Herpetological Inventory of the Great Falls Bypassed Reaches, South Carolina

By Michael E. Dorcas

14 March 2005

Herpetology Laboratory
Department of Biology
Davidson College

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Purpose

This report details the efforts and results of field activities conducted during 2004 and 2005 to assess the status of amphibians and reptiles within the Great Falls Bypassed Reaches of the Catawba River in South Carolina as part of the relicensing effort for the Duke Power-Catawba/Wateree Project.

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Cover Photograph

Plain-bellied watersnake (*Nerodia erythrogaster*) photographed at the Great Falls Long Bypassed Reach, South Carolina by E. Pierson Hill, September 2004.

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TABLE OF CONTENTS

INTRODUCTION

The southeastern United States is the stronghold of amphibians and reptiles (herpetofauna) in the United States and Canada. Of the more than 450 U.S. herpetofaunal species, approximately half occur in the Southeast and about 20% are endemic (Gibbons 1993, Palmer and Braswell 1995, Conant and Collins 1998). Amphibians and reptiles represent a significant component of the native biodiversity in virtually every natural terrestrial and freshwater habitat in the southeastern geographic region. Hence, the status of herpetofauna is likely to reveal the environmental well-being of a habitat as well as the consequences of habitat destruction or other forms of environmental degradation (Gibbons 1988, Knutson et al. 1999, Vitt et al. 1990).

Despite their prevalence, amphibians and reptiles are vital, albeit often overlooked, components of southeastern ecosystems. They can serve important roles as both predators and prey (Gibbons and Dorcas 2004, Taylor et al. 1988), thus forming critical trophic links in many ecosystems. Additionally, because amphibians and reptiles are ectotherms with high energy conversion efficiencies, the biomass of many populations can far exceed that of endotherms (e.g., mammals and birds; Burton and Likens 1975, Congdon and Gibbons 1989, Godley 1980, Iverson 1982, Petranka and Murray 2001). Because of their life history characteristics and their functional roles in natural communities, the herpetofauna

Copperheads (*Agkistrodon contortix*) are extremely efficient predators.

collectively can serve as indicators of environmental integrity (Gibbons et al. 2000); hence, comprehensive accounts of regional species composition and diversity are fundamental to initiating meaningful monitoring or research programs applicable to conservation issues.

Inventories to develop species lists at prescribed locations for particular taxonomic groups are vital to assessment of an areas' ecological integrity and typically precede monitoring efforts or in-depth research on populations and communities. Confirmed species lists at a specific site can enhance and give direction to conservation efforts and land management initiatives. The determination of species richness and diversity is the first step in evaluating status and trends of species in a prescribed area.

Unfortunately, knowledge of the herpetofaunal diversity and distribution in many areas of the Southeast is still lacking. One such region is the majority of the state of South Carolina. Except for intensive, long-term surveys of a few areas (e.g., the Savannah River Site), little documentation of the distribution of herpetofauna in South Carolina is available. Nevertheless, there are certain areas in the state that are likely to harbor high herpetofaunal diversities and abundances. One such area includes the Great Falls Bypassed Reaches. Because it is situated only slightly north of the juncture of the Piedmont and Upper Coastal Plain, this area is likely to harbor herpetofauna characteristically found in the Piedmont, but may include some species typically associated with Coastal Plain environments. Duke Power is required by the federal government to relicense the Catawba-Wateree Project, which includes the Great Falls Bypassed Reaches along the Catawba River. The intent of relicensing is to resolve impacts related to operation of hydroelectric facilities and one of the issues that must be addressed are the potential impacts on wildlife habitat affected by the hydro project.

In this study, we use extensive field surveys to document the diversity of amphibians and reptiles in the Great Falls Bypassed Reaches of the Catawba River in South Carolina.

Specific Objectives

1. Provide a list of amphibians and reptiles potentially occurring in the Great Falls Bypassed Reaches and the zone of operational influence.
2. Document the amphibian and reptile species inhabiting the Great Falls Bypassed Reaches, including any rare, threatened, or endangered species.
3. Estimated relative abundances of species and groups of species in the Great Falls Bypassed Reaches.
4. Discuss impacts related to more regular flooding.

METHODS

Study Site

The Great Falls Bypassed Reaches are situated along the Catawba River near the town of Great Falls, Chester County, SC (Fig. 1). The Great Falls Long Bypassed Reach is immediately downstream of the Fishing Creek Dam and was created in 1907 by the building of the Great Falls Diversion Dam (Fig. 2). The purpose of the diversion dam is to divert water through a canal west of Mountain Island for hydroelectric generation at the Great Falls and Dearborn stations. The Long Bypassed Reach consists of approximately 2.25 mi (3.2 km) of old riverbed and nearby upland habitats. The Short

Bypassed Reach, which was not studied in 2004 but will be evaluated several times in 2005 to determine if the herpetofaunal community differs from that in the Long Bypassed Reach, is 0.75 mi (1.2 km) long.

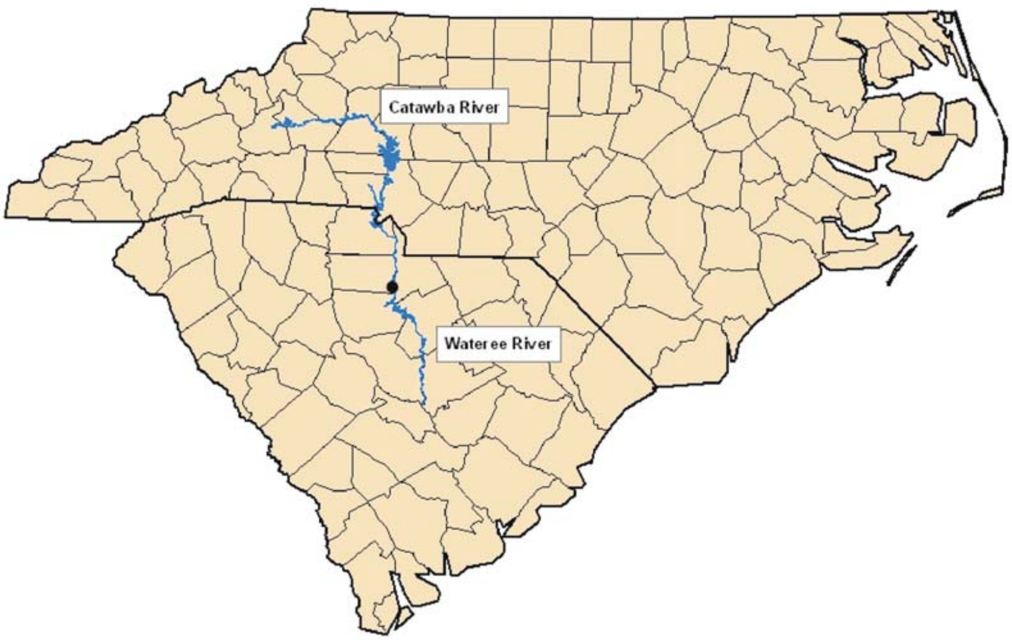


Figure 1. Location of the Great Falls Bypassed Reaches (black dot) along the Catawba River near the junction of Lancaster, Fairfield, and Chester Counties, SC.

