Maximum total length is 3.2 inches (95 mm). A narrow dark line passes from the snout through the eye to the neck on each side of the head. The skin is rough, not smooth as in other salamanders.

Sexual dimorphism: In males, the tail fin is substantially higher (wider) than that of females, and males possess black toe tips and a line of raised black patches on the inside of the thighs. Females lack the black toe tips and black line inside the thighs. These sexually dimorphic features are most pronounced in the breeding season.

Juveniles: The immature stage of this salamander (eft) is fully terrestrial and brightly colored. Body color ranges from red to orange to yellowish. The broken stripe is not as strongly bordered by black as it is in adults. The bright color signals a warning to potential predators that the glands in the skin produce a toxic mucous. Efts metamorphose into adults in three to seven years.

Eggs: Females lay about 200-300 eggs and wraps each one in a leaf or blade of aquatic vegetation.

Larvae: The larvae of this salamander are light brown to yellowish-green in color with a dark line from the snout through the eye to the neck on each side. The dorsal tail fin extends onto the back. The legs are longer than any

of the other larval salamanders in the area and appear somewhat spindly. The larvae metamorphose into the eft stage.

Distribution: Dare County Bombing Range, Marine Corps Air Station Cherry Point and Marine Corps Base Camp Lejeune.

Seasonality: Adults remain in the aquatic habitat year round unless the pond dries up. If that happens, adult newts will seek shelter under debris in the dried pond or in the nearby forest. The extended breeding season lasts from about March through June. Larvae are present June through November.

Habitat: Many types of freshwater wetlands are used by adults and larvae this salamander, including beaver ponds, farm ponds, road rut puddles, woodland pools, water-filled depressions in old fields, and pools in riparian areas. Fish may or may not be present. Efts wander widely in the forest from their home pool or pond, and may disperse as far as a half mile. Mature hardwood forest is the optimal habitat for efts, although they occur in several habitats in this region, including hardwoods, mixed hardwood and pine, pine flatwoods, long leaf pine stands, and pocosins.

Identification notes: No other salamander in this region has the rough skin, green body color, and broken red lines on the back. Pay attention to the dark stripe on the side of the head of larvae that passes horizontally through the eye. Head stripes on other salamander larvae do not pass through the eye.

Eastern Mud Salamander (*Pseudotriton montanus montanus*)

Adults: Adults are yellowish red to reddish brown and reach a maximum total length of about 6.5 inches (165 mm). The snout is short, usually the length is about the diameter of the eye. The eye is brown. Several scattered, distinct black spots occur on the back. The venter is pale salmon in color with dark spots. Old adults may be purplish with obscure spotting on the back. The margin of the chin may be lined with black flecks.

Sexual dimorphism: Females are slightly larger than males but there are no obvious differences between the sexes externally.

Juveniles: Colored and patterned as adults but brighter.

Eggs: Females lay about 30-130 eggs following courtship and mating in summer. Eggs are laid deep underground attached to vegetation in seepage areas and springs.

Larvae: The larvae are robust but are elongated and have a paddle-like tail. They are dark brown to reddish brown in color with indistinct black spotting on the dorsum. The tail fins have a variable amount of mottling and the venter is pale white without a pattern.

Distribution: Marine Corps Base Camp Lejeune and possibly Cherry Point Marine Corps Air Station.

Seasonality: Mud salamanders spend winters deep in seepages and springs. They emerge about March or April usually remain in seepage zones. Although they move into adjacent forests, they do not disperse widely in terrestrial habitats. Females move back to springs and seepages in late summer and lay eggs in the fall months. The larval stage lasts for 2-3 years, and metamorphosis occurs in summer.

Habitat: Adults may be found in early spring and fall in seepages, springs, and margins of swamps. In late spring, summer, and early fall adults may be found under logs in moist soil in hardwood or mixed forests. The combination of springs or seepages and forest is essential habitat for this species.

Identification notes: The reddish coloration, short snout, distinct black spots on the back, and the brown eyes will distinguish this species from other salamanders.

Many-lined Salamander (*Stereochilus marginatus*)

Adults: Many-lined salamanders are yellowish to dull brown in overall coloration. The sides of the body have a series of indistinct, dark, longitudinal lines which may be broken in numerous places, forming only a few dark spots. The venter is yellowish in color with scattered dark specks. The head is noticeably small and the tail conspicuously short.