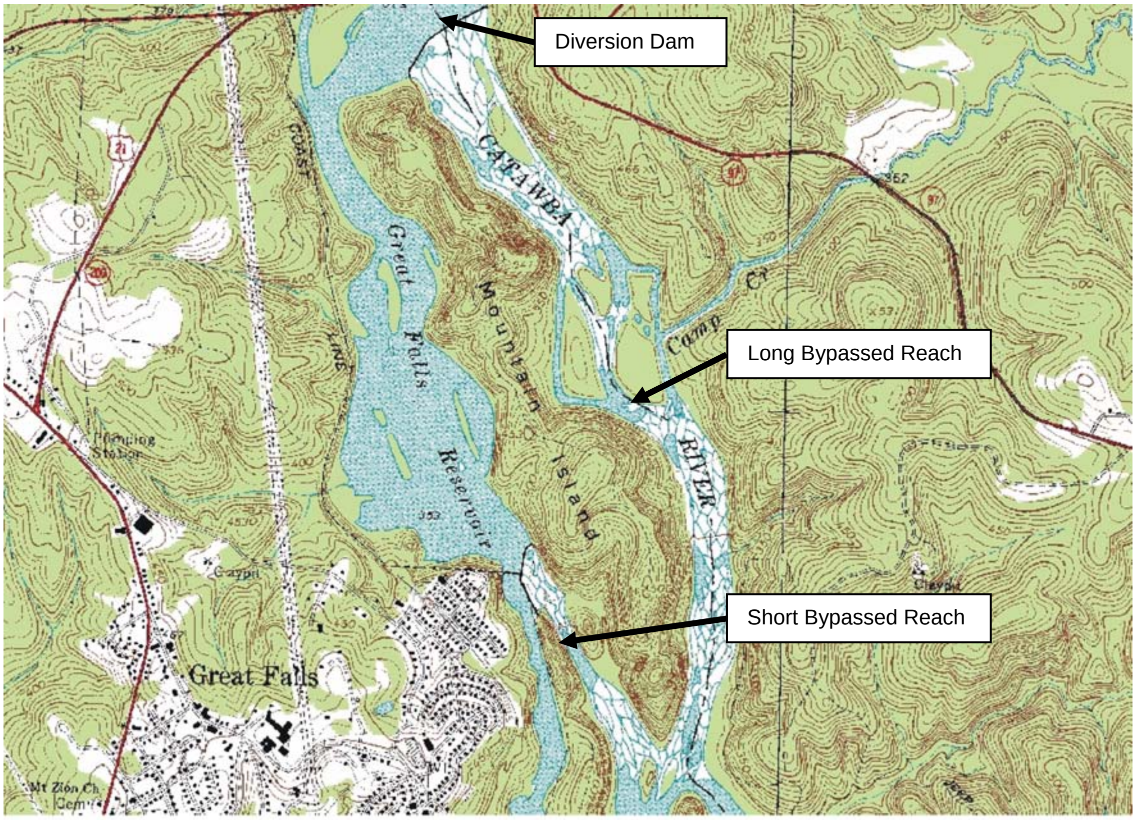


Figure 2. Topographic map of Great Falls Bypassed Reaches. Note the numerous small wetlands and pools present throughout the Reaches.

Numerous habitats exist within the study area. Upland habitats include pine, hardwood and mixed pine-hardwood forests on the islands and hillsides on either side of the study area. Forested habitats on the eastern side tend to be drier than those on the western side of the study area. One major stream (Camp Creek) enters the Long Bypassed Reach and provides considerable water flow along the

Small pools are abundant within the study area.

eastern side of the study area for approximately 1.8 km. Numerous seeps provide other aquatic habitats throughout the study area.

Periodic flooding over the Diversion Dam also provides water to aquatic habitats during high water events. As a consequence of the periodic flooding and the terrain, numerous wetlands and ponds can be found throughout the study area. Some of these are found in upland habitats that apparently were not part of the old riverbed. Most are found throughout the old riverbed with some being ephemeral and others apparently permanent.

Permanent ponds such as this one are home to several turtle species.

Potential Species Lists

Prior to initiating field surveys, a list of within-range species for the study area was generated based on geographic distribution maps published by Conant and Collins (1998). Unfortunately, there are no publications or documents that provide detailed distribution records for amphibians and reptiles in South Carolina. Consequently, we requested all amphibian and reptile records for Chester, Lancaster, and Fairfield counties in South Carolina from 34 museums, universities, and other appropriate organizations (Appendix 1) to assist in developing a more accurate potential species list.

Sampling Methods

We sampled from 3 to 6 days per month from March through June 2004 and then sampled 2 additional days during September 2004 (Table 1). Sampling was not conducted during July and August because many amphibians and reptiles become inactive, and thus difficult to find, during this time.

Table 1. Sampling effort from March to September 2004.