Sexual dimorphism: There is no obvious sexual dimorphism in this species. Enlarged ova in females may be visible through the ventral skin.

Juveniles: Colored and patterned like the adults.

Eggs: Eggs are laid in clumps of sphagnum moss or other moist substrate at the edges of swamps and streams. Clutches normally number from 10 to 30.

Larvae: Larvae are normally light brown in coloration and possess external gills. They resemble those of the Southern Two-lined Salamander but with a relatively smaller head and shorter tail.

Distribution: Dare County Bombing Range, Marine Corps Air Station Cherry Point and Marine Corps Base Camp Lejeune.

Seasonality: Many-lined salamanders tend to be more active in the spring and fall. Breeding occurs in early spring. Larvae can be found May through July.

Habitat: Many-lined salamanders frequent shallow water at the edges of ponds, swamps, ditches, bays, and pocosins. They can sometimes be found under logs or other sheltering objects. Sphagnum moss is often part of the microhabitat. Larvae are aquatic and occur in the same microhabitats, seeking refuge among leaf litter and vegetation.

Identification notes: The presence of thin longitudinal lines along the sides, coupled with the relatively small head and short tail will serve to distinguish this salamander from others that may be encountered in the same habitat.

Two-toed Amphiuma (*Amphiuma means*)

Adults: This is a large eel-like salamander reaching a total length of 45 ¾ inches (760 mm). There are two pairs of tiny legs, each with two toes. The dorsum is dark brown to black and the venter is dark gray. There are no external gills.

Sexual dimorphism: The inside walls of the vent are sexually dimorphic. There is at least some melanistic coloration on the inside walls in females. Males lack any melanistic coloration.

Juveniles: Patterned and colored the same as adults.

Eggs: Amphiumas lay 50 to 200 eggs in long, relaxed strings which are then formed into a ball-like mass. The eggs are laid in depressions under logs, boards, or similar covering objects. Females remain with the eggs until they hatch, a period lasting up to 5 months.

Larvae: Larval amphiumas resemble adults except for the presence of small, feathery external gills. Transformation is fairly rapid in this species, occurring within 2-3 weeks of hatching.

Distribution: Dare County Bombing Range, Marine Corps Air Station Cherry Point, and Marine Corps Base Camp Lejeune.

Seasonality: Amphiumas can be found throughout the year. In this area they apparently breed in mid to late winter. They will aestivate in the mud in drying ponds by forming a cocoon with mucous and waiting until rains fill the pond again.

Habitat: Amphiumas frequent swamps, ponds, and streams, as well as such manmade habitats as ditches and impoundments. Within these habitats they inhabit piles of bottom debris and leaf beds, mats of vegetation, and holes in mud banks. They occasionally move short distances overland on rainy nights.

Identification notes: The lack of external gills, and the presence of two pairs of legs, each with only two toes, will distinguish this species from the Greater and Lesser Sirens.

Lesser Siren (*Siren intermedia*)

Adults: This fully aquatic salamander is similar to *S. lacertina* but smaller, reaching a maximum length of about 502 mm (19 ¾ inches). They are uniformly gray in color with large external gills and only one pair of legs, the forelegs. The rear legs are lacking completely. Number of costal grooves are 32-33, counting from the foreleg to the position of the cloaca.

Sexual dimorphism: The jaw muscles in males are enlarged, making the temporal region of the head appear swollen. Males are also slightly larger in size than females.

Juveniles: Similar to adults in color and pattern.

Larvae: Larval Lesser Sirens have a conspicuous dorsal fin, a short tail, and large, feathery gills anterior to the small forelegs. Body color is gray to dark gray. A broad, dark and sometimes inconspicuous band with a light streak down the middle occurs on each side. This band may be reddish in some individuals. The venter and middorsal region are lighter in color. Small individuals may have a reddish patch on the snout.

Distribution: Marine Corps Air Station Cherry Point and Marine Corps Base Camp Lejeune.

Seasonality: Little is known about the seasonal activities of this salamander. They are probably active from about March through November and may be inactive when the water is cold in winter. Nothing is known about their reproductive behavior or life history.

Habitat: Lesser Sirens inhabit streams and associated ponds that are choked with vegetation. Adults and larvae have been found in beaver ponds and marshy bottomlands of creeks.

Identification notes: Rely on costal groove counts to separate this species from Greater Sirens.