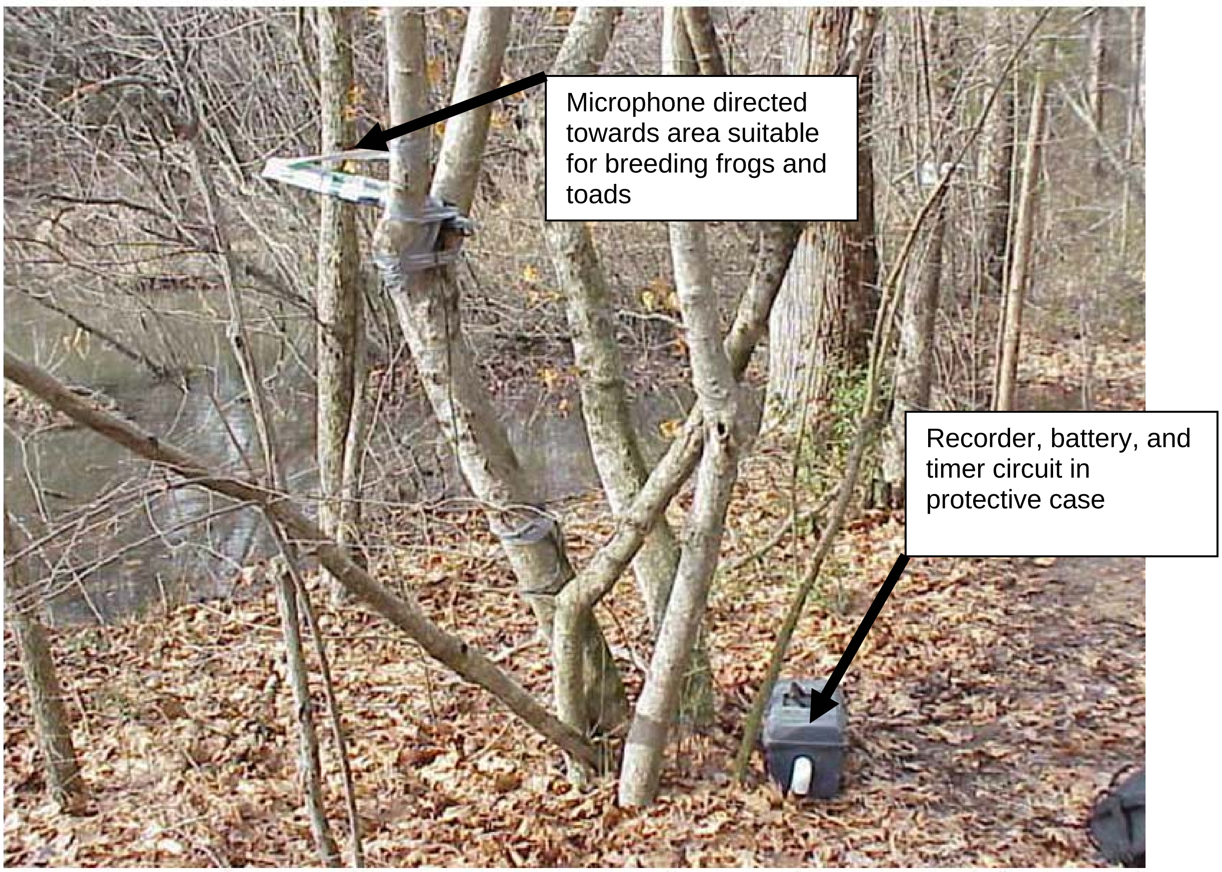
Month	**Total Days**	**Total Person Days**	**Automated Recorders (recorder days*)**
March	4	48	14
April	6	84	40
May	5	60	14
June	3	33	0
September	2	14	0
Total Sampling Effort	**20**	**239**	**68**

* a "recorder day" is defined as the number of recorders times the number of days they were deployed.

In general, we sampled during the daytime, but on several occasions when weather conditions were favorable for calling anurans, we sampled at night. During the spring of 2005, we anticipate sampling for an additional 3-4 days to assess the impacts of heavy flooding that occurred as a result of hurricane events during September 2004.


Investigator checking a turtle trap.

We conducted intensive sampling at 7 aquatic sites within the study area (Fig. 3). These sites were selected because they were representative of the various types of aquatic habitats present in the study area. At these sites, we used combinations of automated recording systems (Peterson and Dorcas 1994, Bridges and Dorcas 2000), systematic dipnetting, minnow traps, and turtle traps baited with sardines to sample amphibians and reptiles intensively. In addition to intensive sampling at these sites, we extensively sampled the rest of the study area using general herpetological collecting techniques including turning over cover objects, systematic searching in favorable habitats, dipnetting, and anuran calling surveys.



Automated recording systems were used in sampling frogs and toads at the Great Falls Long Bypassed Reach. Such systems use a timer system to periodically record animal calls and can be used to monitor calling animals when investigators cannot present be present.

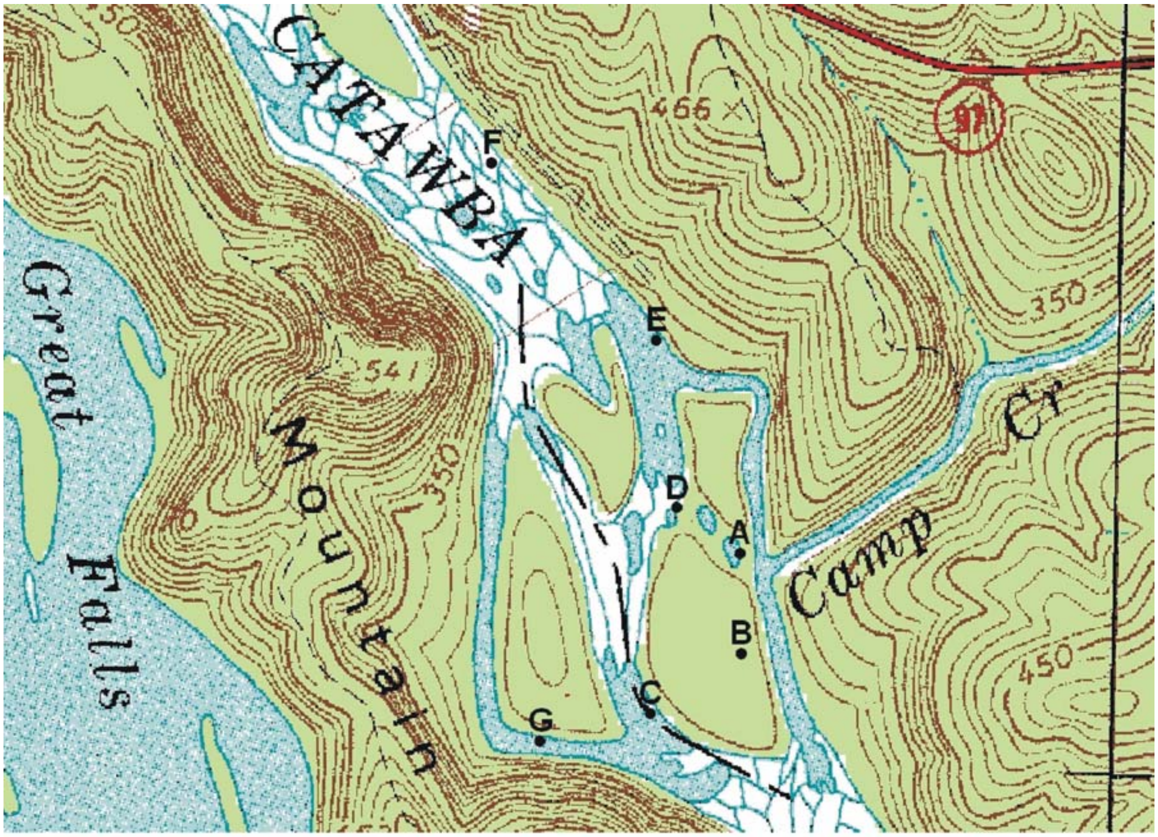


Figure 3. Topographic map of the Great Falls Long Bypassed Reach indicating the 7 sites selected for intensive sampling of herpetofauna.