Greater Siren (*Siren lacertina*)

Adults: This is a large, fully aquatic salamander reaching a maximum length of over 700 mm (28 inches). They are uniformly gray in color with large external gills and only one pair of legs, the forelegs. The rear legs are lacking completely. The sides of the body are lighter in color than the dorsum and usually have pale green flecking or blotches. Number of costal grooves are 37-38, counting from the foreleg to the position of the cloaca.

Sexual dimorphism: The jaw muscles in males are enlarged, making the temporal region of the head appear swollen when compared to females of similar size.

Juveniles: Similar to adults in color and pattern.

Larvae: Larval greater sirens have a gray head and dorsum, a dorsal fin, and a light stripe along each side from the gills to the tail. This species lacks the reddish patch on the side of the head.

Distribution: Dare County Bombing Range, Marine Corps Air Station Cherry Point, and Marine Corps Base Camp Lejeune.

Seasonality: Unknown in this area but probably active year-round unless the water is near freezing.

Habitat: Greater sirens are known to inhabit streams with abundant vegetation.

Identification notes: This species is difficult to identify from Lesser Sirens, so costal groove counts are required to separate them.

Mabee's Salamander (Rusty Gaul)

Marbled Salamander (Joe Mitchell)

Southern Dusky Salamander (Rusty Gaul)

S. Two-lined Salamander (Joe Mitchell)

Dwarf Salamander (Rusty Gaul)

Atlantic Coast Slimy Salamander (Joe Mitchell)

Broken-striped Newt, adult (Joe Mitchell)

Broken-striped Newt, eft (immature) (Gaul)

Eastern Mud Salamander (Joe Mitchell)

Many-lined Salamander (Joe Mitchell)

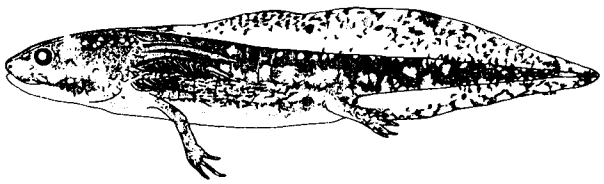
Two-toed Amphiuma (Rusty Gaul)

Two-toed Amphiuma (Joe Mitchell)

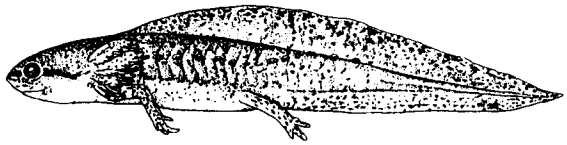
Lesser Siren (Joe Mitchell)

Dwarf Waterdog (from Roble et al., 1999)

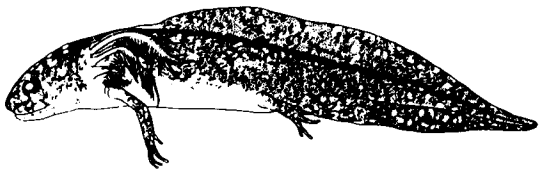
Salamander Larvae



Mabee's Salamander

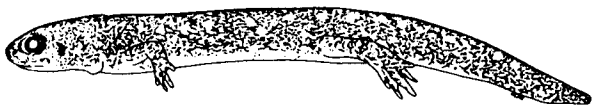


Broken-striped Newt



Marbled Salamander

Eastern Mud Salamander

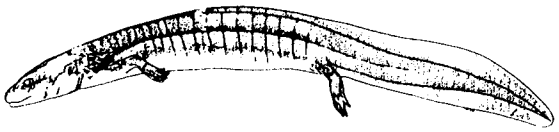


Southern Dusky Salamander

Many-lined Salamander

Southern Two-lined Salamander

Lesser Siren



Dwarf Waterdog

Acknowledgments

I thank the resource managers and wildlife biologists of the following installations for allowing access to the study areas and for their help with logistics: Scott Smith (Dare County Bombing Range), Bill Rogers (Cherry Point MCAS), and Carmen Lombardo (Camp Lejeune). Rusty Gaul assisted in many ways, including providing early drafts of some of the species accounts and several photographs. Trip Lamb provided the photograph of the southern chorus frog and Rusty Gaul loaned several frog and salamander photos. Artists Alison Schroeer and Molly Griffen skillfully executed the pen-and-ink drawings of the tadpoles and salamander larvae from preserved specimens. I am grateful to the staff of the Legacy Resource Management Program of DoD for their continued support of amphibian monitoring on military, especially Alison Dalsimer and Peter Boice.

Bibliographic Resources

Altig, R., R.W. McDiarmid, and K.A. Nichols. 1998. A key to the anuran larvae of the United States and Canada. Contemporary Herpetology 1 (on-line, URL: http:/vmsweb.selu.edu/~pcsd4805/)

Bishop, S. A. 1941. Salamanders of New York. New York State Museum Bulletin 324:1-365.

Bishop, S.A. 1943. Handbook of Salamanders. Cornell University Press, Ithaca, NY. 555 pp.

Conant, R., and J.T. Collins. 1998. A Field Guide to the Reptiles and Amphibians of Eastern and Central North America. Third edition, expanded. Houghton Mifflin, Co., Boston, MA. 612 pp.

Dodd, C.K., Jr. 1996. Use of terrestrial habitats by amphibians in the sandhill uplands of north-central Florida. Alytes 14:42-52.

Dodd, C.K., Jr. 1997. Imperiled amphibians: a historical perspective. Pp. 165-200 In G.W. Benx and D.E. Collins (eds.), Aquatic Fauna in Peril: The Southeastern Perspective. Special Publication 1. Southeast Aquatic Research Institute, Decatur, GA.

Green, D. M. (ed.).1997. Amphibians in Decline, Canadian Studies of a Global Problem. Herpetological Conservation, Number 1. Society for the Study of Amphibians and Reptiles. Saint Louis, MO. 338 pp.

Heyer, W.R., M.A. Donnelly, R.W. McDiarmid, L.C. Hayek, and M.S. Foster (eds.). 1994. Measuring and Monitoring Biological Diversity, Standard Methods for Amphibians. Smithsonian Institution Press, Washington, D.C.

Martof, B.S., W.M. Palmer, J.R. Bailey, and J.R. Harrison, III. 1980. Amphibians and Reptiles of the Carolinas and Virginia. University of North Carolina Press, Chapel Hill, NC. 264 pp.

Petranka, J.W. 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, DC. 586 pp.

Pfingsten, R.A., and F.L. Downs. Eds.1989. Salamanders of Ohio. Ohio State University, Columbus, OH. 315 pp + 29 plates.

Stebbins, R.C., and N.W. Cohen. 1995. A Natural History of Amphibians. Princeton University Press, Princeton, NJ. 316 pp.

Wright, A.H., and A.A. Wright. 1949. Handbook of the Frogs and Toads of the United States and Canada. Cornell University Press, Ithaca, NY. 640 pp.

Literature Cited

Altig, R., R. W. McDiarmid, and K. A. Nichols. 1998. A key to the anuran larvae of the United States and Canada. Contemporary Herpetology 1 (on-line, URL: http:/vmsweb.selu.edu/~pcsd4805/)

Bishop, S. A. 1943. Handbook of Salamanders. Cornell University Press, Ithaca, NY. 555 pp.

Broughton, R. G., J. Staiger, and R. Franz. 2000. Use of PVC pipe refugia as a sampling technique for hylid treefrogs. American Midland Naturalist 144:168-177.

Conant, R. and J. T. Collins. 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America. Third edition, expanded. Houghton Mifflin Co., Boston, MA. 612 pp.

Dodd, C. K., Jr. 1996. Use of terrestrial habitats by amphibians in the sandhill uplands of north-central Florida. Alytes 14:42-52.

Drost, C. A., and G. M. Fellers. 1996. Collapse of a regional frog fauna in the Yosemite area of the California Sierra Nevada, USA. Conservation Biology 10:414-425.

Dundee, H.A. 1998. *Necturus punctatus* (Gibbes). Catalogue of American Amphibians and Reptiles 663:1-5.

Freda, J. and W. A. Dunson. 1985. The effect of acid precipitation on amphibian breeding in temporary ponds in Pennsylvania. U.S. Fish and Wildlife Service, Eastern Energy and Land Use Team, Biological Report 80(40.22). 85 pp.

Freda, J., and W. A. Dunson. 1986. Effects of low pH and other chemical variables on the larval distributions of amphibians. Copeia 1986:454-466.

Grant, B. W., A. D. Tucker, J. E. Lovich, A. M. Mills, P. M. Dixon, and J. W. Gibbons. 1992. The use of coverboards in estimating patterns of reptile and amphibian biodiversity. Pp. 379-403 In D.R. McCullough and R. H. Barrett (eds.), Wildlife 2001. Elsevier Science Publishers, Inc., London, England.