For each species encountered, we recorded the species name, sampling technique used, GPS coordinates (NAD 1983 UTM Zone 17N), number of individuals, and sampling site (if appropriate). Additionally, we recorded comments such as behavior, size, reproductive condition, etc. We recorded basic weather conditions for each day sampled. To increase our sampling efficiency, we did not record all individuals encountered for some extremely abundant species (e.g., cricket frogs, anoles) when we encountered these species in areas where they were already documented. However, snake and turtle observations were always recorded. All data were entered into a database and incorporated into a GIS (ArcGIS 8.3, ERSI, Redlands, CA) to evaluate distributions in relation to geographic features. A single map representing all recorded combined herpetofaunal localities is presented in Figure 4. We considered species abundant if 8 or more observations were recorded, common if 3-7 observations were

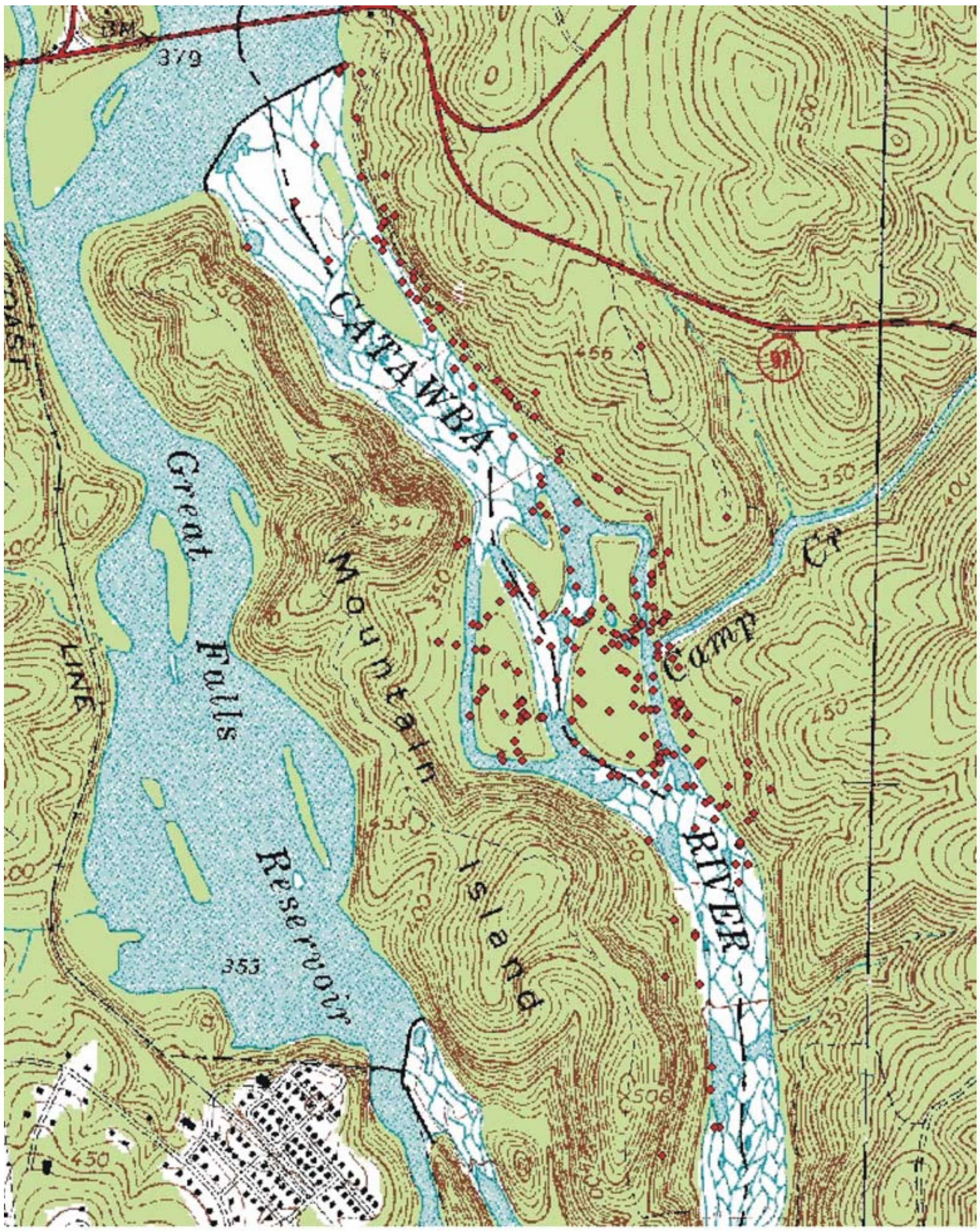


Figure 4. All locations (red dots) where amphibian and reptile localities were recorded in the Great Falls Long Bypassed Reach during 2004.

recorded, somewhat rare if the species was documented only twice, and rare if only one observation was made.

When possible, we documented all species using digital photography in order to allow for identification to species. For calling anurans, digital recordings were made when possible. For some species (anuran tadpoles, salamander larvae) we collected a limited number of voucher specimens. All voucher specimens were deposited in the North Carolina Museum of Natural Sciences.

RESULTS AND DISCUSSION

Based on published distributions, other documents, and specimen records, we determined that 19 anurans, 17 salamanders, 8 turtles, 9 lizards, and 32 species of snakes potentially occurred within the study area (Tables 2 and 3). We documented 12 species of anurans, 6 salamanders, 7 turtles, 6 lizards and 11 snake species (Tables 2 and 3; Fig. 4). Like most surveys, the number of total documented species increased sharply then leveled off over time (Fig. 5). Note that some of the undocumented species potentially occurring in the Great Falls Bypassed Reaches (e.g., sirens, four-toed salamanders) are less likely to actually occur there than other undocumented species (e.g., eastern hognose snakes) due a lack of suitable habitat.

Marbled salamander (*Ambystoma opacum*)

Table 2. Potentially occurring and documented amphibians of the Great Falls Bypassed Reaches.

Scientific name	Common name	Status
Acris crepitans	Northern Cricket Frog	Potential**
Acris gryllus	Southern Cricket Frog	Documented
Bufo americanus	American Toad	Documented
Bufo terrestris	Southern Toad	Potential
Bufo fowleri	Fowler's Toad	Documented
Gastrophryne carolinensis	Eastern Narrowmouth Toad	Documented
Hyla chrysoscelis	Cope's Gray Treefrog	Documented
Hyla cinerea	Green Treefrog	Documented
Hyla femoralis	Pine Woods Treefrog	Potential
Hyla squirella	Squirrel Treefrog	Documented
Hyla versicolor	Gray Treefrog	Potential
Pseudacris crucifer	Spring Peeper	Documented
Pseudacris feriarum	Upland Chorus Frog	Documented
Pseudacris ornata	Ornate Chorus Frog	Potential
Rana catesbeiana	Bullfrog	Documented
Rana clamitans	Green Frog	Documented
Rana palustris	Pickerel Frog	Potential**
Rana sphenocephala	Southern Leopard Frog	Documented
Scaphiopus holbrookii	Eastern Spadefoot Toad	Potential
Ambystoma maculatum	Spotted Salamander	Documented
Ambystoma opacum	Marbled Salamander	Documented
Ambystoma tigrinum	Eastern Tiger Salamander	Potential***
Amphiuma means	Two-toed Amphiuma	Potential
Desmognathus auriculatus	Southern Dusky Salamander	Potential
Desmognathus fuscus	Northern Dusky Salamander	Documented
Eurycea cirrigera	Southern Two-lined Salamander	Documented
Eurycea guttolineata	Three-lined Salamander	Documented
Eurycea quadridigitata	Dwarf Salamander	Potential
Hemidactylium scutatum	Four-toed Salamander	Potential*
Necturus punctatus	Dwarf Mudpuppy	Potential
Notophthalmus viridescens	Red Spotted Newt	Potential
Plethodon cylindraceus	White-spotted Slimy Salamander	Documented
Pseudotriton montanus	Mud Salamander	Potential
Pseudotriton ruber	Red Salamander	Potential
Siren intermedia	Lesser Siren	Potential
Siren lacertina	Greater Siren	Potential

*** Denotes Species of Special Concern in North Carolina**
**** Denotes Species of Special Concern in South Carolina**
***** Denotes Species of Special Concern in South Carolina and Threatened in North Carolina**

Table 3. Potentially occurring and documented reptiles of the Great Falls Bypassed Reaches.

Scientific name	**Common name**	**Status**
Apalone spinifera	Spiny softshell turtle	Documented*
Chelydra serpentina	Common snapping turtle	Documented
Chrysemys picta	Painted turtle	Documented
Kinosternon subrubrum	Eastern mud turtle	Potential
Pseudemys concinna	Eastern river cooter	Documented
Sternotherus odoratus	Common musk turtle	Documented
Terrapene carolina	Eastern box turtle	Documented
Trachemys scripta	Yellow-bellied slider	Documented
Anolis carolinensis	Green anole	Documented
Cnemidophorus sexlineatus	Six-lined racerunner	Potential
Eumeces fasciatus	Five-lined skink	Documented
Eumeces inexpectatus	Southeastern five-lined skink	Documented
Eumeces laticeps	Broadhead skink	Documented
Ophisaurus attenuatus	Slender glass lizard	Potential
Ophisaurus ventralis	Eastern glass lizard	Potential
Sceloporus undulatus	Fence lizard	Documented
Scincella lateralis	Ground skink	Documented
Agkistrodon contortrix	Copperhead	Documented
Agkistrodon piscivorus	Cottonmouth	Potential
Carphophis amoenus	Worm snake	Documented
Cemophora coccinea	Scarlet snake	Potential
Coluber constrictor	Black racer	Documented
Crotalus horridus	Canebrake rattlesnake	Potential***
Diadophis punctatus	Ringneck snake	Documented
Elaphe guttata	Corn snake	Potential
Elaphe obsoleta	Rat snake	Documented
Farancia abacura	Mud snake	Potential
Farancia erytrogramma	Rainbow snake	Potential
Heterodon platirhinos	Eastern hognose snake	Potential
Heterodon simus	Southern hognose snake	Potential***
Lampropeltis calligaster	Mole kingsnake	Potential
Lampropeltis getula	Eastern kingsnake	Documented
Lampropeltis triangulum	Scarlet kingsnake-milksnake	Potential**
Masticophis flagellum	Coachwhip	Potential
Nerodia erythrogaster	Plainbellied watersnake	Documented
Nerodia fasciata	Banded water snake	Potential
Nerodia sipedon	Northern banded watersnake	Documented
Nerodia taxispilota	Brown watersnake	Documented
Opheodrys aestivus	Rough green snake	Potential
Pituophis melanoleucus	Pine snake	Potential***

Table 3. (continued)

Scientific name	**Common name**	**Status**
Regina septemvittata	Queen snake	Potential
Sistrurus miliarius	Pigmy rattlesnake	Potential*
Storeria dekayi	Brown snake	Documented
Storeria occipitomaculata	Redbelly snake	Potential
Tantilla coronata	Southeastern crowned snake	Potential
Thamnophis sauritus	Ribbon snake	Potential
Thamnophis sirtalis	Garter snake	Potential
Virginia striatula	Rough earth snake	Potential
Virginia valeriae	Smooth earth snake	Documented

*** Denotes Species of Special Concern in North Carolina**

**** Denotes Species of Special Concern in South Carolina**

***** Denotes a Species of Species Concern in both North and South Carolina**

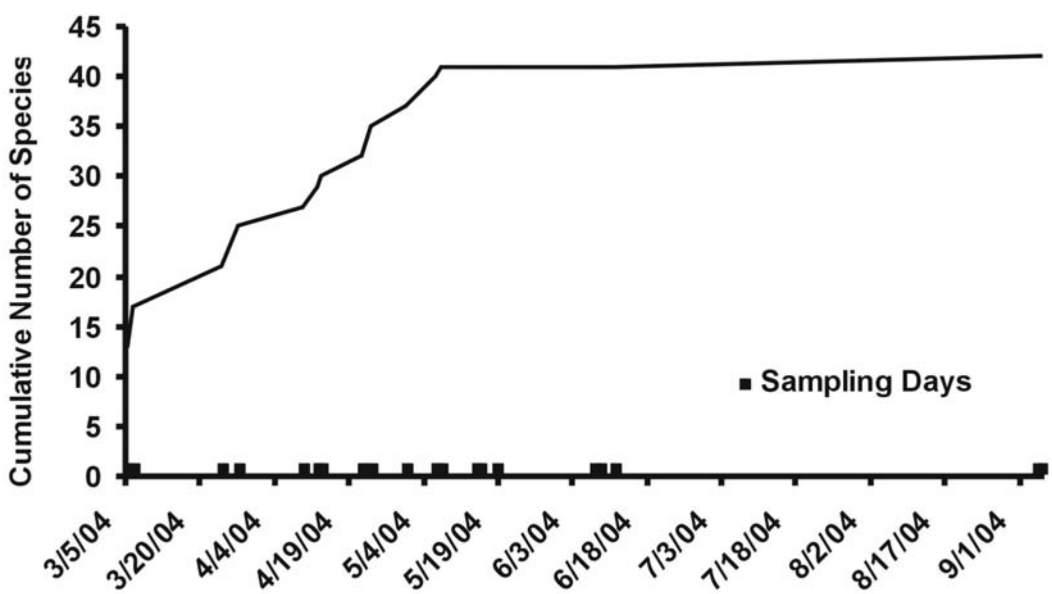


Figure 5. Species accumulation curve for sampling during 2004.