Heyer, W. R., M. A. Donnelly, R. W. McDiarmid, L. C. Hayek, and M. S. Foster (eds.). 1994. Measuring and Monitoring Biological Diversity, Standard Methods for Amphibians. Smithsonian Institution Press, Washington, D.C. 364 pp.

Hopey, M. E., and J. W. Petranka. 1994. Restriction of wood frogs to fish-free habitats: how important is adult choice? Copeia 1994:1023-1025.

Lamb, T. and J.C. Avise. 1986. Directional introgression of mitochondrial DNA in a hybrid population of tree frogs: the influence of mating behavior. Proceedings of the National Academy of Science 83:2526-2530.

Laurance, W. F., K. R. McDonald, and R. Spears. 1996. Epidemic disease and the catastrophic decline of Australian rain forest frogs. Conservation Biology 10:406-413.

Lips, K. R. 1998. Decline of a tropical montane amphibian fauna. Conservation Biology 12:106-117.

Livermore, B. 1992. Amphibian alarm: just where have all the frogs gone? Smithsonian, October 1992:113-120.

Mitchell, J. C. 1996. Natural history notes on a recently extirpated suburban wetland in central Virginia. Banisteria 7:41-48.

Mitchell, J. C. 1998. Amphibian decline in the mid-Atlantic region: monitoring and management of a sensitive resource. Final Report for Year 2. Legacy Resource Management Program, US Department of Defense, Arlington, VA. 144 pp.

Mitchell, J.C. 2000. Monitoring and management of a sensitive resource: a landscape-level approach with amphibians. Final Report for FY 99. DoD Legacy Resource Management Program. Arlington, VA. 124 pp.

Mitchell, J.C. 2001. Monitoring and management of a sensitive resource: a landscape-level approach with amphibians. Final Report for FY 00. DoD Legacy Resource Management Program. Arlington, VA. 149 pp.

Mitchell, J.C. 2002. Monitoring and management of a sensitive resource: a landscape-level approach with amphibians. Final Report for FY 99. DoD Legacy Resource Management Program. Arlington, VA. (in final preparation).

Petranka, J. W. 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, DC. 586 pp.

Peterson, C. R., and M. E. Dorcas. 1994. Automated data acquisition. Pp. 47-57 In W.R. Heyer, M.A. Donnelly, R.W. McDiarmid, L.C. Hayek, and M.S. Foster (eds.). Measuring and Monitoring Biological Diversity, Standard Methods for Amphibians. Smithsonian Institution Press, Washington, D.C.

Pfingsten, R. A., and F. L. Downs. Eds.1989. Salamanders of Ohio. Ohio State University, Columbus, OH. 315 pp + 29 plates.

Phillips, K. 1990. Where have all the frogs and toads gone? Bioscience 40:422-424.

Phillips, K. 1994. Tracking the vanishing frogs. St. Martin's Press, New York, NY. 244 pp.

Roble, S.R., D.J. Stevenson, and C.S. Hobson. 1999. Distribution of the dwarf waterdog (*Necturus punctatus*) in Virginia, with comments on collecting techniques. Banisteria 14:39-44.

Tiner, R. W., Jr. 1987. Mid-Atlantic wetlands, a disappearing natural treasure. US Fish and Wildlife Service, Newton Corner, MA.

Wright, A. H., and A. A. Wright. 1949. Handbook of the Frogs and Toads of the United States and Canada. Cornell University Press, Ithaca, NY. 640 pp.

Wyman, R. L. 1988. Soil acidity and moisture and the distribution of amphibians in five forests of south-central New York. Copeia 1988:394-399.

Wyman, R. L. and D. S. Hawksley-Lescault. 1987. Soil acidity affects distribution, behavior, and physiology of the salamander *Plethodon cinereus*. Ecology 68:1819-1827.

Frog call identification tapes

The Calls of Frogs and Toads, NorthWord Press, Inc., P.O. Box 1360, Minocqua, WI 54548 (800-336-5666)

Voices of the Night, Library of Natural Sounds, Cornell Laboratory of Ornithology, 159 Sapsucker Woods Rd., Ithaca, NY 14850)

Sounds of North American Frogs. C.M. Bogart. Smithsonian Institution, Folkways Cassette Series 06166. (Center for Folklife Programs and Cultural Studies, 955 L'Enfant Plaza, Washington, D.C. 20560).