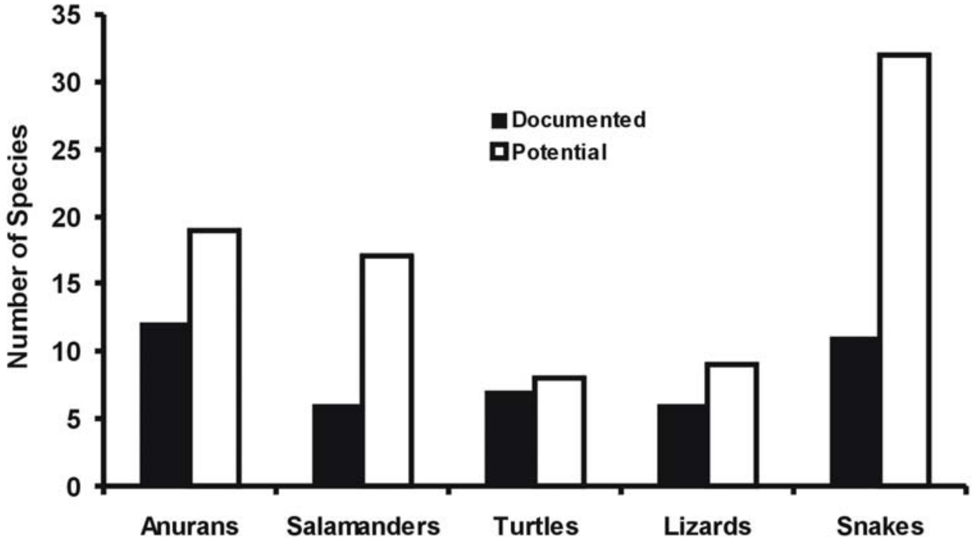


Figure 6. Number of potential and documented species for herpetofaunal groups for the Great Falls Long Bypassed Reach.

Spotted salamander (*Ambystoma maculatum*) egg mass

Our literature searches and regulatory agency contacts revealed that 3 amphibian and 3 reptile species potentially occurred within the study area that were (or are) being considered Species of Special Concern by the state of South Carolina. The amphibians included the northern cricket frog (*Acris crepitans*), the pickerel frog (*Rana palustris*), and the eastern tiger salamander (*Ambystoma tigrinum*). Reptiles included the timber/canebrake rattlesnake (*Crotalus horridus*) – (currently under review by SCDNR), southern hognose snake (*Heterodon simus*), and the milksnake (*Lampropeltis triangulum*). None of these 6 species were documented during our surveys. Cricket frogs (*Acris* sp.) were extremely abundant throughout the Great Falls Bypassed Reaches. All cricket frogs we collected were identified as southern cricket frogs. However, because the northern cricket frog is difficult to discern reliably from the southern cricket frog, it is possible that we failed to properly identify some individuals that should have been identified as northern cricket frogs. There are several localities of northern cricket frogs from the Catawaba-Wateree River basin and, if these museum specimens are identified correctly, then it is likely that they occur in the Great Falls Bypassed Reaches. We determined that it is unlikely that any of the other five species considered threatened or endangered by either state or federal government occurs in the study area.

A number of notable species were found that are not assigned status by any regulatory agency but that are either locally rare, difficult to find, and/or restricted to specific habitats. Marbled salamanders (*A. opacum*) and spotted salamanders (*A. maculatum*) were both found during our surveys. Both of these species rely on ephemeral wetlands, habitats that are disappearing from much of the southeastern United States, for reproduction (Petranka 1998). Marbled salamander larvae and adults were abundant in and around many of the small wetlands within the study area. The distinctive egg masses (>20) of spotted salamanders were found in a single ephemeral wetland on the

Spotted salamander (*Ambystoma maculatum*)

Snapping turtle (*Chelydra serpentina*)

west side of the riverbed within the study area. This wetland dried before transformation of the larvae could occur and we assume this resulted in no recruitment. Several observations of spiny softshell turtles (*Apalone spinifera*), a species of which some populations are considered a Species of Special Concern in North Carolina but not in South Carolina, were made. Softshells are rather secretive and notoriously difficult to trap using standard turtle trapping techniques.

During our surveys, we failed to document several potentially occurring species that we expected to find based on geographic range and habitat. For example, we did not find any eastern mud turtles (*Kinosternon subrubrum*), despite extensive trapping. Mud turtles are generally easily trapped using standard techniques (Rice et al. 2001) and are generally common in ponds and wetlands throughout the Piedmont and Coastal Plain of South Carolina. We did not find any queen snakes (*Regina septemvittata*), although apparently suitable stream habitat was present south of the junction of Camp Creek and throughout the study area and crayfish, their preferred food, were prevalent throughout all aquatic areas (Gibbons and Dorcas 2004). Surprisingly, we also failed to document any garter snakes or ribbon snakes (*Thamnophis sirtalis* and

Queen snake (*Regina septemvittata*)

Scarlet kingsnake (*Lampropeltis triangulum*)

T. sauritus, respectively). Many areas of suitable habitat were present as were many anurans and small fish (e.g., mosquito fish, *Gambusia* sp.), the primary prey of these species (Rossman et al. 1996). The absence of these three species of snakes is perplexing. Some of the other snake species potentially occurring in the study area such as corn snakes (*Elaphe guttata*), scarlet kingsnakes (*L. triangulum*) and timber/canebrake rattlesnakes (*C. horridus*) likely inhabit in the area, but these species may occur in such low numbers and/or are so secretive that detection is difficult.

Relative Abundances

Our sampling regime was designed to document as many species of amphibians and reptiles as possible, and thus, not intended to estimate relative or absolute abundances. However, based on our extensive surveys, we were able to comment somewhat qualitatively on the numbers of individual amphibians and reptiles encountered and make qualified statements regarding the abundances of each within the study area. In general, species requiring wetlands for breeding or for foraging were relatively abundant within the study area. These species include many amphibians such as marbled salamanders (*A. opacum*), Fowler's toads (*Bufo fowleri*), green treefrogs (*Hyla cinerea*) and leopard frogs (*Rana sphenocephala*).

Table 4. Qualitative relative abundances of amphibians and reptiles of the Great Falls Long Bypassed Reach.

Scientific name	Common name	Status
Anurans		
Acris gryllus	Southern Cricket Frog	Abundant
Bufo americanus	American Toad	Common
Bufo fowleri	Fowler's Toad	Abundant
Gastrophryne carolinensis	Eastern Narrowmouth Toad	Common
Hyla chrysoscelis	Cope's Gray Treefrog	Abundant
Hyla cinerea	Green Treefrog	Abundant
Hyla squirella	Squirrel Treefrog	Common
Pseudacris crucifer	Spring Peeper	Rare
Pseudacris feriarum	Upland Chorus Frog	Common
Rana catesbeiana	Bullfrog	Somewhat Rare
Rana clamitans	Green Frog	Common
Rana sphenocephala	Southern Leopard Frog	Abundant
Salamanders		
Ambystoma maculatum	Spotted Salamander	Rare
Ambystoma opacum	Marbled Salamander	Abundant
Desmognathus fuscus	Northern Dusky Salamander	Somewhat Rare
Eurycea cirrigera	Southern Two-lined Salamander	Abundant
Eurycea guttolineata	Three-lined Salamander	Rare
Plethodon cylindraceus	White-spotted Slimy Salamander	Common
Turtles		
Apalone spinifera	Spiny softshell turtle	Somewhat Rare
Chelydra serpentina	Common snapping turtle	Common
Chrysemys picta	Painted turtle	Abundant
Pseudemys concinna	Eastern river cooter	Common
Sternotherus odoratus	Common musk turtle	Abundant
Terrapene carolina	Eastern box turtle	Common
Trachemys scripta	Yellow-bellied slider	Abundant
Lizards		
Anolis carolinensis	Green anole	Abundant
Eumeces fasciatus	Five-lined skink	Common
Eumeces inexpectatus	Southeastern five-lined skink	Rare
Eumeces laticeps	Broadhead skink	Somewhat Rare
Sceloporus undulatus	Fence lizard	Abundant
Scincella lateralis	Ground skink	Abundant
Snakes		
Agkistrodon contortrix	Copperhead	Common
Carphophis amoenus	Worm snake	Abundant
Coluber constrictor	Black racer	Common