Appendix 1

Standardized List of Data to be Collected on Each Inventory and Monitoring Field Trip

This list is derived from Fellers and Freel (1995) and is intended to help field personnel keep in mind the list of data fields used for most inventory and monitoring studies.

Site - state, county, installation, specific site.
Date
Begin and end time
Total time
Observers
Locality - exact locations with map
Elevation
Topographic map name
Weather
Wind
Air temperature
Water temperature
Site description (habitat type, size)
Drainage (from topographic map; alterations)
Substrate type
Vegetation (description, canopy cover)
Species found (adults, juveniles, eggs, larvae)
Other species present (reptiles, fish, birds, mammals)
Individual data (sex, body size, tail length, weight)
If Aquatic habitat - maximum and average depth, water flow, turbidity, mid-day shade, emergent and floating vegetation, fish present?, fishing tackle present?)
Photographs taken (roll and frame numbers)

Appendix 2

Equipment Checklist

The list of supplies and equipment listed for each of the major types of methods described above is not exhaustive. You may find other items that suit your needs. Abbreviations: FC = frog call surveys, EM = egg mass surveys (including direct observation), and LV = larval surveys with dip nets and minnow traps, PVC = PVC pipe transects, and CB = coverboard transects.

Equipment checklist:	FC	EM	LV	PVC	CB
Collecting permit	x	x	x	x	x
Data forms with clipboard and pencil/pen	x	x	x	x	x
Cassette recorder, with extra batteries	x				
Microphone with switch	x				
Blank cassettes (60 min non-metallic)	x				
Watch with second hand or stopwatch	x				
Metric tape measure (50 m)	x	x	x	x	x
Headlamp and extra batteries	x	x			
Binoculars		x	x		
Pesola® scales	x	x	x	x	x
Waders	x	x	x		
Rainsuit	x	x	x	x	x
Dipnets		x	x		
Aquarium dipnets			x		
Spoons			x		
Plastic bags	x	x	x	x	x
Plastic metric rulers	x	x	x	x	x
Hand lens (10X)			x	x	x
Sling psychrometer	x	x	x	x	x
Thermometer (Celsius)	x	x	x	x	x
pH meter	x	x	x		
DO meter	x	x	x		
Minnow traps			x		
FrogLoggers*	x				
Flagging tape		x	x	x	x

Appendix 3

Sources of Equipment and Supplies

Vendors:

Forestry Suppliers, Inc., P.O. Box 8397, Jackson, MS 39284-8397 (800-647-5386) (clipboard with cover; thermometers (Celsius); Justrite headlamp - FS 02155; extra bulbs for headlamp; Pesola scales; tape measures; Rite-in-the-Rain copy paper; pH and DO meters)

Ben Meadows Co., 3589 Broad St., Atlanta, GA 30341 (800-241-6401) (clipboard with cover; thermometers (Celsius); Justrite headlamp -BM 130594; extra bulbs for headlamp; Pesola scales; tape measures; Rite-in-the-Rain copy paper)

Carolina Biological Supply, 2700 York Rd., Burlington, NC 27215 (800-334-5551) (ethanol, chloretone, field supplies)

Wards Natural Science Establishment, Inc., 5100 West Henreitta Rd., P.O. Box 92192, Rochester, NY 14692-9012 (800-962-2660) (dipnet, D-frame - 10W0620; extra dipnet bags - 10W0625)

Diagger and Company, Inc., 199 Carpenter Ave., Wheeling, IL 60090 (800-621-7193; FAX 800-320-7200). (Nalgene™ water sample bottles)

University Products, Inc., PO Box 101, 517 Main St., Holyoke, MA 01041 (800-628-1912) (100% rag, 28 lb, 8.5x11 inch paper, 100 sheets)

Fisher Scientific, 52 Fadem Road, Springfield, NJ 07081 (800-766-7000) (formaldehyde, 37% stock solution)

Bass Pro Shops, 2500 East Kearney, Springfield, MO 65898-0123. (800-227-7776) (minnow traps, waders)

Local = local sources (plastic bags, quart size; spoons; pens/pencils; cassette recorder with external microphone on cord; cassette tapes; batteries for cassette player; batteries for headlamp; magic markers (black); Styrofoam boxes for shipping water bottles; shipping tape; box for specimen jars)

Appendix 4

Example Field Data Sheets

1. Frog Call Data Sheet
2. Dipnet and Minnow Trap Data Sheet
3. Terrestrial Transect Data Sheet
4. PVC Pipe Transect Data Sheet

LECACY PROJECT - JOSEPH C. MITCHELL, PRINCIPLE INVESTIGATOR

FROG CALL DATA SHEET

Date _____ Location: Dare Cherry Pt. Lejeune Site _____

Observers _____ Begin time _____ End time _____

Air temp _____ Water temp _____ Tape number _____

Weather (circle all that apply) clear cloudy pcloudy rain drizzle fog thunderstm

Species	Chorus size	Notes	Other species observed
Acris gryllus			
Bufo fowleri			
Bufo terrestris			
Bufo quercicus			
Hyla cinerea			
Hyla chrysoscelis			
Hyla femoralis			
Hyla gratiosa			
Hyla squirella			
Gast carolinensis			
Pseud crucifer			
Pseud nigrita			
Pseud ornata			
Pseud ocularis			
Rana areolata			
Rana catesbeiana			
Rana clamitans			
Rana palustris			
Rana sphenocephala			
Rana virgatipes			
Scaph holbrookii			

Chorus size: 1 - single male; 2 - individuals can be counted (>2); 3 - individuals cannot be distinguished but not full chorus; 4 - full chorus

Tape session: record for 10 minutes before observation session

LEGACY HERP PROJECT - JOSEPH C. MITCHELL, PRINCIPLE INVESTIGATOR

DIPNET AND MINNOW TRAP DATA SHEET

Collection No. _____ Date (d/mo/yr) _____ Location: Dare Cherry Pt Camp Lejeune (circle 1)

Start time _____ End time _____ Observers _____ Dip/Trap No _____ Toe clip no. ____

Habitat _____ Weather: (circle) clear cloudy pcloudy rain drizzle fog **Air Temp** _____

frogs *lizard/snake*

trap, dip/#	Species	sex	SVL	Tail Lth	Total Lth	Wt.	Eye dia	Tymp dia	HW	HL	Toe no.	Notes (incl developmental stage)

Notes: behavior, abnormalities, coloration, gravid, # eggs palped, mental gland, recapture; **1 line per individual**

Sex: Male, Female, Juvenile, Metamorph; **Tail lgh**: original + regenerated; **EyeD**: frogs & snakes

LEGACY HERP PROJECT - JOSEPH C. MITCHELL, PRINCIPLE INVESTIGATOR

TERRESTRIAL TRANSECT DATA SHEET

Collection No. _____ Date (d/mo/yr) _____ Location: Dare Cherry Pt Camp Lejeune (circle 1)

Start time _____ End time _____ Observers _____ Transect No _____ Toe clip no. ____

Habitat _____ Weather: (circle) clear cloudy pcloudy rain drizzle fog **Air Temp** _____

frogs *lizard/snake*

cover bd no	P/T	Species	sex	SVL	Tail Lth	Total Lth	Wt.	Eye dia	Tymp dia	HW	HL	Toe no.	Notes

Notes: behavior, abnormalities, coloration, gravid, # eggs palped, mental gland, recapture; **1 line per individual**
Sex: Male, Female, Juvenile, Metamorph; **Tail lgh**: original + regenerated; **EyeD**: frogs & snakes; **P/T**: pine/tin

Coverboards without herps (list numbers) _____ Pg ____ of ____

LEGACY HERP PROJECT - JOSEPH C. MITCHELL, PRINCIPLE INVESTIGATOR

PCV PIPE TRANSECT DATA SHEET

Collection No. _____ Date (d/mo/yr) _____ Location: Dare Cherry Pt Camp Lejeune (circle 1)

Start time _____ End time _____ Observers _____ Transect No _____ Toe clip no. ____

Habitat _____ Weather: (circle) clear cloudy pcloudy rain drizzle fog **Air Temp** _____

frogs *lizard/snake*

Pipe no.	Species	sex	SVL	Tail Lth	Total Lth	Wt.	Eye dia	Tymp dia	HW	HL	Toe no.	Notes

Notes: behavior, abnormalities, coloration, gravid, # eggs palped, mental gland, recapture; **1 line per individual**
Sex: Male, Female, Juvenile, Metamorph; **Tail lgh**: original + regenerated; **EyeD**: frogs & snakes

PCB pipes without herps (list numbers) _____ Pg ____ of ____