Table 4. (continued)

Scientific name	**Common name**	**Status**
Diadophis punctatus	Ringneck snake	Common
Elaphe obsoleta	Rat snake	Common
Lampropeltis getula	Eastern kingsnake	Abundant
Nerodia erythrogaster	Plainbellied watersnake	Abundant
Nerodia sipedon	Northern banded watersnake	Common
Nerodia taxispilota	Brown watersnake	Common
Storeria dekayi	Brown snake	Rare
Virginia valeriae	Smooth earth snake	Rare

Rare - 1 observation
Somewhat Rare - 2 Observations
Common - Between 3 and 7 Observations
Abundant - 8 or more

Plain-bellied watersnakes (*Nerodia erythrogaster*), a species federally listed in other parts of its range, appear to be abundant within the study area (Table 4; Fig. 7). The abundance of plain-bellied

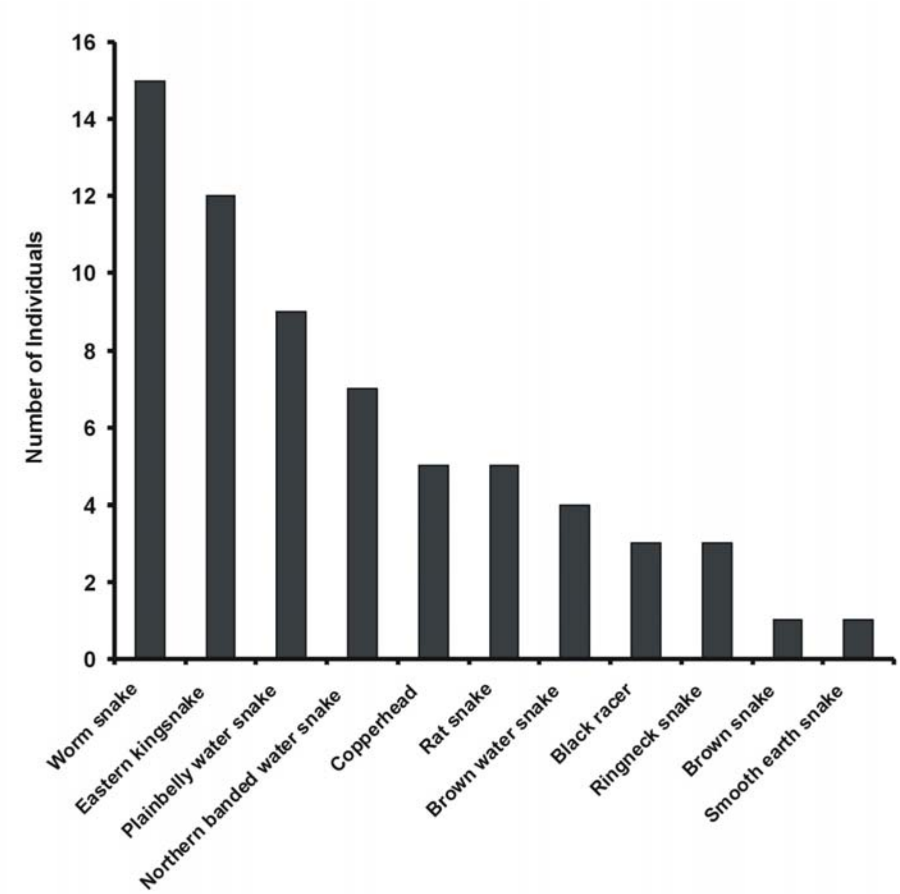


Figure 7. Relative abundance of all snake species documented in the Great Falls Long Bypassed Reach during 2004.

watersnakes is likely related to food availability and is due to the presence of many small wetlands harboring large amphibian populations (Gibbons and Dorcas 2004). Common kingsnakes (*L. getula*) were very common within the study area. In fact, we captured at least one kingsnake on nearly every sampling day. The author (MED) has never seen common kingsnakes present in such high numbers, which suggests an abundance of suitable habitat and prey for this species. Brown watersnakes (*N. taxispilota*), which are

Plain-bellied watersnake (*Nerodia erythrogaster*)

abundant in other parts of the Catawba River System in South Carolina, were notably low in numbers within the study area (Fig. 7). Because brown watersnakes are riverine species, their rarity is likely due to the variability of water and water levels in the bypassed area. We suspect that they are more common within the canal to the west of the study area.

Responses to Periodic Flooding During Fall 2004

Results of sampling in the spring 2005 and interpretations based on those results will be inserted in this section once that work is completed.

Effects of More Regular Flooding

How various species of amphibians and reptiles would likely be impacted by more regular flooding within the bypassed reaches is somewhat difficult to predict. Specific habitat requirements and other ecological requirements for many species are still poorly understood, making their response to environmental change difficult to forecast. However, inventory of herpetofauna within the study area and assessment of qualitative relative abundances does allow one to make educated guesses of how the herpetofauna of the study area has changed since the diversion dam was built and how that same herpetofauna might respond to other changes, such as more regular flooding.

Many of the habitats within the Great Falls Long Bypassed Reaches are unique. Only rarely are such lentic systems, including vast numbers of ephemeral wetlands, found in old river beds. Wetlands within the Long Bypassed Reaches range from small, temporary pools with rocky bottoms to large, permanent ponds. Such diversity of habitats provides unique habitats for many animals, especially many species of amphibians and reptiles.

The change from an apparent high-volume riverine system prior to the installation of the Diversion Dam to the present system of periodically watered, interconnected and isolated aquatic systems has resulted in an apparent increase in species utilizing lentic and emphemeral aquatic habitats and an apparent decrease in species that use lotic systems. For example, the abundances of many amphibians that typically breed in isolated wetlands (*Ambystoma* sp., *Hyla* sp., *Pseudacris* sp.) have likely increased in the last century whereas populations of species such as brown watersnakes (*N. taxispilota*) and river cooters (*Pseudemys conncina*), which are most abundant along rivers of the southeastern United States, have likely decreased in the study area. These riverine species are now likely more abundant in the canal west of the study area through which water is currently diverted. Likewise, many herpetofaunal species that are primarily terrestrial in nature now inhabit the riverbed of the Long Bypassed Reach. These include lizards such as green anoles (*Anolis carolinensis*) and four species of skinks (*Scincella lateralis,* and *Eumeces* sp.) and many species of snakes.

Common kingsnake (*Lampropeltis getula*)

Intentional, more routine flooding with associated higher flows and velocity would likely alter the habitat within the study area dramatically. The ponds within the Long Bypassed Reach would become more riverine in nature and wetlands that are currently ephemeral would likely become less so or disappear altogether. Small, rivulets and areas of shallow water currently provide refuge for salamanders (*Desmognathus, Eurycea*) typically found in small, rocky streams. More frequent flooding would submerge such habitats under larger water flows for greater periods of time. Additionally, many of the terrestrial areas which are currently infrequently flooded would become more regularly flooded, resulting in greater displacement of ground litter. Issues such as introduction of aquatic predators (e.g., fish) and flushing of eggs and larvae also are likely detrimental impacts.

Such changes in habitat due to regular, intentional flooding would likely decrease or eliminate populations of species utilizing ephemeral wetlands within the study area. These species would include spotted and marbled salamanders (*A. maculatum* and *A. opacum*, respectively) and many of the anurans such as chorus frogs (*Pseudacris* sp.) that inhabit the study area. Salamanders found in the small rivulets that typically inhabit small streams (*Eurycea* and *Desognathus*) would likely disappear. Additionally, populations of species such as plain-bellied watersnakes (*N. erythrogaster*), which rely on foraging for anurans among ephemeral wetlands, would likely also decrease. Populations of painted turtles (*Chrysemy picta*), which inhabit ponds and other wetlands, would likely decrease as well. Planned flooding events would likely also decrease populations of species generally considered terrestrial that currently inhabit the study area (many species of lizards, box turtles, and numerous snake species). Concomitantly, intentional periodic flooding might increase populations of some species. As noted above, species favoring lotic habitats such as brown watersnakes (*N. taxispilota*) and river cooters (*P. concinna*) might increase in number over time if intentional regular flooding occurred. However, it is likely that sustained, continuous flow of water would be necessary for populations of these species to persist in high numbers.

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LITERATURE CITED

Bridges, A. S. and M. E. Dorcas. 2000. Temporal variation in anuran calling behavior: implications for surveys and monitoring programs. Copeia 2000:587-592.

Burton, T.M., and G.E. Likens. 1975. Salamander populations and biomass in the Hubbard Brooks Experimental Forest, New Hampshire. Copeia 1975:511-546.

Conant, R., and J.T. Collins. 1998. Reptiles and Amphibians: Eastern/Central North America. Houghton Mifflin Co., Boston, MA. 616 pp.

Congdon, J.D., and J.W. Gibbons. 1989. Biomass productivity of turtles in freshwater wetlands: a geographic comparison. p. 583-592 *in* Freshwater and Wetlands and Wildlife. R.R. Sharitz and J.W. Gibbons, editors. Office of Scientific and Technical Information, U.S. Department of Energy. Oak Ridge, TN.

Gibbons, J.W. 1988. The management of amphibians, reptiles, and small mammals in North America: the need for an environmental attitude adjustment. p. 4-10 *in* Management of Amphibians, Reptiles, and Small Mammals in North America. Flagstaff, AZ, July 19-21, 1988.

Gibbons, W. 1993. Keeping All the Pieces: Perspectives on Natural History and the Environment. Smithsonian Institution Press, Washington, DC. 182 pp.

Gibbons, J.W. and M.E. Dorcas. 2004. North American Watersnakes: A Natural History. University of Oklahoma Press, Norman, OK.

Gibbons, J.W., D.E. Scott, T.J. Ryan, K.A. Buhlmann, T.D. Tuberville, B.S. Metts, J.L. Greene, T. Mills, Y. Leiden, S. Poppy, and C.T. Winne. 2000. The global decline of reptiles, Deja Vu amphibians. BioScience 50: 653-666.

Godley, J.S. 1980. Foraging ecology of the striped swamp snake, *Regina alleni*, in southern Florida. Ecological Monographs 50:411-436.

Iverson, J.B. 1982. Biomass in turtle populations: a neglected subject. Oecologica 55:69-76.

Knutson, M.G., J.R. Sauer, D.A. Olsen, M.J. Mossman, L.M. Hemesath, and M.J. Lannoo. 1999. Effects of landscape composition and wetland fragmentation on frog and toad abundance and species richness in Iowa and Wisconsin, U.S.A. Conservation Biology 13:1437-1446.

Palmer, W. M., and A. L. Braswell. 1995. Reptiles of North Carolina. Univ. North Carolina Press. Chapel Hill, NC.

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

Petranka, J. W. 1998. Salamanders of the United States and Canada, Smithsonian Institution Press, Washington, D.C.

Petranka, J., and S. Murray. 2001. Effectiveness of removal sampling for determining salamander density and biomass: a case study in an Appalachian streamside community. Journal of Herpetology 35:36-44.

Rice, A. N., T. L. Roberts, J. G. Pritchard, and M. E. Dorcas. 2001. Historical trends and perceptions of amphibian and reptile diversity in the western Piedmont of North Carolina. Journal of the Elisha Mitchell Scientific Society 117:264-273.

Rossman, D. A., N. B. Ford, and R. A. Seigel. 1996. The Garter Snakes: Evolution and Ecology. University of Oklahoma Press, Norman, OK.

Taylor, B.E., R.A. Estes, J.H.K. Pechmann, and R.D. Semlitsch. 1988. Trophic relations in a temporary pond: larval salamanders and their microinvertebrate prey. Canadian Journal of Zoology 66: 2191-2198.

Vitt, L.J., J.P. Caldwell, H.M. Wilbur, and D.C. Smith. 1990. Amphibian as harbingers of decay. BioScience 40:418.

Appendix 1: Museums, universities, and other organizations from which geographic distribution records were requested.

American Museum of Natural History, Auburn University, Brigham Young University - Bean Museum, California Academy of Natural Sciences, Carnegie Museum, Charleston Museum, Clemson University, College of Charleston, Cornell University, Field Museum of Natural History, Harvard Museum of Vertebrate Zoology, Illinois Natural History Survey, Louisiana State University, Michigan State University, Milwaukee Public Museum, Museum of York County, North Carolina Museum of Natural Sciences, North Carolina Natural Heritage Program, Smithsonian Institution, South Carolina Natural Heritage Program, Texas A&M University, Tulane University, University of Arkansas, University of California – Berkeley, University of Florida Museum of Natural History, University of Georgia, University of Kansas, University of Michigan, University of Missouri, University of Nebraska, University of New Mexico, University of North Carolina at Wilmington, University of Oklahoma, University of Richmond, University of Texas – Arlington, University of Texas – Austin, Yale University.